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EXAMINATION OF FACTORS RELATED TO THE RECYCLING INTENTION OF MOBILE PHONES BY UNDERGRADUATES

Abstract:

In our study, we assessed the approaches of university students toward electronic waste by utilizing a questionnaire. To ensure a diverse sample, a solicitation email was distributed to 74 universities across Turkey, encompassing rural and urban settings, private and public institutions, as well as both small and large universities. This outreach spanned a month and included a link to a SurveyMonkey website for participants to submit their responses. From the 772 responses received, 700 were deemed valid. The survey findings reveal that participants' decisions regarding changing their mobile phones are not primarily driven by the need to keep up with technological advancements. Instead, they are influenced by practical considerations, such as the limitations of their current devices, the desire to maintain privacy, and a reluctance to recycle without exploring alternative ways to give their mobile phones a second life. Additionally, our results indicate that future environmental concerns are expected to play a more prominent role in their decision-making, despite varying levels of explicit knowledge about e-waste.

Keywords:

Environment, Electronic waste, Recycling, Cellphone, Statistics.

JEL Classification: Q53, Q59, A13

1 Introduction

Humanity has dedicated considerable attention to addressing environmental pollution over the years, actively seeking solutions that span across various aspects of life, as well as economic and social domains. Reducing carbon emissions is recognized as a significant challenge and environmental concern, as highlighted by Nobel Prize winner Nordhaus in 2013. The primary categories of pollution that were recognized concern the air and the water, essential for life of all living creatures, with the more recent addition of e-waste.

The world's one of the fastest-growing waste streams is e-waste. As electrical and electronic equipment (EEE) gets disposed of, a waste stream consisting of valuable and hazardous materials is produced. E-waste, or Waste Electrical and Electronic Equipment (WEEE), is the term used to describe this waste stream. A number of regulations have been specifically created for this purpose. According to Zheng et al. (2021), the European Commission (2003) stated what is considered as the first WEEE regulation on this issue, in force since February 2014.

In 2019, 53.6 million tons of e-waste was generated worldwide, an average of 7.3 kg per capita based on statistics. (Forti V. et al., 2020). In 2019, Asia produced the largest amount of e-waste, totaling 24.9 million metric tons (Mt), with the Americas generating 13.1 Mt and Europe contributing 12 Mt. Meanwhile, Africa and Oceania produced 2.9 Mt and 0.7 Mt, respectively. When considering e-waste generation per capita, Europe led globally with 16.2 kg per capita, followed by Oceania at 16.1 kg per capita and the Americas at 13.3 kg per capita. In contrast, Asia and Africa had lower per capita figures, producing only 5.6 kg and 2.5 kg per capita, respectively. (Forti V.et al. 2020). Depending on those statistics, it can be said that countries with greater wealth generally provide more e-waste per capita than developing countries perform. In a devastating report, UNITAR reveals that the world e-waste is growing 5 times than officially reported, i.e. .62 million tons of e-waste in 2022, accounting for 62 billions USD, a quantity expected to increase by 33% for the end of the decade. The worst region in this sad prize list are Europe followed by Oceania and USA.

2 Literature Review

The use of electronic equipment and information and communications technology (ICT) devices is expanding globally. The huge increase of devices produced by the information technology industry, years after years, and the lack of concern about their disposal have the consequence to bury Earth under tons of obsolete electronic gadgets, a global concern named electronic waste (e-waste).

According to the projection regarding the generation of electronic waste, the amount of electronic waste in 2030 is predicted to be 74.7 million metric tons. The projected amounts for electronic waste, which was 53.4 million metric tons (Mt) in the year 2019, until the year 2030 are as follows for the years indicated in parentheses: 55.5 Mt (2020), 57.4 Mt (2021), 59.4 Mt (2022), 61.3 Mt (2023), 63.3 Mt (2024), 65.3 Mt (2025), 67.2 Mt (2026), 69.2 Mt (2027), 71.1 Mt (2028), 72.9 Mt (2029), and 74.7 Mt (2030) (Forti V. et al., 2020).

Electronic waste causes serious harm to our living and consequently becomes a concern of public health. Several studies show that dangerous substances like mercury, lead, cadmium, etc. are present in electronic equipment [8]. Lead, among these, is one of the most important substances released into the environment when e-waste is recycled, stored, or disposed of ineffective recycling and disposal practices lead to soil contamination. The actual approach of burning e-waste (often in under-developed countries by kids risking their life) is not a solution since it releases major pollutants in the air, that will subsequently fall into oceans and it translate into the leaching of toxic materials during landfill decomposition.

