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WEEE Behaviour from Households: a Qualitative Approach

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Abstract

E-waste disposal strategies related to environmental sustainability have become a prominent subtopic of debate. Effective e-waste management is essential for reuse, recycling, and value recovery. In Malaysia, only 20% (8.9 Mt) of the e-waste generated in 2016 was properly collected and recycled. It is critical to recognise the importance of waste management systems in improving environmental quality and boosting the economy. Collaboration involving all logistics chain participants including households, governmental, and commercial entities is crucial for efficient e-waste management. A qualitative approach was employed to explore the various perspectives of stakeholders on the essential factors to sustain e-waste from landfills.

Keywords: Recycling; reverse logistics; solid waste management; WEEE

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1.0 Introduction

Over the last several decades, the expansion of the global economy and technological capabilities has resulted in the generation of large quantities of Waste from Electrical and Electronic Equipment (WEEE). WEEE refers to equipment generated from the manufacturing and repair processes of electrical and electronic devices and intended for disposal (Morris, 2016). The ever-increasing WEEE has significantly impacted waste management efforts in developed and developing countries. This is because WEEE is ubiquitous. The global e-waste production reached 53.6 Mega tonnes (Mt) in 2019, with only 20% officially documented as collected and appropriately recycled utilising proper recycling channels. This generation is expected to jump from 44.7 Mt in 2016 to 74.7 Mt by 2030 (Forti et al., 2020). According to Baldé et al. (2017), the exponential pace of technical innovation and the continually decreasing

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average of product lifespan are two contributing factors fueling the spread of WEEE. The consumption trend for major technological appliances among households has increased over time. However, if these items are not appropriately disposed of, the impact on human health and the environment would be detrimental. Large amounts of metals, including lead, cadmium, mercury, barium, arsenic, beryllium, chromium, selenium, and halogenated compounds, can be found in electronic and electrical items. Schumacher (2016) agreed that improper disposal of WEEE can pose risks to human and environmental health, including soil and groundwater contamination.

The management of WEEE poses a formidable challenge, primarily due to its hazardous properties and the exponential growth in its quantity. Despite the existence of WEEE management plans, these strategies lack sufficient guidance for both local consumers and municipal authorities regarding the appropriate handling of WEEE. Currently, the recycling and disposal of WEEE remain primarily unstructured. Thus, it is imperative to establish an adequately configured WEEE recycling system that can effectively guide the general public toward achieving sustainability through recycling. The involvement of stakeholders in this matter is crucial in augmenting household engagement and awareness of WEEE recycling. It is incumbent upon householders to recognise their responsibility and conduct in managing households' WEEE, while local authorities or municipalities must devise a sustainable solution for WEEE disposal and recycling. According to A-Jalil et al. (2014), the implementation of household recycling systems typically involves the participation of two primary stakeholders: individual households and local government entities. Comprehending the characteristics of both stakeholders is imperative in establishing appropriate waste management frameworks, potentially facilitating their concentration on the recycling of WEEE.

This research aims to augment the theoretical understanding of the integration between the local municipalities of Malaysia and the households residing within their jurisdiction. This research focuses on the dynamic relationship between personal factors, including householders' WEEE recycling behaviour, and the situational factors of the recycling systems provided by the authorities. According to the study conducted by A-Jalil (2015), the conduct of households or individuals is influenced by their engagement with situational factors, whether in an internal or external environmental context. Therefore, this study elucidates the interaction between the abovementioned factors, which manifests a mutually advantageous association, thus indicating a symbiotic effect between local authorities and the households they serve in the pursuit of sustainability through WEEE recycling.

