HUMAN HEALTH BENEFITS IN VIETNAM’S E-WASTE MANAGEMENT STRUCTURE

Research question:

To what extent is Northern Vietnam's E-waste recycling structure more beneficial to human health in the formal sector?

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Introduction

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Electronic and electrical waste (E-waste) refers to the discarded electronic equipment that are nearly at the end of their "useful life" (Great Lake Electronics Corporation, 2021). The term covers a wide range of categories, from large machines such as refrigerators or washing machines, to smaller IT equipment such as mobile phones and laptops. These items can be reused, resold, refurbished, recycled, or ended up in landfills. The frequent use and discard of these devices in human daily operations make them the chosen subjects for this investigation.

E-waste is a global threat, especially to developing countries such as Vietnam. In recent years, the country has been seeing exponential growth of 20-25% annually in the discard of e-waste, as the technology industry has been striving and the growth of the middle-income population gave rise to the number of households owning electronic devices. (Nguyen, 2020, 4) With Vietnamese's lack of awareness about E-waste, the situation poses more risks rather than brings back benefits, especially to Vietnam's waste management structure, and threatens the safety of workers in the field, due to various reasons.

Firstly, there is a high dependence on the informal sector to process the E-waste. In May 2015, The Prime Minister of Vietnam passed out Decision No .16/2015/NĐ-CP and No .38/2015/NĐ-CP, highlighting that *"unusable electronic devices which are categorized as harmful waste must be collected and processed by the units with certification from the Ministry of natural resources & environment that allows the handling of toxic waste"* (Báo điện tử Chính Phủ, 2021). Although the legislation may serve as a base to the management of E-waste, due to lack of specific and strict regulations, much of the E-waste is still being processed by the informal sector across the Northern's 61 informal sites (Nguyen, 2020, 13). There are only 3 formal sector organizations fully equipped to treat the waste across Northern Vietnam (Hien et al. 2019). Moreover, the manual dismantling of the waste in the informal sector forces workers to be exposed to the toxicity contained in the devices (mostly chemicals and heavy metals), which might pose risks not only to their health but also to the people living nearby. These include organs failing, premature and defected birth, cancer, etc (WHO, 2021). With one of Northern Vietnam's largest informal sector craft villages based in my grandmother's hometown in Hung Yen province, I feel the urge to conduct research discussing the potential health impacts of E-waste on craft villagers.

Fig 1: Vietnam's location (Google map)

Secondly, the flow of E-waste into Vietnam is unpredictable. Located in SouthEast Asia, Vietnam shares borders with countries such as China, Laos and Cambodia. This contributes to the unrecorded illegal importing of E-waste for handling in the informal sector (Nguyen, 2020, 14). Due to high demand and need of finance, workers highly undervalued the hazardous health impacts E-waste poses, and therefore continue to do the jobs without proper protection equipment such as gloves or masks (Appendix A). Furthermore, the lack of technology to treat the toxic chemicals in the E-waste leads to workers only dismantling the plastic cover of many devices, and the rest of the components are disposed in landfills or being burned in incinerators, producing combustion that leads to respiratory issues.

Fig 2: Northern Vietnam map (Luong, 2013)

This research is essential to evaluate the impacts of mishandling of E-waste on human health and safety in the informal sector. The scope of the essay will be a discussion and comparison of the informal and formal sectors, focusing on analyzing the different processes in each one, sources of e-waste, and challenges in the handling of this type of waste to explore the potential health hazards. It includes interviews with "craft villagers" at Hung Yen to view their opinions on the issue, and data gatherings from official reports, past papers, published journals, and local news to gather reliable information for the discussion. It also includes analysis of the chemicals and metals contained in the sample electronic devices.

Methodology

1. Secondary sources

This research explored a wide range of data collected from official reports, university papers, published journals, and local news. Most of the data were accumulated from reports of university researchers. For example, estimation of E-waste growth rate and toxic components contained in the electronic devices were taken from Nguyen, T. N.'s report at Vietnam's Ministry of National Resources and Environment; potential E-waste health impacts and E-waste recycling structure were referred from Huynh et al. at Hanoi University of Science and Technology and WHO articles.

2. Primary sources: Interviews at craft villages

Besides the secondary resources, the research was carried out directly at the informal sector craft villages based in Hung Yen province through interviews with authorities, local environmental police, and most importantly, the craft villagers. The aim was to gather information from different perspectives to construct a discussion objectively. As Hung Yen based some of the largest craft villages in Northern Vietnam, it was chosen as the location to do primary research. A random of households in the dismantling field were selected (reference to Appendix C), and they were asked questions focusing on the daily amount of E-waste processed by each household, the dismantle and recycling processes, the sources of E-waste, the export destinations, the reasons they chose to work in the field, their opinions on the health impacts of E-waste, and many more (reference to Appendix A). These questions aim to gather villagers' views on E-waste and provide insights into the recycling structure in the informal sector. Most of them had experience working in the dismantling field.

