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Firm and Board Characteristics, and E-Waste Disclosure: A Study in the Era of Digitalisation

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Abstract: Business sectors face the advent of digitalisation, bringing attention to e-waste, or waste generated from obsolete electrical and electronic appliances. In addressing this issue, the study intends to examine e-waste disclosure by Bursa Malaysia listed firms. Specifically, this study investigates the extent and quality of e-waste disclosure, observes whether the reporting differs between industries and the boards on which the firms are listed, and investigates if e-waste disclosure is associated with firm and board characteristics. A total of 92 firms in the telecommunication and technology industries, listed on the Main and Ace boards of Bursa Malaysia, were selected as samples. The results reveal that despite an indication that e-waste reporting applies to the two sectors, only 16% of the firms report their commitment to managing e-waste. The disclosure shows how e-waste reporting is low in quantity and is circulated with only very general, qualitative information. An independent sample *t*-test reveals that firms listed on the Main board report significantly more e-waste information than their counterparts. Another *t*-test indicates an insignificant difference in e-waste disclosure between the firms under study. Furthermore, firm size significantly impacts e-waste disclosure, while firm performance, board size, and board gender diversity show insignificant impact. The results of this preliminary study shed some light on business firms' commitment towards their e-waste management and reporting, which is a substantial factor for Malaysia to achieve environmental sustainability.

Keywords: e-waste; disclosure; digitalisation; annual reports; Malaysia

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1. Introduction

Digitalisation has brought many benefits to business organisations [1]. By leveraging digital technology, firms may enjoy efficiency in business transactions [2,3], may be enabled to develop more products and enter new markets at lower costs [4], may enjoy increased competitive advantage [5], and, in the long-run, greater profitability [6]. Despite these benefits, digitalisation has also been found to negatively affect the environment [7]. Among the environmental issues that receive much attention in the digitalisation era is the waste from electrical and electronic appliances (e-waste) [8].

In the digitalisation age, where information may be retrieved with the point of a finger, the use of electrical and electronic appliances has increased exponentially [9]. These appliances contain components that are usually filled with toxic materials and heavy metals such as mercury, lead, and brominated flame retardants that are considered hazardous under the Basel Convention. When these appliances reach the end of their useful life (referred to as e-waste), the toxic components that are not properly disposed of will eventually end up in landfills. Toxic and hazardous chemicals will be generated through open burning, or by permeating the soil, thus endangering human health and the environment. Improperly managed e-waste results in soil, atmospheric and aquatic contamination [8,10], which poses a threat to humans, animals and plants [10]. Within humans, exposure to e-waste leads

to health problems such as changes in thyroid function, respiratory problems, changes in temperament and behaviour, decreased lung function, DNA damage and cancer [10,11].

The statistics of globally generated e-waste show staggering results. A report by the United Nations University's Global E-waste Monitor 2020, reveals that in 2019, a striking figure of 53.6 million metric tons (Mt) of e-waste was generated [5]. Almost one-half of this staggering figure (24.9 Mt) is contributed by Asian countries [12]. Most of the generated e-waste comprises devices such as computers, monitors, smartphones, and tablets [13]. By 2030, it is estimated that 74.7 Mt of e-waste will be generated [12]. This figure is projected to escalate to 120 Mt in 2050 unless drastic action is taken [13]. Furthermore, the generation of e-waste is found to be out of line with its handling. Global statistics show that of the 53.6 Mt of e-waste generated, only 17.4% indicates proper documentation on the treatment of such e-waste [12]. The remainder is believed to be reused as second-hand items or placed in landfills for burning or incineration. Even more alarming, e-waste is moved to other locations through illegal transboundary movements [14,15], which poses grave danger to the environment and health of the receiving locations.

