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Strategies Used in United States E-Waste Recycling Businesses

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
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Walden University
2024

Abstract

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MS, American Military University, 2016

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Increased consumer demand for the latest electrical and electronic technology and products has increased the amount of consumer and manufacturer-generated e-waste, leading to collection, handling, disposal, and environmental issues across the United States. Grounded in Bass's curve theory, the purpose of this qualitative multiple case study was to explore strategies that southern United States company leaders used to recover funds from the disposal of e-waste. The participants included 13 leaders from 13 organizations in the solid waste recycling industry. Data were collected using semistructured interviews and peer-reviewed articles. Data analysis included occurrence frequency, with five themes emerging: (a) communication, (b) handling methods, (c) selling materials, (d) labor/employment, and (e) policies. A key recommendation is for company leaders to use marketing or advertising tactics and cold calls to reach potential customers. The implications for positive social change include reducing the amount of e-waste deposited in landfills and decreasing the potential for poisonous materials to leach into groundwater.

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Dedication

I dedicate my research study to my family, without whom I could not and would not have achieved so much. To my wife, Angela, thank you for supporting me and reassuring me when I had doubts. To my children, Gisla, Emmanuel, and Daniel thank you for being patient and believing in me. To my youngest son, Daniel, I know it was not easy to understand why I could not play or watch television, but I promise you it was worth it in the long run. I also want to thank my parents and mother-in-law for believing in me and praying for my success. I give all the glory to God for being there from the beginning to the end. Finally, I want to dedicate this study to my grandparents. You all taught me to be better and strive for more. Thank you all for everything, and I love you.

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I acknowledge the guidance and assistance from my chair, Dr. Elisabeth Musil, and my second chair, Dr. Richard Johnson. I also want to thank Walden University for the opportunity to experience a community of scholars and professionals.

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Section 1: Foundation of the Study

Background of the Problem

Mandić et al. (2019) stated that electronic waste (e-waste) is the world's fastest growing waste lifecycle. Mandic et al. also noted that the decreased lifespan of electrical devices, the rapid development of technology, and a consumer-driven society are the foundations for the increase in the generation of e-waste. Technology increases influenced consumer demand for cheaper electronics, such as those from overseas markets. For companies to capitalize on the increased amount of waste electrical and electronic equipment (WEEE), consumers must adequately dispose of the items (Shaikh et al., 2020).

E-waste such as smartphones contains valuable recyclable materials, but recycling occurs for only about 15% of smartphones (Schischke et al., 2022). The concentration of precious metals in mobile phones and smartphones combined includes 5,413 ppm of silver, 2,333 ppm of gold, and 174 ppm of palladium (Holgersson et al., 2018). The precious metals in e-waste represent several stable elements found on the periodic table of elements and minerals (Mandić et al., 2019).

F. Chen et al. (2019) noted that the equipment used daily by consumers, such as televisions, cell phones, and computers, is the basis for e-waste. F. Chen et al. also stated that China has a unique place of top producers and users and is the largest destination for e-waste. F. Chen et al. also identified that the generation of e-waste outpaces the disposal capacity and means to properly recycle e-waste instead of sending these items to a landfill for disposal.

Problem and Purpose Statement

The specific business problem was that some leaders from US-based companies lacked strategies to recover funds through recycling e-waste. The United States and Canada were North America's top electronic e-waste producers (Patil & Ramakrishna, 2020). The volume of small appliances produced in 2017 was 2.1 million tons, and 2.84 million tons of electronics (US Environmental Protection Agency [EPA], 2017). According to the US EPA (2017), of the electronics produced, 35.9% of the recycled materials were electronics, and 6% were small appliances. Many US-based companies dispose of e-waste in landfills or export it to overseas markets instead of recovering funds through recycling. Materials collected from recycled e-waste can decrease the environmental impact of mining and can result in overall savings (Van Yken et al., 2021).

The current qualitative multiple case study explored the strategies leaders from companies used to recover funds through recycling e-waste in the United States. The targeted population for the current study was leaders from solid waste collection companies that operated within the southern United States and successfully recovered funds through recycling e-waste. The interview questions for this study were open-ended and provided the information necessary to identify successful strategies leaders used.

Population and Sampling

The targeted population for the present study was leaders from solid waste collection companies that operate within the southern United States who have successfully recovered funds through recycling e-waste. The sample population was 13 leaders/subject matter experts from 13 companies that operated in the southern United

States with 3 years of practical experience in solid waste recycling. The sample population for this study provided the insight and expertise necessary to answer the research question. The qualitative research method includes purposive samples for data saturation (Grant et al., 2020). Grant et al. (2020) also stated that data saturation occurs when the gathered information no longer produces new findings for the study. Therefore, each participant identified must know how to answer the interview questions. The criteria for determining participants in the current study included the following:

- a minimum of 3 years of experience,
- WEEE knowledge,
- knowledge of EPA compliance requirements, and
- understanding of the strategic and tactical levels for achieving corporate goals.

Nature of the Study

Scholars use three research methods: quantitative, mixed methods, and qualitative (Guha et al., 2021). Qualitative methodology was the foundation for studying recycling e-waste. Qualitative methodology affords many tools, such as interviews, observations, and focus groups, to capture data through open-ended questions during participant interviews (Bleiker et al., 2019). Qualitative methodology facilitated capturing information in the current study through open-ended questions during participant interviews. Mwita (2022c) noted that qualitative researchers use tools such as open-ended questions, which offer respondents flexibility to express their input. Mwita further stated that these tools provide relevant information for conclusions.

Conversely, quantitative researchers use closed-ended questions with predefined assessment choices (Brosius et al., 2022). Quantitative researchers begin with a hypothesis and test established theories with predictive questions (Coy, 2019). No set ideas or predictive questions guided the participants' responses in the current study. Coy (2019) also stated that the mixed-methods approach contains quantitative and qualitative methodologies for a more inclusive study. The mixed-methods approach focuses on the purpose and nature of the research to ensure a more complete view, which can assist with complex topics (Taherdoost, 2022). According to Coy, the mixed-methods approach generates a comprehensive single-item inquiry. Mixed-methods research was possible in the current study; however, the research question did not require quantitative data. Using the mixed-methods approach would have increased the time to complete the study without significant gains.

There were four qualitative designs considered for the current study on the recycling of waste electronic devices: (a) ethnographic, (b) phenomenological, (c) grounded theory, and (d) case study. Ethnography's primary use is for studying the behavior and beliefs of people (Tomaszewski et al., 2020). Podjed (2021) also noted the long interaction period with participants, which was not conducive to the time restraints of the current study. According to Podjed, the phenomenological design focuses on participants' lived experiences. The current study had no basis for exploring participants' lived experiences; therefore, the phenomenological design was inappropriate for the study. Grounded theory is used to refine theoretical research and decrease the topic's complexity (J. X. Zhang et al., 2023). J. X. Zhang et al. (2023) also stated that the grounded theory presents the plurality of the subject. Using grounded theory for the current study was not feasible because there was no research on behavior or its impact on recycling e-waste. Finally, the case study is used to answer the researchers' questions and is a tool for understanding the form and reasons behind a decision (Quintão et al., 2020). The case study was the most appropriate choice for exploring the strategies for recovering e-waste recycling funds. Case studies represent a complete study focusing on a community, organization, or program (Tomaszewski et al., 2020).

Research Question

The research question for the current study was the following: What strategies do some leaders from southern United States companies use to recover funds from e-waste recycling?

Interview Questions

1. What strategies do you use in your solid waste collection business to recycle e-waste for funds recovery?
2. What method did you use to formulate your e-waste recycling strategies for recovering funds?
3. What key process did your organization use to implement a successful recycle e-waste for funds recovery strategy?
4. What are the main challenges you experienced in the implementation of the strategies to recover funds through recycling e-waste?
5. What did you do to overcome these challenges in the implementation of the strategies used to recover funds through recycling e-waste?

6. What additional information would you like to add about the strategies you use to recover funds through recycling e-waste?

Conceptual Framework

The conceptual framework for the present study was Bass's curve theory. Bass's original diffusion model focused on an identified population influenced by advertising and word of mouth (Horvat et al., 2020). In the original Bass theory, two consumer groups with a positive attitude toward new products were innovators and imitators (Moskalev & Tsygankov, 2021). Innovators are consumers or businesses that face uncertainty about their investment return while entering a new market (Duffy & Ralston, 2020). Duffy and Ralston (2020) also stated that innovators may encounter new ideas, products, or concepts and determine perceived value or use. In addition to the first group (innovators), there is a second group (imitators). Duffy and Ralston also stated that imitators follow the innovation of others, and they have the choice to mimic the innovators or improve on the innovators' actions. Imitators allow innovators to take risks and set a viable platform for use. Imitation is safer and more cost-effective than innovation (Wierzbicki & Nowodziński, 2019). Imitators will realize a profit based on the efforts of previous entities. As applied in the current study, the Bass theory and diffusion model was used to explore companies' market availability for recycling e-waste.

Operational Definitions

Basel Convention: Adopted in 1989 based on international consensus on the need for stricter regulations in reference to the export of hazardous waste to developing countries (Ahmad Khan, 2020).

Belmont Report: A framework of federal regulations governing research with humans (Redman & Caplan, 2021)

Best available technology: A universal mechanism for stimulating modernization of industrial production (Morokishko et al., 2022)

Corporate social responsibility: Representation of the firm's responsibility to the environment, society, and its stakeholders (Le, 2023).

Coronavirus disease 2019 (COVID-19): A respiratory disease that emerged with ties to severe acute respiratory syndrome coronavirus (SARS-Cov-2), which was later declared a pandemic (Cao, 2020)

Electronic waste (*e-waste)*: Electric or electrical items that have reached their end of the lifecycle (Van Yken et al., 2021).

Internet of things: A real-time collection of items requiring observation (J. Yang et al., 2021).

Recycling: A method of waste disposal that is more favorable than disposing of items in landfills (Demir & Öteleş, 2023).

Third-party logistics (3PL): A company that designs, manages, and controls the supply chain of another company (Kramarz & Kmiecik, 2022)

Third-party logistics provider (3PLP): Companies delegated to manage returned products at optimal cost (Wang et al., 2021).

Assumptions, Limitations, and Delimitations

Assumptions

There are many methods available for conducting research. These methods fall under the heading of scientific method, which also leads to assumptions. The assumptions include two viewpoints: The first is that the world is knowable through the five senses, and the second is that the confirmation of knowledge is verification (Adler, 2022). There were two assumptions in the current study. The first was that all individuals selected to participate in the study possessed the knowledge required. The second assumption was that participants would answer the questions honestly.

Limitations

Limitations reflect study items outside of the researchers' control, which is a potential weakness (Theofanidis & Fountouki, 2018). The accessibility of participants was the major limitation faced in the current study. During the initial research, a few requested participants declined to partake in the study due to other obligations such as Earth Day events, and the planning or facilitation of events and standard work requirements did not allow for involvement. The slow growth of the participant pool slowed the study but did not significantly impact the results.

Delimitations

Delimitations are the topics that will not become a part of the researcher's study (Coker, 2022). Coker (2022) also stated that delimitations include the scope and limits imposed by the researcher. The current study boundaries included geographic and material restrictions. The regions identified for this study consisted of the Southeast

United States. A more comprehensive study would have included all of the United States or a world-based analysis. E-waste is a problem that impacts the world, not only certain geographic areas. The scope of the study was not all-inclusive because there are many categories of e-waste, but the focus of the recent study included small electronics. Items not included in the study were large items such as washers, dryers, ovens, and refrigerators.

Significance of the Study

Contribution to Business Practice

The findings of this study may provide recycling business owners with effective sustainability strategies. Recycling WEEE may develop into a multi-billion-dollar industry with the right approach. The focus of the study was exploring recycling strategies and their associated benefits. The handling of e-waste primarily included three scenarios: stockpiling or storage, selling equipment, and giving the equipment away for reuse, with most of the rest sent to a landfill for disposal (Shaikh et al., 2020).

Another part of the study included studying the amount of e-waste exported to overseas areas for processing and the associated cost, which included penalties. Finally, the study included research on the amount of e-waste recycled. According to Abalansa et al. (2021), the United Nations Environmental Program identified the export of 90% of generated e-waste from the producing country. The key takeaway from the current study may provide information on the strategies to improve recycling business sustainability through cost savings and revenue-generating processes.