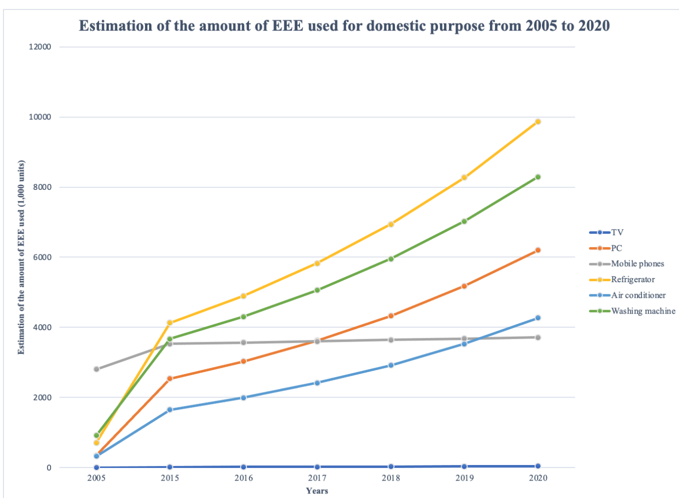
Sources of E-waste in Vietnam

The research focuses on analyzing the sources of E-waste from 3 main areas: Domestic usage and discard, transboundary waste import, and industrial usage.

1. **Domestic usage**

The recent years have shown a significant increase in the importing and producing of electronic and electrical equipment (EEE) for domestic usage. According to (URENCO, 2007), the largest share of EEE in Vietnam includes equipment such as mobile phones, laptops, refrigerators, washing machines, and televisions (TVs). As electricity has become more affordable and bigger parts of the population reach the middle-income range, more people decided to purchase the devices to assist their daily operations, which leads to a higher demand for the electronics industry. The chart below shows the estimated increase in the number of EEE entered the market from the year 2005 to 2020:

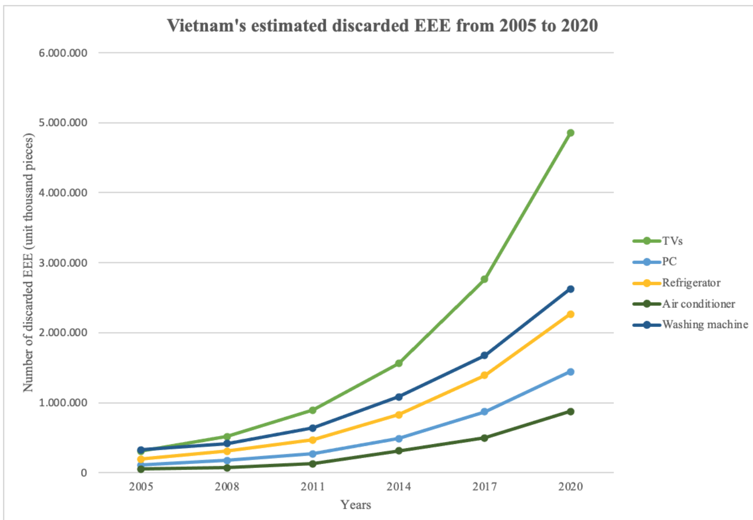
Fig 3: Estimated number of Vietnam's E-waste from 2005 to 2020 (URENCO, 2007)



According to the graph, all of the chosen devices experienced rapid growth in usage numbers during the period of 2005-2020. Although not clearly shown on the graph, TVs were actually the second fastest-growing equipment, with almost 20% in annual growth rate, behind air conditioners with 21%.

The graph below shows the E-waste discarded from the year 2005 to 2020:

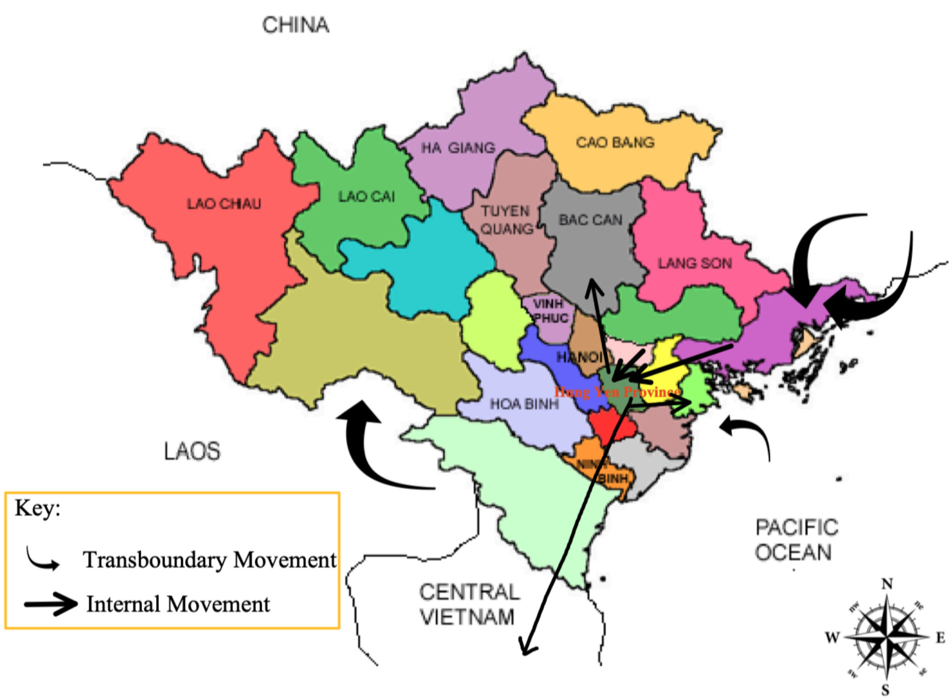
Fig 4: Estimated pieces of Vietnam's discarded E-waste from 2005 to 2020 (URENCO, 2007)



TV was again the equipment with the largest discard throughout the years with almost 5 million pieces being thrown out, and it has been experiencing exponential growth in waste production from the year 2014. (Tran et al., 2014) recognized this trend as being caused by people's preferences to replace old TVs for newer ones rather than giving to other consumers. (Huynh et al., 2015) reported that Vietnam generated 1.3kg of E-waste per capita annually, but this number was only an estimation of the average reported waste. The unreported domestic waste was not taken into account, especially those that are collected by private collectors. Domestic E-waste accounted for 2% of total waste in Vietnam but they have tremendously high toxicity (Nguyen & Tran, 2019).