The above situation certainly looks alarming and raises concern among governments and regulators. To curb the damage from improperly managed e-waste, governments and regulators have put pressure on business organisations to properly dispose of their e-waste and to report what actions have been taken regarding their obsolete electrical and electronic equipment used for business operations. For instance, in Malaysia, the reporting of e-waste is published in the current Sustainability Reporting Guide, as an element to be reported under the environmental aspect of sustainability [16]. Such reporting applies to firms listed on Bursa Malaysia, particularly those in the technology and telecommunication industry [17], as their activities are highly related to the usage of electronic appliances. Therefore, this study aims to examine the commitment of these business organisations towards their environmental sustainability, particularly in e-waste management. Specifically, this study looks at the extent and quality of reporting of e-waste by these organisations, investigates the difference in e-waste reporting between the two industries and the boards in which they are being listed, and examines the factors contributing to such commitments and disclosure.

The results from this study may shed some light on the commitment and reporting of business firms concerning their environmental engagement, particularly on how they are taking precautions concerning their e-waste management and reporting. In this digitalisation age, business firms should embrace digital technologies due to their potential benefits. However, the adverse outcomes, for instance the e-waste generated from technology adoption, need to be managed appropriately, as failure to do so will jeopardise the fate of humans and the environment. The findings may help authorities such as the Department of Environment (DOE), the Malaysian Communication and Multimedia Commission (MCMC), and Bursa Malaysia observe these business organisations' commitment to fulfilling their obligations in e-waste handling. Finally, the results may also contribute to Malaysia's success in addressing its environmental concerns, consistent with the objectives specified in the Sustainable Development Goals 2030.

2. Literature Review and Development of Hypotheses

2.1. Electric and Electronic Waste (E-Waste)

Generally, e-waste, sometimes referred to as the waste of electrical and electronic equipment (WEEE), is a term used for unwanted electrical and electronic equipment that is obsolete, discarded, or at the end of their useful lives. The United Nations (UN), through the Basel Convention [18], defines e-waste as any "electrical or electronic equipment which is waste including all components, sub-assemblies and consumables, which are part of the product at the time of discarding". E-waste may also be defined as "any appliances utilising/or exercising electrical supply that has accomplished to end-of-life during its product lifetimes" [19]. According to the United Nations University (UNU), in its Global E-waste Monitor Report, e-waste can be classified into six major categories: temperature

exchange equipment, screens and monitors, lamps, large equipment, small equipment and small information technology (IT), and telecommunications equipment [12].

In the Malaysian context, e-waste is defined as "the waste from electrical and electronic assemblies containing components, such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl" [20]. This type of waste is categorised as hazardous; thus, the treatment for disposal of e-waste is regulated under scheduled wastes (SW110) of the Environmental Quality (Scheduled Wastes) Regulations 2005.

At the end of its useful life, electrical and electronic equipment will finally be discarded due to its obsolescence. However, the equipment contains hazardous components, materials, and chemicals, therefore, improperly disposed e-waste may result in negative impacts, not only on the environment but also on humans' health. E-wastes contain dangerous chemicals such as polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), and polyaromatic hydrocarbons (PAHs), as well as heavy metals such as nickel (Ni), lead (Pb), copper (Cu), chromium (Cr), arsenic (As), and cadmium (Cd) [10]. Improper disposal of e-waste means that it is treated similarly to the treatment of other household waste, which usually is placed in waste landfills. Such a disposal method is hazardous since toxic materials may be generated from e-waste during burning activities at the landfill, eventually polluting the environment and affecting human health. Poisonous chemicals will also seep into the ground, slowly polluting the environment and where exposure to these toxic chemical and material constituents may lead to health problems among humans. Several studies document that humans exposed to e-waste may experience several health issues such as changes in thyroid function, respiratory problems, changes in temperament and behaviour, decreased lung function, DNA damage, and cancer [10,11].

Global statistics regarding e-waste show a staggering amount of global e-waste generation. In 2019, 53.6 million metric tons (Mt) or 7.3 kg per person of e-waste was generated, an increase of 21% as compared with 2014 data. In the Global E-waste Monitor Report 2019, the UNU estimated the figure to grow at an alarming rate to 74 Mt in 2030. The report also reveals that e-waste was primarily generated in Asia (24.9 Mt), followed by the Americas (13.1 Mt), and Europe (12 Mt) [12]. Thus, these figures make e-waste the world's fastest-growing domestic waste stream, fuelled mainly by higher consumption rates of electric and electronic equipment, short life cycles, and few options for repair. Unless something changes by 2030, the world will be surrounded by obsolete electric and electronic components, putting the lives of humans and animals at stake. Table 1 depicts global e-waste generation according to regions.