Implications for Social Change

Reducing the amount of e-waste deposited in landfills may decrease the amount of toxic material leaching into groundwater. Another benefit to the environment may be the recycling of materials. The need to mine materials from the planet may decrease by reusing recycled materials from e-waste. Another benefit of recycling may be the creation of jobs. One example of job creation that could benefit the United States is the Republic of Rwanda, which initiated a program to train students on recycling e-waste. The program provided 9,000 workers to the recycling industry upon graduation (Nkurunziza, 2019). Creating jobs may affect the employee community, the businesses in those communities, and the city's status. Recycling may have economic and societal benefits, which include saving money, generating wealth, creating jobs, and protecting the environment.

A Review of the Professional and Academic Literature

WEEE plays a pivotal role in urban mining, serving as a rich source of precious and rare earth metals (Annamalai & Gurumurthy, 2021). Collecting these metals through urban recycling contributes to the recovery of valuable resources and diminishes reliance on primary raw materials, thereby fostering sustainability (Annamalai & Gurumurthy, 2021). Establishing a recycling branch within businesses yields many benefits beyond financial gains. Primarily, it addresses environmental concerns by reducing the volume of e-waste in landfills, thereby mitigating associated ecological risks. The current synthesis of professional and academic literature on recycling WEEE provides a comprehensive overview of recovery methods and business strategies. The inclusion of a substantial percentage (85%) of articles published within the last 5 years ensured the incorporation of contemporary insights and developments, underscoring the relevance and timeliness of the findings.

The research method for this study was qualitative. The qualitative method provided rigor through my awareness as the researcher in determining themes (see Ayre & McCaffery, 2022). Furthermore, the use of coding is data driven (inductive), data interpreted (deductive), or a mixture of inductive and deductive. According to Ayre and McCaffery (2022), inserting themes into frameworks does not ensure accuracy or reliability.

The concept of reverse logistics is a new development in the business world. The simplest way to describe reverse logistics is collecting materials and returning them to the production chain (Houlin et al., 2019). The idea that once an object reaches the end of its life cycle, it has no value is incorrect. The reverse logistics process receives these products and breaks them down to their base elements for other industries. The primary purpose of reverse logistics strategies is to recoup value from items at the end of their designated usage. End-of-life items such as computers, telephones, and other electronic devices have many profitable and precious materials for recouping, such as gold, silver, and copper (Kumar & Singh, 2019). There are other valuable items including petroleum-based products manufactured for electronic devices. These items usually end up in landfills, but reverse logistics generates profits. There are many tools for reverse logistics, but the current study focused on recycling.

The interest of corporate stakeholders continues to increase with the increased quantity of used electronic goods. The terms used to identify used electronic goods are WEEE and e-waste (Pekarkova et al., 2021). Pekarkova et al. (2021) also stated that WEEE is considered a valuable resource or precious metal available through recycling and noted that ignorance of the potential economic and climate impacts led to the disposal of WEEE in the residual waste stream. Pekarkova et al. also noted that small electrical and electronic equipment has the most significant economic recovery rate, with nearly 75% available for resale.

One of the critical e-waste contributions is from different technologies including legacy items, monitors, and modern TVs (Althaf et al., 2021). According to Althaf et al. (2021), end-of-life electronics are a source of recyclable materials that could displace primary-source mining. The economic value of e-waste, according to Althaf et al., relies on the value of gold, and is essential for future sustainability.

Rajesh et al. (2022) noted that the global production of e-wase was nearly 50 million metric tons (mt). The higher output of e-waste, according to Rajesh et al. occurred within developed countries such as the United States. Rajesh et al. also noted that the United States produced 13.3 kilograms of e-waste per capita. The increase in e-waste, as identified by Rajesh et al., coincides with the increased use of new products based on evolving technologies. Rajesh et al. also noted that e-waste encompasses many recyclable materials such as steel, iron, gold, silver, and copper. As a sustainability tool, the recycling of e-waste is essential for creating circular economies (Seif et al., 2023). Reverse logistics is a crucial component of sustainability (Pourmehdi et al., 2022). The reverse logistics process includes receiving end-of-life products that provide financial benefits through discounts, and companies providing end-of-life electronic product exchange with a foundation in economic benefits from customer exchanges (Sabbir et al., 2023).

Burnson (2018) conducted a qualitative study on reverse logistics and its concepts, including discussions on 3PL companies, material returns, and risk acceptance. Burnson focused on the "age of entitlement" effects on e-waste production. The age of entitlement refers to the growth of technology and consumers' desire to purchase these items (Burnson, 2018). The issue is buyers' desire to buy and exchange items, leading to increased e-waste. E-waste is one of the fastest growing solid waste areas, but some consumers keep these electronic devices instead of disposing of them. According to Casey et al. (2019), sometimes consumers store these devices as backup electronic devices for later use. Casey et al. also noted that hoarding devices is a conscious habit by consumers based on the rare occurrence of needing a backup device or electronic item. One of the reasons for this action is that the consumer wants to keep the old phones as a backup if the new model breaks or is lost. Keeping these items in such a manner is called storage, which impacts the lifespan of electronics (Ylä-Mella et al., 2022). Consumers intend to maintain and use the device, but storage reduces performance and the likelihood of reuse. Avoided disposal or improper disposal impacts sustainability by preventing the recycling of these usable materials.

Siringo et al. (2019) conducted a qualitative study of the recycling process in Indonesia. The extensive research included televisions, refrigerators, laptops, and mobile phones. Consumers' desire to recycle is one of the primary issues when dealing with e-waste. In Indonesia, consumers opted to hold onto specific devices instead of recycling them because they were concerned about data leaks of personal information. An apparent mistrust of government-run recycling facilities also plays a part in consumers' lack of recycling. The Siringo et al. study focused on how residents disposed of their end-of-life electronics, the factors influencing the public's response to formal e-waste collection, and support of the formal e-waste recycling program. The 225 self-administered surveys in Jakarta, Indonesia, resulted in 28 surveys validated for further review. Information collected from the study identified the average lifespan of 10 commonly owned electric appliances. The item identified with the longest life span of 6.84 years was the TV, while mobile phones had the shortest life span at 3.58 years. The disposal of these items encompassed many avenues, including selling.

Owners often retain smaller appliances such as personal computers, laptops, and cell phones, but many are discarded carelessly (L. Zhang et al., 2019). L. Zhang et al. (2019) showed that an e-waste recycling program operated by the government is supported, but most people will keep or sell some electronic items. One of the benefits of using reverse logistics is to increase the efficiency of the collection and transportation of reusable materials (Cole et al., 2018). Reverse logistics is a multifaceted approach when properly used. Cole et al. (2018) also stated that the use of reverse logistics includes recycling, repurposing, and reusing to recover assets from a collection and transportation perspective. Retaining assets includes removing precious metals from electronic components and collecting returned customer merchandise. The key initiative in this action is that these items still hold value. Reverse logistics helps to mitigate the losses by finding other opportunities or uses for these items. The cost and value of operations are determining factors in the decision-making process for businesses.

One of the critical questions in reverse logistics is the economy of the operation; companies want to ensure that the return on investment (ROI) is worthwhile (Meng et al., 2017). The foundation of the question on reverse logistics ROI concerns acquiring mishandled items with no reusable value, resulting in a decrease in ROI. In the economics of the business industry, ROI is a critical concept. Initiating a third-party logistics company or entering a contract with one is difficult, but many companies outsource their third-party logistics to include recycling processes. Outsourcing to other companies opens the possibility of advantages and disadvantages for the company. The long and complex reverse logistics process is a significant undertaking for companies, so some companies assign the role to a third-party reverse logistics provider (L. Chen et al., 2022). L. Chen et al. (2022) also stated that outsourcing reverse logistics gives businesses a competitive advantage.

Another business theory companies use is the base of the pyramid operations strategy. The bottom of the pyramid identifies lower income consumers in the retail environment (Calmon et al., 2018). Durable goods that could benefit low-income people are only sometimes available to these consumers. Calmon et al. (2018) also stated that the products consumers have access to are usually of lower quality and less durability. Along with the lower class and durability of consumer goods, assistance after the sale is lacking. Low-quality items that do not last will reach their end-of-life value and become waste for deposit in a landfill. Calmon et al. also stated that the salvaged item's value benefits the distributor more than the consumer based on consumer education. The more consumers know and understand products, the more apt they are to make expensive purchases. The lower the education level of consumers, the more profit a company can garner from its investments. Consumers who are uneducated about products may purchase items with a shorter life expectancy. A more temporary product life expectancy increases the likelihood of consumers repurchasing to replace defunct items. The base of the pyramid theory is not the only perspective for researchers.

The solid waste operations in Pakistan resulted in over 87,000 tons of solid waste, primarily from the industrial sector (Javed et al., 2021). The team also discussed reverse logistics, including compilation, inspection, and segregation of end-of-life products. Once segregated, disposition operations occur upon segregation, but disposition operations differ based on the waste category. Javed et al. (2021) noted that the reverse logistics process is crucial to achieving increased success, and organizations must manage and track product life, usefulness for the end customer, and product flow throughout different stages, with reverse logistics and product disposition identified as critical applications. Under the concept of reverse logistics performance, Javed et al. noted that recycling rests on quality, but the choice to reproduce is subjective to the quality of the items.

The nature of the study by Javed et al. (2021) was cross-sectional, with a limited scope that included the Pakistan manufacturing industry. Javed et al. also used a questionnaire based on the hypothesis for collecting manufacturing sector information linked to reverse logistics. Javed et al. used the Smart-PLS software for evaluation and analysis in a Microsoft Excel spreadsheet after numerical coding. Javed et al.'s decision regarding disposition significantly influenced reverse logistics' internal and external factors.

Khrustalev et al. (2022) studied the new recyclable PCB design, which showed the amount of recyclable copper in each waste PCB has an annual value of 1.6 billion to 5.38 billion. Khrustalev et al. also stated that PCBs are components in mobile phones, household appliances, vehicles, and industrial processes. Mobile phones' PCBs house copper and gold plating that electrically connect and support the other components (Annamalai & Gurumurthy, 2021). PCBs comprise high-value metals such as gold, silver, and copper, which are 30% of PCB metal components (Silva et al., 2021). The recovery of metals and precious metals from PCBs is an important step. Reverse logistics can be used to recover metals from PCBs, such as gold, silver, copper, and palladium.

WEEE is one of the fastest growing waste streams in the world. According to Nithya et al. (2021), e-waste is any discarded electronic item or device that is nonfunctioning or at the end of its usable life. The amount of WEEE generated requires some means of handling and disposal. According to Nithya et al., the initial approach to handling WEEE is pretreatment, which includes physical separation followed by metallurgy separation. Nithya et al. also stated that WEEE items include domestic utilities such as laptops, TVs, refrigerators, and copiers. Nithya et al.'s objective was to assist those interested in dealing with e-waste. The outcome of the research identified the importance of recycling WEEE for companies. Furthermore, the financial and societal benefits of the process provided enough positive gains to validate a recycling program.

The concept of reverse logistics refers to the processing of products from consumers and producers back to the company (Pramono et al., 2021). According to Pramono et al. (2021), reverse logistics is the opposite of forward logistics in that it allows for product return to the company. Pramono et al. noted that, as in other markets, a proper reverse logistics program is necessary to improve effectiveness. Similar to Pramono et al., M. Zhang et al. (2021) focused on reverse logistics and e-commerce. The increased number of online purchases returned results from profit-driven consumers, emotional consumption, and defective products (M. Zhang et al., 2021). M. Zhang et al. also noted that the demand for reverse logistics is crucial to customer satisfaction and profit revenue.

Meng et al. (2017) introduced the idea of remaining useful life (RUL) in the reverse logistics study. Failure data and condition monitoring data predicate the idea of RUL. Meng et al. also stated that the older and more abused the consumer objects, the shorter the RUL. The use of RUL can assist companies in determining the value of the collected items, and the business can decide how to handle the materials by knowing the value of collected items. According to Meng et al., companies appear willing to incur quality-driven recovery costs for end-of-life items. RUL’s use helps determine the potential remaining life or commercial value of a product to the company and the salvageability of the parts for refurbishing, repurposing, or destruction. Decreasing the amount of waste deposited in landfills is one concept of RUL.

E-waste items deposited in landfills with other household waste will slowly leach toxic materials into groundwater (Eisenstein, 2022). The poisonous chemicals are dangerous to the environment and the associated ecosystems. According to Eisenstein (2022), e-waste contains many materials including plastics and precious metals. Eisenstein also stated that some precious metals are toxic to humans and the environment.