Nomenclature

WEEE	waste from electrical and electronic equipment
E-WASTE	electronic waste
ICT	information and communication technology
DOE	department of environment
NGO	non-governmental organisations
FGD	focus group discussion

2.0 Literature Review

2.1 Overview of Households' WEEE Management in Malaysia

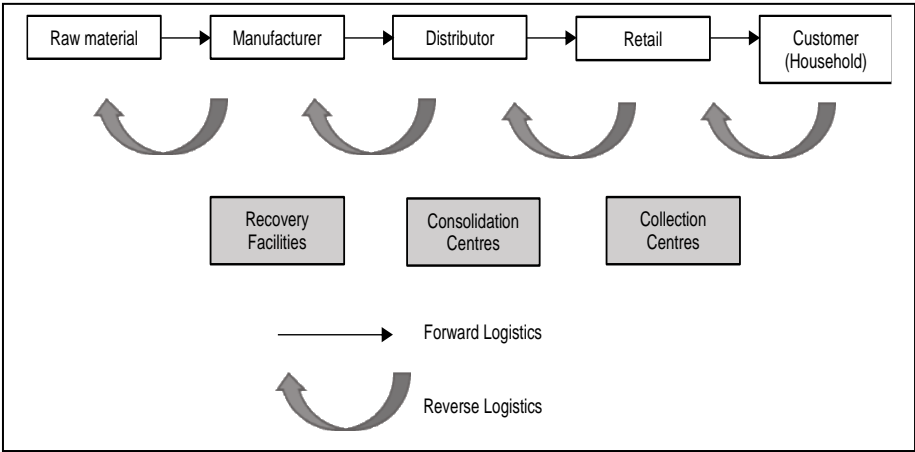


Fig. 1: Forwards and reverse logistics chain

The movement of products within contemporary supply chains is not restricted solely to customers. Numerous commodities undergo multiple life cycles after serving their primary function for the initial consumer. Consequently, the product has the potential to generate multiple sales. To effectively capture this value, it is necessary to adopt a comprehensive perspective of the logistics chain that incorporates the implementation of a novel process known as reverse logistics, as shown in Fig. 1. Referring to Nik Abdullah & Yaakub (2015), reverse logistics refers to the transportation of goods or materials in a direction that is opposite to the traditional logistics chain. The utilization of reverse logistics services has gained significant traction since the 1960s, owing to its ability to generate value from

recycled materials. This approach is centred on waste recycling and recovering value from discarded materials (Alnoor et al., 2019; Grabara & Man, 2014). Therefore, to attain sustainability and mitigate adverse effects, authorised parties must incorporate the notion of reverse logistics into their comprehensive WEEE management framework. Effective collaboration is imperative for the optimal execution of e-waste management across all stakeholders in the logistics chain, encompassing households, governmental bodies, and commercial entities.

Presently, a wide range of electronic and electrical household appliances are extensively utilised within households. These appliances encompass various items, ranging from sizable appliances such as refrigerators and stoves to more compact, portable alternatives such as mobile phones and other handheld electronic and electrical devices. In response to the rapid pace of technological advancement, the DOE has established a system in Malaysia for collecting and disposing of WEEE generated by households. This system allows households to drop off their e-waste, including mobile phones, batteries, computers, and devices, to designated collection facilities managed by local solid waste authorities (Tiep et al., 2015). In Malaysia, the management of WEEE is subject to regulatory limitations that confine it to licensed facilities duly authorised by the DOE. DOE has licensed 111 collection centers, 88 e-waste retailers, and 58 recovery facilities. These entities are authorised to engage in the recovery of valuable metals from WEEE. Even though the usage of electrical and electronic devices has increased along with population growth, there are still significant gaps in the systems for managing and disposing of WEEE. The biggest problem with WEEE disposal in Malaysia is the householders' lack of interest in recycling their obsolete electronics and electrical equipment. Currently, no specific department in Malaysia is responsible for overseeing the entire WEEE management process. The collection and disposal processes of solid waste and scheduled waste often intersect, as these two categories of waste are commonly encountered (Haron, 2015).