This has been connected to adverse effects of water contamination, respiratory illnesses, and even the increase in cardiovascular and respiratory mortality. Because of financial constraints, informal ways of recycling have become prevalent in numerous emerging economies. Without the right protection equipment, workers destroying e-waste are confronted with dangerous materials, which pose serious health risks like skin conditions, respiratory problems, and hearing loss because of noise, stress, and potentially heart disease .

3 Materials And Method

In our research, the current approaches of university students to the issue of electronic waste were measured through a questionnaire. In the literature, studies using similar methods. There is a publication in which a literature review is also carried out by our research team on the behaviors that affect recycling decisions.

The main body of our study, which is the empirical examination of previous research. Our population consists of university students over the age of 18. The reason for this choice of participants is that they are member of a generation expected to be heavy users of technology, namely mobile phone, which generates the e-waste under investigation. Exclusion criteria from the study would be to be under the age of 18 and not be a university student. A solicitation email was sent to a convenience set universities of Turkey, to cover the diversity of students, from rural to city, private and public universities, small and large, for one month. The email comprised a link to a website (SurveyMonkey), where their answers were collected. The students answered the questionnaire and the results were shared with SPSS.20 compiled. Results are presented and discussed below.

4 Result And Discussion

4.1 Respondents

The researchers received 772 responses of which they removed the answers from respondents who did not change their phone lately, and as such could not produce useful answers, leaving a global participation of 725 respondents. For consistency purposes, the researchers also removed 25 respondents who reported that they had not bought a phone in the last five years and those exceptional individuals who bought more than 5 phones, leaving 700 valid respondents. Table 1 below shows the number of phones bought in the last five years by the remaining respondents.

	Frequency	Percent	Valid Percent	Cumulative Percent
1	366	52.3	52.3	52.3
2	275	39.3	39.3	91.6
3	48	6.9	6.9	98.4
4	6	0.9	0.9	99.3
5	5	0.7	0.7	100.0
Total	700	100.0	100.0	

Table1: Frequency of replacement

More than half of the respondents bought only one phone in replacement and 40% only two. Given the fact that youths' wide is centered on social media and internet, this small consumption may be attributed to budget consideration and shall be kept in mind when interpreting other results.

Ölmez et al. (2023) also carried out a similar study. According to this, Participants were queried about their annual acquisitions of electrical/electronic devices [13]. The responses revealed that 83% of the participants prefer to purchase 1-3 such devices annually, with 4% opting for a higher range of 4-6 devices. Furthermore, 13% reported refraining from any device purchases for a year. Interestingly, none of the participants selected the 7-9 or more than 10 device purchase options. It is noteworthy that the study's participants, individuals aged 18-25, despite their inclination to stay technologically informed, exhibited a pattern of acquiring only a limited number of devices per year.

4.2. Previous conduct at the occasion of mobile phone replacement

Many reasons are invoked by respondents for changing their phone and the choices available for their old phone. Namely, some decide to keep their old phone and have a wide range of reasons to do so while some decide to throw it away for their own reason. Many reasons can explain why respondents change their phones, as computed in Table 2. On a scale where 1=irrelevant, and 5 =crucial, the highest score is given to "cannot repair" (mean= 3.36), poor functions- cannot upgrade (3.18) and "longer battery life" (3.28). By opposition "more fashion" is very low as a reason to change with a mean of 2.17 and this statement has a mode of 1. In summary, functional improvements motivate the decision to change. The market appears to have an important influence on the decision to change, since the upgrade offer from network operator is not negligible although low and the possibility to have a newer product with improvement appealing although not irresistible.

Main reason to change	**Valid**	**Missing**	**Mean**	**Median**	**Mode**	**Std. Dev.**
Broken phone-cannot repair	689	11	3.36	3	3	1.43
To increase the duration of a battery charge	688	12	3.28	3	4	1.37
Poor functions- cannot upgrade	688	12	3.18	3	3	1.30
More storage needed for my music/pictures	686	14	3.02	3	3	1.44

Newer products cheaper	684	16	2.38	1	1	1.95
upgrade phone from network operator	686	14	2.29	1	1	1.98
It is no more fashionable	687	13	2.17	1	1	1.79

Table 2: Main reason to change mobile phone

Table 3 presents the decision made regarding of the disposal of their old phone when it came the time to replace it. From the results below, it appears that half of the respondents (50.4%) prefer to keep their old phone and one out of four (28.3%) intend to give it a second life by providing it to a friend or charity. Only 1% gave their old phone for recycling while 16% got a financial advantage of the disposition thru sale or discount.