Recycling

Recycling is one of the reverse logistics concepts that companies can use to recoup value from end-of-life items. The item evaluated for recycling in the current study was e-waste. Mandić et al. (2019) noted that e-waste is one of the fastest growing waste streams. Mandić et al. also determined that e-waste is a global problem affecting developed and developing nations, with the estimated growth of e-waste production on an annual scale rate of nearly 5%. The growing issue of e-waste continues to draw attention from researchers. Electronics are commonplace not only in business and manufacturing segments but also in everyday life.

Recycling in the electronics industry is an underdeveloped area for commerce. E-waste includes refrigerators, mobile phones, TVs, DVD players, and telecommunications devices (Thukral et al., 2023). Among e-waste's high-value components are gold, copper, silver, and iron, as well as low-value materials such as aluminum, silicon, and calcium (K. Liu et al., 2022). Recycling benefits companies and helps generate income through the recovery of precious metals and the creation of jobs. One of the researcher's primary findings is that the number of electronics purchased is not governed by the population but by their wealth. The members of the manufacturing industry studied this effect and the ability to exploit opportunities. Forti et al. (2020) provide updated totals for generation, recycling, and e-waste disposal as globally documented. The problem of e-waste generation continues to increase as the consumption rate of electronics increases by 2.5 million metric tons annually (Forti et al., 2020). The information found in the article also focuses on the economic value of recycled materials. Forti et al. (2020) stated that the worldwide value of the raw materials found in e-waste is approximately $57 billion. The collection and use of these materials decreased the demand for virgin materials like iron and copper. Future studies should include items not included in these totals, like electric car batteries. With the electric vehicle industry's expansion, it is necessary to study its impact.

Old EOL electronics represent both hazards and an opportunity for sustainability. E-waste is an environmental hazard based on the toxic components used to construct electronic items. If thrown into landfills, these toxins can leach into groundwater and streams, fouling the waterways. The study by Siringo et al. (2019) focused on recycling consumer goods such as televisions and smartphones. The critical concept is to understand why recycling e-waste is not widespread. Siringo et al. designated Jakarta, Indonesia, and Tanah Abang districts for their geographic sampling. Siringo et al. wanted to understand the recycling behavior of people with lower, middle, and upper-class backgrounds. Improper recycling occurs in the Jakarta, Indonesia, and Tanah Abang districts through the unauthorized deconstruction of e-waste. Families collect the e-waste and dismantle the items in an exposed location with no safety equipment.

According to Siringo et al., recycling has five attributes: knowledge, information, convivence, attitude, and intention. The decision to participate in an e-waste recycling plan ultimately depends on the consumer’s choice. Some consumers support government intervention in e-waste recycling programs. The establishment of recycling drop boxes occurred in multiple locations, but consumers only used the drop boxes when seen and convenient. Siringo et al. also identified that through knowledge and easy-to-access drop bins for e-waste, only 81% of people favored and participated in the government-run program.

In the journal article by Cole et al. (2018), the increase in industry speed coincided with consumer sales growth for new and replacement items. The increased sales and replacement also lead to the disposal of electronic and electrical equipment. There are many ways for companies to take advantage of reverse logistics besides recycling or repurposing. The article by Cole et al. identified the potential for the growth of reuse and refurbishing. The authors are conveying that a company can create a closed-loop system through reverse logistics in concert with its supply chain. The closed-loop system will allow the company to maintain control of items from the cradle to the end of its original life. Keeping control of a closed system also means profits and revenue remain within the company. A closed-loop system can take advantage of the exchange of electronic equipment as a source of income.

Wansi et al. (2018) reported that electronic items have a service life that depends on the arrival of the next desired technology item. The current exchange rate for these electronic items is 2 years, which has resulted in 700 million phones discarded yearly. The materials in each phone are iron, lead, silver, and gold, all precious or finite natural Earth materials. The discussion in the article includes how to break down cell phones and break down the valuable parts. The problem is how to separate elements of the phones quickly. The suggested efficient means is for individuals to accomplish the task by hand. If the number of employees increases, the process's volume of recouped materials will also increase. Efficiency is a recycling issue, but it should not become a deterrent because the amount of e-waste will continue to change. However, the foundation of the information in this article will remain an asset to researchers and companies. Identifying limiting factors and reduced efficiency information solidifies the foundation for companies entering reverse logistics. E-waste is not limited to commercial businesses but applies to the domestic sector.

Domestic items like computers and mobile phones, which are no longer usable, are part of the increased e-waste (Rahim et al., 2018). The number of electronic devices discarded continues to grow. In Manaus, the most populated city in the Amazon region, dumping electronics in landfills is the usual process. The waste generated in Manaus did not go through selective waste collection, which would allow for the appropriate disposal of e-waste. The result of the inappropriate disposal of e-waste items is a loss of potential revenue generated by recovering precious metals and recyclable materials. The issue is that 1.7 metric tons, or 4% of e-waste, end up in landfills (Baldé et al., 2017). Only 20% of all e-waste generated had correct collection and recycling documentation, meaning 80% failed to meet the proper disposal criteria (Murthy & Ramakrishna, 2022). The global e-waste monitor article authored by Baldé et al. (2017) as a resource highlights the breakdown of e-waste generation, accumulation, proper handling, and shipping. The generated information aids in clearly identifying e-waste growth areas and mapping them according to consumer wealth and countries' gross domestic product (GDP). The global e-waste monitor is published yearly and includes updated information on e-waste and its impacts, including societal and environmental factors. The comprehensive publishing provides information without drawing definitive conclusions. Qualitative information allows the readers to draw conclusions based on the preponderance of collected and presented data.

Communication is critical for consumers and manufacturers to obtain knowledge about recycling and reuse of materials. Vonk (2018) explored the circular and attention economies toward perspectives on media. The research further reviewed the opposing environmental viewpoint on the carbon footprint and toxicity of the digital commodity. He also identified consumers' increased concern about environmental issues. Information consumption takes time and physical acts; therefore, Vonk (2018) further focused on Facebook is an informational platform that requires participants to select, read, watch, listen, and share. Facebook is a valuable tool for production activity. Vonk also advised that how a person reads and writes is based on their social and biological factors. Communication is a crucial component of recycling e-waste.

The use of reverse logistics concepts like recycling has the potential to help generate profits for motivated companies. Razi (2016) presented that the reverse logistics process for the review and use of businesses for recouping materials from discarded e-waste is a labor-intensive process of manually breaking down the e-waste items' components and separating them. Razi also stated that the increased e-waste generated is partially due to the intrusion of items like laptops, smartphones, and tablets, decreasing the need for desktop computers. The desktop computer is not portable, sometimes making it inefficient. The handling of end-of-life desktop computers presents the opportunity to collect valuable components found in desktop computers. Desktop computers are an excellent recycling choice due to their large size. Razi also identified that collecting iron and other metals from the casing and selecting precious metals like gold, silver, and pallidum is part of the value of reverse logistics. The volume of electronics has increased across the world, and as a result, e-waste has also grown. Z. Li et al. (2019) stated that rare earth elements like gold, copper, and silver are e-waste components.

The ability to collect e-waste for recycling depends on proper placement in the waste stream but discarded smartphones present disposal challenges for consumers and manufacturers. Zink et al. (2014) researched the disposal of smartphones' overall impact on end-of-life (EOL) devices and found that improper processing and disposal of EOL smartphones can result in environmental fouling. Zink et al. identified EOL options for handling smartphones, including recycling or refurbishing. As smartphone purchases continue to increase, so does the gravity of dealing with EOL devices. The ability to collect e-waste for recycling depends on proper placement in the waste stream; however, discarded smartphones present disposal challenges for consumers and manufacturers. Zink et al. researched smartphone disposal's overall impact on end-of-life (EOL) devices and found that improper processing and disposal of EOL smartphones can result in environmental fouling. Zink et al. identified EOL options for handling smartphones, including recycling or refurbishing. As smartphone purchases continue to increase, so does the gravity of dealing with EOL devices. Refurbishing is the process of preparing the devices for use or sale. The devices are not new and may cost substantially less than the original purchase amount (Zink et al., 2014). Recycling parts from broken appliances can supplement the refurbishment industry for smartphones.

Recycling is a viable avenue toward corporate sustainability and protecting limited resources. Consumers upgrade or purchase new cell phones to replace older models, but instead of turning the older models in for recycling, consumers store the items. The potential value for these items still exists, but locked in a dead storage period nullifies that value. The reasons consumers keep old cell phones range from using them as a backup to protecting the information left in the phone's memory. The components in the phone still have manufacturing value and are a recyclable commodity. Consumers must participate in recycling programs for the most significant benefit. Due to consumers' lack of knowledge and understanding of how to dispose of WEEE, these items are most often thrown away in household refuse (Casey et al., 2019). Cell phones discarded in landfills or exported to other countries for dismantling represent an economic value leakage (Sabbaghi & Behdad, 2018). Recycling is a viable avenue toward corporate sustainability and protecting limited resources. Consumers will upgrade or purchase new cell phones to replace older models, but instead of turning the older models in for recycling, they store them. The potential value for these items still exists, but locked in a dead storage period nullifies that value. The reasons consumers keep old cell phones range from keeping them as a backup to protecting the information left in the phone's memory.

WEEE items are often discarded in household refuse (Casey et al., 2019). Cell Phones discarded in landfills or exported to other countries for dismantling represent an economic value leakage (Sabbaghi & Behdad, 2018). Casey et al. (2019) identified small waste electrical and electronic equipment (sWEEE) as part of a significant waste stream. Small-sized WEEE also contains valuable amounts of precious metals and rare earth materials. Casey et al. also stated that consumers often keep or hibernate old items instead of exchanging them due to emotional attachments. Garnering significant recycling benefits requires storage, separation, and smelting facilities.

One of the critical factors in the life span of electronics is consumer desire for updated products (Holgersson et al., 2018). The previous life span of electronic items was 5 years, but now it is 2 years. The amount of e-waste continues to increase based on consumers' desire to change items out of choice, not necessity. The need to find a way to recoup value from e-waste is where reverse logistics begins. One of the critical elements of the submission is savings through reverse logistics. Holgersson et al. also discussed the difference between collecting raw materials through reverse logistics and mining precious metals. The edge goes to reverse logistics with a 10-15% cost savings over mining for the ore. Cost savings can help companies remain sustainable in their sector.

As defined in the article by Kinoshita et al. (2016), sustainability is the likelihood that a business will remain competitive. There are many different aspects of corporate durability, but the two main ones in this article deal with the environment and profitability. The article also discusses the closed-loop supply chain as a cost-effective reverse logistics management method. In the closed-loop supply chain, few materials are collected or sold by an independent third party. Instead, the parent company owns the process from the beginning to the termination. By doing this, the company recoups all the usable materials from old systems. The different collected materials include precious metals and other minerals and elements. By harvesting these elements from old components, the company does not have to pay for additional mining, which is a cost-saving. Technological advancements occur with high frequency, which can result in higher e-waste materials.

The corporate interest in green industries has continued to grow. One way for companies to take part in the green sector is reverse logistics. Thukral et al. (2023) identified in their journal article that the proper disposal of e-waste is necessary to prevent adverse effects on the environment and human health. E-waste disposal in landfills can lead to environmental issues, such as toxins leaching into groundwater and surrounding ecosystems. Using reverse logistics is complex, and many companies choose not to partake due to the uncertainty of profit margins versus financial investment. Han and Trimi (2018) also investigated reverse logistics and its importance, focusing their research on using social-related exchange activities. Han and Trimi identified a new business model using social media to support social-related activities. Han and Trimi also discussed evaluating reverse logistics performance as a measurement tool for gaining profit. Han and Trimi stated that the use of social platforms reflects technology's impact on reverse logistics. The continued efficiency of reverse logistics will improve along with technological innovations.

Technological advancement in communication between devices is one of the key themes in the Gusukuma and Kahhat (2018) article. These advancements helped make it possible to speak wirelessly to other devices from great distances. The same type of advancements has happened in the personal entertainment area. Technology has also changed televisions from large units with cathode ray tube (CRT) displays to smaller units with liquid crystal displays (LCD). The changes in the television structure also generated an additional problem. The construction of CRT displays included leaded glass, a hazardous substance. As television units reach the end of life, the question is, what is the disposal process for these hazardous CRTs? The income disparity also impacted those likelier to purchase CRTs, and lower-income households were more apt to buy the lower-cost CRTs (Shaikh et al., 2020). The US started the conversion away from CRTs before Peru, but the Peruvian transition continues to progress. The debate on handling will continue until an efficient method to properly remove lead from the CRTs, as not all recycling opportunities provide efficient and safe options to garner a profit. Boundy (2020) identified the lack of recycling for specific materials used in small electronic devices. Some of these materials are not recycled because, currently, there are more cost-effective means to supply the demand for the materials.

