111 年度氣候變遷創意實作競賽
決賽作品說明書
國立中興大學

NetZerO

Team Members:

武阮明莊

文容嘉

庄秉勛

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決賽作品說明書

隊伍編號+名稱	16／AgriBuds
作品中文名稱	NetZerO
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參賽學校：國立中興大學

指導老師：陳思宏

團隊成員：武阮明莊 文容嘉 庄秉勛

Table of Content

1. **Chinese and English abstract of the work (less than 100 words)**

NetZer0 設計了一個生態系統，包括一個二合一智能盒子和智能應用程序，以提高對電子廢物回收影響的認識和了解。 此外，NetZer0 項目將提高台灣的回收率，因為我們為電子用戶提供激勵和選擇，以支持國際組織在剛果終止因鈷礦開採而遭受的童工勞動； 或森林遭受非法採伐。

NetZer0 has designed an ecosystem including a 2-in-1 Smart Box and Smart App to increase more awareness and understand about the impacts of e-waste recycling. In addition, recycling rate in Taiwan will be increased with NetZer0 project as we offer e-users incentive and options to support international organizations in either fighting to end child labor in Congo who are suffered from Cobalt mining industry; or the forests suffered from illegal logging.

2. **Problems**

   a. *Effects of e-waste on climate change and environment*

Electronic waste (E-waste) is electrical and electronic equipment of any kind that has been discarded or unwanted electronic products that have exceeded their shelf life (Terazon et al., 2006). Globally, there are **20-25 million tons** of e-waste yearly, categorized as unwanted electronics such as computers, phones, printers, and fax machines. Within the last 10 years, the main source of e-waste is from phones and personal tablets. E-waste has now become a global problem as large amounts are being transported overseas from developed countries to lower income countries for disposal. If the materials in e-waste are not recycled, they cannot substitute primary raw materials and reduce greenhouse gas emissions from extraction and refinement of primary raw materials. However, even when e-waste was being handled, traditional e-waste recycling methods released approximately **98 Mt of CO2**-equivalents into the atmosphere. This is approximately **0.3% of global energy-related emissions** in 2019 (IEA). In addition, e-waste disposal has contributed to climate change from the chemicals released when being burned. Electronics contain materials like copper (Cu), aluminum (Al), and iron (Fe), mercury, brominated flame retardants (BFR), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), polybrominated diphenyl ethers (PBDE) and polybrominated biphenyls (PBBs) are the principal toxins released to the environment when electronics are burned. PBDEs are used as flame retardants in electronics, and during combustion also release carbon dioxide (CO_2) (1&2).

   b. *Effects of e-waste on biodiversity and health human health*

It is estimated that mass emissions of PBDE which is between 82,207 and 188,118 tons, alongside with 50 tons of mercury and 71 kt of BFR plastics from the undocumented flows of e-waste have been

released into the environment annually. This causes a serious health risk to humans and wildlife as toxins can contaminate the soil and water which are in turn accumulated by organisms (1).

c. *Low rate in e-waste recycling*

In 2019, the world generated 53.6 Mt of e-waste with an average of 7.3 kg per capita. However, despite the high amount of e-waste generation, the recycling rate is still very low. Recycling rate in Asia is 11.7%. While Taiwan is ranked as one of the countries with the highest mobile ownership (3), last year, the rate of recycling mobile phones in Taiwan was only 5.2% (4).

d. *Waste raw material*

In today's modern world, e-waste has been gradually considered as 'urban mine' because it contains precious, critical, and other non-critical metals including iron, copper, and gold that, if recycled, can be used as secondary materials. The value of raw materials in the global e-waste generated in 2019 is equal to approximately $57 billion USD. The recycling of iron, aluminum, and copper could contribute to a net saving of 15 Mt of CO_2 (2).
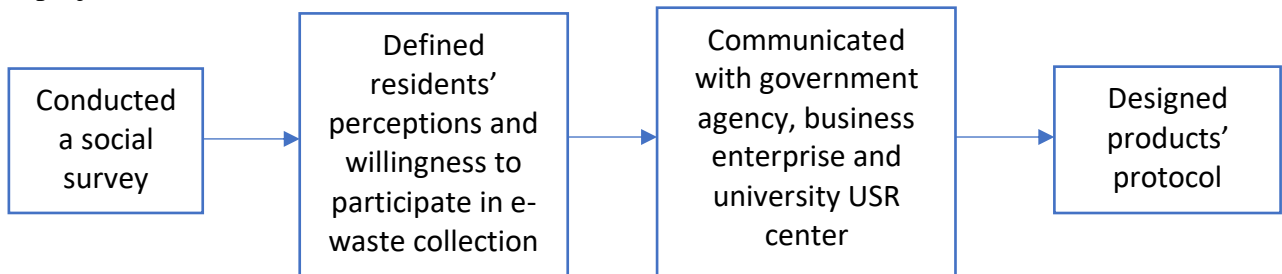
e. *Cobalt and the child labor*

The Democratic Republic of Congo (DRC) has some of the world's most valuable minerals, such as copper, gold, coltan, cobalt, and diamonds, and has the earth's second-largest forest after the Amazon. In addition, more than half of the world's cobalt resources are located in the DRC with over 70% of the world's cobalt mining occurring there (5). Cobalt is a crucial raw material used by large tech companies mainly for rechargeable lithium-ion batteries in electronic devices, and electric cars. However, the mining industry has caused environmental abuses, and corruption in the DRC (6). Moreover, out of the 255,000 Congolese mining for cobalt, 40,000 are children. While they would earn less than $2 per day, their job was done mainly by using their hands which greatly damaged their health (7). Unfortunately, as the technology-driven surge in cobalt continues to grow, demand for cobalt is projected to grow by 60% by 2025 (8), meaning those issues mentioned above would only continue to grow.

