

Strategic Improvement of Smartphone E-Waste Collection: Evaluating Customer Awareness and Process Optimization

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Abstract— Technology has directly affected the lives of human beings over the years. Many of the things we do are done using technology, from our home appliances down to the devices that are needed in our workplace. Technology is all around us, and it is rapidly growing as time passes by. With the continuous demands of people to make life a little easier, innovators, inventors, and manufacturers work hand in hand to meet these increasing needs of people. However, with the use of technology comes its price. Since the lockdown happened and a global pandemic, known as COVID-19, was declared, subsequent lockdowns have had a big effect on modern society. Furthermore, statistical tools and process mapping assessment will be used in the study to present important data that will serve as proof of the need to address problems in the Smartphone Industry. It will include environmental assessment and impact where specified in the ISO 14000 series of standards, with a definition of both provided by. For environmental impact, it is stated as 'any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects'. An "environmental aspect" is also defined by the standards as an "element of an organization's activities, products, or services that interacts or can interact with the environment" Electronic waste collection is hardly a topic for collection in the Philippines. As seen with the awareness and collection procedures of different groups and organizations, the processes involved need to be streamlined so as to monitor the flow of electronic waste. Upgrades are frequently practiced in the mobile industry as technology continues to advance, assisting humanity in making tasks or work faster and easier. A bulk of discarded old phones that are outdated. As a result, some of the waste produced is left discarded with no proper storage.

Index Terms—Smartphone, E-waste, Process Optimization, Awareness.

1. Introduction

Technology has directly affected the lives of human beings over the years. Many of the things we do are done using technology, from our home appliances down to the devices that are needed in our workplace. Technology is all around us, and it is rapidly growing as time passes by. With the continuous demands of people to make life a little easier, innovators, inventors, and manufacturers work hand in hand to meet these increasing needs of people. However, with the use of

technology comes its price. Since the lockdown happened and a global pandemic, known as COVID-19, was declared, subsequent lockdowns have had a big effect on modern society.

Telecommuting for business, education, and pleasure has resulted in an increase in demand for electronic items, straining global manufacturing supply chains as well as upstream mineral supplies and resources. It required physical distancing measures from the community, thus introducing a new work and education set-up such as "telework and flexible learning." Working from home necessitates the purchase of electronic devices in order to perform job-related tasks and activities [1]

In educational institutions, students are required to purchase gadgets and devices to attend classes and do tasks.[3] mentioned that, as a result of the COVID-19 epidemic, students all around the world have been required to continue their education online. Students require access to gadgets such as computers and cellphones, which is one of the limitations of this modality.

Smartphones are the most affordable of these possibilities because of their cheaper rates. In "The Importance of Technology in Philippine Education" (2021), Childhope Philippines wrote that these advancements in technology and the rise of electronic devices and electrical equipment, ranging from domestic appliances to small solar panel networks or smart phones and other ITC items, provide enormous benefits to society and open up new development potential.

These are valuable tools for improving society's welfare, extending education, providing high-quality health-care services, promoting trade, and tackling climate-change-related concerns.

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However, there are enormous amounts of wasted resources throughout this entire value chain, from the extraction of valuable ores (iron, copper, gold, etc.) included in the composition of electronic products, to their production, transportation, retail sale, consumption, and elimination from the circuit, and the system generates many negative effects and a large ecological footprint. Electronic and electrical equipment that is discarded can contain potentially harmful elements, polluting the environment and posing health concerns to individuals who work in the recycling industry. Every year, some 50 million tons of electronic and electrical waste (e-waste) are produced around the world, which is the weight of all commercial airplanes ever manufactured [2]

With the increasing demands of smartphones and the hidden danger that people should be aware of, it is a must to give importance to the process of collection and handling of electronic waste in order to control the pollution that may result from improper disposal. A method which is known as "Processing Mapping" is introduced in the study to generate and locate where improvements should be made and how to graphically present problems in a manner that will easily identify existing and potential problems. Process Mapping, according to [5] is a tool that assists in graphically presenting a working process against which it will evaluate rooms for improvement that are rooted in some existing problems where process redesigning is possible.