The critical point to changing this process is knowledge. Business managers need experience selling large quantities of materials to manufacturers, paying off outstanding debts, and employing laborers (Boundy, 2020). Boundy conducted e-waste recycling research emphasizing liquid crystal displays (LCDs), with the estimated volume of LCDs generated in the United States and Canada equal a rate of 362g per person per year. Boundy used scenarios and information from published investigations dealing with waste valorization for LCDs to create an economic model. Boundy further employed an internal rate of return to calculate which investment provided the greatest return on investment

(ROI). The study's primary limitation is the focus on LCDs and no other e-waste. Future studies could benefit by expanding the criteria to include other e-waste, such as electric car batteries and other electronic components.

The focused study of Zadmehr et al. (2018) identified that e-waste has great recycling benefits. E-waste makeup includes electronics that have reached the end of their usable life and are broken, defective, or returned by customers. The Zadmehr et al. article analyzed the value of the components gathered from e-waste items. These components included gold, silver, copper, and other valuable metals. After conducting the analysis using the cost-benefit analysis model (CBA), the opportunity for profit in recycling exists. The amount of discarded end-of-life products increases the materials in the e-waste stream. Using a circular economy model will help control the amount of discarded end-of-life products. Almeida and Borsato's (2019) journal article focused on the different strategies used for end-of-life items. Almeida and Borsato identified and defined six strategies, but two of the methods were for recycling. The first is for recycling with a breakdown, and the second is for recycling without disassembly. The benefit of the article by Almeida and Borsato is that it provides more meaningful information on the hierarchy of dealing with e-waste materials. Almeida and Borsato identified reuse as the suggested means of dealing with waste. Almeida and Borsato also stated that the third process in the hierarchy is recycling without dismantling. The strategies identified in the journal article provided essential data for the evaluation of e-waste recycling.

Numerous motivation techniques to convince consumers to recycle e-waste include hedonic, self-interest, and moral (Onel & Mukherjee, 2017). Each person is motivated to accomplish tasks or encouraged not to perform them, and the same is true when dealing with consumer recycling. The Onel and Mukherjee study used surveys from the US-based company Terra Cycle to accumulate data. Consumers' decisions to partake in recycling actions include accessibility, reward, associated cost, realized value, and unrealized value. Onel and Mukherjee's research criteria focused on companies actively participating in recycling actions. Researchers gained access to participants by placing the survey in the company's monthly newsletter. The survey's accumulated responses represented employees of at least 18 years old with varying education and salary levels.

Social Responsibility

A critical concept is social responsibility, which businesses must consider in their operations. The viewpoint of this article is from the closed-loop supply chain and the available benefits with responsibility for items from creation to the end of life. Companies collect and process items by recycling them instead of sending them to landfills. The forward supply chain does not collect end-of-life items for reprocessing. The benefits of recycling include economic, social, and environmental for businesses interested in utilizing this function. Jaunich et al. (2020) identified that even with the environmental and financial benefits associated with e-waste in the US, it may take incentives for higher recycling levels. Using documented formal collection and recycling rates shows the potential to recover a material value of $10 billion from e-waste (Forti et al., 2020). The increase in revenue from recovered materials from e-waste can also increase employment, which is necessary for business sustainability.

Social responsibility is obtainable via sustainability. The connection between social and environmental impact also impacts financial performance (Verwaal et al., 2022). In this study, one area identified for improvement is the focus on social sustainability indicators. Reinvigorating the recycling industry is a step towards sustainability by achieving the triple bottom line structure. The benefits of recycling include environmental, economic, and job generation, and it encompasses social responsibility. Social responsibility contains two main categories: internal, which deals with how employers treat employees, and external, which focuses on the stakeholders (Rentizelas et al., 2020). In conclusion, a clear definition of indicators and quantitative characteristics still requires full addressing. Sustainability is a crucial avenue for full social responsibility.

The implications of positive social change include finding ways to improve the community's socioeconomic status. For example, Rwanda instituted a program that provided technical skills and practical application for training youth volunteers to dismantle e-waste (Nkurunziza, 2019). At one point, the United States had a program that employed prisoners as laborers to handle e-waste (Ogunseitan, 2023). The better choice for the e-waste industry is to invest in childhood education and training for handling recyclable e-waste (Ogunseitan, 2023).

One form of Corporate Social Responsibility (CSR) is the closed-loop supply chain system (CLSC). The use of CSR increased the number of businesses that adopted CSR tenants within their supply chain and reminded them that a consumer surplus represents CSR fulfillment (Cheng et al., 2023). Cheng et al. noted that CSR challenges corporate environmental and economic goals but is still viable for achieving profit maximization and social responsibility.

Reverse logistics is an essential part of maintaining social responsibility. Simão et al. (2018) identified the importance of reverse logistics based on environmental issues. Protecting natural resources such as finite minerals, rare earth materials, and the natural environment is a tenet of social responsibility. Reverse logistics is also a tool for social responsibility in job creation, advancement opportunities, and growth, impacting the community. Simão et al. also discussed the importance of corporate social image. Sustainability for any company is affected by public opinion, and businesses can garner excellent public opinion through positive environmental and socially responsible employment actions.

Bag and Gupta (2020) identified reverse logistics as a complex process that requires a high degree of communication between partners. Bag and Gupta also stated that an organization’s culture of continuous improvement requires adopting best practices. Along with best practices, Bag and Gupta also stated that adopting reverse logistics provides excellent advantages to remanufacturing firms. One of Bag and Gupta’s final thoughts was that reverse logistics must align with the business objectives, as reverse logistics is proactive and reactive (Can Saglam, 2023).

The improper handling of e-waste can also result in regulatory fines and penalties. The primary reason for these actions is that some e-waste components are hazardous or toxic to people and the environment. Companies need to represent themselves as socially responsible, which includes multiple areas, including environmental protection and employment, and the manufacturer will recycle the materials into a usable commodity instead of discarding them. One way to view this is as the extended producer responsibility (EPR; Huang, 2021). EPR extends the producer's responsibility to handle produced materials through their entire life cycle, including recycling and disposal (Huang, 2021).

Handling e-waste includes recycling, incineration, and landfill disposal (Wijesooriya & Amitha, 2021). Wijesooriya and Amitha also stated that there are instances of improper handling of e-waste or the unregulated release of e-waste, which leads to environmental contamination. Wijesooriya and Amitha noted that the chemical content of e-waste disposed of in landfills leaches into the soil and groundwater sources. According to Wijesooriya and Amitha, there are four concepts for properly handling e-waste: reduce, reuse, recycle, and recover to reduce the environmental impact. Another controlling factor in e-waste handling, according to Wijesooriya and Amitha is policies and regulations, such as the Basel Convention. Wijesooriya and Amitha identified that the Basel Convention deals with the transboundary movement of e-waste and its proper disposal.

The best available techniques (BAT) reference the universal mechanism to stimulate the modernization of industrial production (Morokishko et al., 2022). In an article by Smith et al. (2020), the BAT provided the best efficiency and lower carbon emissions for the artificial nitrogen fixation process. The best techniques for handling e-waste are reducing waste generation in industrial production and extracting natural minerals (Pouikli, 2020). Urban mining is one of the ways to minimize the need to extract natural minerals through traditional mining (Abalansa et al., 2021). Abalansa et al. also stated that the world's environmental problems result from different manufacturing activities, such as plastic pollution and e-waste.

Global Perspective/Impact

Wang et al. (2021) identified reverse logistics as a crucial part of a successful supply chain. Wang et al. also stated that reverse logistics optimizes value and sustainability for businesses through the management of item returns from consumers to manufacturers. The number of items available for online return continues to grow, leading to an increase in reverse logistics (M. Zhang et al., 2021). Demetrious et al. (2018) focused on waste generation and collection challenges for countries worldwide. Not all e-waste remains in the country of origin; for example, Nigeria receives some European e-waste (Thapa et al., 2023). Another industrialized nation that exports 50-80% of its generated e-waste is the United States (Canavati et al., 2022). The expenditure to collect and dispose of waste is far better in developed than in developing countries. The wealth of a nation impacts the level of importance applied to recycling materials. The economic benefit of recycling solid waste is the potential to generate nearly $120 per day. Earning $120 daily through recyclable mining materials from items discarded as waste is a good investment return. The cost-benefit of recycling, compared to outsourcing, is an area that businesses must address.

According to Wang et al. (2021), sustainability is a strategic position for businesses with reverse logistics as a critical effort. The Wang et al. paper is a framework with theoretical and managerial implications. Reverse logistics has a significant impact on relationships between customers and business operations. Wang et al. noted that reverse logistics deals with the return process, including goods collection. Wang et al. stated that some businesses have difficulty handling reverse logistics processes and, as such, choose to utilize a third-party logistics provider (3PLRP). According to Wang et al., 3PLRP can handle the complicated processes associated with reverse logistics.

Third-party logistics companies are crucial to modifying and enhancing supply chains and loops. Solid waste is an ongoing issue that is not going away; the best action is to find a way to create something positive from something negative. The model identified by Santos and Marins (2015) identified the link between the significant contributors to solid waste and how all the pieces fit together. Santos and Marins also identified the need for equilibrium between the triple-bottom-line concept's environmental, economic, and social aspects.

The primary focus of this study is collecting and recycling e-waste items. Consumers discard many types of solid waste from their households, and the typical recycling network requires articles for separation before pick-up. The new avenue attempted is called single-stream recycling. The single-stream method allows members to dispose of all recyclable materials in one bin (Berardocco et al., 2022), decreasing the need to separate items and boosting recycling efforts. With prior notice, homeowners could still dispose of electronics, including oversized items like ovens and refrigerators.

Industrialization and increased urbanization are two areas that caused substantial changes in the amount of waste generated (Gutberlet et al., 2020). Gutberlet et al. identified that waste disposal creates global hazards, like greenhouse gases from incineration plants. Gutberlet et al. also stated that e-waste is more valuable as a tradeable commodity than non-value-added incineration. Waste disposal is a problem that plagues the world regardless of its GDP. Countering the waste problem through inventive methods is one way to reduce the amount of waste slated for destruction. Gutberlet et al. also found that secondhand and repair shops opened in overseas markets to prolong some items' helpful life cycles. Through a cooperative effort, nations across the global economy can mitigate the waste generated for destruction and increase the options for recycling, repurposing, and reusing materials.

E-waste management is a global issue impacted by many factors. Consumer disposal behavior and awareness play an essential part in the management of e-waste globally. The disposal and handling behaviors for e-waste within the Asian theater vary, but some include treating e-waste as maintaining value (Borthakur & Govind, 2017). In Japan, retail shops collect e-waste from consumers and deliver the items to selected stockyards. Borthakur and Govind (2017) found that local governments collect and transport e-waste to their chosen recycling centers in Korea.

In North America, consumers form the basis for the handling of e-waste. E-waste handling is not a government-mandated program, but there are incentives for recycling these items (Borthakur & Govind, 2017). Borthakur and Govind identified that some states within the US also offer drop-off locations for used e-waste items, and the idea is that the increased availability of drop-off locations will increase the likelihood of consumers utilizing the facilities. Even with the offer of incentives, the favored approach of most Americans is to store the devices at home (Zhao, 2023). The primary concept is that handling e-waste may differ between countries, but e-waste handling is still a significant undertaking.

Employment

Recycling waste materials benefits the environment by reducing the amount of waste deposited in landfills. Another benefit of recycling is to businesses. Companies can save money by using recycled materials and from decreased disposal costs. There is a common theme between these actions; they all require employees to retrieve or separate recyclable materials. Job generation through recycling is another benefit essential to the industry's social impact.

Recycling is one of the fastest-growing concepts of reverse logistics. The recycling industry spans the globe and is essential in the greening process. According to Econie and Dougherty (2019), the jobs associated with recycling are called green-collar and include picking and sorting. The manual labor green-collar jobs are not luxurious or highly sought after in the labor market. In the article by Econie and Dougherty, recycling is a dirty job full of dangers and hard work. The benefits and values of recycling far surpass the conditions and hazards of sorting materials for companies and countries' economic strength. Additionally, recycling allows unskilled and semi-skilled people to find jobs.

The flow of e-waste into the waste stream can generate an avenue for increased employment and community opportunities. Opportunities may also come at a price. The legislative focus on treating WEEE has a basis in environmental, social, and economic areas (McMahon et al., 2021). The growth of e-waste continues to increase, and with that increase is the likelihood of improper disposal of electronic items (Davis, 2021). One way to help minimize global e-waste is to use a sustainable production process to reuse or recycle items from WEEE. WEEE is a source for urban mining of metals like gold, silver, and platinum, as well as rare earth elements like gallium and germanium (Annamalai & Gurumurthy, 2021). Annamalai and Gurumurthy (2021) also identified that extracting minerals from ores is costly, and there is no idea of the amount of metal removed.