3. NetZer0 Project

a. Project's aim

This project aims to identify the reasons for low recycling of personal gadgets (mobile phones and Ipads/ tablets) in Taiwan in order to fill out the gap between low rate of recycling, high amount of raw material being wasted, and the impacts on the environment from traditional urban mining. The steps of our projects are illustrated as below:

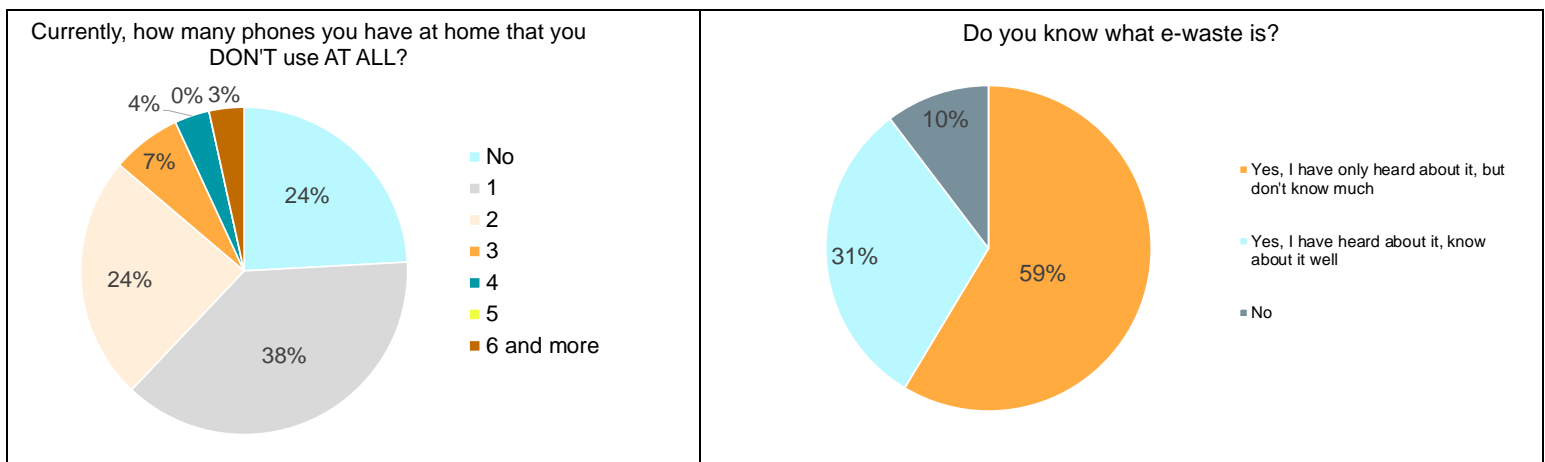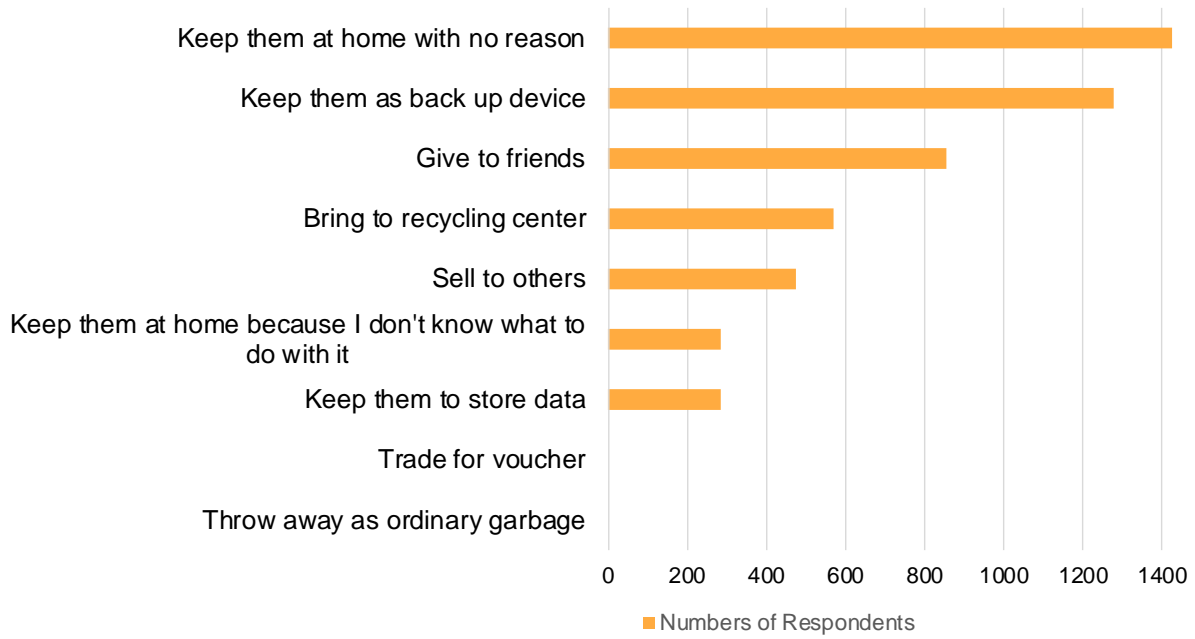| Conducted a social survey	→	Defined residents' perceptions and willingness to participate in e-waste collection	→	Communicated with government agency, business enterprise and university USR center	→	Designed products' protocol

b. Survey results

From our survey from 1450 respondents throughout Taiwan, it confirmed that 76% of respondents have at least 1 device at home that they don't use at all; only 31% really know what e-waste is; and 72% have never recycled their phone or tablets/ ipads, and the top 3 reasons were:

1) they don't know e-waste is harmful to the environment;