Process Maps can be in the form of graphs or flowcharts that portray different tasks, activities, roles, and choices that are given within an organization's processes. It defines all the steps in a given process, from what is happening to whom it is in-charge, what materials and equipment are included, and the data or tasks needed to be fulfilled. It is actually the same as a map where it will guide you through how the business process works. Furthermore, statistical tools and process mapping assessment will be used in the study to present important data that will serve as proof of the need to address problems in the Smartphone Industry. It will include environmental assessment and impact where specified in the ISO 14000 series of standards, with a definition of both provided by. For environmental impact, it is stated as 'any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects'. An "environmental aspect" is also defined by the standards as an "element of an organization's activities, products, or services that interacts or can interact with the environment". [7]

2. Methodology

The study made use of the descriptive research design, this study centers on the development of the best method of collecting e-waste as well as the service facility and provision of a monitoring application for e-waste collection specifically on Smart Phones that can be practiced in the mobile industry in the Philippines, where the researchers made use of descriptive research design. Through surveys and their subjective

perceptions via observational methods, they will be at the center of creating the data to be presented in this study [1].

The study includes primary data gathered by the researchers through surveys, interviews, and feedback. This is a first-part data collection which is gathered directly from the intended participants. Additionally, the other sources came from secondary data, through which it has many positive attributes as it is reliable and accurate. Resources like people who have written articles or published previous studies, as well as online sources, can be used as references and support for the study topic by the researchers. [4].

To gather the needed data for the research study, the researchers conducted interviews and provided survey questionnaires for the three categories, namely: mall participants, student awareness, and local government unit. The initial step to collecting the data needed is asking the person in charge of the stores to initiate an interview or to answer a quick open-ended survey on a sample of employees that is focused on the research topic. The interview is done to know and get a picture of what is currently happening in the disposal process of each of the mobile stores and of the city where the malls are located and if there are existing standards to assess. It is also important if customers, identified as students, are aware of such systems, so a form is created to identify the level of awareness. [5]

Once questionnaires are reviewed and approved, they will be printed and distributed for each of the categories to answer the questions provided. For the students' awareness, a google form is created in order to reach out easily to the selected number of samples. A link and a QR code are available to access the google form. All of the data collected will be extracted and be able to organize, transcribe, and tally data for statistical analysis.

The researchers identified all the shopping malls in San Fernando Pampanga, which are tabulated below. From it, the shopping malls which do have mobile stores will be subjected for distribution of the research questionnaires. Employees from these mobile stores should answer the questions which are in line with the e-waste collection and disposal.

Table.1.

Respondent Details

Name	Location	Owner
Jenra Mall Sindahan	San Fernando	
Jenra Mall Dolores	San Fernando	
Robinsons Starmills	JASA, San Fernando	Robinsons Land Corporation
BuyMaxx Supermarket	San Fernando	
Robinsons Supermarket	San Fernando	
SM City Pampanga	Mexico/San Fernando	SM Prime Holdings
SM City San Fernando Downtown	San Fernando	SM Prime Holdings
SM City Telabastagan	San Fernando	SM Prime Holdings
S&R Membership Shopping	JASA, San Fernando	

Shopping malls which are in red depicts that there are no existing Mobile stores while green shows all of the shopping malls which passed the set of conditions delimited by the study.

There are four sets of questionnaires which are conducted differently:

Survey and Interview prepared by the researchers. These are subjected base on the following category and the method used in delivering the questionnaire:

1. Employees from mobile stores
2. Student's awareness
3. Admin - in charge of Waste Management (Malls)
4. Local Government Unit (CSFP)

Further, this will contain an in-depth approach on the study as it will seek to investigate the processes there are in e-waste disposal.

The respondents for this study consisted of three categories:

- Mall Respondents
- Customers
- Local Government Unit

3. Result And Discussion

Mall Respondents: For the first category, the participants are from two types of employees: Data will be gathered from these employees using a survey questionnaire and an interview. The different mobile stores found at each of the shopping malls indicated in the scope section of the study are in the vicinity of San Fernando, Pampanga. These listed participants are the official stores located in the targeted establishments. Selected stores are focused primarily on a single brand, which are the following:

- Apple > Personal computers, cellphones, tablet computers, computer accessories, and software are all made in the United States. It was the world's first profitable personal computer startup, and it popularized the graphical user interface (GUI).
- Huawei > Huawei Technologies, the world's largest telecoms equipment provider, tries to develop 15,000 new retail shops in order to achieve a record-high distribution of smartphones and increased sales of premium-priced products.
- Xiaomi > Xiaomi was initiated by Lei Jun in April 2010 and was China's top smartphone business in 2014. Xiaomi is now one of the top five smartphone manufacturers in the world. The selling of smartphones contributes to the high amount of Xiaomi's income. The business is said to have sold 119 million handsets in 2018.
- Oppo > Oppo was first registered in China in 2001, and the company was formed in 2004. They've expanded to every corner of the globe since then. Oppo became China's largest smartphone manufacturer in June 2016, with over 200,000 retail locations carrying the company's products.

- Vivo > Since 2011, Vivo has been recognized in more than 100 nations and regions throughout the world, indicating that the company has taken international location. Vivo has operations in India, Malaysia, Indonesia, Thailand, Myanmar, Vietnam, and the Philippines at the moment. In mainland China, vivo sold 25 million devices in 2014, with 45 million sold globally in 2015, at an average retail price of \$300. A total of 60 million units are produced each year.

Table.2.
Target Sample of each Store

Malls	Mobile Stores	Total Number of Employees each Store	% of Population	Target Sample for Each Store
SM City Pampanga	PowerMac	8	17	5
	Samsung	8	0.17	5
	Oppo	6	0.13	4
	Huawei	4	0.09	3
	Xiaomi	7	0.15	5
	Vivo	10	0.21	7
	Asus	4	0.09	3
Total	n = 32	47		32
SM City San Fernando Downtown	Huawei	4	0.57	4
	Realme	4	0.57	4
Total	n = 8	8		8
SM City Telabastagan	PowerMac	8	0.42	7
	Realme	5	0.26	4
	Samsung	6	0.32	5
Total	n = 16	19		16

Table.3.

Interview Participants Each Store

Mall	PIC of Waste Management	Method use to collect data
SM City Pampanga	2	Interview
SM Telabastagan	2	Interview
SM City San Fernando Downtown	2	Interview

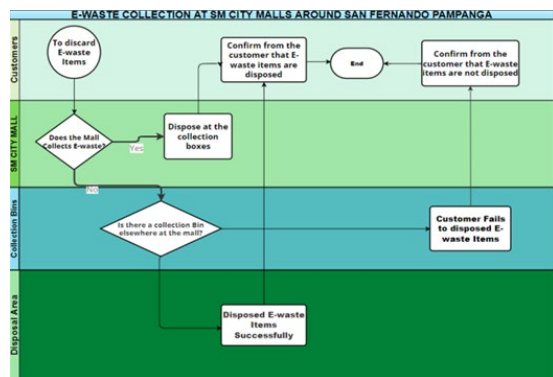


Fig.1. SM City Malls Process Flow Chart

In determining what factors to improve on the collection method of Smartphones E-waste, the researchers seek to study

the current process in collecting discarded phones. Based on the results shown in figures 4-9, there is no standard process in collecting discarded phones. Most of the participated mobile stores have no collection systems. Apple and Samsung do have programs in raising awareness for e-waste collection and this will is currently known as “trade in trade up or TITU” for Samsung and “Uptrade” for Apple. Wherein Samsung store will evaluate or assess the customers phone and deduct the discarded phone price to the total price of the phone upgrade chosen by the customer. Both Stores are also affiliated with Comp Asia Corporation that reuses the old phone (recycle) by selling 2nd hand models.

Table.4.
Things to do for smartphone no longer use

Categories	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Mean
My parents	12	25	24	15	2	78	3.38
School	31	28	15	3	1	78	4.09
Television	15	37	20	5	1	78	3.77
Radio	7	19	27	16	9	78	2.99
Social Media	32	34	8	2	2	78	4.18
Municipality	8	21	19	23	7	78	3.00
Community Care Groups	9	20	27	16	6	78	3.13
Workplace	7	20	23	21	7	78	2.99
I have not known What E-waste is	7	15	22	15	19	78	2.69