Job creation and security are two critical factors in a sustainable business venture. Econie and Dougherty (2019) researched the impact of recycling on the job market. Jobs in recycling are available, but they are not glamorous or comfortable. Recycling jobs are hazardous and arduous as workers are often subjected to extreme temperatures and work, resulting in the loss of life or limb (Econie & Dougherty, 2019). Econie and Dougherty also stated that working long hours paid only slightly better than minimum wage. Temporary agencies often provide the labor used in these facilities. The issue for workers is that these positions are temporary; therefore, there are no job security benefits or protections (Econie & Dougherty, 2019). In the green sector, as stated by Econie and Dougherty, recycling is one of the standouts for expedited growth, but there is still inequality in hiring practices. According to Econie and Dougherty, many leadership roles are available in direct-hire positions; even as the recycling industry changes, employment opportunities may become scarce.

According to Owusu-Sekyere et al. (2022), handling e-waste requires a technical standard because of its hazardous nature. One way of handling e-waste, according to Owusu-Sekyere et al., was to shred the components while preventing the escape of gasses. According to Owusu-Sekyere et al., most waste transported to the Agbogbloshie scrapyard in Ghana contains scrap and e-waste. Owusu-Sekyere et al. also noted that e-waste and scrap metals received at the scrapyard receive an informal treatment process.

Recycling Considerations

One of the primary concerns for this study is that some companies do not recycle. Recycling is just a buzzword to some to garner attention, but it is so much more. Recycling is a process open to any company that takes the initiative. The levels can begin with putting a plastic bottle in a recycling bin to collecting end-of-life electronic items. Zielke and Catanzaro (2014) proved that recycling could provide positive financial benefits, even on college campuses, based on the idea that 100% of e-waste is recyclable, which is the basis for their paper. Recycling is not a one-dimensional process open only to corporations and big businesses but also to consumers. Onel and Mukherjee (2017) researched the sale impact of merchandise as a critical concept in recycling and sustainability. The authors' desire to determine why citizens recycle resulted in 12 possible responses for testing. The same study method is valid for use in the corporate world to determine reasons for recycling or not recycling. The problem with e-waste in the US is the need for a thorough evaluation. The continued population growth and the demand for materials, energy, and products increase the amount of solid waste generated (Tsai et al., 2021). E-waste categorization falls under miscellaneous durable goods in the US EPA's facts and figures (2017). Categorizing e-waste as a subcategory led to a misconception that it is only a small portion of solid waste. The volume of e-waste versus other solid waste items is much less, but the recycling value is worth identifying and researching.

The efficiency of recycling depends on many different aspects. One way to make recycling more efficient is through a circular economy model. In a circular economy, the manufacturer's responsibility covers the product's origination to the final disposal. The opportunities for businesses to mine raw materials from e-waste, according to Ryen et al. (2018), are positive steps toward efficiency and income generation. Electronic items house precious metals for extraction, such as gold, platinum, silver, and copper. The extraction of materials from waste electronics is most efficient when accomplished manually. The extraction of materials from waste electronics is most efficient when completed manually, and roughly 10 of 23 processes were manually disassembled (Tutton et al., 2022). The collected materials other than precious metals were plastics, ferrous, and non-ferrous. The different means of recycling or collecting materials include a pre-processing inspection of the equipment. During the bulk inspection, workers dismantle e-waste and separate rare earth elements and precious metals.

Recycling is one of the more popular options for dealing with outdated e-waste, but the collection is an area of concern. The collection of e-waste items could occur from various entities. The viewpoints of these entities vary, as some feel they should be the priority when receiving electronic items. As Cole et al. (2018) identified, one such entity is charities. Charities believe the first option is to be resold or used by consumers instead of disposal or dismemberment. Another potential collector is private companies. Private companies may collect e-waste through contractual obligations, which differs from charities that rely on donations from different sectors. The similar area in both is the state of the collected items upon arrival. Unfortunately, not all collection methods preserve the usable capacity, and there is no additional care or protection for these items treated as waste material. Cole et al.'s (2018) journal post focuses on the benefits of reusing e-waste instead of recycling based on the level of care and protection given to these items at the time of collection, and their usability is relatively low.

Recycling is a viable means to protect our environment and preserve our natural resources. As Bleicher (2020) identified, there is still some opposition to recycling. Some believe recycling represents valuable items now specified as trash and reused. The secondhand use mentality is different from the benefits of recycling. The resources used in manufacturing are not infinite, but they are replaceable. The same materials used once retain their value and applicability for reuse. The issue is not the material but the mindset of people. The business perspective for making recycling decisions includes price competition between recycled and primary materials (Cui & Sošić, 2019). Comparing recycled items to raw materials and deeming them less valuable is a mistake. Recycled materials are still usable in primary or secondary markets or manufacturing. The scarcity of raw materials will continue to force their price up, and the direct way to combat these costs is by recycling what is already available. Bleicher (2020) further identified that a mental shift would have to occur for recycling to work. Consumers must view recycled materials as valuable, not secondhand items made with dilapidated materials.

A circular economy is a tool that can decrease energy consumption, reduce carbon dioxide production, and alter the consumption patterns of consumers (Triguero et al., 2022). Triguero et al. further identified that a circular economy is a regenerative system that reduces resource usage and waste generation. Circular economy, according to Triguero et al., includes the 3-R criteria: reduce, reuse, and recycle. Another addition to the 3-R criteria is recovery, which, according to Triguero et al., recovery is the process of recovering energy from the incineration of waste.

Future Impacts

The future of waste electrical and electronic equipment surpasses the normal handling operations of recycling. Defective electronic items make an excellent source for the electronic testing industry. Nithya et al. (2021) identified that the future of recycling is in the process of more efficient recovery through thermodynamics and reaction mechanisms. In addition, incentives are available to increase the number of electronic items turned in for recycling. Recycling is a beneficial undertaking, but it requires actions to achieve success. One way to convince members to recycle items is through a consumer-friendly point reward system (Zhong et al., 2022). There are other choices for rewards or incentives that are not financially based. Choices for intangible rewards are goal setting, descriptive social norms, feedback, commitment, or a tangible symbolic reward like a gift (Y. Li et al., 2021). The primary concern is to convince consumers to properly dump e-waste through recycling or exchanging (Sabbir et al., 2023).

Society benefits from the increased number of electronic items returned for recycling, which helps the environment and economy. The amount of e-waste generated yearly exceeds 50 million tons, equivalent to 125,000 jumbo jets or 4,500 Eiffel towers (Houlin et al., 2019). One of the publications' critical points is identifying that e-waste discarded in landfills, burned, or handled by sub-standard means exceeds 40 million tons yearly. The relevance of the e-waste produced and dumped may garner little attention, but let us view this from a financial perspective. Houlin et al. stated that the smartphone retail market represents a sales value above $1.4 billion, but recycling the raw materials could net over $11 billion in return.

The forum concludes with the idea of a global e-waste reset. The time for change is here, and the opportunity is ready for those willing to take a chance. The amount of e-waste increases exponentially at a rate of two Mt per year, with an estimated generation of 74 Mt in 2030 (Withanage & Habib, 2021). The increased amount of e-waste materials available and the increased volume of new purchases are cornerstone pieces to the e-waste recycling proposal. During the review of recycling practices, it is apparent that there are many different names or descriptions for recycling.

Schroeder et al. (2019) opted to review the process from the circular economy standpoint. Other terms used to research circular economy included industrial symbiosis, remanufacturing, and circular economy recycling. The link between circular economy and sustainability is recycling, reusing, and repurposing materials. Schroeder et al. (2019) further identify the conceptual overlap between circular economy concepts, practices, and principles. Employing a circular economy model's tactics may help ease the burden of initiating a recycling business. The development of future recycling business concepts exists and provides an avenue for innovators or imitators to develop a workable business model. Some companies maintain recycling operations, but fewer are delving into the field due to new controls and restrictions. The journal article by Wierzbicki and

Nowodziński (2019) defines innovation as processes or activities that lead to the creation of a new product. Once research and development identify an approved procedure, the company may move forward with the actions. Wierzbicki and Nowodziński also identified that imitators have a smaller risk factor and cost and are safer for businesses to achieve their goals. Imitators may not have the budget or qualifications necessary to initiate research and development but may have the skills and base for marketing. Entry into a recycling business may not cause undue cash expenditure or require detailed research and development based on these concepts as the companies already exist. With little research, the efficiency of these businesses is perfect as a model for other companies to follow.

The e-waste industry has challenges that can impact company sustainability. Some challenges include environmental, difficulty processing, and an ever-increasing e-waste generation (Xu et al., 2020). The correlation between the challenges businesses face and sustainability tenants is unmistakable. The journal article by Xu et al. identified that risk assessment methods typically evaluate risk elements separately, and the separate evaluation does not sufficiently assess risk as many parts are related. To mitigate these risk factors, companies must develop new strategies. Ismail and Hanafiah (2020) identified the need to evaluate the aspects of e-waste management systems. E-waste management systems provide an avenue for increased sustainability. The management system needs further investigation and evaluation before fully supporting various risks and differing opinions. During the development of this study, Xu et al. (2020) reviewed other published bibliometric studies. One such study by Gao et al. (2019) identified 2,800 articles published in 571 journals. Gao et al. also stated that the number of publications dealing with e-waste increased, with China, the USA, and India at the forefront. Due to continued research, the future of e-waste management practices will change.

Transition

The first section of this study discussed the background of the problem, the problem statement, and the purpose statement. The background of the problem is the ever-growing issue of e-waste accumulation. The precious rare earth materials collected are helpful in other manufacturing processes. In too many instances, companies must dispose of the e-waste in landfills or export the materials overseas for processing. The specific business problem is that some leaders from United States-based companies lack strategies to recover funds through recycling e-waste. This study aimed to research the strategies leaders from companies use to recover funds through recycling e-waste in the United States. The study's targeted population was 13 leaders from 13 solid-waste collection companies that operated in the southern United States who have successfully recovered funds through recycling e-waste.

The second part of the study aimed to evaluate the correlation between the company's use of recycled materials in industry instead of maintaining dependence on raw materials. The basis of the study is a quantitative research methodology with a theoretical framework. In section 2, the answers to the research questions will be answered and built upon for the study's remainder. The culmination of responses from the identified participants from separate companies will also help solidify the research basis.

In the final portion of the study, section 3 finalizes the study. The construction of this last portion ensured coverage of all the primary avenues for this study, with all the research questions answered and all texts evaluated. Also, this section provides the opportunity to present the implications for change and future study options for continued research.

Section 2: The Project

Purpose Statement

The current qualitative multiple case study explored how leaders from successful companies in the Southeast United States recovered funds from recycling e-waste. The targeted population was leaders from solid waste collection companies operating within the southern United States who have successfully recovered funds through recycling e-waste. The interview questions for this study were open-ended and elicited the information necessary to identify successful strategies leaders used.

Role of the Researcher

The researcher's role in conducting a study is to conduct inquiries into the subject and present the answers (Elmersjö & Rosqvist, 2022). Elmersjö and Rosqvist also stated that the researcher's role is a two-way relationship between the researcher and the research object. Another vital requirement for researchers is to ensure no misconduct occurs by adhering to the Belmont report, which the US Office for Human Research Protections administers (Redman & Caplan, 2021). One role of the researcher is to explore the participants' perspectives and beliefs based on the study requirements (Gani et al., 2020). Gani et al. also noted that it is essential for the researcher to ensure an understanding of the interview questions during interviews. Hui et al. (2022) noted that the quality of the interview questions impacts the quality of the data obtained for the study.

Participants

The participants for the current qualitative study were from solid waste collection companies that operated in the Southern United States and recovered funds through recycling e-waste. The targeted population for this study was leaders from solid waste collection companies that operate in the Southeast United States who have successfully recovered funds through recycling e-waste. The sample was 13 leaders/subject matter experts from 13 companies that operate in the Southeast United States with 3 years of practical experience in solid waste recycling. Gaining access to the participants occurred via telephone calls. Participants received a copy of the informed consent form and interview questions.