Table 1. Global E-waste Generated in 2019.

Region	Million Metric Tonne (Mt)	Total
Asia	24.9	53.6 (7.3 kg per capita)
Americas	13.1	
Europe	12.0	
Africa	2.9	
Oceania	0.7	

(Source: Global E-Waste Monitor Report 2019).

The fact that 53.6 Mt of e-waste was produced globally in 2019 is not the only horrifying issue. Another alarming issue is how this waste is being handled. Statistics show that only 9.3 Mt of e-waste has formal documentation of collection and recycling, representing only 17.4% of the total generation of e-waste [12]. The fate of the other 82.6% is uncertain and varies across regions (See Table 2). Some of it may land in waste bins (about 8%), and finally in the landfills for burning or incineration. Some might be treated as second-hand items or reused and refurbished (7–20%). However, evidence shows that the remaining e-waste is

involved in illegitimate transboundary movements, exported from high-income countries to middle-income and poor counterparts [12]. Several studies explain that developing nations such as India and China face this kind of problem due to the availability of low-priced workers and the underprivileged environmental strategies of these countries [14,15]. The exporting countries aim to cheaply dispose of e-waste by neglecting the adverse effects that the importing countries face.

Table 2. Global E-waste Flows.

Narration		Percentage
Documented	Reused as second–hand products	7–20%
	Discarded in waste bins	8%
Undocumented		82.6%

(Source: Global E-Waste Monitor Report 2019).

The statistics above reveal that the issue of e-waste should not be taken lightly. Table 2, above, indicates the global e-waste flows in 2019, and it is alarming to see that most e-wastes are undocumented, leaving questions about how this hazardous waste has been treated. Undocumented e-waste may bring notions that the waste is illegally transported worldwide, especially to poor countries, thus jeopardising the lives in that particular location. Unless something drastic is done, the issue of e-waste will escalate, and we will face a threatening global scenario.

E-waste generated in Malaysia also shows an alarming rate of increase. In 2014, 232 kt (Kiloton) of e-waste was recorded, equivalent to 7.6 kg per person [21]. The figure continues to escalate to 280 kt or 8.8 kg per person in 2016 [22] and 364 kt or 11.1 kg per person in 2019 [12]. E-waste in Malaysia may be categorised as one of the top six waste streams being generated [23]. It may be further classified into the categories of household and industrial e-waste. Household e-waste refers to the electrical and electronic waste that comes from household and commercial institutions, while industrial e-waste refers to those generated by industries [23,24]. Industrial e-waste in Malaysia has shown a substantial increase of 60.3% within just three years from 2015 to 2017 [23]. The Malaysian Department of Environment (DOE) indicates the states of Pulau Pinang and Selangor as the primary contributor of e-waste generation [23,25].

2.2. E-Waste Studies in Malaysia

Studies on waste management in Malaysia are growing substantially; however, those focused on e-waste management and practices exist, but are rather limited. Earlier studies identified that the awareness of Malaysians concerning e-waste and its implications are extremely low [26,27]. Malaysians were found to be unaware that e-waste should be disposed of in a proper manner [26]. E-waste practice in Malaysia also faces the problems of converting e-waste into source materials [24], as there is insufficient expertise, facilities, or the political and financial will [27]. Jeyaraman et al. [28] suggest that awareness of e-waste hazards and social consequences are essential factors that need to be addressed. Sufficient awareness may positively lead to proper management and disposal of e-waste. Malaysia urgently needs an appropriate e-waste management system for its households to reduce the possibility of e-waste flow into the current municipal solid waste facilities and maximise the utilisation of currently available e-waste processing infrastructures and facilities [29].