2. Transboundary waste import

Fig 5: Movement of E-waste into and within Northern Vietnam (Hai, 2014)



As shown on the map, the largest transboundary E-waste flow into Northern Vietnam came from China and Laos. As Vietnam shares a long border with these 2 countries, much of the illegal imports and exports are happening at Quang Ninh (through mountains) and Hai Phong (through seaports). Vietnam mostly imports used EEE from foreign countries to disassemble and refurbish them to be re-exported (Nguyen, 2020). In 2013, the government announced Decree No .187/2013/ND-CP on the commercial law regarding the importation and exportation of goods with foreign countries, and the legislation was enforced on February 20, 2014. It strictly pointed out that used electronic applications are banned from being imported into Vietnam, unless they are imported for specific purposes such as to support scientific exploration or to be temporarily imported and then re-exported (Báo điện tử Chính Phủ, 2021). However, despite the law, illegal importing of E-waste is inevitable, as the country's physical landscape provides favorable conditions for the private sectors to trade E-waste transboundary. In 2009, a case of illegal

Fig 6: Vietnam's shared border (Google map)

importing of used EEE was reported: there were 400 tons of discarded lead battery and 40 tons of used EEE from Hong Kong waiting to cross the border. Since the traders denied their responsibility, all of the E-waste was then destroyed in Vietnam with funds from government organizations (Yen, 2020).

After E-waste is imported, much goes to "craft villages" in the informal sector to be treated. From the direct interviews with craft villagers at Hung Yen, the respondents said they mostly received the waste from traders and private sections, and after dismantling, reusable parts will then be sold to other stakeholders to be re-exported to foreign countries. In their opinion, parts of this process are considered illegal, but they still do it for the stable income.

3. **Industrial usage**

A majority of E-waste sourced from industrial usage are big machines such as medical equipment, mining equipment or agriculture machinery. The smaller ones include PCs, projectors, etc. Unlike domestic waste, industrial E-waste is often processed in the formal sector, on a business-to-business basis (Huynh et al., 2015).

Treatment of E-waste - the formal sector

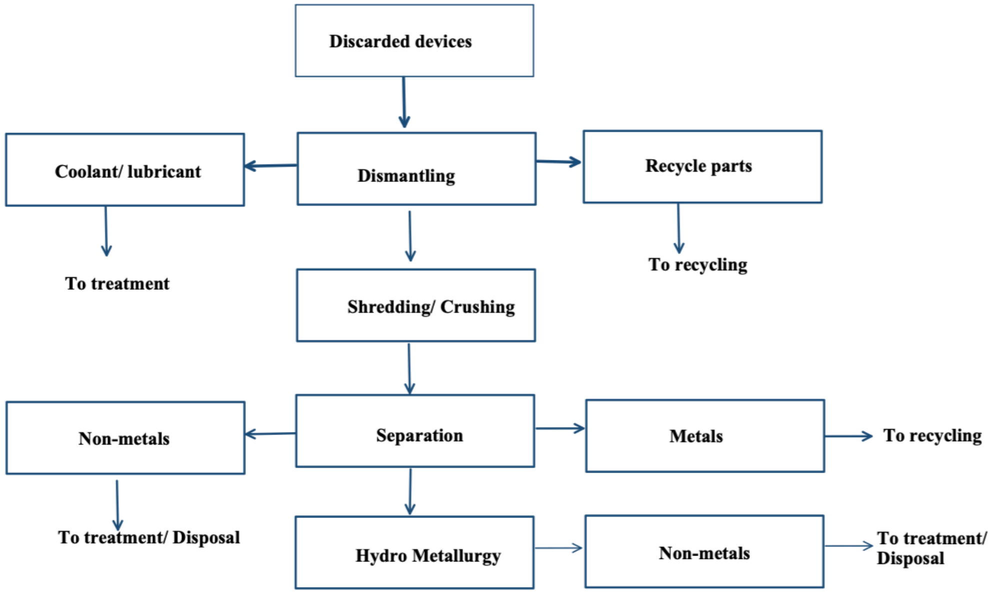
After E-waste is generated, there are 4 routes the waste can go into (Forti et al., 2018):

- Formally collected and treated by national organizations

- Informally collected by individual companies but treated by standard management structure
- Ended up in trash bins
- Informally collected by private sectors and treated in informal sectors such as "craft villages"

In Vietnam, the formal sector includes routes 1 and 2. Across Northern Vietnam, there are only 10 formal sector organizations qualified to treat the waste (Hien et al. 2019). Some are Tan Thuan Phong Company (collecting and treating industrial waste), URENCO (collecting, treating and recycling), Vietnam Recycles (collecting and recycling), RLG (re-purchasing, collecting, treating and destroying), and others. These are organizations that are certified by the government to deal with hazardous waste, based on Decision No. 155/1999/QĐ-TT (identifying hazardous materials and publishing requirements and responsibilities of formal sector organizations) and Circular No.36 /2015/TT-BTNMT (guidance for hazardous waste management including storing, transporting, treating and disposing of HW). During the process of treating E-waste, workers manually dismantle the devices and separate them into different categories, such as recyclable parts (e.g plastics, glass, batteries) and non-recyclable (e.g PC liquid coolant) (Huynh, 2014).