Overall, establishing an appropriate framework for WEEE management necessitates the involvement of households, local government, and corporate entities to enhance recycling performance and promote sustainability. The conduct of households is subject to the impact of situational and personal factors. This paper further explains the projection of households' recycling behaviour; personal factors are primarily based on the individual mindset of households, with the involvement of local government and corporate entities; and situational factors. Numerous factors contribute to the participation of households in recycling practices that intend to promote sustainability.

2.2 Personal Factors

An early researcher in behavioural science, Ajzen (1985), declares that individuals' decision-making processes can be attributed to factors that lead to either positive or negative actions. The decision of households to engage in recycling as an environmental behaviour is reflected in specific situational factors within the household. These factors include the availability of recycling facilities and systems provided by local authorities or commercial entities, which subsequently contribute to increased household recycling behaviour. The inclination of households to participate in recycling initiatives for WEEE constitutes a crucial aspect of the conceptualisation phase of an electrical and electronic waste management framework (Nguyen et al., 2019). The possession of relevant knowledge and a willingness to engage in recycling activities contribute to forming an individualised recycling norm.

Empirical evidence has demonstrated that the significance of knowledge is pivotal in comprehending the underlying factors that prompt consumers to dispose of their WEEE in an unsuitable manner. When individuals possess sufficient knowledge regarding the significance of recycling, they exhibit a greater propensity to participate in endeavours related to the recycling of WEEE (Saritha et al., 2015). In addition, previous experience was included in the conceptual framework of this research, in addition to the knowledge of householders. Previous research that Xu et al. (2017) have carried out has shown that people's motivation to recycle waste consistently increases in tandem with their levels of expertise in the activity. In addition to knowledge, numerous studies indicate that awareness is a primary contributor to insufficient consumer engagement in waste recycling. According to a study by Nguyen et al. (2019), environmental consciousness and recycling awareness are the most influential factors in individuals' decisions regarding the recycling of WEEE.

2.3 Situational Factors

The concepts of accessibility and availability of facilities and services are essential in logistics theory as they play a crucial role in maintaining an uninterrupted flow of products from their source to their final destination. Logically, to enable householders to utilise facilities or services, the authorities must make them readily available in the first instance. The principle, as agreed upon by A-Jalil (2015), indicates that the combination of these two elements serves as the fundamental drive for householders to participate in recycling activities consistently. The findings of a recent study by Oke & Kruijsen (2016) suggest that the availability of suitable recycling infrastructure plays a crucial role in promoting recycling engagement.

In addition, providing incentives for waste recycling is one of the variables under situational factors in implementing an effective recycling system. Incentives are aimed at motivating individuals to engage in recycling activities, either through monetary or non-monetary rewards (Grilli & Curtis, 2019). The study has suggested that incentives can catalyse the promotion of positive behavioural changes among individuals, leading to increased participation in e-waste recycling. Furthermore, adopting and enforcing appropriate legislation and standards are crucial to increasing residential waste separation and recycling rates (Kihila et al., 2021). Nguyen et al. (2019) agreed that the execution of policies and regulations mandated by the government plays a significant role in the recycling of WEEE.

The reduction of waste necessitates the dissemination of knowledge and consciousness-raising efforts. The lack of education and consciousness regarding environmental sustainability is likely to result in an escalation of waste production among the communities. Research conducted by Liu et al. (2019) has indicated that the implementation of proficient advertising strategies and educational

initiatives that focus on promoting environmental consciousness can yield favourable outcomes in terms of increasing households' participation in recycling activities. In addition, it is imperative to promote environmental education to augment consumer consciousness regarding the necessity of WEEE recycling.