2) they don't know e-waste contains recyclable and valuable material;

3) they know very little about what they should do with their waste and where they should bring their waste to.
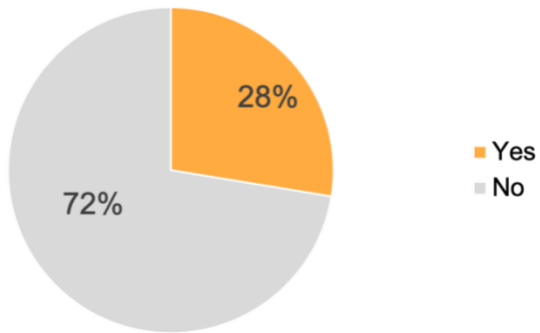
While asking if the respondents would recycle their wasted devices more there is an e-waste collection program in which residents can drop off their devices to a smart bin placed conveniently in public places and residents will receive incentive for their recycling, 97% responded with yes.


Currently, how many phones you have at home that you DON'T use AT ALL?
- 4%, 0%, 3%, 7%, 24%, 24%, 38%
- Legend: No, 1, 2, 3, 4, 5, 6 and more

Do you know what e-waste is?
- 10%, 31%, 59%
- Legend: Yes, I have only heard about it, but don't know much; Yes, I have heard about it, know about it well; No

How do you treat your previous e-waste?

Category	Numbers of Respondents
Keep them at home with no reason	~1420
Keep them as back up device	~1280
Give to friends	~850
Bring to recycling center	~570
Sell to others	~470
Keep them at home because I don't know what to do with it	~290
Keep them to store data	~290
Trade for voucher	0
Throw away as ordinary garbage	0

Have you ever recycled your electronic devices?

- Yes: 28%
- No: 72%

If there is an e-waste collection program that residents could easily drop the waste devices in public places and who recycle e-waste would get incentive/ reward, are you willing to participate?
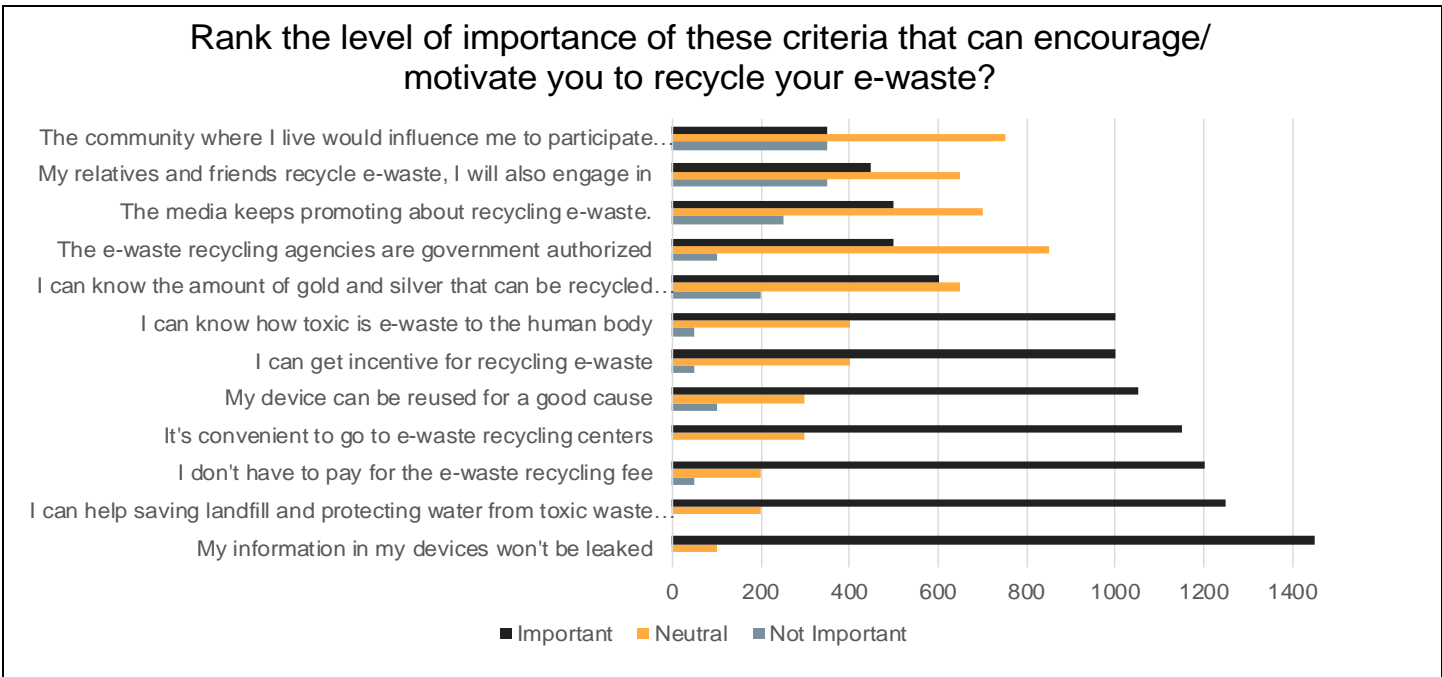
- Yes: 97%
- No: 3%
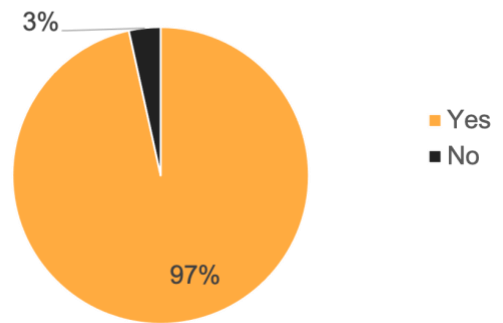
Figure 1. Few of NetZer0 Social Survey about Residents' perceptions and willingness to participate to an e-waste collection in Taiwan