As discussed above, studies on e-waste reporting in Malaysia concentrate more on addressing citizens' awareness of e-waste issues and management. However, studies that focused on the commitment and reporting of business organisations are still lacking. Although studies on environmental reporting or waste disclosure among Malaysia listed firms are extensively conducted [30–33], limited evidence has been found on e-waste disclosure, one of the disclosures enacted in the Sustainability Reporting Guide for Bursa

Malaysia listed firms. According to the guide, Bursa Malaysia listed firms are required to disclose their commitments in handling e-waste, mainly applied to those involved in the telecommunication and technology industries. Regardless of this requirement, limited study has been found concerning e-waste disclosure among Malaysian listed firms. One study by Nik Azman and Mohd Salleh [34] has been conducted to examine if firm performance is linked to e-waste reporting. The study involved 59 Malaysian public listed firms. The evaluation of e-waste reporting was made based on the initiative of the sampled firms to recycle, reuse, reduce, substitute, treat, or phase out e-waste. The results indicate a mean of 57% of e-waste reporting by Malaysian listed firms; however, some companies indicate non-disclosure of e-waste information. Further analysis reveals that the financial performance of the firms is not a significant factor in determining e-waste reporting.

The discussions above reveal that studies on e-waste in Malaysia, particularly regarding the commitment of, and reporting by, business organisations, are still lacking. Even though household and industrial e-waste in Malaysia shows a significant increase in recent years [12,22,23], such information from large business firms has yet to be obtained. Large firms, such as those listed on Bursa Malaysia, have the capability and resources to perform the environmental agenda. Their ability to commit to environmental-related activities may be justified by past research [30–33]. Despite their capability in committing to the environmental sustainability agenda, evidence on the commitment to e-waste management is scarce. Therefore, this study intends to fill this gap by examining firms' commitment towards the environmental agenda, focusing on their e-waste management and reporting. The findings from this study are expected to contribute to the Malaysian plan for achieving sustainability objectives outlined in the Sustainability Development Goals 2030.

2.3. Factors Affecting E-Waste Disclosure

As explained earlier, except for a study by Nik Azman and Mohd Salleh [34], limited evidence has been found regarding the factors that have an impact on e-waste disclosure. However, many past studies confirm that factors such as firm characteristics and board characteristics significantly affect environmental disclosure or reporting. Most studies used legitimacy theory to support the links between the firm and board characteristics on environmental disclosure.

Legitimacy theory explains that organisations continually attempt to ensure that they are perceived as functioning within the bounds and norms of the society in which they operate [35]. Therefore, organisations will act to what they think is necessary to legitimate their existence [36] by making sure that their activities are acceptable to society's expectations [33,37–40]. Such actions often need to be publicised, and the most common method is through the disclosure of information in an annual report. The past few decades have witnessed the expectations of stakeholders and the public on business firms' engagement to sustainability commitments, which integrate the performance of firms in terms of economic, environment, and social obligations [41–44]. Large and profitable business firms are receiving particular pressure from stakeholders and the public; therefore, they will tend to report more sustainability commitments compared with their smaller, lesser performing counterparts. Furthermore, larger and more profitable firms are seen to have the ability and the resources needed to be engaged with sustainability activities.

Past studies have evidenced the impact of firm size [33,45–47] and firm performance [30,45,48] on sustainability reporting or environmental disclosure. Using the premise of legitimacy theory, [33] revealed that environmental disclosure by environmentally sensitive Malaysian listed firms is positively and significantly affected by their performance [49]. Meanwhile, a consistent finding is shown in a few studies [45,47], that examined the level of corporate environmental reporting by Nigerian listed firms and by Anditto and Yustrida [45] in the Indonesian context. In a developed country, Denmark, Andrikopoulos and Kriklani [46] also revealed firm size as an essential determinant for environmental disclosure.

Using the same vein of legitimacy theory, Tarquinio and Raucci [48], who studied the reporting of sustainability matters in Italy, Spain and Greece, reported that firm performance, proxied by the return on assets (ROA), significantly determine the level of sustainability disclosure. A similar finding is revealed by Anditto and Yustrida [45], who found that firm performance significantly affected the environmental performance of Indonesian listed firms. Meanwhile, in a Malaysian scenario, Khan, Muttakin and Siddiqui [32] revealed that firms' financial performance is an essential indicator of Malaysian listed firms' sustainability disclosures. Similarly, Buniamin, et al. [31] and Suryani and Pirzada [50] explain that firm size and performance positively impact environmental disclosure by business firms.

