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E-Waste Practices Post-Pandemic Covid-19: The Case Of Malaysian Technology and Telecommunication Companies

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Abstract: Malaysian government has been proactive in pursuing green growth for sustainability and resilience. The attention is now shifted to e-waste due to the surge in demand for electric and electronic devices, especially after the pandemic Covid-19 hit. Focusing on Malaysian publicly listed technology and telecommunication companies, this study aims to identify the types of e-waste generated, how e-waste is managed, and the difference in e-waste practices between the two industries. This study found that screens and monitors and small IT and telecommunication equipment are the most e-waste generated by the two industries, whilst the least e-waste generated is industrial e-waste and temperature exchange equipment for technology and telecommunication industries. Moreover, both industries managed their e-waste by showing a high level of adherence to authorities' rules, regulations and guidelines. Lastly, there is no significant difference between the two industries in managing their e-waste.

Keywords: E-Waste; Practices; Technology; Telecommunication; Malaysia

1. Introduction

Environmental sustainability has become a global buzzword, and Malaysia is not left behind regarding its commitment to the environment. One of the pillars in the 11th Malaysia Plan has highlighted pursuing green growth for sustainability and resilience. In this pillar, Malaysia focused on pursuing development in a more sustainable manner by shifting the narrow environmental focus on natural assets to include consumption and production processes in all sectors and households [1].

To achieve the national agenda of preserving environmental sustainability, every level of society needs to play its role. The digitalized age has brought vast consumption of electric and electronic components, which eventually reach their end of useful life. Additionally, electric and electronic device usage has risen considerably since the pandemic Covid-19 hit. Home offices and schooling, online hang-outs and shopping, movie streaming, and other activities are driven higher by COVID-19 lockdowns. This situation triggers the question of how these used or obsolete components are being treated for. The used or obsolete component, referred to as e-waste is usually filled with veritable toxic materials that affect the human and animal bodies and the environment [2]. When e-waste is not properly handled, it will eventually end up in landfills, thus putting both human health and the environment at risk [2].

In the global scenario, statistics on e-waste generation demonstrate alarming concern. As reported by the United Nations University's Global E-waste Monitor 2020, approximately 53.6 million metric tons (Mt) of e-waste were generated in 2019 [3], and almost half of this staggering figure (24.9 Mt) was contributed by Asian countries [4]. This

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staggering figure mostly contains e-waste from devices such as computers, screens, smartphones and tablets. This situation may be worsened as it is estimated that by 2030, the world will face 74.7 Mt of e-waste generated [4] and 120 Mt in the year 2050 if some drastic actions are not taken up [5].

Focusing on Malaysia, e-waste is being spelt out as one of the top six waste streams generated in Malaysia [6]. Furthermore, industrial e-waste generated by business organizations has shown a substantial increment of 60.3% from the year 2015 to 2017 [6]. Forti et al. [4] also recorded e-waste generation of 364 kilotons (Kt) or 11.1 kg per person in 2019. To date, the DOE [2] envisaged the total amount of discarded e-waste to be increased by an average of 14% per year and 21.38 Mt of e-waste will be generated by the year 2020.

Following the alarming statistics on e-waste generation, its management has become the next burning issue all over the world. Developed countries like the United States of America (the USA), Europe and Australia have been identified as the major e-waste producer. The e-waste was then transported to several developing countries such as China, India, Vietnam and Nepal due to the easy availability of open space for dumping and also low-cost labour for recycling purposes [7]. Unlike the developed countries, Arya and Kumar [8] stated that most e-waste in developing countries is handled improperly through scientific methods, which is commonly known as 'backyard recycling' that could pose a potential local and global threat.

The above scenarios trigger the question of what can be done concerning this critical condition of e-waste, particularly in Malaysia. It is crucial to handle e-waste properly as the results from the proper handling will determine whether the objective of achieving green growth for sustainability and resilience, as spelt out in the 11th Malaysian Plan may be achieved. Green growth refers to the growth that is resource-efficient, clean and resilient which will ensure that the precious environment and natural endowment are conserved and protected for present and future generations [1]. Furthermore, proper handling of e-waste will lead to achieving our Sustainable Development Goal 11 which aims to have sustainable cities and communities may be achieved. Also, the hazardous substance from e-waste may harm the health of the community, thus preventing the world from achieving Sustainable Development Goal 3, which aims to have good health and well-being of the community.