c. Solution

From our communication with key partners including International Climate Development Institute, Taiwan Hsinchu Green Industry Association, UWin company who is developing and promoting the practice of eco- urban mining and results from residents' survey, we confirmed that in order to fill out the gap between low rate of recycling, high amount of raw material being wasted, and the impacts on environment from traditional urban-mining, the most suitable solution is a special logistic hub that can handle recycled mobile phones and ipad/tablet/laptop as well as can act as a platform to provide up-to-date information relating to e-waste recycling in order to increase residents' awareness in e-waste recycling. Our solution is creating an initiative acting as a special logistic hub handling recycled mobile phone and ipad/tablet. This special logistic hub relies on an ecosystem between a 2-in-1 smart box and a mobile application. The 2-in-1 smart box acts as an e-waste smart bin that can collect residents' wasted devices, and at the same time, a vending machine that can resell wasted devices.

2-in-1 Smart box	Smart App

Figure 2. NetZer0 project products
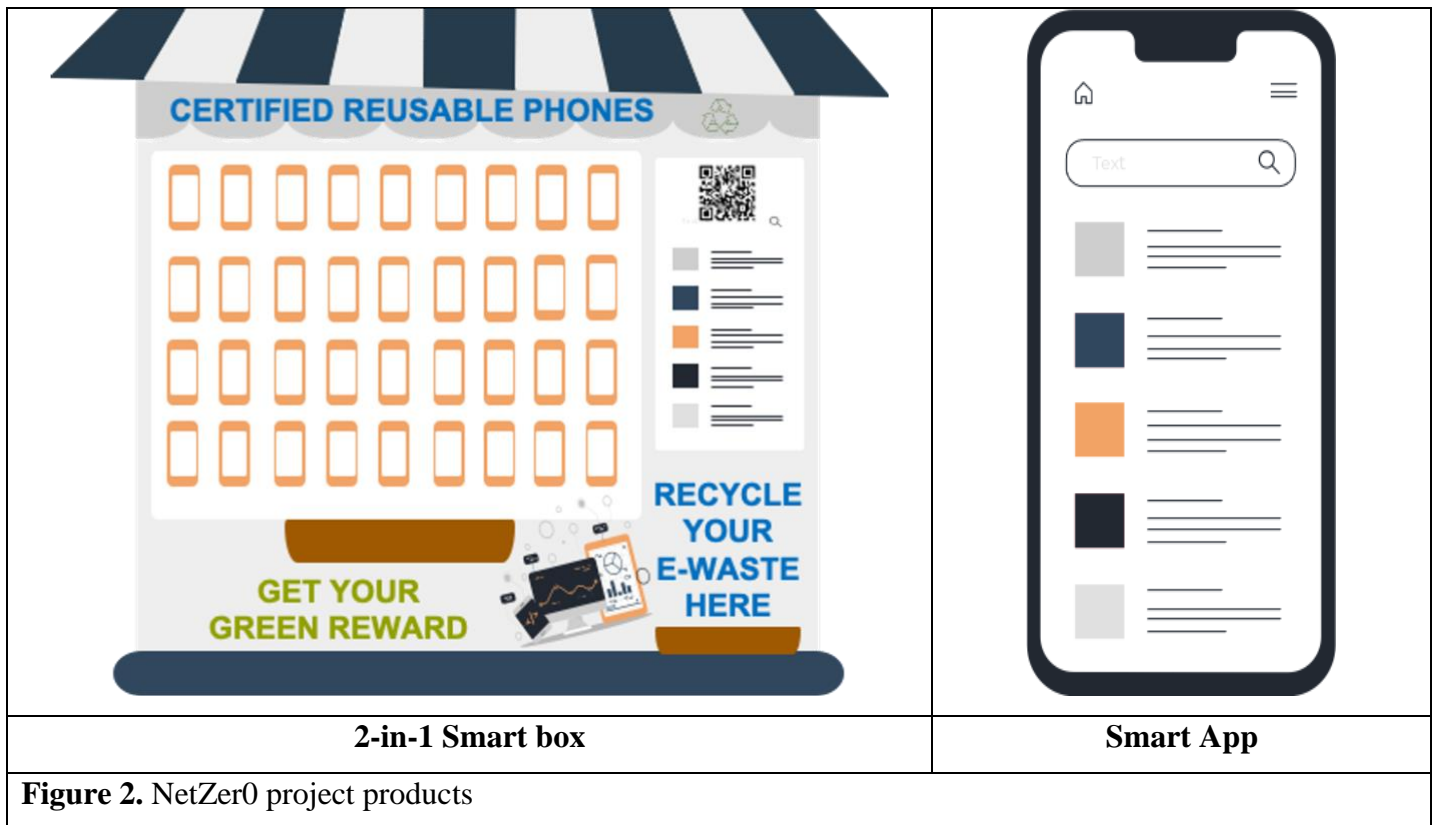
4. Concept design

Functions of this ecosystem are illustrated in figure 3. All of those tasks are upon the residents' requests, consents and agreements, and residents will receive incentive from their recycling to encourage more e-waste recycling. The incentive will be transferred to EZ card and the amount of the incentive will be dependent on which they would want their devices to be handled, either disposing for parts, donating as a whole or reselling. In addition, profits generating from working with an eco-urban mining company, or from reselling the devices will be used for 3 reasons: 1) to provide support to children in the DRP through UNICEF; 2) to donate devices as GPS and calling devices to protect trees from illegal logging (9); and 3) to operate the logistic process.