Fig 7: Formal sector model of E-waste recycling (Hai et al. 2015)



The materials will then be further separated using a powerful magnetic overhead to separate heavy metals and lighter ones, and no worker is needed in this stage. Hazardous materials such as lubricants are completely removed, while heavy metals and other non-hazardous materials are washed and then further treated using technologies.

In Northern Vietnam, there has been a rise in the implementation of modern technology to treat E-waste by big companies. The most widely-used one is low-energy hydro-metallurgy - a separation and collection technique used to utilize the preservation of copper. There are 3 steps included in the process, as described by (Hocking, 2005):

1. *Acidophiles*: Using extreme acids as a solvent to melt the metals.
2. *Bioleaching*: Using microorganisms, such as At. ferrooxidans to collect heavy metals from E-waste sludge. This wastewater contains the highest concentration of heavy metals.

3. *Metal recovery*: Using electrolysis or cementation to retrieve pure copper.

Hydro-metallurgy is proven to yield acceptable recovery rates, as using acid can preserve 9-95% of the metals in the devices (Ahamed, 2020). However, the melting and discarding of the waste is less beneficial to workers and the surrounding environment, as fast leaking can lead to contamination of the soil near the processing areas. The associated risks include severe burning and possible crop genetic alteration, as well as contamination of the sewage system if not handled properly (Isildar, 2018).

Another method used by the formal sector is controlled combustion by incinerators. This method is carried out after the shredding/crushing processes, and the aim is to gather the recyclable metals from the mixture's remains. One drawback of this method is that it produces toxic emissions that require proper disposal to minimize the impacts.

Tan Thuan Phong is one of the first organizations in Northern Vietnam qualified for hazardous waste treatment (Trang vang truc tuyen, 2001). The company uses a variety of technologies to deal with E-waste, including combustion and hydro-metallurgy. Its 11 facilities include a large incinerator (capacity 2,000kg/hr), chemical treatment system (capacity 17,000kg/hr), hydro-metallurgy (capacity 1,200kg/hr), and more. The company even has a separate system to recover copper sulfate from E-waste plunge. They claimed that the whole treatment process is being monitored strictly to minimize the impacts on workers' health and the surrounding environment and being tested by government agencies for safety every 4 months, following Decision No. 2909/QĐ-SLĐTBXH (Haiphong.gov.vn 2020). It is mandatory for workers to wear masks, gloves, goggles, and protection clothes while entering the treatment area. Moreover, Tan Thuan Phong's 187 workers receive quarterly health checks and certified training to deal with hazardous waste. Besides their monthly salaries of 8,000,000 VND, the workers receive a 200,000 VND bonus of "health guarantee fee". The company also provides workers with free health and social insurance. Although most of the work is still being done manually, the importation of new technologies such as conveyor belts that lead directly to the incinerator is the company's effort to minimize workers' exposure to waste.

Fig 8: Sample image of the new incinerator (Tinkinhte.com, 2010)

Tan Thuan Phong's newest "invention", low-cost TTP - 4/1 incinerator, is being recognized as a "solution" to reduce emissions from combustion activities. The device includes 4 primary plus 1 additional burning incinerator, and an emissions treatment system using water's dampness to absorb the gases. The inventors claimed that the new device will help lower the toxic waste discarded to the environment, while minimizing the levels of gases at the site, reducing workers' exposure to the burned materials.

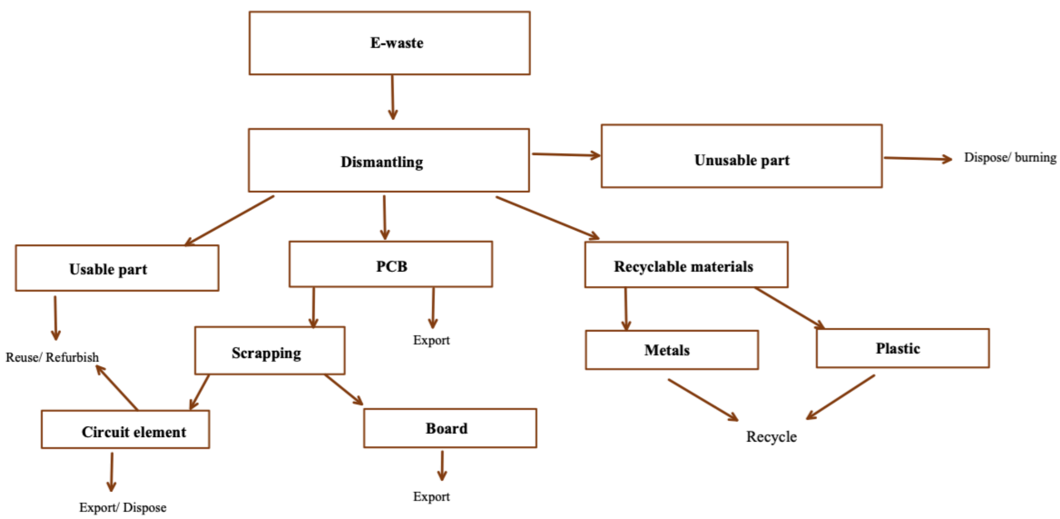
Treatment of E-waste - the informal sector