Based on the premise of legitimacy theory and supported by the evidence discussed above, this study predicts that firm size and performance will positively impact e-waste disclosure by business firms [51]. As e-waste disclosure is a part of environmental disclosure, this study predicts that both variables will have the same effect on the disclosure of e-waste. Therefore, this study hypothesises:

Hypothesis 1 (H1). *E-waste disclosure is positively associated with firm size.*

Hypothesis 2 (H2). *E-waste disclosure is positively associated with firm performance.*

As legitimacy theory posits that business firms must engage in sustainability activities to prove their legitimacy [33,35,36], they will always ensure quality and sufficient resources to conduct sustainability commitments. Among the resources that have gained prominence in sustainability and environmental reporting studies are the board size and board gender diversity.

Board size refers to the number of people sitting on the corporate boards of business firms. Legitimacy theory suggests that business firms will do whatever it takes to legitimise their existence in the eyes of stakeholders [36]. Therefore, having many persons sit on the board with various experience and qualifications may enhance their legitimacy. Past studies have demonstrated a strong association between sustainability or environmental practices and board size [31,52–54]. Benomran, et al. [52], who studied the effect of board size on corporate social and environmental disclosure in Libya, revealed the positive and significant linkage between the two. The results suggest that the greater the number of board members, the higher the corporate social and environmental disclosure will be. A similar result has been found by Rao, Tilt and Lester [46], who studied environmental reporting by firms listed on the Australian Stock Exchange. Board size was also found to be the most significant attribute in influencing environmental reporting in Malaysian listed firms.

Board gender diversity brings the notion of fair representation of men and women on corporate boards [55]. Regarding the area of environmental reporting, past studies revealed that corporate boards with gender diversity significantly affect environmental reporting [56–58]. Women directors show greater sensitivity towards environmental and social issues [59]. Therefore, firms that are led by female leaders will demonstrate increasing commitment to environmental issues [60]. A study by Liao, Luo and Tang [57] on carbon disclosure by firms in the United Kingdom revealed that board gender diversity significantly impacts greenhouse gas emissions. Furthermore, board gender diversity is also found to be a significant predictor of a firm's environmental initiatives in United States public firms [57]. A similar result was also found by Zahid, et al. [58], who revealed that women directors play an imperative role in improving environmental sustainability.

Based on the premise of legitimacy theory and supported by the evidence discussed above, this study predicts that board size and board gender diversity will positively impact e-waste disclosure by business firms [61]. As e-waste disclosure is a part of environmental disclosure, this study predicts that both variables will have the same effect on disclosing e-waste. Therefore, this study hypothesises:

Hypothesis 3 (H3). *E-waste disclosure is positively associated with board size.*

Hypothesis 4 (H4). *E-waste disclosure is positively associated with board gender diversity.*

3. Research Methodology

The study sample consists of 92 firms from the technology and telecommunication industries, listed on both Main and Ace boards of Bursa Malaysia. These firms are selected on the basis that they are required to report their e-waste information as stated in the Bursa Malaysia Sustainability Guide [17]. There are 112 firms (22 firms in the telecommunication industry and 90 firms in the technology industry) altogether, and the study applies the method by Krejcie and Morgan [62] to determine sample size. The sampling is made using stratified random selection based on the type of industry. The final sample arrives at 95 samples (19 firms in the telecommunication industry and 76 firms in the technology industry, or 45 firms from the Main board and 50 firms from the Ace board). However, 3 samples need to be discarded due to the normality issue, thus, arriving at the final sample of 92 firms.

The study utilises a secondary data collection method. The data were obtained from the sustainability section in the sampled firms' 2019 annual or stand-alone sustainability reports. Content analysis was used to analyse the data. Content analysis is the technique of obtaining data commonly transmitted on written documents, particularly documents which are historical [63]. The purpose is to make replicable and valid references from data to their contexts [64]. This method has been used mainly by sustainability-related research [65–68].

The disclosure of e-waste (EWS) is measured through its extent and quality. Two measurements measure the extent of reporting: (1) number of words and (2) number of sentences; while a 4 points quality scale measures the quality of reporting (0 = a non-disclosure; 1 = a general qualitative disclosure; 2 = specific qualitative disclosure; and 3 = quantitative disclosure). These techniques are consistent with past sustainability studies [68,69].