Table.5.
Things to do for smartphone no longer use

Categories	Strongly Agree	Agree	Disagree	Strongly Disagree	Total	Mean
Store as E-waste At home	14	46	15	3	78	2.91
Discard with household waste	2	32	34	10	78	2.33
Donate	19	49	9	1	78	3.10
Sell to individuals	16	49	9	4	78	2.99
Sell to recyclers	20	44	11	3	78	3.04
Burn	1	7	32	38	78	1.63
Dump at dumpsite	2	7	34	35	78	1.69
Give to collection centers	16	43	16	3	78	2.92

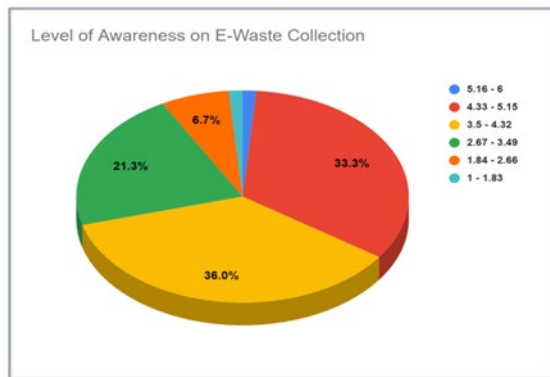


Fig.2. Level of Awareness on E-Waste Collection Method

To get the ranges Subtract the Highest from the Lowest Scale then divide the difference from the highest scale value.

For this Likert Scale, the ranges will be:

$$6 - 1 = 5 ,$$

$$5 / 6 = 0.83$$

Environmental Aspect and Impact Register is a tool used to document the assessment and evaluation of activities or operations that can result in any changes to the environment. It is one of the building core of the Environmental Management System to which actions should be done in order to prevent and eliminate the negative impacts of an organization. In this study, the researchers investigated the Environmental Aspect and Impact of Smartphones specifically on the Disposal Process by using the EAIR Procedure or the Environmental Aspect and Impact Register Tool. The table below is known as the EAIR which will list the three phases of Smartphone E-waste Collection; Assessment, Storage and Transport.

Table.6.
Environmental Aspect and Impact Register

Activity	Inputs	Aspect	Environmental Impacts				
			Air	Water	Land	Use of Natural Resources	Others
Assessment on E-waste Items	Machines, Tools and Electricity Papers Ink	Solid Waste Spills		Water Contamination	Increase in Landfill	Natural Resources Depletion	Deforestation and Destruction of Habitat
Storage	Bins, Papers Ink Plastics	Solid Waste & Spills			Increase in Landfill	Depletion of Natural Resources	Deforestation
Transport	Usage of Vehicle	Emission and Noise	Air Pollution				Noise

For the study the researchers used Risk Assessment method is used to determine the significance in consideration of the following factors:

1. Probability of an adverse event
2. Consequences of an adverse event
3. Probability of detection of the effect or the degradation which results from loss of control

Table.7.
Risk Assessment Criterion

Probability of Occurrence		Probability of Detection		Severity of Degradation	
CRITERIA	SCALE	CRITERIA	SCALE	CRITERIA	SCALE
Very Low	1	Certain	1	Negligible	1
Low	2	High	2	Low	2
Moderate	3	Moderate	3	Moderate	3
High	4	Low	4	High	4
Very High	5	Very Low	5	Very High	5

Level of significance can be determined using the Risk Priority Number (RPN) which is discussed and used in the study of D.R. Kiran (2017).

Wherein:

- $RPN = (Severity \times Occurrence \times Detection)$
- Minimum RPN: 1
- Maximum RPN: 125

In order to analyze the current situation in Mall Facilities on the disposal of waste, an interview is also conducted to the Local Government Unit around the City of San Fernando. The City Environment Natural Resources Office, stated that there is no collection of Electronic Waste conducted by LGU, only Solid Waste Management is being conducted by the organization.