According to (Nguyen et al. 2019), the biggest reason for the high reliance on the informal sector to process E-waste is due to Northern Vietnam's lack of a reliable and stable E-waste treating system, which is currently unable to handle a large number of discarded electronics, so most of the domestic generated waste goes to the middle stakeholders - the "craft villagers" in the informal sector - to be dismantled and then exported/ resold to other businesses for further purpose. Moreover, the report mentioned that Vietnamese consumers often sell their discarded

Fig 9: Private collector (Kenh 14, 2018)

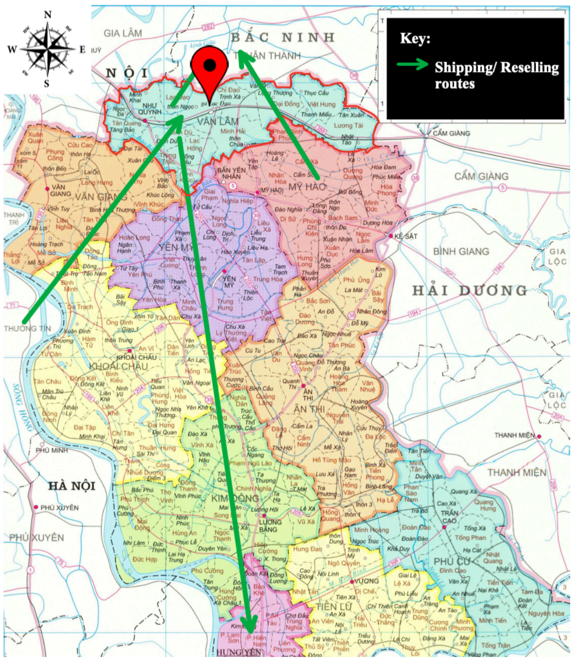
appliances to private collectors (thousands of whom travel between streets daily) and junk shops instead of bringing them back to their manufacturers, giving rise to the number of E-waste being treated in the informal sector. (Nguyen, 2017). The recent years have been seeing an increase in the number of official E-waste drop-off sites, such as the Vietnam Recycles program, but many consumers show disinterest as they prefer selling to collectors from whom they can get some money. The typical informal system is shown below.

Fig 10: Informal E-waste treatment system (Hai, 2014)



Dismantling and refurbishing are the most common activities being carried out by the "craft villagers" - countryside citizens whose income mainly comes from dealing with E-waste. Despite being aware of the toxicity of E-waste, more villagers have been switching from crop raising to part-time waste dismantling, which gives rise to the number of existing "craft villages" (Appendix A).

Fig 11: Van Lam, Hung Yen location (Galaxyland, 2020)



From the direct interview with craft villagers at Van Lam and Bui Dau, Hung Yen, I could summarize some key points about the system:

After receiving the waste from collectors, manufacturers such as Samsung Bac Ninh, or private shops, villagers will sort the waste into 3 categories:

1. *High-value E-waste:* PCBs, phones, etc to sell to big collectors after extracting the rare metals.
2. *Lower-value E-waste:* plastics, copper, iron, etc to resell to smaller collectors for recycling.
3. *Invaluable E-waste:* plastic dust, TV screen, etc to burn at the nearby landfills.

With category 1 devices, workers will mix the materials with charcoal, cement, and other chemicals to harden the components into packages before shipping out to nearby recycling and metalizing units (to Bac Ninh or Ho Chi Minh city, for example). The estimated daily import of 1 household is 2 tons, and monthly export is 40 tons. Most devices arrived at the recycling organization missing most of the valuable metals, leaving only some challenging-to-recover components (Nguyen, 2020, 10).

Because of the focus on dismantling and reprocessing, the informal sector is noticeably labor-intensive. The workers are often found not wearing any protective clothing, even gloves, and masks. When being asked about this, they answered: "Due to limited sources of finance, we think it is unnecessary to wear those". Without protection, frequent exposure to heavy metals in electronics such as lead or flame retardants leads to "slow-poisoning". Study by (Ngo et al., 2020) showed that heavy metals found in children's blood at My Hao village were significantly higher than in non-exposed children; study by (Go et al., 2014.) showed that DRCs levels in human milk are 3.2 times higher in women at Bui Dau village than woman at non-recycle villages. The researchers also found retardants in the breast milk of exposed women. These differences are correlated with the burning activities that produce dioxin and other compounds. Compared to the formal sector's workers, informal ones tend to be lacking suitable protective equipment and modern technology, making them more vulnerable to toxins.

Combustion plays a big role in the system, and materials are spontaneously burned in open air within landfills without any authorities monitoring or any filtration. Unusable parts such as batteries and circuit elements often end up at this stage. This action poses high risks not only to workers' health but also to the people' living nearby, as E-waste burning releases toxic gases containing concentrated metals like dioxins and furans, resulting in organ damages and skin abnormalities (Jayapradha, 2015). Moreover, heavy metals found in rice and water due to landfill leakage concern residents about the safety of supplies (Ngo et al., 2020). The dust can travel to other areas via acidified water. Workers also face risks of burning during the acid-metal mixing processes (this method is common in the informal sector as it can maximize the gold collected) (Lucier & Gareau, 2019). "Our daily operations are affected by the pollution from the trucks shipping E-waste to the village. They caused traffic jams and uncontrolled burning and disposing of waste along the roads", said a Van Lam villager (Appendix B).