Although waste in Malaysia has been regulated since the year 2005 [2], there is no specific regulation on e-waste, which control the treatment, recycling, and disposal of scheduled waste, including e-waste [9]. Despite the regulations on waste (including e-waste) being imposed by the DOE, previous studies found that Malaysians have low awareness with regard to e-waste handling [10]. Most problems associated with proper e-waste management in Malaysia are in its collection system [11], lack of modern recycling plants and insufficient collection facilities [10].

Due to these circumstances, it is important for a study to be conducted in the Malaysian scenario on how e-waste has been handled, especially in business organizations which are facing tremendous pressure to engage with the digitalized era and Industrial Revolution (IR4.0). This study aims to examine two industries, which are Technology and Telecommunication as their activities demand vast usage of computer and network applications. Therefore, the objective of this study is to investigate the types of e-waste generated, how e-waste is being managed by the Malaysian public listed companies in Technology and Telecommunication industries and examine the difference in e-waste generation between the two industries, as they are prone to produce more e-waste as compared to other industries based on their nature of business.

2. Literature Review

2.1. Malaysian Regulation of E-Waste

In Malaysia, e-waste has been regulated since the year 2005, where the Department of Environment (DOE) within the Ministry of Natural Resources and the Environment (NRE) is responsible for planning, as well as enforcement of the regulatory requirements pertaining to e-waste. There is no specific regulation on e-waste, but the management of e-waste is incorporated within the Environmental Quality (Scheduled Waste) Regulation 2005, and the Environmental Quality (Prescribed Premises) under Treatment, Disposal Facilities for Scheduled Waste Regulation 1989, which control the treatment, recycling, and disposal of scheduled waste, including e-waste [9] . The Environmental Quality (Scheduled Waste) Regulation 1989 was revoked to form the 2005 version, all these under the Environment Quality Act (EQA) 1974 published by DOE specifically to control and prevent environmental pollution in Malaysia [6]. Importation or exportation of e-waste is regulated under Section 34B of the Environmental Quality Act 1974 and the Basel Convention on the Transboundary Movements of Hazardous Waste and Disposal 1989. E-waste in Malaysia is collected and treated only at licensed facilities by the Department of Environment.

The collection of e-waste is carried out by transporters holding the permits given by DOE, where these transporters were typically managed by the recovery facilities since the operating license is often merged with the transportation licenses. Some of the fraction of household e-waste is collected by both formal and informal collectors, but only the formal collectors are bounded by the DOE regulation [6]. By 2013, DOE has licensed 18 full recovery and 128 partial recovery facilities of e-waste to perform the recovery process of precious and valuable metals (gold, silver, platinum, copper, aluminium and nickel). These facilities are also expected to handle the hazards found in e-waste such as heavy metals (cadmium, lead, mercury) to prevent them from polluting the environment and risking human health, as well as managing recyclable items such as glass, and plastics [12]. Currently, the regulation and enforcement of the regulation are only for the management of e-waste generated

from industrial premises, and there is no legal mechanism for the control and management of e-waste generated by households.

Plus, there is no formal system for managing household e-waste in an environmentally sound management system for recovery and disposal [13]. Pertaining to this, DOE has drafted 3 guidelines; 1) the guideline for collection, storage, handling and transportation of household e-waste, 2) the guideline on reporting for household e-waste, and 3) the guideline for household e-waste recycling. DOE has initiated a household e-waste collection program in cooperation with the Japan International Cooperation Agency (JICA) to kick start a more established household e-waste collection from residences. A pilot program (WEEE recycling project/the Penang pilot project) was launched in Penang starting from September 2011 until March 2013 where the public is encouraged to return their WEEE to the relevant retailers by offering vouchers to them. However, only a small portion of household e-waste was collected by this pilot program and the majority of them were from washing machines [11].