Below is the deployment flowchart in collecting of E-Waste

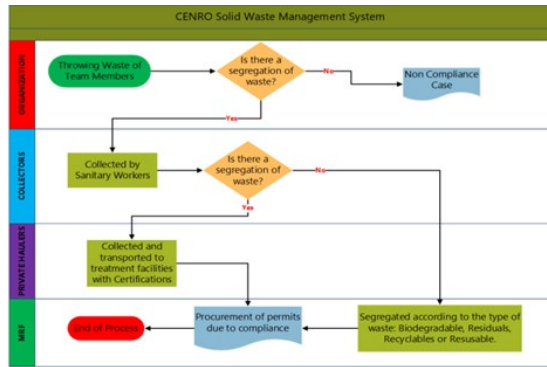


Fig.3. Collection Process of LGU

Rank	CRITERIA: OCCURRENCE	Rank	CRITERIA: DETECTION	Rank	CRITERIA: SEVERITY
1	Rare (possible to occur once every 2 years)	1	Almost Certain Regular Inspection (daily/weekly at site level) Regular Monitoring	1	No damage to the environment
2	Low occurrence (possible to occur once every 2 years)	2	High Consistent Monthly Monitoring/ Inspection Procedure	2	Minor environmental impact Affects a small area within the facility emissions meet the set limits
3	Moderate (possible to occur once a year) mostly contractual are affected	3	Moderate Annual Audit/Annual Physical Examination Inconsistent recording/escalation	3	Moderate environmental impact Affects several areas within the facility isolated cases of emissions above the set limits
4	High (possible to occur once a month) most employees are affected	4	Very Low Inconsistent monitoring/inspection No recording/escalation	4	Local environmental impact Affects nearby community emissions constantly above the set limits
5	Very High (possible to occur Weekly/Daily) All employees, contractors are affected	5	Almost Impossible No monitoring/ inspection; No detection	5	Major environmental damage Global environmental impact Irreversible damage

Fig.4. EAIR Risk Level Identification

The scores obtained for the risk levels are generated from the results survey of participants and the criteria used for assessment, wherein there is a low detection when it comes to the storage versus the two identified processes since transport rarely happens due to the unawareness of such facilities, while on assessment of E-waste items only two brands uses this offer, hence it is also monitored unlike the collection bin that is not noticed by the public as well as there is a little knowledge on employees of its function and process.

Smartphone disposal raises additional socio-environmental concerns, such as the export of potentially harmful garbage to many developing countries. Every year, 435k tones of smartphones are anticipated to end up in landfills. (George Power, 2019). As seen in the Risk Factor determinant, the storage method produces the higher risk in Environmental Aspect and Impact this is primarily because of its low results under the probability of detection wherein the effects of these kinds of waste are not yet resolved and needed programs to raise the level of awareness. This is also supported by the survey results that gathered low scores on Smartphones E-waste disposal and collection awareness questionnaires as well as the

level of E-waste Knowledge by the identified customers

4. Conclusion

Electronic waste collection is hardly a topic for collection in the Philippines. As seen with the awareness and collection procedures of different groups and organizations, the processes involved need to be streamlined so as to monitor the flow of electronic waste. Upgrades are frequently practiced in the mobile industry as technology continues to advance, assisting humanity in making tasks or work faster and easier. a bulk of discarded old phones that are outdated. As a result, some of the waste produced is left discarded with no proper storage. The information gathered through surveys, interviews, and observations summarizes the current process of collecting e-waste for each store, which is also responsible for phone manufacturing, to the point where it demonstrates a lack of monitoring and assessment on what is happening with these hidden problems caused by smartphone procurement. As NASA scientists conduct a rally about the remaining lifespan of the Earth, people should be aware of the hidden dangers behind useful devices or applications. This should be the beginning of solving the problem of electronic waste as early as possible by always seeking continuous improvement and strictly monitoring compliance. It should be made not only as a policy but as a hobby for everyone who owns and uses mobile gadgets.

The promotional campaign will be utilized on research is Internet Advertising since a lot of people are active on the internet especially social media. There will be a launch video on how this application works and its benefits to the user. Proving the video of how e-waste has affected the environment during the past time, reminding all of the people around the world to take care of the environment and giving the possible remaining time if this kind of activity does not change immediately. To create a more strategic plan on promoting awareness on Smartphone's Electronics Waste, the researchers created a strategic marketing plan that comprises three goals. First is to create partnership towards the manufacturing sectors and sellers of Smartphone, this is to establish the point of sale on customers, then to establish and create a strong base on internet advertising in order to raise awareness across the country and lastly to collaborate with organizations, institutions and government employees on corporate social responsibility activities to promote Environmental Protection towards the negative effect of technology advancement.

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