Human health comparison

The list of elements identified as hazardous in some samples of electronic waste is shown below.

Fig 12: Common elements found in E-waste and the associated health risks **(Lucier & Gareau, 2019)**

Element	Main applications	Health risks	Ways of exposure
Lead	PCB, Phones, PCs, TV	Blood, kidney and neuron damage, brain and poisoning in children	Breathing/ swallowing substances with lead
Mercury	Batteries,	Long term brain and neuron damage	Consuming food with mercury (especially fish)
Cadmium	Batteries, Phones	Kidneys and liver damages	Breathing/ swallowing substances with cadmium
Plastics	ACs, PCs, Refrigerator, Phones, TV	Developmental issues, reproduction issues, carcinogenic when burned, endocrine effect, asthma, DNA damage	Breathing burned particles/ consuming food with plastic packaging
Beryllium	Phones, PCs, TVs, cable	Respiratory damages such as inflammation, blockage	Inhalation of dust/ vapors
Nickel	Batteries and wires	Lungs and kidneys cancer, stomach damages	Inhalation of particles
Zinc	Batteries, TV	Skin and lungs damages	Ingestion of materials containing zinc
Copper	ACs, PCs, Refrigerator, Phones, TV	Irritation of nose/ mouth/ eyes, vomiting and diarrhea, kidneys and liver damage	Ingestion of too much copper-rich food
Selenium	Photocopies	Loss of hair and nail, diarrhea, skin rashes, neuron damage	Breathing/ swallowing subtances with selenium
Brominated Flame Retardants	PCBs, PCs	Hormonal issues, immune system damage, cancer	Inhalation of burned particles
Barium	PCs, vaccum	Gastrointestinal disorders, muscular weakness	Inhalation/ ingestion
Cr+6	Cable cover, wire insulation	Nose bleeding, ulcer, sinuses damage	Inhalation/ ingestion
Arsenic	PCBs, computer chips, TV and phones' LCD display	Skin and lungs cancer, kidneys and liver damage	Inhalation/ ingestion
Aluminium	PCs, Refrigerator, Phones, TV	Neuron damage, muscle weakness, seizures, bone problems, development issues (in children)	Inhalation of aerosols/ particles, ingestion of food, skin contact

Some of the widely-used electronic devices such as PCs, ACs, phones, TVs and washing machines are investigated. It is found that workers in the field are most frequently exposed to elements such as polyvinyl chloride (PVC) in plastics, lead, cadmium, nickel, mercury and brominated flame retardants, and the most common types of exposure are inhalation and ingestion of the dust's particles.

Although both formal and informal workers have high risks of exposure to chemicals, workers in the formal field are claimed to receive more protection and attention from authorities. As being discussed above, organizations e.g Tan Thuan Phong Company provided workers with certified equipment and training to treat the waste, as well as regular health checks. Their aim is to *"recover and recycle as much as possible while following the safety guidelines"* (Huynh et al., 2015). From the published information on the company's website and local news, it is reasonable to argue that workers receive more benefits working in the formal sector. In addition, though Northern Vietnam's formal sector still relies on manual work, recent years have seen an increase in the implementation of technologies such as the TTP-4 incinerator or the conveyor belts to reduce the time workers have to be in direct contact with the waste. However, despite most of the organizations' commitment to follow the safety procedures such as using at least gloves, masks, face screens, or wearing further protection clothes like helmets, respirators, and shoes while working, not all facilities have the ability to provide all of the workers with the full clothing packages (Nguyen, 2019). Some of the workers who do not receive those decide to ignore the guidelines so in some cases, formal sector workers are still at high risk.

Activities in "Craft villages", on the other hand, rely more on the workers' hands. From the primary sources, it is pointed out that workers in the field often choose not to wear protective clothing. The informal sector's aim is to "*collect as much rare metals as possible, regardless of the techniques used".* Without gloves, skin contact with the metals such as lead or cadmium is inevitable and leads to the associated health risks (reference to fig.12). Moreover, the old techniques such as open-air burning in the informal sector result in respiratory problems, burning, cuts, bruises, and even birth defects (due to breast milk being contaminated). Researchers have found a correlation between high exposure to E-waste with lung and liver malfunctions, DNA alterations, etc (Nguyen, 2020, 12). The lead leakage is also a major problem in craft villages, as crops and water, used by villagers for their daily operations such as cooking and consuming food, can absorb the toxins, and long-time ingestion of those results in health issues (reference to fig.12). Informal sector workers whose families work and live in the same area face the highest risks of exposure to E-waste's hidden hazards.

Reliability of data collection

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1. **Secondary resources**

Benefits: Most of the resources used came from official websites such as government legislation publication sites, universities' researchers' reports, universities' classes materials made by professors, newspaper articles from the Ministry of Natural resources and Environment and alternative sources. The credibility of those sources, to an extent, is satisfactory.

Limitations: This research relies mostly on published materials, so most of the reported information is based solely on what was found on Google Scholar and the Internet. Discussions surrounding the health benefits of the formal sector are sourced from the organizations' websites and social media pages, so the view is partly limited to the organizations' positive sides. The downsides are found in private newspapers, Youtube videos, and reports, so the credibility is somewhat questionable.

All of the advantages and disadvantages of the sources are taken into consideration while constructing the conclusion.