More importantly, the program was also used as a preliminary platform for the drafting of legal frameworks and guidelines for household e-waste management [6]. Following this, a technical cooperation project was then launched in August 2017 that covers a period from September 2017 to February 2018. This project was in collaboration with 9 companies to investigate guidelines 1 and 2 involving electronic retailers, e-waste recovery facilities, as well as a non-governmental organization. The DOE also started the e-waste Alam Alliance program on 11th December 2013 in 6 States in Malaysia, resulting in collection points at the outlets of electrical equipment (for example at Senheng Electric), hypermarkets and other voluntary retail outlets to facilitate the collection of household e-waste. Subsequently, several other household e-waste collection points were established following the Alam Alliance program [6].

In the latest development, the government is now planning to make it mandatory for consumers to send certain e-waste to places licensed to handle e-waste with proposed regulations covering television, air-conditioners, refrigerators, washing machines, personal computers and mobile phones-where most of these items currently being recycled by the informal sector. The informal sectors consisting of house-to-house collectors, community bodies, and non-governmental groups have little expertise and resources where they rip apart appliances and devices, burning some components to extract materials that could be resold with little thought on its environmental and health effects, hence regulation is overdue. The draft regulation will be known as the Environmental Quality (Recycling and Disposal of End-of-Life Electrical and Electronic Equipment) Regulations [9]. The proposed new regulation will likely take the form of an extended Produce Responsibility system based on the concept of shared responsibility where manufacturers and importers must pay recycling fees upon putting their products on the market, making them responsible for the products until the end of its life cycle.

Similarly, the consumers are supposed to pay the recycling fees once they purchase EEE and no refund is planned once they return the WEEE [6]. The recycling fee will be used to pay for proper collection and recycling in an environmentally sustainable manner [6,13]. This system has been applied in many countries, including the European Union, Taiwan, Hong Kong, Japan, South Korea and China.

2.2. E-waste Research in Malaysia

Research on waste management in Malaysia is growing considerably vast, however, studies that focused on electronic waste or e-waste, although found, are rather limited. Some of the e-waste studies found have focused on e-waste management practices [14] while others have emphasized factors that contribute to proper e-waste handling. However, limited evidence has been found to date with regard to how environmental strategies may be utilized in creating better management and performance of e-waste. Among the studies that examine e-waste management practice is by [14], which has focused on e-waste management practice by households. The results from this study revealed that most residents prefer to store or sell their used electronic devices as second-hand equipment. Only a smaller fraction of residents prefers to find ways to dispose of their electronic devices in recycling facilities as there is no efficient take-back scheme for consumers. It is also quite surprising to learn that most households do not know where and how to dispose of electronic waste in a proper manner [14].

Consequently, they resort to disposing of electronic waste outside their premises together with other household wastes. This scenario is alarming as improper handling of e-waste may jeopardize the environment and human health as e-waste is filled with veritable toxic materials [2]. Therefore, it is crucial for the government to improve collaboration among stakeholders in order to enhance public awareness of and handling of electronic waste [14], as past studies identify incentives, law enforcement and public awareness as the determinants in minimizing e-waste production [15]. Research on e-waste in Malaysia has identified a handful of problems with regard to e-waste management. Past studies have proven that awareness of e-waste issues is still extremely very low [10].

The main difficulty associated with the implementation of e-waste management processes in Malaysia is its collection system [11]. There are also the problems of lack of actual data on e-waste generation and expertise, lack of ultramodern recycling plants, insufficient collection facilities [10], and insufficient political and financial will to solve the problem of transboundary movement of e-waste and its residual [10]. E-waste recovery facilities in Malaysia were also facing the problem of converting e-waste into a source material [12]. The issues include the e-waste supply, the importation of e-waste derived products and coding, and finally the need to develop the criteria for e-waste processing

technologies to ensure the safety and the sustainability of the facilities [12]. Jayaraman, Vejayon, Raman and Mostafiz [16] suggest that awareness of e-waste hazards and social consequences is among the important factors that need to be addressed as sufficient awareness may positively lead to proper management and disposal of e-waste. Likewise, Ismail and Hanafiah [17] underscore the importance of developing proper household regulations on e-waste management because the regulations are still in their infancy. Meanwhile, Tan, Ramayah, Yeap, and Ooi [17] recommend that the public's intention to conduct e-waste recycling is determined by their attitude towards recycling and the influence of their subjective norms on recycling practice.