With the 2-in-1 smart bin which will be placed in places like public areas, universities, schools and train stations, it will be much easier for residents to dispose of their devices. Alongside with the mobile application, Netzer0 provides a close ecosystem in which residents will be able to track the process of logistic their disposed devices as well as know what they will be used to. Whether the devices are disposed for parts, for reselling or for donating to fight against illegal logging, residents will be the one to make the decision.
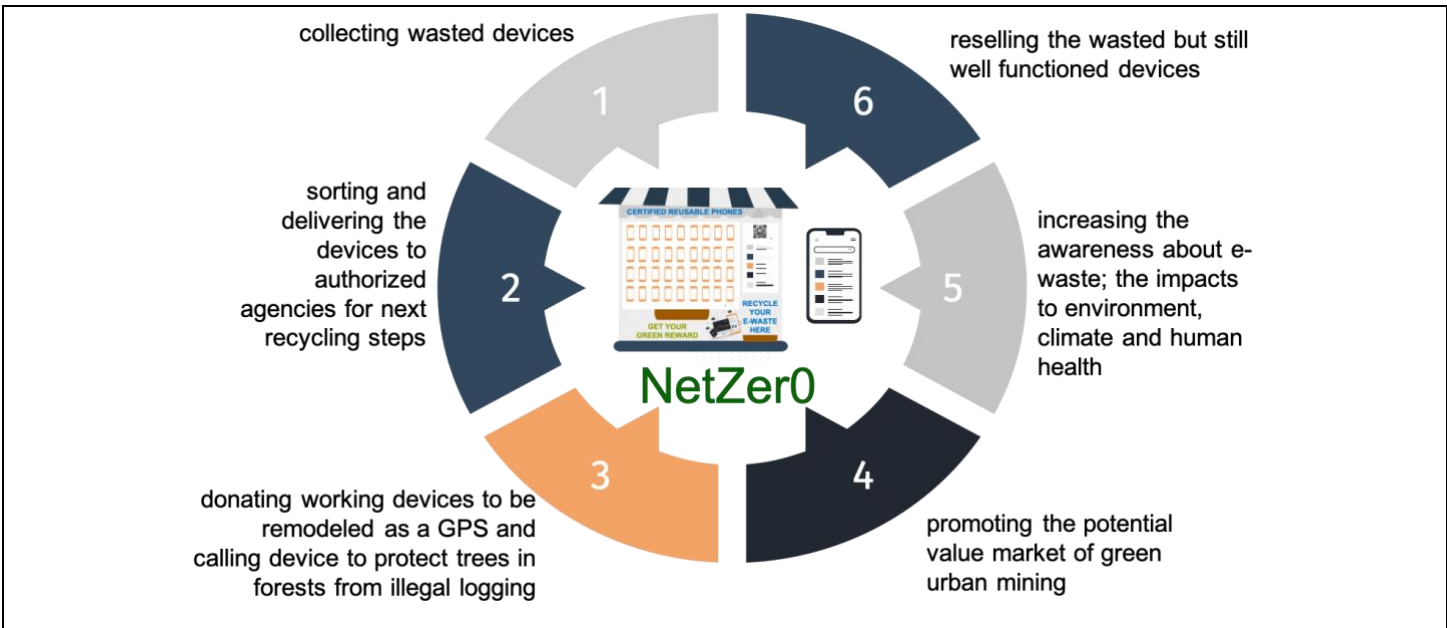
Figure 3. NetZer0 ecosystem functions