Research Method and Design

The method used for this study was qualitative, and the design was the case study. The qualitative approach allows researchers to provide iterative changes in the literature, the data collection, and the analysis (Siregar et al., 2020). According to Siregar et al., the qualitative method paired with the case study design provides an opportunity to obtain explanations, understanding, or interpretation of the research topic. The semistructured interview is one of the tools associated with qualitative methodology. The semistructured interview allows the researcher to maintain the focus of the discussion by asking the interview questions (Bulut, 2020). Other qualitative data collection methods include focus groups and observations, but the case study focuses on the specific business problem and offers a strategic advantage for collecting and processing data pertinent to the research (Grant et al., 2020).

Research Method

The current study's chosen research method was the foundational element for the study's construction. The research methodology choices were quantitative, qualitative, and mixed methods. These methods have inherent strengths for researchers to use. The chosen methodology for the current study was qualitative. Qualitative methodology focuses on discovering information and allows participants to provide input (Coy, 2019). Conducting interviews with subject matter experts in recycling provided a viable means of answering the research question. Data is collected in a narrative rather than numerical form in the qualitative method (Santos & Marins, 2015).

Quantitative methodology is an excellent tool for providing reproducible results based on specific variables and hypotheses. The quantitative method involves the statistical assessment of a theory (Depaoli et al., 2018). Quantitative methods provide a technical basis for quantified or justified courses of action using statistical correlation as a catalyst. The application of numerical data assists in answering many different research questions and provides a foundation based on facts, not conjecture. There are strengths in using the quantitative method, but not all research questions need numerical data or statistical analysis.

The mixed-methods approach was another option for conducting the current study. Zadmehr et al. (2018) used information gathered through qualitative and quantitative methods. Zadmehr et al. employed observations and direct visits to landfill sites to collect information. Zadmehr et al. used the Cochran formula to determine the study's appropriate sample size. The extensive mixed-method study was thorough and provided a well-rounded research result. The study's limiting factors included geographic, time, and availability of assets and site and personnel limitations.

Research Design

The ethnographic design focuses on prolonged interactions to collect the required data (Podjed, 2021). The foundation of ethnographic research is to improve findings with extended and direct observation periods. The research conducted by Gillooly et al. (2020) focused on corporate naming rights for stadiums for football fans. The multiphase study included engagement with fans in Stage 1 and the focus groups in Stage 2. According to Gillooly et al., the final phase included researchers who attended sporting events to mingle with the fans and look for historical markers from previous stadium names. The ethnographic design provided the appropriate foundation for long-term studies with in-depth details based on participant feelings and views. Ethnography is a research design that allows for the intersection between theory and method and method and subject (Meier zu Verl & Meyer, 2022). The ethnographic theory originates from the targeted topic.

Another qualitative design is phenomenology, which provides another means for gathering data. The approach was traditionally a philosophy-based design (Fernandez, 2020). The basis for the use of the phenomenological design in qualitative studies results from the foundation of philosophy. According to Arnal-Palacián et al. (2020), the phenomenological design is a method for mathematical analysis. The premise of phenomenology is that there is a lack of awareness of the world's effects on people's thoughts and actions (Freeman, 2021).

There are many different designs available in qualitative research. The case study is another viable design. A case study involves extensive data collection methods (Grant et al., 2020). Grant et al. also noted that the primary strength of the case study is the ability to understand different phenomena. Grant et al. also stated that case studies provide a versatile tool encompassing one or more data sources for comparison and evaluation. The purpose of case studies is to highlight the importance of understanding phenomena and dynamics (Reynaers, 2022). The qualitative method includes purposive samples to ensure data saturation when the gathered information no longer produces new data for the study (Grant et al., 2020).

Population and Sampling

The current study focused on recycling e-waste such as cell phones, radios, and other small- to medium-size appliances. The research question focused on the strategies for recycling e-waste materials. One of the significant determinations for this study was population sampling. There are many different methods for population sampling, such as volunteer sampling, snowball sampling, purposive sampling, and theoretical sampling (Gill, 2020). The sampling method selected for the current study was purposive. The purposive sampling method used included a list of companies that operated within the scope of the research area (see Bakkalbasioglu, 2020). The number of interviewees selected for this study was 13 leaders from 13 companies. The population chosen for this study provided the insight and expertise necessary to answer the research question. Each participant identified needed to have knowledge I could use to answer the research question. The criteria for determining participants included experience, WEEE knowledge, knowledge of EPA compliance requirements, and knowledge of the strategic and tactical levels for achieving corporate goals.

Participants' minimum experience level was three years of practical experience in solid waste recycling. The primary candidates had management experience in the solid waste industry and waste electrical and electronic handling procedures and requirements. The US federal agency, the EPA, oversees environmental concerns, protection, and management. Compliance with EPA requirements is mandatory; failure to adhere leads to substantial fines and penalties.

Potential participants needed to understand the strategic and tactical requirements for accomplishing corporate goals in recycling. In a case study of Industry 4.0, Zinn and Vogel-Heuser (2019) conducted interviews with experts from eight companies, and the selected experts worked in manufacturing positions. Zinn and Vogel-Heuser identified that small companies' representatives came from upper management with a technical background. Knowledge of the strategy led to a viable plan to reach the corporate goals of recycling e-waste for a profitable undertaking. The plan was only a part of the needed information for success. The tactical requirements included the tools necessary to enact the strategic plan. Interviewees with this level of knowledge provided the most significant opportunity to achieve viable responses to the posed research questions.

Gaining access to a viable participant pool required the use of multiple venues. Using membership with other professional organizations and honor societies to request alumni assistance was the starting point for the current study, and additional requests to solid-waste companies provided the next participant pool. Identifying a common interest or background was the most efficient means to establish a rapport (see Hathaway et al., 2020). The use of terms familiar to the participants helped me maintain open lines of communication based on trust. The critical point was ensuring the participant was willing to participate in the study and could provide valid answers to the interview questions.

Ethical Research

Conducting doctoral research presented researchers with questions of right and wrong. When conducting research, a process called ethics in practice, which refers to everyday ethical moments, may arise (Kamlongera & Katenga-Kaunda, 2023). In research, Kamlongera and Katenga-Kaunda noted that participants have the right to consent to participate. Kamlongera and Katenga-Kaunda noted that informed consent is an ethical obligation ensuring participants have all the information about the research project. Informed consent protects human research participants (Bazzano et al., 2021). Informed consent applies to any study with human participants, not only medical research. The Belmont Report, which focuses on ethical guidelines and principles, identified three concepts (Bazzano et al., 2021) that are a critical part of informed consent: information, comprehension, and voluntariness. Researchers need to provide information to participants about the study and its use. Researchers also need to ensure that participants comprehend the research requirements and are willing to volunteer for the study. The Belmont Report, sometimes called the “Common Rule,” is meant to curb misconduct in research, which has the potential to cause harm to participants and skew the integrity of the study (Redman & Caplan, 2021). Taquette and Borges da Matta Souza (2022) acknowledged that unexpected situations during the study require researchers to make decisions to ensure ethical requirements remain intact. However, ethical research is crucial in accomplishing a doctoral study.

In the current study, the consent form provided a list of rules and expectations for the interviewer and interviewee. The interviewee's rights required protections, including no misrepresentation of responses and no disclosure of personal information. Among the essential information provided in Part 1 of the informed consent form was a request for participation and a description of the researcher. The consent form also included a brief summary of background information and the procedures to be followed for the interview. The form included what the study involved, the line of questions, the expected participation time, and a sample of the questions.

Participation in this study was voluntary, and participants received guidelines and opt-out abilities. The nature of the study indicated how many people I required to reach data saturation. Individuals participating in the interviews provided a narrative of the risks and benefits associated with the investigation. There were no monetary benefits in this study. Each participant in this study received privacy rights and guarantees. I protected participant information from release and will secure it for at least five years, per Walden University policy. One of the critical aspects of ethical research is transparency. Taquette and Borges da Matta Souza (2022) noted that as the study continues, there is a risk that the researcher may lose impartiality, which may lead to biased findings.

Data Collection Instruments

Data collection started after receiving my approval number from the Walden University Institutional Review Board (04-01-22-0759481). Qualitative data collection instruments represented the means of collecting information for this study. The primary instrument in data collection was me, but other commonly used instruments include focus groups, interviews, document analysis, and observations (Nassaji, 2020). I used the qualitative interview for data collection, which is commonly used (Mwita, 2022b). According to Mwita (2022b), the qualitative interview provides in-depth details and is a flexible tool for gathering data. Mwita also acknowledged that the foundation of qualitative interviews is the sharing of information between the researcher and the interviewee. Mwita stated that there are three general types of interviews, which are structured, semistructured, and unstructured. The difference is the questions used for the interview and the generated responses. In the current study, I used open-ended interview questions. I conducted semistructured interviews because I wanted each participant to provide responses based on the same questions. Another feature of this study was the informed consent form. The informed consent form provided guidance and information for the participants, such as background information, procedures, privacy, and the voluntary nature of the study. Conducting the interviews empowered my interaction with each participant, allowing me to capture the interviewee’s responses without controlling them (see McGrath et al., 2019).

Data Collection Technique

Qualitative research was a naturalistic inquiry without a specific concentration on numerical data that sought to understand and explore instead of explaining or manipulating variables (Nassaji, 2020). The interview was the selected data collection instrument for this study. According to Nassaji qualitative research information occurs with strict rigor, quality, robustness, and informed and is well-documented. Nassaji (2020) also acknowledged using interviews, field notes, or observations for qualitative research where the results were credible and confirmable regardless of the researchers' tool (Nassaji, 2020). By exploring interviewee experiences, the qualitative interview process provided information for this study (D. R. Johnson et al. 2021). According to D. R. Johnson et al., a face-to-face interview is better than remote interviews such as Skype and telephone calls. The mode comparison of face-to-face interviews over remote deals with the quality analysis of the collected information (D. R. Johnson et al. 2021). The interview method used to gather data from participants has changed. Researchers must pay attention to the interview limitations, such as schedules and travel costs (D. R. Johnson et al. 2021). As stated before, conducting face-to-face interviews has many limitations; combating these limitations using other means is a viable choice. Other interview means, such as SKYPE, Microsoft Teams, or telephone calls, offer flexibility (D. R. Johnson et al. 2021). According to D. R. Johnson et al., conducting telephone interviews provides a calmer and more private setting, which results in richer information. There are no costs associated with conducting telephone interviews, whereas face-to-face interviews can cost the interviewer fuel or transportation.

After completing the interviews, validation of the results is necessary. One way to accomplish this validation is member checking. In addition to establishing trustworthiness, member checking is also known as participant checking (Motulsky, 2021). There are two approaches to member checking identified in the Motulsky (2021) article. The first approach is to provide the participant with an interview transcript for review, correction, and editing (Motulsky, 2021). The second approach provides participants with a draft copy of the study to review and allows them to respond in writing or request additional interview sessions to review the results.

Data collection techniques changed due to restrictions limiting face-to-face interactions as a preventative measure for reducing the spread of COVID-19. Electronic platforms for online interviews, such as videoconferencing, became standard for online discussions (Lobe et al., 2020). The use of electronic measures to conduct interviews also occurred under specific requirements and, according to Lobe et al. required access to stable internet connections through a device such as a laptop, computer, or smartphone. Lobe et al. also acknowledged some requirements remained similar for conducting interviews, such as a quiet space where participants felt safe and comfortable interacting with researchers.

Some platforms available for video interviews included Skype, Zoom, Teams, and GoToMeeting. The researcher decided on the interview platform, ensuring it supports audio and video communication. One concern for researchers was securing and protecting the participants' information and responses, which is paramount in an electronic interview environment (Lobe et al., 2020). A stable Internet connection was another critical concern for using video interview platforms (D. R. Johnson et al. 2021).

Following the interview sessions, each participant received information about their responses. Member checking allowed participants to review the researcher's interpretation of their responses, which was accomplished by reading the collected responses to the participants for verification. Additionally, participants received an emailed copy of their responses from the researcher. In one example, participants had 2 sessions with researchers; the 1st was for the interview, and the 2nd was for follow-up or member checking (de Loyola González-Salgado et al., 2022). Following the initial interviews with participants, their responses were reviewed with each of them to ensure the interpretation matched their responses.

Data Organization Technique

Collecting data was a crucial aspect of conducting research for this study, but collecting data was only a part of the puzzle. One part of the puzzle was keeping track of the collected data. I transferred the collected information to my computer to ensure quick and easy access throughout the study. The data collected from the qualitative methods of interviews still required evaluation. Extracting information from interviews was foundational to gaining in-depth knowledge of an identified subject (Jouis et al., 2019). Qualitative data from surveys, interviews, or focus groups left researchers needing help handling the abundance of data, and a large amount of collected data needed categorization (Vaughn & Turner, 2016). Vaughn and Turner acknowledged the strategies used for qualitative data analysis included identifying categories, mapping relationships, and setting exclusion criteria. The responses provided by the interview participants contained lots of valuable information, which led to categorization. Then, a grouping of the individual responses occurred, which resulted in recurring themes. After employing these actions, the analyzed information became part of this study. The collected data from interviews was preserved and protected following Walden University requirements of five years.