Firm size and firm performance represent firm characteristics [70]. Firm size (FSZ) is measured by log total assets, while firm performance (FPF) is measured by log return on assets (LROA). Meanwhile, board size and board gender diversity represent board characteristics. Board size (BSZ) is measured by total directors, while board gender diversity (BGD) is measured as the percentage of women over total directors. The hypotheses are tested with the regression line stated below:

$$EWS = \alpha + \beta 1FSZ + \beta 2FPF + \beta 3BSZ + \beta 4BGD + \varepsilon$$

4. Results

4.1. Availability of E-Waste Disclosure

The first objective is to determine the availability of e-waste reporting by the sampled firms. The results are tabled in Table 3.

The above results indicate that out of 92 firms under study, only 15 firms (15.79%) have e-waste commitment disclosed in their annual reports. For firms listed on the Main Board, only 27.72% of firms disclose e-waste reporting, while for Ace Board, only 6.25% indicate e-waste disclosure.

Furthermore, out of 92 firms, 17 firms are from the telecommunication industry, while 75 are from the technology industry. The results reveal that only 23.53% of firms in the telecommunication industry and 14.67% in the technology industry have e-waste information disclosed in their annual reports.

Table 3. Availability of e-waste reporting according to board and industry.

	Availability (Board)		
	Yes	**No**	**Total**
Main Board	12 (27.27%)	32 (72.72%)	44 (100.00%)
Ace Board	3 (6.25%)	45 (93.75%)	48 (100.00%)
	15 (16.30%)	80 (86.96%)	92 (100.00%)
	Availability (Industry)		
	Yes	**No**	**Total**
Telecommunication	4 (23.53%)	13 (76.47%)	17 (100.00%)
Technology	11 (14.67%)	64 (85.33%)	75 (100.00%)
	15 (16.30%)	77 (83.70%)	92 (100.00%)

4.2. Extent and Quality of Reporting

The second objective is to investigate the extent and quality of e-waste disclosure by the sampled firms, results of which are highlighted in Table 4.

Table 4. Extent and quality of disclosure.

	N	**Min**	**Max**	**Mean**	**SD**
Extent—Number of words	92	0	167.00	11.36	29.25
Extent—Number of sentences	92	0	5	0.41	1.06
Quality	92	0	3	0.27	0.70

In Table 4, the minimum score reveals 0 in the number of words, sentences, and quality index. This finding is consistent with the results in Table 3, where firms do not perform the disclosure of e-waste. The maximum score, however, shows some hope in e-waste disclosure. The results indicate the maximum score of 167 words, 5 sentences, and a quality score of 3, which indicates a quantitative disclosure. However, the mean score indicates poor and weak disclosure, with 11.36 words, 0.41 sentences, and 0.27 on the quality index, showing that the quality is centred between nothing to general qualitative disclosure.

4.3. Test of Difference

The third objective is to examine if there is any difference in e-waste reporting by the sampled firms according to the board in which they are listed and the industries they represent (See Tables 5 and 6).

Table 5 indicates a significant difference in the mean scores of the number of words, sentences, and e-waste reporting quality between firms listed on the Main and Ace boards. In all reporting measures, the former shows a higher extent (18.84 words and 0.64 sentences) and quality (0.48) of reporting than the latter, with 4.50 words, 0.21 sentences, and 0.08 on the quality index. Levene's test of equality of variances indicates that all measures' difference is significant (p =< 0.01).

Concerning industry, the results indicate no significant difference in e-waste disclosure between firms in the telecommunication and technology industries in all measures (See Table 6). Firms in the telecommunication industry indicate e-waste disclosure of 15.88 words, 0.59 sentences, and quality of 0.35, while firms in the technology industry indicate 10.33 words, 0.37 sentences, and quality of 0.25. Furthermore, Levene's test for equality of variance shows that the difference between the extent and quality is insignificant (p = > 0.01).

Table 5. Test of difference (board).