5. Operation description

NetZer0 is designed with a goal of ensuring the most convenience for residents to look for information about e-waste recycling as well as tracking their disposing of their devices. The ecosystem uses a cloud base for input and processing the data. At the same time, NetZer0 also makes sure that it can provide a circular economy to the e-waste recycling management, leaving no more waste left behind.
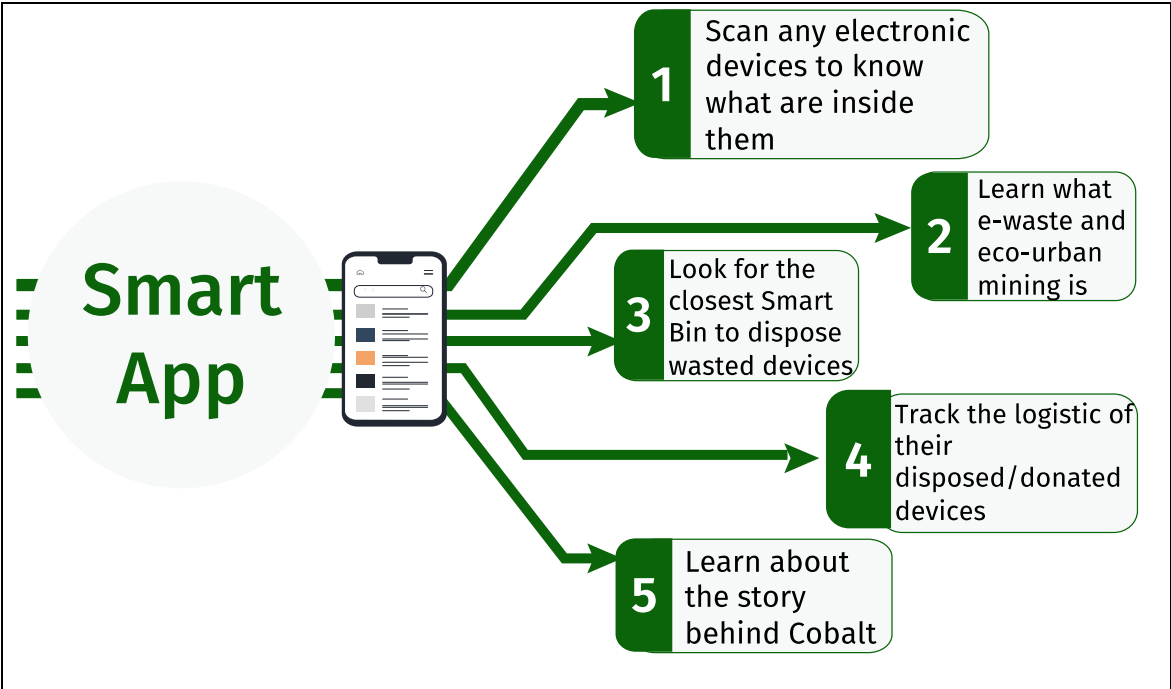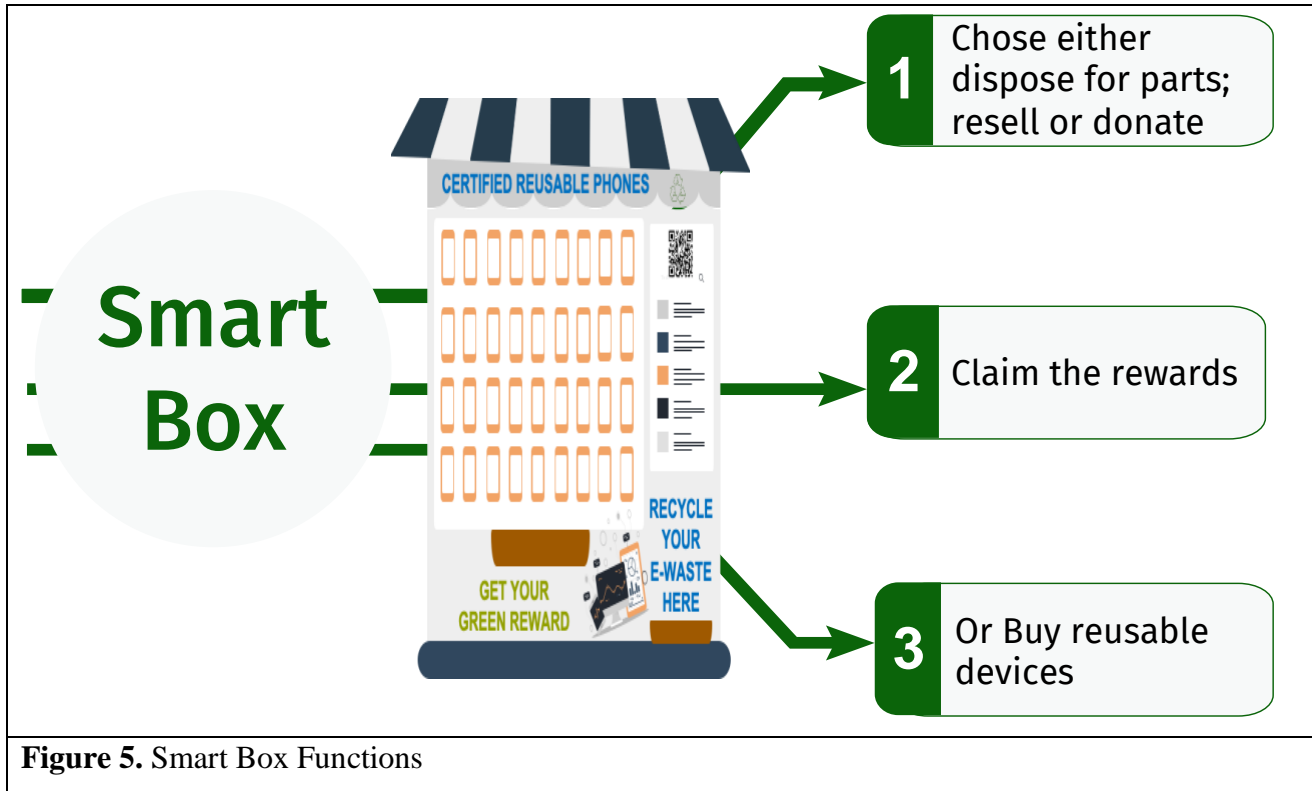
a. Smart App

Figure 3. Smart App Functions

b. 2-in-1 Smart Box

Figure 5. Smart Box Functions

The figure shows the following callouts:
- **1** Chose either dispose for parts; resell or donate
- **2** Claim the rewards
- **3** Or Buy reusable devices

Labels on the box: CERTIFIED REUSABLE PHONES, RECYCLE YOUR E-WASTE HERE, GET YOUR GREEN REWARD. Center label: Smart Box

6. Description of work

a. Smart App

NetZer0 Smart App is a mobile application with an eye-catchy user interface. The application is a bridge for consumers to learn more about what is inside their electronic appliances (including metal and hazardous elements, foot print), the story of cobalt, to know how toxic those elements are to the environment and human health, and to locate closest e-waste recycling centers as well as NetZer0 Smart. Moreover, users can easily find e-waste collection sites or our smart boxes that are closest to their location.

NetZer0 application users may access a variety of fascinating information on the negative environmental effects of e-waste, which is believed to encourage people's desire to decrease their e-waste. Moreover, the NetZer0 project has capabilities that allow users to scan their devices and estimate how much natural resources could be recycled from their devices and how much impact that the users will contribute to the environment. In addition, the users can earn "green points" through EZ card for any activities including discounts for their next purchase of electronic devices. The NetZer0 project also acts as a liaison between Taiwanese firms involved in e-waste management and persons who own e-waste. Our