Qualitative data collection generated a significant amount of information for analysis. One means used to analyze data was coding, which reduced data and presented it as readily accessible packets (Linneberg & Korsgaard, 2019). According to Linneberg and Korsgaard, using coding allowed deep immersion into the collected data for researchers and provided transparency in development and presentation. One advantage of coding was reviewing data during segmentation (Linneberg & Korsgaard, 2019). Coding the research data is one of the significant parts of analysis, and coding the data involves converting large data packets to make them manageable themes (Ningi, 2022). Allsop et al. (2022) noted that open coding focuses on coding what is said, not what the text means. Allsop et al. also acknowledged that by coding what the interviewee said, the researcher reduces the likelihood of inputting their own words into the results. Giesen and Roeser (2020) state that coding is a valuable tool for analyzing large data packets, and in qualitative research, coding is fundamental to analysis. I collected the information in this study and conducted an occurrence-based grouping to identify which items occurred with the most significant frequency. The high-frequency items identified in the study became the controlling themes.

Once collected, the data requires an additional step called coding. Coding is finding and assigning a code to the participant's words (Allsop et al., 2022). Different methods are available for coding information, such as software or manuals (J. L. Johnson et al. 2020). J. L. Johnson et al. stated that the manual approach is inefficient for large data sets and that software is appropriate for researcher coding. According to J. L.

Johnson et al., using software provides exceptional benefits, but the responsibility still lies with the researcher to interpret and analyze the data.

The Google search engine and NVivo analysis software provided other viable platforms. Top-ranked data analysis software platforms included at least 14 products. The operating system provided the restrictive decision element for the applicable data software. Some analysis programs did not work with a Mac Operating system without additional modification or layering of the analysis software. In addition to the operating system requirements, a financial cost was associated with the coding software. The price range included a free or trial basis to upwards of 1200 dollars per month for some analysis software. Each researcher determined the appropriate software for coding the collected information.

The Statistical Package for the Social Sciences (SPSS) software was the chosen tool for analyzing information collected from interview questions with selected participants. The collected interviews underwent categorization based on the provided responses. The initial categorization included color-coding the reactions based on each interview question. The following information partition separated the data into like responses and unlike reactions. The SPSS software was viable for use at any point in the process. As previously stated, combining manual and electronic resources provided the tools necessary to ascertain the collected data's usefulness.

Data Analysis

Data analysis is crucial to ensure the collected data's validity and reliability (Fusch et al., 2018). One means of data analysis is triangulation. Triangulation represents a strategy for validation and increased scientific rigor. (da Silva Santos et al., 2020). There are four forms of triangulation: method triangulation, investigator triangulation, theory triangulation, and data source triangulation (Moon, 2019). Data triangulation represents the different information of the same event and occurs over days, weeks, months, and years, and investigator triangulation occurs when several researchers review the phenomenon (Fusch et al., 2018). According to Fusch et al., the third is theory triangulation, which applies theories and alternative theories to the data. Fusch et al. also stated that the final type of triangulation is methodological, a collection of multiple information collection methods. The four triangulation methods occur in a stand-alone usage or together (Moon, 2019). Triangulation explores similar items' different levels and perspectives and ensures the study's validity (Fusch et al., 2018). One critical aspect of conducting research was documenting the data gathered from the interviews (Mohamed, 2022). The researcher selected strong examples or interview excerpts that defined specific themes (Matteson, 2021). In this study, Appendix C is the interview category table listed by theme and comprises six tables broken down into primary themes. The constant comparative method determined similarities based on each piece of data (Corring et al., 2019). The chosen process of triangulation for this study was methodological triangulation. The triangulation method included researching relevant peer-reviewed articles on the same subjects in the study. Methodological triangulation is a widely used tool for ensuring the validity and reliability of studies (H. Liu et al., 2021). Some data collection methods include interviews, surveys, and observation (Campbell et al., 2020). In my study, I used interviews as a means of data collection. Triangulation for my research included interviews, member checking, and data saturation. Member checking included conducting interviews with participants first. After the interview, I documented the participants' responses and reviewed them with each volunteer to ensure I had adequately and accurately collected their responses. The next step was to categorize the responses until data saturation.

Software-based qualitative analysis tools provided transparency and trustworthiness in the research process (O'Kane et al., 2019). After researching several computer-aided/assisted qualitative data analysis software (CAQDAS), I found the software program's compatibility with Macintosh (MAC) computers was complex and cumbersome (Niedbalsk & Slezak, 2021). Researching these two options provided neither the accessibility nor trustworthiness required, but an additional software program appeared to meet the requirements. The most viable software program was called the Statistical Package for the Social Sciences (SPSS; Purwanto et al., 2021).

The Statistical Package for the Social Sciences (SPSS) was the chosen software for data analysis during this study for its simplicity and availability. SPSS offered a graphical interface for users and was one of the most popular academic platforms (Sahin & Aybek, 2019). The text files, such as interview responses and additional notes, were loaded to SPSS for other classifications. Once loaded, different aspects identified by the researcher led to initial categorization. Following initial categorization, the responses underwent further analysis and identification of the final categories. Using SPSS included the same benefits identified in other CAQDAS software, like data organization and text search capability (O'Kane et al., 2019). CAQDAS software was a tool that helped ensure trustworthiness and transparency (O'Kane et al., 2019).

Reliability and Validity

Conducting research was a detailed process that allowed reliability and validity in this study (Coy, 2019). According to Coy (2019), researchers also paid attention to the limitations of study designs. Researchers directly participated with selected individuals for the interviews, and the researcher was responsible for accurately documenting and interpreting interviewee comments. In research, validity identifies the accuracy of a measure of a measurable variable (Ahmed & Ishtiaq, 2021). Empirical conceptions as universal law included evidence, objectivity, truth, and deduction, which were the root of validity. The information found in the study represented reliable and validated information. Evaluated information validity fell into five different domains. The five domains were communication, teamwork, lifelong learning, innovation, and entrepreneurial competencies (Cruz et al., 2021).

Reliability

The intersection of safety, effectiveness, and resilience is one definition of reliability (Ramanujam & Roberts, 2018). Ramanujam and Roberts (2018) noted that organizations flourished toward a common goal as the company's founders established an operational vision. Researchers set goals in researching a doctoral study, such as responding to the study's research questions. Studies with a limited number of participants faced issues with establishing reliability. In some instances, increased reliability requires the same interview at different times with the same participants (Marx et al., 2021). Conducting the interviews for a doctoral study encompassed some of the same tactics. Researchers provided participants with questions to answer about the study. Upon completion, the interviewer reviewed participant responses as understood by the interviewer. The secondary meeting provided another opportunity to review the interviewee's answers and their interpretation to ensure reliability.

Generating reliable information meant developing respectful relationships and requiring accountability for the data, which included conversations and the collected information (Barlo et al., 2021). Researchers sought and received approval for the data contained in studies from ethical review boards (Licker et al., 2020). Licker et al. also identified that reviewing and using previous studies to derive information was commonplace in some studies but still required ethical review and approval.

Validity

Establishing validity in a qualitative study included credibility, transferability, confirmability, and how researchers reached data saturation. Peers and other experts scrutinized all research projects for worthiness and merit, and qualitative studies required a determination of rigor and trustworthiness instead of quantitative ones, which looked at reliability and validity (Cypress, 2017). Cypress also stated that not all parties believed reliability and validity belonged in qualitative studies but only practical for quantitative researchers.

The basis of validity was empirical conception as a universal law; reasons, facts, reliability, and validity were critical for designing doctoral students' studies (Cypress, 2017). Establishing validity included three core items for review: credibility, transferability, and conformability. According to Cypress (2017), the first core item was credibility, which considered depicting the participant's lived experiences, and the second item of transferability dealt with purposeful sampling methods and reflected detailed and accurate descriptions of participant experiences. During the research process, Cypress (2017) emphasized the importance of accurately documenting and journaling experiences and information. As an instrument of the study, the researcher analyzed the collected data and transformed it into thematic descriptions, patterns, or theoretical models (Haven & Van Grootel, 2019). Haven and Van Grootel (2019) identified one area of strength for qualitative studies: its flexibility, which also strengthens the study's validity.

Validating collected information was a vital part of the research. The means used to validate information may vary, but the result did not. Data validation techniques included mechanisms broken down into two options. Data-based validation was the first option, and non-data-based validation was the second, but both types require a reviewer to ensure validity (Kim & Yun, 2019). The researcher maintains responsibility for the integrity of the collected data and other information for the study (Taquette & Borges da Matta Souza, 2022).

Different avenues of validation enhance the reliability and validity of doctoral studies. Researchers set predetermined numbers of participants for interviews, but the predetermined number of participants may not fulfill data saturation requirements (Haven & Van Grootel, 2019). Haven and Van Grootel stated that researchers continued with interviews if the selected participants failed to achieve the required data saturation.

Determining the number of participants necessary to reach data saturation differs with each study, and my study reached data saturation with 13 participants. Saturation occurs when the research no longer generates new themes and may result in around 13 interviews (Mwita, 2022a). Mwita (2022a) also acknowledged that data saturation helps ensure the study information's validity and credibility. According to Hennink and Kaiser (2021), data saturation occurs between 9–17 participants, and the mean is 12–13 interviews. In my study, I collected and categorized the responses of the participants. No new themes emerged during the categorization process. My study's data saturation point was 13 participants.

According to Islam and Aldaihani (2021), the first step is for the researcher to familiarize themselves with the information. Familiarization includes reading the interview transcripts to ensure an understanding of the data. After familiarization, according to Islam and Aldaihani (2021), initial coding of the information occurs based on line-by-line coding. Islam and Aldaihani also noted that after initial coding, a search of the data to identify themes occurs. Identifying the themes included reviewing the coding for patterns. Once identification and review of the themes occur, the themes become part of the study.

Transition

Section 2 of the study detailed the researcher's role after restating the problem statement. The researcher's role in conducting a study is to present inquiries into the subject and then collect the answers (Elmersjö & Rosqvist, 2022). Elmersjö and Rosqvist (2022) also stated that the researcher's role remains a two-way relationship between the researcher and the research object. The next area focused on the participants for the qualitative research. The participants worked within solid waste collection companies in the southern United States, and the targeted population was 13 leaders from 13 solid-waste collection companies. After identifying the participants, the next area focused on the study's qualitative research method and design.

The qualitative research method was the basis for the study. The qualitative research method consisted of four steps: literature search, matching, assessment of the degree of contribution, and review and gap identification (Schroeder et al., 2019). The chosen research design for the study was the case study, which provided a versatile tool encompassing one or more studies for comparison and evaluation (Grant et al., 2020). Many design theories were available for qualitative studies, but the case study basis was not on generalization but particularization, which was the best choice.

The participants for the study required a minimum of three years of practical experience in solid waste recycling. The primary candidates also had management experience in the solid waste industry and waste electrical and electronic handling procedures and requirements. In order to conduct the interviews, we identified the participants and requested their permission. After conducting the interviews and accumulating data, the next area of this study was ethical research. When conducting research, a process called ethics in practice, which refers to everyday ethical moments, may arise (Kamlongera & Katenga-Kaunda, 2023). In conducting research, Kamlongera and Katenga-Kaunda stated that individuals had the right to consent to participate. Kamlongera and Katenga-Kaunda noted that informed consent was an ethical obligation that ensured participants had all the required information about the research project. Participation in this study was voluntary, with no compensation offered.

The next area included data collection instruments, collection, and organization techniques. The data collection instrument for this study was a naturalistic inquiry without a specific concentration on numerical data that seeks to understand and explore instead of explaining or manipulating variables (Nassaji, 2020). The interview delivery method changed based on the ongoing COVID-19 Corona Virus Pandemic. Instead of face-to-face meetings, platforms such as Skype, ZOOM, and GoToMeeting became venues where personal meetings could not occur. The researcher decided on the interview platform and ensured the platform supported audio and video communication availability. Researchers must protect the participants' information and responses in an electronic interview environment (Lobe et al., 2020). Section 2 of the study finished under the heading of data analysis, which identified the method researchers used to code collected information for analysis. The data analysis tool used for this study was the Statistical Package for the Social Sciences (SPSS).