2.4 The Symbiosis Effect

Symbiosis is a concept that pertains to a mutually advantageous relationship between two separate entities that are in close physical proximity to each other (Oxford University Press, 2022). This paper acknowledged that the two discrete groups of individuals comprising householders and stakeholders are intricately interconnected, thereby providing mutual advantages. The phenomenon of symbiosis in the context of household behaviour and recycling systems has received limited attention in the existing literature. Most research on individual recycling behaviour typically conducts empirical testing on isolated factors without considering their interaction in primary analyses. This paper further aims to analyse the impact of the symbiotic relationship between households' behaviour and recycling systems provided by stakeholders. The present investigation adheres to the theoretical framework proposed by A-Jalil (2015), which emphasises the significance of interactions and interdependencies as crucial components in a mutually beneficial association for the effective handling of waste. The majority of prior research has concentrated on either the technical components of recycling systems, also known as situational factors, or solely on the behavioural aspects, also known as personal factors. The recycling habits of households, however, are influenced by both situational and personal factors. The comprehension of the interactions between the two primary factors (personal and situational) can be enhanced by considering the phenomenon of symbiosis.

3.0 Methodology

The present investigation utilises a qualitative methodology, precisely a qualitative inquiry that involves semi-structured interviews conducted following the phenomenological method as outlined by Roulston (2018). The study involved a sample of seventeen participants, comprising individuals from local government, private organisations, and licensed NGOs who are closely related to waste management. Fourteen of the participants were drawn from these sectors. The demographic characteristics of the three remaining respondents were varied, and they resided in the three distinct sub-clusters (urban, suburban, and rural) located within the Northern Region of Malaysia. This research collected data from the various stakeholders via the use of the FGD approach during three consecutive sessions. The data obtained from FGD and individual discussions with stakeholders and households were analysed for over four months, commencing in January 2023. This research utilises a purposive sampling approach to gather data from stakeholders with diverse backgrounds and varying levels of proficiency in the management of WEEE. The FGDs were conducted using an online platform to easily bring together specialists on WEEE from various authorities and organisations simultaneously, while individual discussions were conducted face-to-face at households' homes for the convenience and comfort of the respondents. The present study employs a purposive sampling technique, as the selection of key informants is based on their ability to provide the necessary information. The informants were chosen due to their strong position and ability to offer insights relevant to the study. Moreover, their expertise is derived from their firsthand experience in managing WEEE. In addition, an individual interviewing session was used to compile the information that was gathered from households. The utilisation of semi-structured techniques within households offers a notable advantage as it enables the researcher to obtain valuable insights into the cognitive processes surrounding WEEE disposal. The data was inputted into the ATLAS.ti software version 8.4.3 for coding and allocation of themes. The study employed directed thematic analysis as a method of identifying recurring themes and subthemes through the categorisation of codes.

4.0 Findings & Discussion

Table 1. Demographics of Respondents

The respondents	Total
Stakeholders	
Local government / authorities	5
Private waste organizations	6
Licensed NGOs related to waste management	3
Total	14
Householders	
Urban resident	1
Sub-urban resident	1
Rural resident	1
Total	3

The interview data was subjected to thematic analysis, guided by priori literature, resulting in the identification of nine overarching themes. 1) Attitudes, 2) Social norms, 3) Knowledge & Experience, 4) Awareness, 5) Accessibility and availability, 6) Convenience, 7) Incentives, 8) Policy & Regulations, 9) Education. The themes were categorised into two distinct groups, namely personal and situational factors as clearly shown in Fig.3. Personal factors are equipped with different elements of recycling behaviour among households to participate in WEEE recycling. In contrast, situational factors are stakeholders' involvement in initiating appropriate measures to develop

an efficient WEEE management system. The finding of this study explored deeper in the notion of a symbiosis perspective through the explanation of different themes that were found to be interrelated and influential in promoting WEEE recycling behaviour among householders. Fig.2 shows the ATLAS.ti network analysis that was derived from the interview session conducted with stakeholders and householders on household behaviour (personal factors) and recycling systems (situational factors) in WEEE management. The network displays the interrelated variables that signify the existence of a symbiotic relationship between householders and local stakeholders in enhancing household WEEE recycling behaviour. This facilitates the establishment of a well-defined framework by relevant authorities to advance sustainability through the mitigation of WEEE in landfills.