2. **Primary resources**

Benefits: The interview was conducted at Van Lam and Bui Dau villages in Hung Yen Province. The 2 locations were chosen for their high concentration of households working in the E-waste informal field. Besides gathering information from official reports, it is important to also hear from the side of craft villagers and local police. The households interviewed were randomly chosen to minimize bias.

Limitation: Due to the time limit, the interview only covered 15 households: 9 being E-waste dismantlers and 6 being normal villagers living near the areas, so there might have been a limitation to the scope. Moreover, bias is inevitable, so I decided to give gifts to those who took part in the survey to encourage truthful responses.

Conclusion

The rising number of E-waste in Vietnam comes with bigger reliance on the treatment system to process them. Despite having 15 formal sites across Northern Vietnam, only 3 are fully equipped with a daily capacity of 0.5 to 3 tons (Nguyen & Tran, 2019). Each household in the informal sector takes on a daily average of 2 tons, so much of the E-waste from domestic sources and transboundary imports are being processed here. From the published information, it is acknowledged that workers in the formal field receive more health benefits than those in the informal field in terms of having access to the right equipment, training and being provided with health insurance. The utilization of new technologies also reduces the time they have to be in contact with the waste. However, due to limited finance and lack of support from the government, many formal private companies feel reluctant to collect and treat the waste as the cost is paid by their income.

The bigger problem lies in the informal field, as though being fully aware of the toxins in the waste, villagers still choose to do the job without having any prior training or the right equipment. Dismantling the devices with bare hands, they face all the consequences resulting from the skin contact and inhalation of the components.

To minimize the impacts E-waste has on workers' safety, it is needed for the government and authorities to provide workers in both sectors with the right tools and support, as well as raise consumer awareness about the toxicity of the devices and the proper ways to dispose of them.

References

Annamalai, J. (2015). Occupational health hazards related to informal recycling of E-waste in India: An overview. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4446940/

Báo điện tử Chính Phủ. (2021, 2 9). Máy vi tính không còn sử dụng có phải chất thải nguy hại? http://baochinhphu.vn/Tra-loi-cong-dan/May-vi-tinh-khong-con-su-dung-co-phai-chat-thai-nguy-hai/422744.vgp

Công ty TNHH Tân Thuận Phong chấp hành tốt các quy định của pháp luật trong lĩnh vực việc làm, an toàn, vệ sinh lao động. (2020, 5 12). haiphong.gov.vn. https://haiphong.gov.vn/tin-tuc-su-kien/Cong-ty-TNHH-Tan-Thuan-Phong-chap-hanh-tot-cac-quy-dinh-cua-phap-luat-trong-linh-vuc-viec-lam-an-toan-ve-sinh-lao-dong-41684.htm

Forti, V., Balde, C. P., & Kuehr, R. (2018). E-Waste statistics Guidelines on classification, reporting and indicators. United Nations University. https://www.researchgate.net/publication/331714941_E-Waste_statistics_Guidelines_on_classification_reporting_and_indicators

Galaxy lands. (2020). *Bản đồ Hưng Yên khổ lớn phóng to*. galaxylands.com.vn. https://galaxylands.com.vn/ban-do-hung-yen/

Go, S., Nguyen, T. M., Le, T. H., & Katsura, K. (n.d.). Dioxin-related compounds in breast milk of women from Vietnamese e-waste recycling sites: Levels, toxic equivalents and relevance of non-dietary exposure. researchgate. https://www.researchgate.net/publication/262610812_Dioxin-related_compounds_in_breast_milk_of_women_from_Vietnamese_e-waste_recycling_sites_Levels_toxic_equivalents_and_relevance_of_non-dietary_exposure

Great Lake Electronics Corporation. (2021, 0 0). What is E-waste? Definition and Why It's Important. ewaste1.com. https://www.ewaste1.com/what-is-e-waste/#definition

Huynh, H. T. (2014). Electric and Electronic Waste Recycling in Vietnam. https://app.snapandread.com/workspace#action=open_url&source=https%3A%2F%2Fwww.epa.gov%2Fsites%2Fdefault%2Ffiles%2F2014-08%2Fdocuments%2Fvietnam_country_presentation_2-_prof._hai.pdf

Hocking, M. B. (2005). Handbook of Chemical Technology and Pollution Control. Elsevier Inc. https://doi.org/10.1016/B978-0-12-088796-5.X5000-5

Huynh, H. T., Nguyen, Q. D., & Ha, H. V. (2015, 12). An overview of electronic waste recycling in Vietnam. https://www.researchgate.net/publication/286238307_An_overview_of_electronic_waste_recycling_in_Vietnam

Isildar, A. (2018). Biological versus chemical leaching of electronic waste for copper and gold recovery. https://tel.archives-ouvertes.fr/tel-01738056/document

Kenh 14. (2018, 2 20). Nữ sinh buôn đồng nát và cú "ngược dòng số phận". *kenh14.vn*. https://kenh14.vn/nu-sinh-buon-dong-nat-va-cu-nguoc-dong-so-phan-20180220175334023.chn

Lucier, C. A., & Gareau, B. J. (2019, 4 18). Electronic Waste Recycling and Disposal: An Overview. intechopen.com. https://www.intechopen.com/chapters/66785

Luong, A. D., Truong, S. C., & Tra Ho, T. L. (2013). Map of northern Vietnam. https://www.researchgate.net/figure/Map-of-northern-Vietnam-and-location-of-the-study-area_fig1_282152117