Panel A: Group Statistics				
	Group	N	Mean	SD
Extent—Number of Word	Main Board	44	18.84	36.78
	Ace Board	48	4.50	17.84
Extent—Number of Sentence	Main Board	44	0.64	1.24
	Ace Board	48	0.21	0.82
Quality	Main Board	44	0.48	0.9
	Ace Board	48	0.08	0.34
Panel B: Independent Samples Test				
	Levene's Test for Equality of Variances			
	F		Sig. (*p*-value)	
Extent—Number of Word	20.258		0.000	
Extent—Number of Sentence	11.142		0.001	
Quality	32.733		0.000	

Table 6. Test of difference (industry).

Panel A: Group Statistics				
	Group	N	Mean	SD
Extent—Number of Word	Telecommunication	17	15.88	31.31
	Technology	75	10.33	28.89
Extent—Number of Sentence	Telecommunication	17	0.59	1.23
	Technology	75	0.37	1.02
Quality	Telecommunication	17	0.35	0.79
	Technology	75	0.25	0.68
Panel B: Independent Samples Test				
	Levene's Test for Equality of Variances			
	F		Sig. (*p*-value)	
Extent—Number of Word	1.253		0.266	
Extent—Number of Sentence	1.496		0.225	
Quality	0.574		0.451	

The study also examines the theme of e-waste reported by the sampled firms. The results reveal that the themes mainly focus on how e-waste is disposed of, recycled and managed.

4.4. Hypotheses Testing

The final objective is to examine if firm and board characteristics significantly impact e-waste disclosure by the firms under study. Firm characteristics are proxied by firm size and firm performance, while board characteristics are represented by board size and board gender diversity (See Table 7).

Results in Table 7 indicate that only firm size suggests a significant positive impact on all measures of e-waste disclosure. Other tested variables (firm performance, board size and board gender diversity) were found to be of no significance. The results thus confirm H1; however, they do not support H2–H4.

Table 7. Hypotheses testing.

	Model 1 DV = Extent of Disclosure (Number of Words)			**Model 2 DV = Extent of Disclosure (Number of Sentences)**			**Model 3 DV = Quality of Disclosure**		
	coeff	tval	sig	coeff	tval	sig	coeff	tval	sig
FSZ	5.909	2.390	**	0.214	2.375	**	0.160	2.748	**
FPF	−178.6	−1.054		−7.524	−1.216		0.079	0.020	
BSZ	2.668	1.411		0.075	1.093		0.049	1.093	
BGD	13.37	0.571		0.555	0.649		0.553	1.003	
Intercept	292.7	1.043		13.16	0.951		−3.297	−0.370	
R-squared		0.127			0.113			0.149	
Adj. R-sq		0.086			0.072			0.109	
F-statistic		3.152			2.772			3.795	
p-value		0.018			0.032			0.007	

Variables measurement: Firm size (FSZ) is measured by natural log (ln) of total assets; firm performance (FPF) is measured by natural log (Ln) of return on assets; board size (BSZ) is measured by the number of directors sitting on the board; board gender diversity (BGD) is measured by the percentage of women directors over total directors; Bursa Malaysia Board is measured by dummy measurement. ** Significant at $p < 0.01$. N = 92.

5. Discussion

The results from the above analysis show several findings that are not to be taken lightly. Firstly, despite the indication in the Bursa Malaysia Sustainability Reporting Guidelines on the applicability of e-waste reporting by firms in the telecommunication and technology industries [17], only 15.79% of the firms indicate such reporting in their annual reports or stand-alone sustainability reports. The unavailable disclosure has limited the dissemination of information on how firms in both industries have handled e-waste. The scenario is crucial considering that the activities of the firms are highly involved in the utilisation of devices that contribute to the high generation of e-waste. During this digitalisation era, the activities of both industries will continue generating waste from electronic appliances. Therefore, commitments towards environmental sustainability are highly crucial.