main goal is to increase awareness about e-waste from e-devices users as well as establish relationships with e-waste collecting sites, e-waste private companies and commercial e-devices companies.
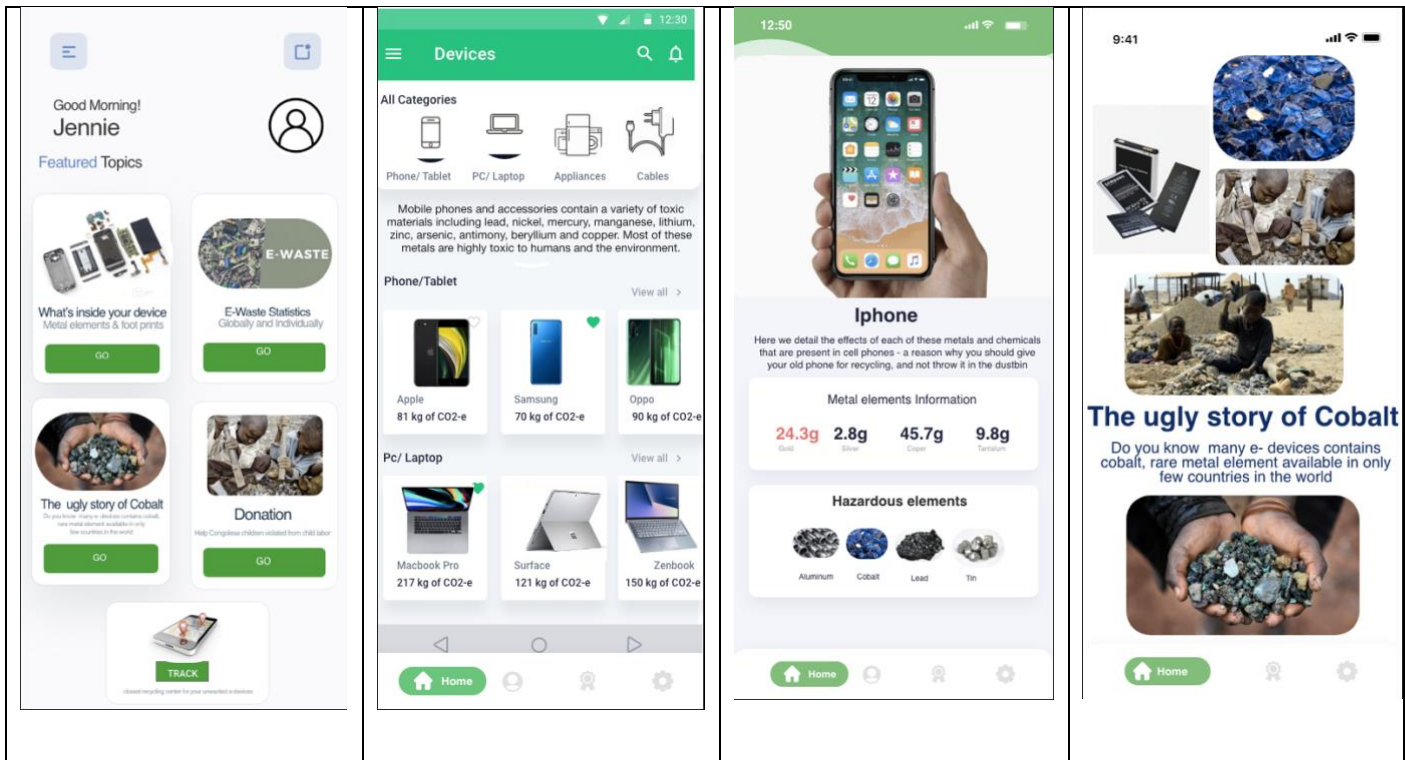

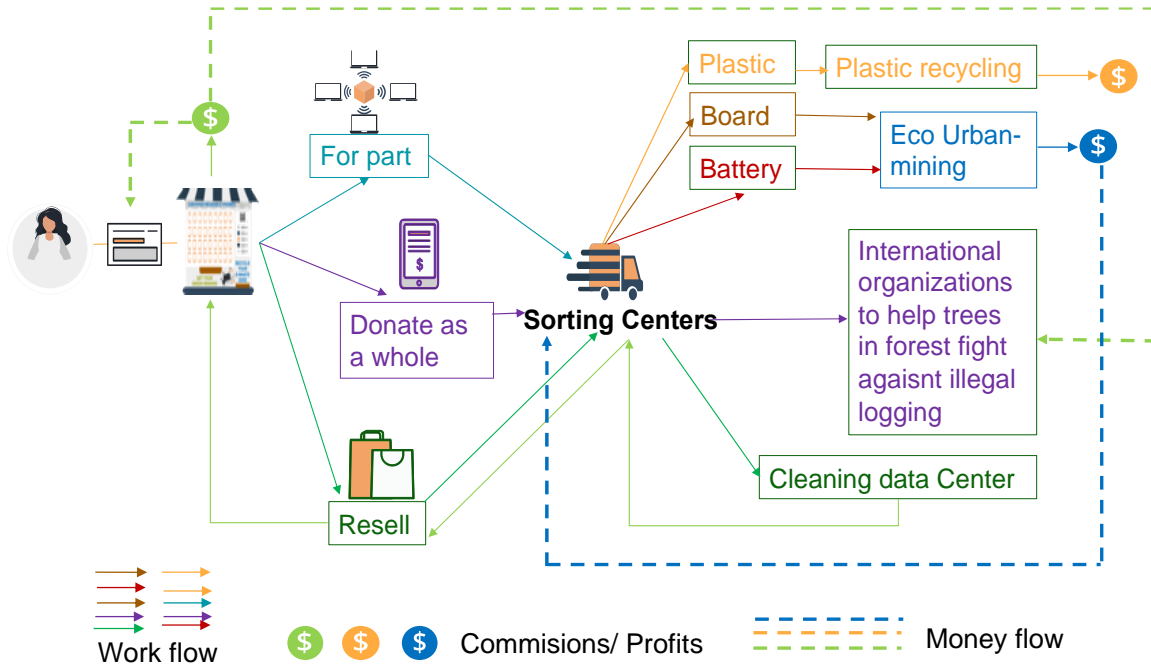**Figure 6.** Demo of NetZer0 Smart App

b. *2-in-1 Smart Box*

Figure 7. Flow work of 2-in-1 Smart Box

The entire flow of the logistic process can be tracked by the users from using the Smart App. This whole ecosystem emphasizes the transparency of the process and money flow in order to ensure the residents their devices are disposed of or recycled as they want.