Ngo, H. T., Liang, L., Nguyen, D. B., Doan, H. N., & Watchalayann, P. (3). Blood heavy metals and DNA damage among children living in an informal E-waste processing area in Vietnam. researchgate. https://www.researchgate.net/publication/339865422_Blood_heavy_metals_and_DNA_damage_among_children_living_in_an_informal_E-waste_processing_area_in_Vietnam

Ngo, H. T.T., Liang, L., Nguyen, D. B., Doan, H. N., & Watchalayann, P. (2019). Environmental Pollution of Heavy Metals in a Vietnamese Informal E-waste Processing Village. https://ph01.tci-thaijo.org/index.php/aer/article/view/219990/163632

Nguyen, D. Q., Ha, V. H., & Yamasue, E. (2017, 12). Material Flows from Electronic Waste: Understanding the Shortages for Extended Producer Responsibility Implementation in Vietnam. https://www.researchgate.net/publication/316270056_Material_Flows_from_Electronic_Waste_Understanding_the_Shortages_for_Extended_Producer_Responsibility_Implementation_in_Vietnam

Nguyen, H. T., & Tran, T. P. (2019). Hoạt động tái chế chất thải ở Việt Nam và một số khuyến nghị. https://app.snapandread.com/workspace#action=open_url&source=https%3A%2F%2Fkhcn.haui.edu.vn%2Fmedia%2F30%2Fuffile-upload-no-title30081.pdf

Nguyen, T. N. (2020, 2). Country report on E-waste in Vietnam. http://bioie.oie.go.th/oieqrcode/uploadFile/oie621360278_1459684422.pdf

Nguyen, Y. T. (2020). Introduction on the management of E-waste and hazardous waste in Vietnam. https://app.snapandread.com/workspace#action=open_url&source=https%3A%2F%2Fwww.uncrd.or.jp%2Fcontent%2Fdocuments%2FDay2_session4_VietNam.pdf

Tinkinhte.com. (2010, 5 19). Công ty TNHH Tân Thuận Phong: Thu vàng từ rác. tinkinhte.jcapt.com. http://tinkinhte.jcapt.com/doanh-nghiep/tin-hoat-dong/cong-ty-tnhh-tan-thuan-phong-thu-vang-tu-rac.nd5-dt.100065.029030.html

Tran, T. Q., Sharp, A., Nakatani, J., & Moriguchi, Y. (2014). Forecasting of the E-Waste Generation and its Future Trends in Vietnam.

WHO. (2021, 7 15). Soaring E-waste affects the health of millions of children, WHO warns. www.who.int.https://www.who.int/news/item/15-06-2021-soaring-e-waste-affects-the-health-of-millions-of-children-who-warns

Appendix A (translation to English from Vietnamese)

Interview with craft villagers involved in the E-waste dismantling field.

1. How long have you been working in the field?
    - Average answer: 5-7 years
2. How much E-waste do you import daily and from where?
    - Average: 2 tons
    - Sources: rebuy E-waste from junk shops, Samsung Bac Ninh and private collectors in and out of Province.
3. How much E-waste do you export daily and to where?
    - Average: 2 tons, about 95% of the imported waste daily.
    - Export sites: ship to recycling sites in HCM city (if there are valuable materials that need to be further treated) and large incinerators in Hai Phong, Thai Nguyen or Nghe An.
4. Describe the dismantling processes.
    - First, bring back to families and separate sites to sort the waste into categories. Workers will dismantle the devices, separate PCBs, phones' bodies, batteries, plastics and other metals then depending on which categories the waste falls into we will distribute them in different ways. Dismantling and then reselling are the most common methods.
    - The ones with highest value will be shipped to HCM city to be recycled with German technology.
5. In which ways do you categorize the waste?
    - Category 1: High-value waste

- Category 2: Lower-value waste
- Category 3: Invaluable waste

6. Do you wear protective clothing while working?
    - Majority answered NO, others replied they only wear masks while working.
7. Share your thoughts on the toxicity of E-waste.
    - We are aware that the waste contains high levels of toxins but they bring back lots of economic benefits so we want to do it.
8. In the past few years, do you recognize any changes/ fluctuations in the number of E-waste generated in Vietnam?
    - In the past few years the number of E-waste we took in increased in an exponential way, as we also receive waste from foreign countries through transboundary import.

      → High competence in the field.

Appendix B (translation to English from Vietnamese)

Interview with nearby villagers who do not work in the field.

1. What are your comments on the number of E-waste being shipped to the village(s)?
    - Average answer: Recently we have been seeing an increase in the number of E-waste being shipped to the village. However, the dismantling, reprocessing and burning of the waste are spontaneous so we can clearly see the air pollution from the smoke coming up from the landfills.
2. Do you recognize any difficulties living near the treatment sites? Are there any inconveniences and how do you rate the living qualities?
    - We are bothered with the pollution, especially when the garbage trucks come in to ship the E-waste. They often block the roads. We also want to mention about the non recyclable waste: workers often discard them not only to landfills but also to the roads and in front of the houses.
3. Do you have any wants towards improving life conditions?
    - We wish someday there will be safe and proper recycling facilities that will collect and treat all the E-waste, not to interfere with the environment as well as our quality of life.

Appendix C

The Sampling Method

The chosen sampling method was Random sampling. It was carried out at the craft villages in Hung yen by physically selecting samples at the sites. To minimize bias, I decided to randomly ask the households whether they work in the dismantling field or not. If they answered "Yes", I would interview them with questions from Appendix A, and if they answered "No", I would interview them with questions from Appendix B.