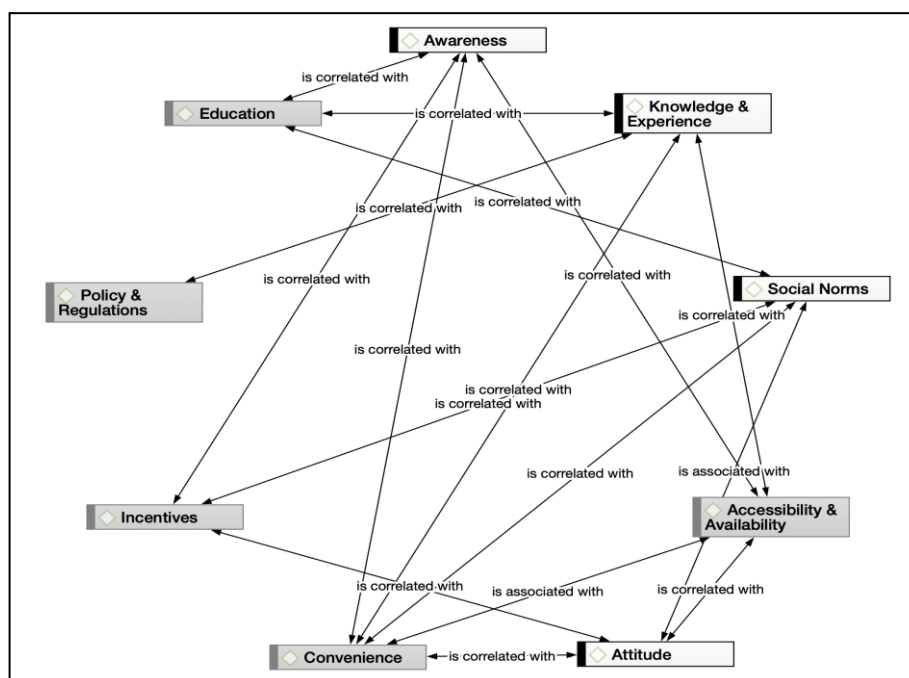


Fig. 2: Network of Household Behaviour and Recycling Systems in WEEE Management

4.1 Existence of Symbiosis Effect between Personal & Situational Factors in Improving Households' WEEE Recycling Behaviour

4.1.1 Personal (Awareness, Attitude) with Situational (Accessibility & Availability)

In the present era of extensive media coverage, Malaysians exhibit a heightened level of consciousness regarding the recycling of WEEE. Government and private WEEE organisations are actively involved in expanding the availability of recycling facilities to the public. The provision of recycling facilities and systems by local authorities or commercial entities has been found to positively impact household recycling behaviour, leading to increased levels of recycling.

"Information with regards to the available recycling centres and drop-off points is provided through our websites. Residents keep bringing all of their household e-waste to our place for recycling."

"We offer facilities such as drive-through centres and even collection centres. In every Malaysian state, we collaborate with other service units to make the collection centre accessible to the local community. We organise campaigns to promote e-waste while collecting e-waste from households. I would say that the public is very much aware of having to recycle their e-waste."

"We do not just provide house-to-house flyers, like those published on the web or social media, but we offer door-to-door collection for e-waste. We are also tied up with the current e-hailing system, that application-based transport system. For example, we are using a LALAMOVE. So, the LALAMOVE operates from our client's location to our area. So basically, the transportation charges become less."