These findings thus signal the importance of awareness, attitude and influence of the norms in shaping proper e-waste practices. Green Growth for Sustainability and Resilience the United Nations defines green growth as an approach sought to harmonize economic growth with environmental sustainability while improving the eco-efficiency of economic growth and enhancing the synergies between environment and economy (sustainabledevelopment.un.org). The Organization for Economic Co-Operation and Development (OECD), a partner of the United Nations with regard to environmental sustainability, defines green growth as the fostering of economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. In Malaysia, green growth is referred to as growth that is resource-efficient, clean, and resilient [1]. It is a commitment to pursue development in a more sustainable manner from the start, rather than a more conventional and costly model of 'grow first, clean up later'. The commitment to green growth will ensure that precious environment and natural endowment are conserved and protected for present and future generations [1].

Malaysia's green growth strategy will lead to a better quality of growth, strengthened food, water and energy security, lower environmental risks and ecological scarcities, and ultimately better wellbeing and quality of life. It will mean a significant reduction in greenhouse gas emissions and improved conservation of terrestrial and inland water, as well as coastal and marine areas including its ecosystems [1]. Sustainable consumption and production practices will increase the adoption of energy-efficient and low-carbon buildings, transport, products, and services. Climate change adaptation measures and disaster risk management, as well as the protection and conservation of natural resources, including biodiversity, will be intensified to protect the nation and its development gains [1]. Proper handling of e-waste is seen as a commitment to green growth, since e-waste can be reused through recycling and recovery, thus contributing to resources generation and wealth initiatives [1]. Despite Malaysia being considered as experienced in managing e-waste as the country has been involved in e-waste management since 2005, further efforts are still needed by different stakeholders to make the efforts a success [18].

3. Research Methodology

The population of the study is the companies in the Telecommunication and Technology industries of the Malaysian Main Market and Ace Market public listed companies. Public listed companies are chosen for this study as they are large companies with the capabilities to perform sound environmental practices. Furthermore, public listed companies in the Telecommunication and Technology industries may have sufficient resources for business activities and may be using current digital technologies which means that more computers and digital appliances are being used in their operations. Furthermore, Bursa Malaysia Sustainability Reporting Guidelines 2nd Edition 2018 has emphasised that companies in these industries disclose and report their electronic waste activities and information in emphasising their environmental commitment [19]. The unit of analysis is the company.

The study uses a questionnaire survey which is being answered by the managers who oversee the waste or e-waste management of the particular sampled companies. The questionnaire was physically distributed and also sent out online. Basically, the questionnaire has two sections, which started with identifying the e-waste types and following with the e-waste practices management section. The measurement of the questionnaire survey items in this study is by means of a five-point Likert scale from 1 to 5, rating from strongly disagreement to strongly agreement. The sample of this study for the Technology industry in the Main and Ace Market is 57 and 75 respectively, while for Telecommunication companies in the Main and Ace Market is 20 and 25 respectively. From this sample, 25 companies in the Technology industry responded to the survey, and 6 companies in the telecommunication industry responded.

4. Results

4.1. Types of E-waste

The first objective of this study is to determine the types of e-waste generated by the sampled companies. The results are shown in Table 1 below.

Table 1: Frequency of Types of E-waste Generated

	N	IEW	TEE	SAM	LMP	LEQ	SEQ	SITE
Tech	25	14	18	24	21	17	21	24
Tele	6	3	2	5	3	3	4	5
	31	17	20	29	24	20	25	29

Variables definition:
IEW = Industrial E-Waste; TEE = Temperature Exchange Equipment; SAM = Screens and Monitors; LMP = Lamps; LEQ = Large Equipment; SEQ = Small Equipment; SITE = Small IT and Telecommunication Equipment

Upon answering the first objective, this study refers to the number of companies that generate e-waste according to technology and telecommunication industries as shown in Table 1. For the technology industry, the results show that screens and monitors and small IT and telecommunication equipment as the type of e-waste that these companies most generated, whereby 24 out of 25 technology companies (96%) generated each of the two types of e-waste. Meanwhile, the least type of e-waste generated is industrial e-waste, only 14 out of 25 technology companies (56%) generated the respective types of e-waste.