7. Descriptions of creativity

- 2-in-1 box as e-waste bin and vendor machine
- Closing ecosystem
- Residents can track all the logistics process
- Vending machine for used phones and tablets/ Ipads/ Laptops
- Residents can check information about what are inside their devices by scanning the devices
- Promote eco-urban mining
- Direct the wasted products directly to the needed companies
- Increase awareness about Cobalt
- Enhance sustainable strategies in waste management which is "reduce, reuse, recycle"
- Provide companies "green" opportunities to direct their CSR and ESG budgets

8. Business Canvas Model

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
• UWIN (eco urban mining) • NCHU USR • Taichung City Government – youth volunteer organization • Electronic waste recycling companies **Motivations for Partnerships** Optimization and economy, Reduction of e-waste, Acquisition of particular resources	• Establishing collaboration with partners • Internet marketing • Connect electronic users with recycling company • Developing mobile application **Key Resources** Intellectual (brand patents, copyrights, data) Business partners Commission and subsidies	• Provide raw materials to the recycling company • Provide valuable information about e-waste • Provide ease / convenience for e-waste users to dispose their e-waste • Reduce the e-waste	• Providing convenience way to dispose e-waste • Providing effective way to save raw materials (copper, gold, silver, and etc.) **Channels** Internet marketing and social media Networks of the key partners	• E-waste recycling company • Electronic devices users • Government • EPA (Environment Protection Agency)

Cost Structure	Revenue Streams
Technology development	Commission from: 1. Recycling companies 2. UWIN (eco-urban mining) 3. Electronic companies 4. Telecommunication companies 5. Subsidies from the government

9. Cost & Benefit Analysis

Taiwan produces around 28.7 tonnes of wasted mobile phones and accessories every year (10), while each phone is estimated to house around 0.034g of gold, 0.34g of silver, 0.015g of palladium and less than one-thousandth of a gram of platinum. It also contains the less valuable but still significant aluminium (25g) and copper (around 15g) (11 &12). One phone is averagely weights as 170g, and with 28.7 tons of phones (approximately 168,824 phones), the amount of value that Taiwan has wasted on phone is illustrated in table below:

One phone	Weight (g)	Market Price (USD)	Total price
Gold	0.034	61.16	2.07944
Silver	0.34	0.75721	0.2574514
Copper	15	0.01	0.15
Palladium	0.015	75.02	1.1253
Aluminum	25	75.02	1875.5

	1879.11
168,824 phones	**317238352.3**

With a circular economy and net zero carbon emission as goals, Netzer0 focuses on partnering with businesses who focus on sustainability as well. Among them is Uwin who has developed and promoted the practice of eco- green urban mining. Below are their comparison between using eco- urban mining to extract valuable elements from board versus traditional urban mining technology. It shows that with eco- urban mining, not only economics enjoys the benefits, but also the environment. This is why NetZer0 focuses on partnering with Uwin to promote the eco-urban mining technology.

	Boards	BGA/IC	MLCC	SIM card connectors	Total (per kg)	Total (per ton)	Total (USD/ ton)
Au	0.057 g	0.293 g	0.0264 g	0.0264 g	**0.402 g**	402 g	18090
Ag	0 g	0.36 g	0.48 g	0.0037 g	**0.844 g**	844 g	479
Pd	0.00165 g	0.0044 g	0.01 g	0	**0.0161 g**	16 g	295
Sn	71.6 g	0 g	0 g	0 g	**71.6 g**	71600 g	1398
Cu	228 g	5.5 g	2.1 g	10 g	**245.6 g**	245600 g	1138
						Total	21400

Figure 8. Eco-urban mining from Uwin vs. traditional urban mining. Source: (13, 14 & 15)

10. SWOT Analysis

Strengths	Weakness
• Increase awareness of harmful consequences of disposed wastes. • Connect e-waste users and collect e-waste sites • Connect e-waste users and electronic device commercial companies as well as telecommunication companies • Reduce of dumped e-waste	• The lack of interest from society about e-waste
Opportunities	**Threats**
• Create multiple connections between key partners • Earn commission from green e-waste companies • Low price of operating	• Technology development

11. Feasibility and development potential

Eco- urban mining has proved to bring benefits to both economics and the environment. The technology of eco- urban mining has been developed and promoted by UWin Company in the past years. In addition, lithium-cobalt ion batteries now can also be recycled by using eco- urban mining technology. Uwin has been working with companies such as Apple and Samsung for supplies, however, as the recycling rate of phone and tablets/ ipads/ laptops in Taiwan is low, their supplies from Taiwan are not as much compared to other countries. Hence, with NetZer0, the recycling rate of those personal gadgets will be improved, and more supplies directly from residents will be delivered to companies such as UWin for eco- urban mining.

As NetZer0 has conducted a social survey to understand the residents' perception and willingness to participate in an e-waste collection program as well as has previously partnered with UWin company who is promoting the practice of eco-urban mining in Taiwan and other countries, the potential of making this ecosystem is very feasible. Results from our survey has firmly indicated that if e-users understand the impacts of e-waste recycling as well as if they can earn benefits and give donations to people needed in Congo and the forests suffering from illegal logging, e-users will be willing to recycle their e-waste more.

12. Work assignment of team members

- Concept and Product Design: 武阮明莊

- Survey designer: 文容嘉

- Coordinator: 庄秉勛

13. Contributions to UN SDG

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