According to information gathered from WEEE operators and local authorities, this authorised organisation is actively engaged in raising public awareness to promote WEEE recycling. Apart from having numerous available and accessible facilities, the level of awareness regarding recycling significantly impacts an individual's decision-making process about the recycling of WEEE. This finding indicates that a significant proportion of individuals engage in WEEE recycling due to their awareness of its favourable environmental outcomes (Nguyen et al., 2019). This indicates that it is crucial to increase user awareness regarding the utilisation of readily accessible facilities to ensure consistent occupancy of the infrastructure. This may aid in generating returns for the authorities and promoting the practice of WEEE recycling. Despite the notable commitment demonstrated by the relevant stakeholders in promoting the recycling of

WEEE, Malaysia still has certain households residing in geographically isolated areas, such as rural regions, who continue to encounter challenges in accessing the aforementioned facilities.

4.1.2 Personal (Attitude, Social Norms) with Situational (Convenience, Incentives)

The utilization of positive reinforcement is a viable strategy for promoting desirable behaviour. According to (Grilli & Curtis (2019), the act of providing incentives is prone to improve participation and promote the pro-environmentalist attitude of an individual towards WEEE recycling.

"In today's reality, people particularly in suburban or rural regions, prefer cash or an incentive upon submitting their recyclables. They desire monetary compensation for each recyclable they deliver."

All three sub-clusters of the householders who were interviewed have reached a consensus on the aforementioned statement by the local authorities. This indicates that the provision of a specific amount of incentives to accompany the recycling of WEEE items is likely to enhance public interest and participation in the WEEE recycling process.

*"I will devote my additional time and energy to WEEE recycling regardless of whether the incentive is monetary or non-monetary."
"...while participating in e-waste recycling, I look forward to any form of incentives offered by the government."*

In addition to the societal expectation of receiving a reward for engaging in environmentally conscious behaviour, an individual's attitude may also be influenced by the cultural norms to which they adhere.

"I am very much aware of e-waste recycling; my colleague and I have this habit of collecting all e-waste to be sent to drop-off bins since it is located at our office."

"I am aware of e-waste recycling, but the closest collection and drop-off locations are far away from my home. Daily transportation consists solely of a motorbike. How should I transport my refrigerator and television for recycling?"

The statement proves that having convenience facilities and services helps to encourage householders to participate in WEEE recycling. The accessibility of facilities and services is positively correlated with the likelihood of community members engaging in WEEE recycling (Senawi & Sheau-Ting, 2016). The presence of recycling facilities nearby encourages individuals to engage in recycling activities. Distances also play a crucial factor in waste management, alongside the provision of convenient infrastructure. Furthermore, the presence of a closely related individual who upholds positive recycling norms serves as a source of attraction for individuals in their proximity, thereby providing positive reinforcement for the performance of certain actions.

4.1.3 Personal (Knowledge & Experience, Awareness) with Situational (Education, Policy & Regulations)

The findings from the FGD with the WEEE operations organisation indicate that the provision of recycling facilities and services to the general public is deemed insufficient. It is imperative for every infrastructure project to adhere to appropriate guidelines and regulations and to have an extensive enforcement policy in place. This measure will compel households to adhere to recycling regulations through mandatory enforcement.

"We are among the existing collection centres, facilities, and infrastructure in Malaysia. Through the DOE's website, the public can locate hundreds of recycling centres with links to those facilities. However, the e-waste policy is reaching the public insufficiently. The public will only recycle e-waste if the government imposes penalties for those who do not."

However, a one-on-one interview session with a household member reveals contrasting outcomes. They believed that it is unfair for authorities to levy fines without ensuring that the general public is fully informed about the rules that pertain to them.

"It makes no sense for the government to impose penalties on the public if the public is unaware of the regulations regarding the recycling of e-waste. Perhaps the government should educate the public first and provide exhaustive details. If I am aware of the e-waste regulations, I will comply; after all, who wishes to pay a fine?"

Liu et al. (2019) suggest that a deficiency in education and awareness regarding environmental sustainability may lead to an increase in waste generation within communities. Hence, all governing bodies must increase their vigilance in educating the public before implementing specific legislation. The imposition of mandatory actions may have adverse effects on the efficacy of systems established by governing bodies. Specifically, in the context of WEEE recycling, such actions may lead to a lack of public interest and participation. Thus, the governing bodies must exercise additional vigilance in formulating a coherent and comprehensive policy that can be comprehended by all stakeholders involved in the management of WEEE.