Concerning to telecommunication industry, the most type of e-waste generated are also screens and monitors and small IT and telecommunication equipment, which is 5 out of 6 telecommunication companies (83.33%) generated each of the respective types of e-waste. Unlike the technology industry, companies in the telecommunication industries generated temperature exchange equipment as the least type of e-waste, whereby only 2 out of 6 companies (33.33%) generated the e-waste type.

From the results above, companies in both industries generated the most e-waste from similar types, in particular, the screens and monitors and small IT and telecommunication equipment. Some examples of the former e-waste type are monitors, laptops, tablets and notebooks. Meanwhile, the latter e-waste type comprises mobile phones, routers, printers and telephones. In the meantime, only a few companies in the technology industry generated industrial e-waste such as the wastes from electrical and electronic assemblies that contain hazardous components like accumulators and mercury-switches, lead, nickel and copper. Meanwhile, the telecommunication industry generated the least e-waste from temperature exchange equipment types, for instance, the refrigerator, air conditioner and freezer.

4.2 E-waste Practices

The second objective of this study is to investigate the practices of e-waste management in the sampled companies. Table 2 presented the results derived from the questionnaire survey using a Likert scale of five-point from 1 to 5 rating from strongly disagreement to strongly agreement.

Table 2: E-waste practices according to board and industry

	E-waste practices (Board)					
	REC	REU	RED	DIS	ADH	REP
Main Board	3.64	3.42	3.67	4.15	4.58	3.25
Ace Board	3.89	3.86	3.78	3.98	4.18	2.49
E-waste practices (Industry)						
Tech	3.71	3.66	3.76	4.08	4.38	2.79
Tele	4.17	3.67	4.08	3.87	4.19	2.78

Variables definition:
REC = Recycle; REU = Reuse; RED = Reduce; DIS = Disposal; ADH = Adherence; REP = Reporting

As reported in Table 2, the results indicate relatively convincing e-waste practices for most sampled companies. For companies listed in the Main Board, their e-waste practices were most likely driven by adhering to the authorities' rules, regulations and guidelines (4.58) and reporting e-waste management deems to be the least practices (3.25). Likewise, the companies listed in the Ace Board also manage their e-waste practices based on adherence to authorities' rules, regulations and guidelines (4.18) and the reporting the e-waste shows the lowest practice, which is as low as 2.49. In conclusion, companies from both Main board and Ace board manage their e-waste practice by obeying the authorities' laws and guidelines.

As for industry classification, the results are rather similar to the board classification as discussed above. Both technology industries' (4.38) and telecommunication (4.19) companies choose to adhere to the authorities' laws and guidelines in managing their e-waste. Also, companies from both industries have poor and low reporting on their e-waste practices.

4.3 Test of Difference

To add richness to the findings, this study further examines if there is any significant difference in e-waste practices by the sampled companies, according to the board in which they are listed and the industry in which they are represented. Table 3 and Table 4 show the results according to the board and industry accordingly.

Table 3: Test of difference according to Board

Panel A: Group Statistics				
	Group	N	Mean	SD
E-waste practices	Ace Board	19	3.7	1.12
	Main Board	12	3.81	1.18
Panel B: Independent Samples Test				
	Levene's Test for Equality of Variance			
	F	Sig. (p-value)		
E-waste practices	0.527	0.483		

Table 3 shows the test of difference between companies listed on the Main and Ace boards. Results reveal an insignificant difference in the mean score of the e-waste practices, in which the companies listed on the Main board demonstrated higher e-waste practices (3.81) compared to the companies on the Ace board (3.7). Levene's test of equality of variances also documented that all measures'

difference is insignificant (p=> 0.001).

Table 4: Test of difference according to Industry

Panel A: Group Statistics				
	Group	N	Mean	SD
E-waste practices	Technology	25	3.76	1.21
	Telecommunication	6	3.72	0.81
Panel B: Independent Samples Test				
	Levene's Test for Equality of Variance			
	F	Sig. (p-value)		
E-waste practices	0.614	0.422		

Pertaining to the test of difference for industries, Table 4 shows an insignificant difference in the e-waste practices between the telecommunication and technology industries. In particular, companies in the technology industry manage better e-waste practices compared to companies in the telecommunication industry with an average of 3.76 and 3.72 accordingly. Correspondingly, Levene's test of equality of variances recorded that all measures' difference is insignificant (p=> 0.001).