Secondly, the sampled firms show a mean score of low reporting of e-waste, with only 11 words and 0.40 sentences. At the same time, the result reveals that the quality is only between non-disclosure to general qualitative disclosure (quality index mean score = 0.26 or 8% of disclosure). These results indicate that the sampled firms have a low extent and poor quality of reporting, which is far different from the results found in a previous study [34]. In their research, Nik Azman and Mohd Salleh [27] found that the disclosure of e-waste was 57% among the sampled firms. The result may be due to the sampling technique used by the authors, where they examined e-waste disclosure of 59 firms through the Environment, Social and Governance (ESG) report, thus concluding that the sampling technique was purposive. Despite the low extent and quality of e-waste disclosure found in this study, the results also reveal that there exist firms that put a high commitment to managing their e-waste and have appropriately disclosed their obligations in their reporting. These findings have shed some light, and perhaps with the authority's more aggressive pushing factor, the level of e-waste disclosure may be improved.

Thirdly, firms listed on the Main board show a significantly greater extent and quality of e-waste reporting than those listed on the Ace board. The scenario may be justified by the ability of the firms on the Main board in terms of resources to engage in better e-waste practice and disclosure. The results, however, fail to identify the significant difference in reporting between the two industries under study.

Finally, the study results reveal that only firm size shows a significant positive effect on the disclosure of e-waste by the sampled firms, which is consistent with several past

studies [33,45–47]. However, the variable only explains 12–14% of the models, thus needing further effort in finding factors that could enhance e-waste disclosure in Malaysian listed firms. Nevertheless, the finding on the effect of firm size on e-waste disclosure confirms the legitimacy theory [35,36], where large firms will tend to report their activities in the hope of finding legitimacy.

6. Conclusions

This paper addresses the commitment towards the disclosure of e-waste by firms listed on Bursa Malaysia, particularly those in the telecommunication and technology industries. These firms, whose activities are highly linked to the usage of electrical and electronic appliances, may face issues in managing their e-waste. Unproperly managed e-waste may result in disastrous implications, not only for the environment but also for the health of humans. The digitalisation era is seen to be a trigger for these industries to pursue their activities along with the advancement in technology. Therefore, it is critical to gauge the commitment of business organisations towards their e-waste management and disclosure. Discussed below are the contribution of the study, its limitations, and avenues for future research.

6.1. Theoretical Contribution of the Study

Theoretically, this study investigates if factors such as firm and board characteristics may impact e-waste disclosure from the lens of legitimacy theory. The theory posits that business firms will always try to legitimise their existence in the eye of their stakeholders. As such, they will tend to disclose information which are of significance to stakeholders, such as reporting their commitment to the environment in the annual reports. Past studies have found that factors such as firm and board characteristics positively impact environmental reporting. Consistent with the previous studies, this study found firm size to positively impact one element in environmental reporting: e-waste disclosure. However, the study fails to find any significant positive impact of firm performance, board size, and board gender diversity on e-waste disclosure. The findings add to the literature of environmental reporting, especially on the commitment to e-waste practices of Malaysian business firms.

6.2. Managerial Contribution of the Study

Despite e-waste disclosure being made applicable to firms in the telecommunication and technology industries, this study concludes that e-waste commitments have not been considered important by the stated firms. This can be seen through lack of availability, the low extent of disclosure, and the poor quality of disclosure. Although the results reveal devastating findings, this preliminary study opens avenues for future e-waste management and disclosure research. The issue is not trivial, as the marks from proper e-waste handling will have an impact on whether the Sustainable Development Goals, which aim to be achieved in 2030, can be materialised. The findings would also help authorities such as the DOE, MCMC and Bursa Malaysia find ways to improve e-waste management by business organisations.

6.3. Limitations of the Study

This study is not without limitations. Firstly, by only studying the effect of firm size and firm performance as proxies for firm characteristics, and board size and board gender diversity as the proxies of board characteristics, this study requires room for enhancement. Secondly, only two industries are examined in this study: the telecommunication and technology industries of Bursa Malaysia listed firms.

6.4. Avenues for Future Research

Future studies may want to add more firm and board characteristics that will promote better e-waste management and disclosure by Malaysian public listed firms. Future studies

may also consider extensively examining the factors (besides firm and board characteristics), such as institutional factors, that may improve e-waste management and disclosure. Furthermore, studies on e-waste management post Covid19 pandemic is also an important avenue to be researched. Considering the increase in usage of electronic devices due to the pandemic, and peoples need to work from home, it is vital to observe the impact of this pandemic on e-waste that is projected to escalate post-pandemic.

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