5.0 Conclusion & Recommendations

Based on the findings of interviews conducted with WEEE management experts and householders residing within the jurisdiction of local authorities, it was observed that both parties acknowledge their mutual responsibility in promoting WEEE recycling across their

sub-clusters. By identifying and addressing personal and situational factors, local communities and nations can promote prolonged environmental sustainability and reduce the amount of WEEE being dumped in landfills. The present study has yielded a symbiosis effect framework as shown in Fig.3 for managing WEEE among stakeholders and households. This framework has been developed based on the data obtained from the interviews conducted during the study.

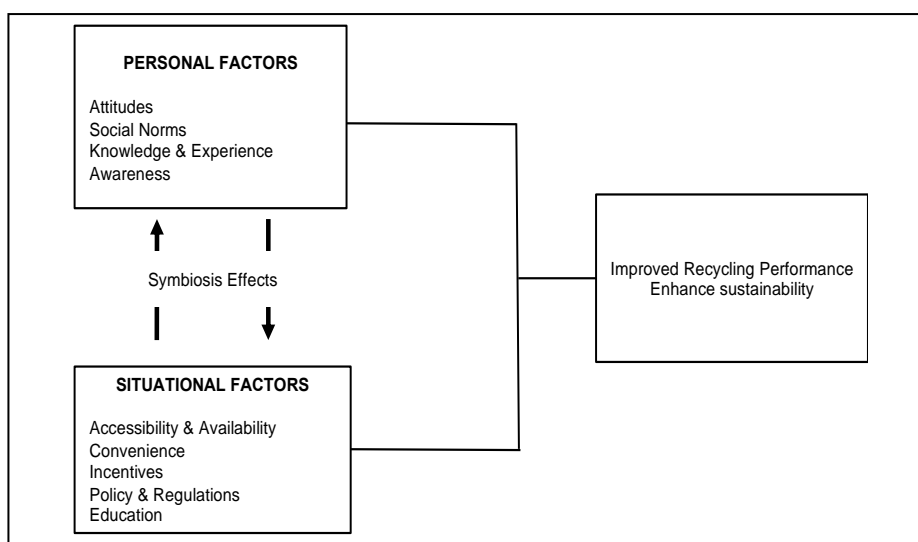


Fig. 3: Conceptual framework of WEEE management

This research proposed that a symbiosis effect occurs in the logistics chain, i.e., the mutual interdependency between householders and authorised stakeholders. In examining household WEEE recycling behaviour, the terrain of findings through our respondents and informants considered a combination of personal and situational factors in promoting WEEE recycling to enhance sustainability rather than emphasising a solitary factor. The primary finding of this research is the existence of a symbiotic relationship between household WEEE recycling systems and household WEEE recycling behaviour. The results of the study, therefore, support the importance of considering the interaction between situational factors and personal factors when examining the effectiveness of entire WEEE recycling systems from the source.

Several limitations were present in this study and should be considered in future research. Behavioural studies include a wide range of personal and situational aspects. Therefore, new relevant indicators might be incorporated to analyse households' recycling behaviour better. The study's environment and sample nature may be limited due to its location in the Northern Region of Malaysia. The distinct culture and recycling practices in this particular geographical setting and specific characteristics may limit the applicability of the findings to other regions and circumstances.

Acknowledgement

The authors would like to thank all the participating householders and key informants among the stakeholders involved in this project.

Paper Contribution to Related Field of Study

This study is expected to contribute to both supply chain management and waste management disciplines. This paper offers a comprehensive analysis of the current state of reverse logistics and waste management issues within the realm of e-waste. This is anticipated to make a valuable contribution to the field of reverse logistics and waste management.

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