5. Discussion and Findings

The results derived from the above analysis show substantial input on the level of awareness among companies in technology and telecommunication listed on Bursa Malaysia. Firstly, the number of electrical and electronic devices increases considering the effect of the pandemic on the business environment. Following that, it is expected that the amount of e-waste generated from different types also rises. Based on the results reported, companies from the technology and telecommunication industries generated the most e-waste in small IT and telecommunication equipment such as mobile phones, routers printers, telephones and personal computers. In addition, both industries also generated a high amount of e-waste from disposing of screens and monitors which comprises monitors, televisions, laptops, notebooks and tablets. This study postulates such a scenario occurs since those devices are commonly used and could be found in most organisations, which explains the high amount of e-waste generated. However, the results showed different findings for the least type of e-waste generated between the two industries. The technology companies produced the least e-waste from the industrial e-waste possibly due to the low usage of electrical and electronic devices that contain hazardous components as most of the sampled companies are corporate offices, not factories. Meanwhile, technology companies generated the least type of e-waste in temperature exchange probably due to the durableness or longer ability to last and these devices are quite uncommon for companies to own.

Secondly, the results demonstrate the practices these companies conducted in managing their e-waste. Despite being classified between board and industry, the results are similar. On average, the sampled companies managed their e-waste by adhering to the authorities' rules, regulations and guidelines. The scenario may be justified by the clear and detailed guidelines provided by the authorities for the companies to refer to. These findings have shed some light, and perhaps the authorities could further develop a more advanced and comprehensive guideline that could push the companies to improve their e-waste practices. Additionally, the results reveal that the sampled companies practice poorly in terms of reporting their e-waste management regardless of based on the board or industry classification. These results are somewhat consistent with the previous study [20] that reported low reporting on e-waste despite the enactment of the Bursa Malaysia Sustainability Guide requiring these companies to disclose and report their e-waste information. As such, the respective authorities should be more aggressive and proactive in encouraging these companies to improve their e-waste reporting.

Thirdly, companies listed on the Main Board show a greater way of managing their e-waste practices for all themes compared to the companies listed on the Ace Board. The results may be explained that the companies listed on the Main board are those major names of companies in prominent industries that possess greater resources that could positively influence their e-waste practice. Moreover, these companies are of public interest which requires them to project a favourable reputation or image. Lastly, the results exhibit insignificant differences concerning the e-waste practices between board and industry classification.

6. Conclusion

The commitment of companies listed on Bursa Malaysia in managing e-waste practices, particularly those in the technology and telecommunications industry, is discussed in this article. Ever since the plague hit, these businesses may encounter greater difficulty in managing their e-waste since their operations are closely related to the use of electrical and electronic devices. E-waste that is not properly managed might have severe effects on human health as well as the environment. As the usage of electrical and electronic devices increase, it is important to evaluate the types of e-waste typically generated from these companies and what are the practices conducted in managing e-waste.

This study offers several contributions. Despite the results on e-waste practices are relatively satisfying in general, the poor practices on reporting e-waste are worrying and can be considered as immaterial by the sampled companies. The results trigger alarming concern especially to the companies listed on the Main board as these companies are known to have greater resources and stricter requirements especially on reporting e-waste information. As such, the findings could assist authorities such as the DOE, MCMC and Bursa Malaysia to improve their guidelines and requirement, particularly on e-waste

reporting for all listed companies.

Unfortunately, this study also bears certain limitations. Firstly, this study only examines listed companies from the telecommunication and technology industries. Future studies may add more companies from different industries, for example, those companies from environmental sensitive industries as the pandemic covid 19 affected all sorts of businesses. Secondly, this study only evaluates the frequency of types of e-waste and e-waste practices. As such, future studies may broaden the research area by gauging any firm or corporate governance characteristics relationship with the e-waste practices.

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