Method of disposal	**Frequency**	**%**	**Valid %**	**Cumul. %**
No disposal - kept for oneself	335	47.9	50.4	50.4
No disposal - intent to give (friend or charity)	188	26.9	28.3	78.6
Donated to organization that re-uses/recycles	6	0.9	0.9	79.5
Given in exchange on a new device	31	4.4	4.7	84.2
Sold it online	75	10.7	11.3	95.5
Threw it away in the recycle bin	10	1.4	1.5	97.0
Threw it away in the general waste	20	2.9	3.0	100.0
Total	665	95.0	100.0	
Missing	35	5.0		
Total	700	100.0		

Table 3: Main decision about disposal of old phone

Selling it (11.3%) is an alternative means of postponing the “useful end” of the mobile. Only 3% would throw it away to general waste and 1.5% to the recycling bin and only 1% would recycle it through an organization. The intention behind the disposal was for 95% to dispose of their phone in a useful way.

To understand the motivation of the 50% of those who have preferred to keep their old phones, table 4 summarizes the main reasons expressed on a scale varying from 1=irrelevant to 5=crucial.

Reason to keep	N Valid	Missing	Mean	Median	Mode	Std. dev.
None of the above	275	60	3.48	3	6	2.33
To keep as an alternative in case of emergency	331	4	3.42	3	3	1.34
Valuable information stored (contacts, music, etc.)	327	8	3.32	3	3	1.54
To prevent access to my confidential data	330	5	3.15	3	1	1.75
To send later for re-use or appropriate disposal	328	7	2.86	3	1	1.64
Plan to give it away to friend, family or charity	326	9	2.78	2	1	1.78

By lack of knowledge about what else can be done	325	10	2.73	2	1	1.70
By lack of knowledge about its value	327	8	2.70	3	1	1.60
In order to use spare parts	325	10	2.61	2	1	1.99
In order to sell it or exchange it later	326	9	2.61	2	1	1.95
Old technology is collectable	324	11	2.59	2	1	1.79
By lack of convenient method to send it to recycling	323	12	2.57	1	1	2.01
I keep it as a memento	326	9	2.55	2	1	1.76

Table 4: Reason invoked to keep one's old phone

Table 4 shows that the main reasons for those who kept an old phone are to have a spare (3.42), to protect valuable information (3.32) and fear of leaking private information (3.15), and many other reasons (3.48).
It is important to note that the convenience for sending to recycling is not a concern either because it is not considered at all or because it is not seen as difficult. For nearly half of the respondents, the phone is kept for future use such as to be sold or for spare parts, or to be given.

A factor analysis was performed in order to better understand the reasons to keep their phone. The analysis with varimax rotation) provided two factors explicative of respectively 53% of the variance, presented in Table 5. The two factors are respectively the usefulness (actual or future) of the old phone (41.5%) and constraints and deterrents 11.5%).

Factor analysis (principal component varimax)	**1**	**2**
In order to sell it or exchange it later	0.769	
Plan to give it away to friends, family or charity	0.758	
In order to use spare parts	0.743	
To send later for re-use or appropriate disposal	0.725	
Old technology is collectable	0.628	
To keep as an alternative in case of emergency	0.593	
By lack of knowledge about what else can be done		0.698
To prevent access to my confidential data		0.697
By lack of knowledge about its value		0.671
Valuable information stored (text, contacts, music, video, etc.)		0.610
By lack of convenient method send it to recycling		0.527

Table 5: Factor analysis of reasons invoked to keep

Contrary to the vast majority of the respondents, table 3 shows that 4.5% prefer to throw away their old phones. Among them, only 30 respondents explained their reasons, presented in Table 6.

motive invoked	N	% of motives	% of cases
no collecting value	6	12%	22%
no time	8	16%	30%
complex- tiresome	10	20%	37%
not seeing the necessity	3	6%	11%
now law forcing to recycle	4	8%	15%
do not know where to send it	19	38%	70%
total motives	50	100%	

Table 6: Reasons invoked to throw away an old phone

As can be seen from Table 6, for one-third of the respondents, it is mostly the effort that limits the possibility of recycling (no time=16%, tiresome or complex=20%). In 38% of the cases, it is the lack of information on disposition that prevents them from recycling, and the perceived effort to find a place to dispose of it.
It is important to note that 70% of the respondents who throw away their phone did not know where it can be disposed to be recycled. Most of the respondents appears to have a similar good reason to get rid of their obsolete phone; for those who mention no time or complex process, it may suggest that recycling must be easy, near and simple, suggesting the need for better information on where to recycle, the proximity and convenience of deposit box (ex. near a subway entrance, in malls, in university entrance, etc.) . In summary, the perceived difficulties seem to explain this behavior.

4.3 Intention to recycle

The respondents were 56% mentioned their intention to recycle from now on without condition with a supplementary 31% if recycling can be rewarded with monetary benefit while 13% don't intend to recycle at all, as appears in Table 7, below:

	Frequency	Percent	Valid Percent	Cumulative Percent
will not send, because not see the essentiality of recycling	23	3.3	3.4	3.4
will not send, even knowing the importance of recycling	65	9.3	9.6	13.0
Will only send if there is a financial compensation	210	30.0	31.0	44.0
will send to recycle center	380	54.3	56.0	100.0
Total	678	96.9	100.0	
System missing	22	3.1		
Total	700	100.0		

Table 7: Intention to recycle

Concerning the 9.6% who do not intend to recycle despite their understanding of the importance of recycling, it may be understood as being possibly motivated by another alternative, neither throwing away nor recycling but keeping for other reasons, as it was detailed in the analysis of Table 5. Finally, it should be noted that respondents are university students, who generally are short of money due. This is why the authors question this 56% given this recognized small budget of students. The good intention may fade away when confronted with an irresistible offer from a store or network operator.

When asked about what would motivate them to recycle their phone, respondents answered the following incentives, presented in Table 8. Not surprisingly the issue of environment with a mean of 3.63 (between 3=moderate influence and 4=strong influence) seems to be the main driver to recycling; it also the most frequent choice with a mode of 5. Receiving a compensation is the second most frequent choice. A law requiring to recycling would apparently not have a great influence. Convenience of the disposition (mean= 2.78) does not appear to be a motivation when the set of all respondents is considered.

	Valid	Missing	Mean	Std. Dev.	Median	Mode
Environmental concern	684	16	3.63	1.395	4	5
Receiving a counterpart (money or else)	680	20	3.10	1.354	3	3
Convenience of disposal	665	35	2.78	1.290	3	3
A law forcing recycling	647	53	2.76	1.505	3	1

Table 8: Motivations to recycle

The respondents were asked to precise their knowledge about e-waste and environment. The table 9 below summarizes their relative degree of knowledge.

	Frequ.	Percent	Valid %	Cumul. %
No- first time that I read the term electronic waste	73	10.4	10.4	10.4
I was somehow informed about e-waste but without a clear knowledge	151	21.6	21.6	32.0
I only know that consists of electronic materials	249	35.6	35.6	67.6
I know what it is and I have a clear understanding about e-waste	89	12.7	12.7	80.3
I know what it is &try to be careful in the disposal	138	19.7	19.7	100.0
Total	700	100.0	100.0	

Table 9: Knowledge of e-waste

Table 9 shows that one-third do not know much about it (32%), another third knows the basics of it (35.6%) and one-third is well aware (33.3%).

A correlation test was performed. It shows a very significant relationship (r=.338, n=670, p=.000) between the intention to recycle and the environmental concern and a significant relationship with convenience of disposal but not with e-waste knowledge. The relationship between environmental concern and convenience of disposal suggests that being concerned by environment improve knowledge about disposal possibilities or that the presence of recycling facilities increases environmental concern. This relationship is speculative and would necessitate more study.

Pearson correlation (r, sig, n)	Knowledge of e-waste	Convenience of disposal	Environmental concern	Receiving a counterpart
Intention to recycle	0.067	,249**	,338**	-,094*
	0.083	0.000	0.000	0.016
	678	653	670	666
Knowledge of e-waste		0.069	,085*	-0.054
		0.073	0.026	0.163
		665	684	680
Convenience of disposal			,326**	,191**
			0.000	0.000
			662	661
Environmental concern				-0.061
				0.114
				674

Table 10 : Correlation of intention to recycle with main factors

5. Conclusion

The protection of the environment implies that all of us shall contribute, whenever it is possible and specially in the case of electronic waste disposal. The new generation is the one which will be the most affected by the consequences of today's negligence. Students are those who can make a difference soon or later when they will reach power and decision-level in their respective job. Their past behavior and their actual intention, as well as their level of awareness of the urgency of the situation are crucial.

The respondents of this survey show that their past behavior when it is time to change their mobile phone is not guided by the need to keep pace with technological change but obey a real need due to limitations of their actual phone (ex. defective battery or limited capacity), their intention to keep their device linked to privacy, their refusal to recycle linked to other way of giving a second life to their mobile.

Our results also show that in the future environmental concerns will guide their decisions although their knowledge of e-waste is more or less explicit. The lack of facility to dispose of a phone and the fact that many don't know too much about the environment is indicative of the need to continue awareness activities to favor respectful behavior.

However, it is difficult to conclude too firmly about this study's findings. Indeed despite 700 persons answered the survey it is only a situational picture of the situation and the conclusion cannot be generalized without caution. Further research is needed.

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