Section 3 of the study begins with the Application to professional practice and implications for change. The section begins with a restatement of the purpose statement and a summary of the study findings. The next area presented the findings related to the research questions and identified the study application for professional practice, which focused on how leaders used the study to solve problems.

The fifth area dealt with the implication of social change, which included identifying the advantages garnered for society. The benefits had economic, environmental, cultural, and employee-centric development opportunities. Following the part on social change, the researcher recommended actions. The recommended actions provided a win-win concept for businesses as well as the participants of the study. If there are any further research recommendations, these were part of Section 3 of the study. Section 3 ends with the researcher's reflections on the experience of the DBA doctoral study process and a strong concluding statement.

Section 3: Application to Professional Practice and Implications for Change

The current qualitative multiple case study explored the strategies companies used to recover funds through recycling e-waste in the Southern United States. The targeted population was leaders from solid waste collection companies operating in the Southern United States who have successfully recovered funds through recycling e-waste. The open-ended interview questions provided the data necessary to answer the research question.

I identified 13 participants from 13 companies after compiling a list of companies in the electronics recycling field. I worked to identify members from different parts of the Southeastern United States. Once participants were identified, I collected data from 13 leaders from 13 companies that operate in the Southeastern United States. Of the 13 companies, 10 recycled and three collected e-waste for resale. The key strategies companies used to efficiently manage e-waste materials for recycling, reuse, and repurposing came from the collected data. The theme with the highest frequency of occurrence was communication, which included marketing and advertising.

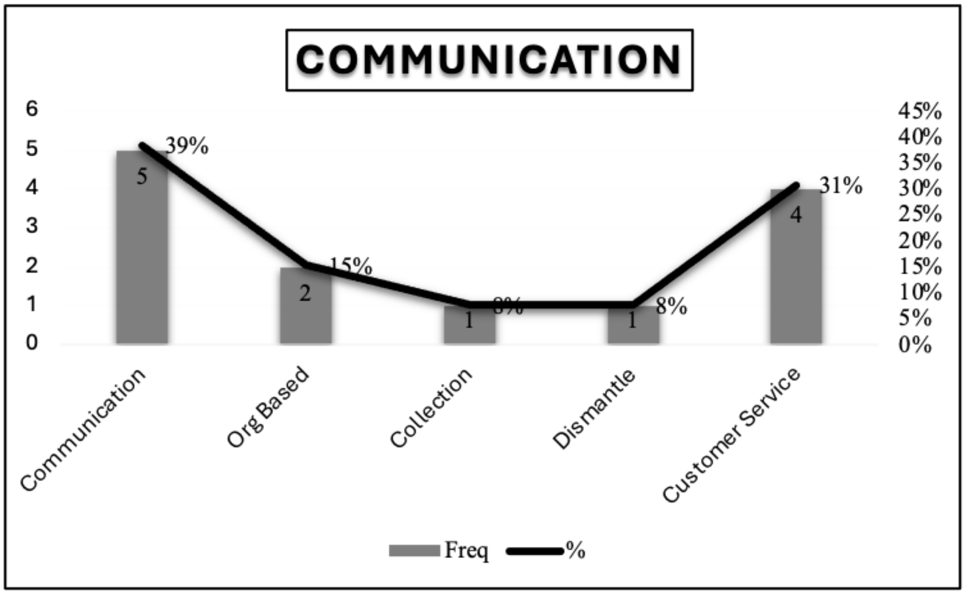
Presentation of the Findings

The overarching question for this study was the following: What strategies do some leaders from southern United States companies use to recover funds from e-waste recycling? The overarching themes realized in this study were (a) communication, (b) handling methods, (c) selling materials, (d) labor/employment, and (e) policies. The collected information came from 13 companies that operated in the southern United States. All participants were over 21 years of age and worked in an e-waste recycling company. All participants had at least 3 years of experience in the recycling industry. The participants were in management/leadership positions. The identification used for participants was alpha-numeric codes (e.g., P1, P2).

Figure 1 is an illustration of the theme with the highest occurrence frequency. The primary business theme listed in Figure 1 is communication. How people share information or ideas verbally or nonverbally is one way of explaining communication (Dragan, 2019). Communication is significant for relevant stakeholders to understand the benefits of recycling (Nanath & Kumar, 2021). The collected responses were summarized and categorized for each question. During the interviews, nine respondents (70%) identified these two themes.

Figure 1

Communication



Theme 1: Communication

Communication between e-waste companies, corporations, government agencies, and consumers via many different means is the foundation necessary for successful business ventures. Some companies use marketing or advertising tactics, while others use cold calls to reach potential customers. Nanath and Kumar (2021) identified communication's critical role in sustainability, such as overcoming the lack of awareness for students and young adults. The technology-driven Generation Z receives much information via smartphones from many different sources, and not all of that information is valid (Pradeep & Pradeep, 2023). Generation Z, refers to individuals born between 1997 and 2012 (Coman et al., 2022). Coman et al. (2022) also stated that Generation Z represents an influential demographic that reflects increasing company expectations. Pradeep and Pradeep (2023) used the theory of planned behavior because it links to intention, attitude, subjective norm, and perceived behavioral control. The theory of planned behavior, according to Pradeep and Pradeep, identifies a person's tendency to engage in specific actions. According to Lee and Krieger (2020), the intersection between communication accommodation and campaign customization results in six communication types. The types include single-channel deficit reduction, multichannel deficit reduction, audience-centric deficit reduction, single-channel translation, multichannel translation, and audience-centric translation. Lee and Krieger noted that single-channel deficit reduction involves a single outlet for displaying information. In contrast, multichannel deficit reduction involves various marketing strategies and media channels for maximum exposure. Lee and Krieger noted that audience-centric deficit reduction segments the preferences and characteristics of the audience for the distribution of messages.

According to Lee and Krieger (2020), the single-channel translational approach involves interpersonal communication, whereas the multichannel translational approach is used to explain information to residents through individual communications. The last of the six communication types is audience centric, which refers to empowerment by actively participating with the audience. In Lee and Krieger's study, the communication fits into the single-channel deficit reduction, which, focuses on information about local recycling, management schedules, and instructions on acceptable materials. According to Lee and Krieger, multichannel deficit reduction refers to using media channels and marketing strategies to communicate persuasive messages and increase information exposure.

The importance of communication, as identified by my interviews, was also established in Nanath and Kumar's (2021) study. Nanath and Kumar identified communication as having a significant role in ensuring sustainability. According to Nanath and Kumar, communication's role is to overcome the critical issue young adults face. The lack of knowledge about handling e-waste to reduce its environmental impact is critical for young adults. Nanath and Kumar identified different forms of communication to share information, such as online guides, conferences, promotions, and pamphlets.

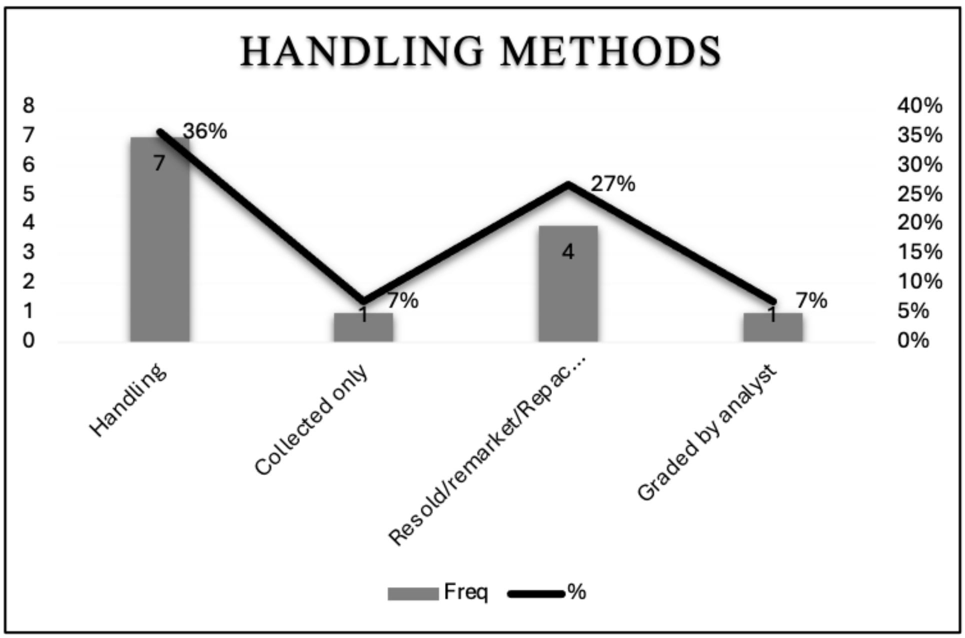
I also researched the topic of communication in e-waste. Searching the terms in the Walden University Library, I found 67 articles. In comparison, I found over 15,000 articles using Google Scholar. The total number of articles found during the search aligned with the study results on the importance of communication in e-waste. Communication is critical to informing businesses and the public about recycling e-waste items.

Theme 2: Handling Methods

The methods companies use for successful e-waste handling varied slightly, but successful companies use them. Based on the interviews, the themes identified included disassembly/breakdown. In Agbogbloshie, Ghana, people manually dismantle e-waste using their bare hands and other more primitive measures (Adanu et al., 2020). The primitive measures used, according to Adanu et al. (2020), are not approved by the EPA because they are an environmental and health risk. One example of the WEEE-dismantling industry in China is the profits from selling the dismantled items and subsidies (Xiao & Wang, 2022). Xiao and Wang (2022) also identified that 90 of 109 domestic dismantling companies accomplish these tasks. The research themes identified in the current study included actions, procedures, and processes used by successful companies. The highest frequency response of disassembly/breakdown of materials is shown in Figure 2.

Figure 2

Handling Methods



As demonstrated in the interview responses, the manual breakdown of e-waste for recycling is essential. Recycling occurs as part of the manual dismantling process for e-waste (K. Liu et al., 2023). According to K. Liu et al. (2023), waste electronics represent scrapped electronic materials moved to an authorized dismantling factory after collection and transportation. In some instances, dismantling occurs in informal sectors through beating, burning, cutting, and drilling (Thongkaow et al., 2022). Informal and formal dismantling, according to K. Liu et al., presents numerous environmental issues from pollution after the destruction of e-waste items. One means of mitigating these issues is by operating workplaces with high safety specifications and well-trained labor.

In Figure 2, I identified the individual breakout of the responses after primary categorization. The primary theme was handling methods, which included manual dismantling, sorting, categorizing, and selling materials to other industries. P4 stated that used computer sales are the basis of their business. The business started as an IT company selling technology, but the question arose about what to do with the old systems. In response, P4 initiated a takeback function for the old systems.

P8's company collects items and remarkets or resells them in other sectors. P8 noted that collected items that are not viable for resale are disassembled and recycled. One example of this process is dismantling, which occurs at different degrees in different countries, with Brazil and Australia using WEEE recyclers in the initial recycling processes (Dias et al., 2022). Dias et al. (2022) also stated that some countries' recyclers dismantle 90% of computers into as few as seven parts, whereas others dismantle computers into 16 parts. The last resort for collected items is to shred them. Shredding is a crucial step in the mechanical separation of scrap metals from electronic items (Gollakota et al., 2020). Shredding typically occurs for nonvalued items such as DVDs and CD players, while dismantling occurs for computers and laptops. Some P5 business partners require destroying things such as hard drives for security purposes. Upon destruction, P5 provides a certificate of destruction to the originating companies.

Companies handling the collected e-waste follow the same steps, but one difference is the collection of materials. Companies such as P5's and P8's provide collection bins or accumulation points. Companies that pick up materials must also consider maximizing vehicle space (Nowakowski & Pamula, 2020). Once trucks are full, offloading occurs before any additional e-waste retrievals. Large bulky items will fill space in transport vehicles quicker and decrease the full use of the area (Nowakowski & Pamula, 2020). Several companies such as P4's will pick up e-waste materials free from residences or businesses. One of the unique businesses, P11's, collects the materials and forwards them to a responsible recycling (R2) certified facility. R2-certified facilities are recognized for handling e-waste through best management practices, work and health, and environmental stewardship (Kumar & Singh, 2019).

P2's and P5's companies do not deal with collecting or recycling e-waste from the public. P2' and P5's companies will only collect materials from businesses. These companies do not provide any collection for consumers because most of the items received belong to the office equipment category. Collection types fit into stationary and mobile categories (Singh et al., 2021). The first category is static, which includes fixed drop-off locations, special collection events, collection points, and WEEE retailers (takeback; Singh et al., 2021). Companies such as P2's and P5's may use these methods for business collections. The second type is a mobile collection, which includes door-to-door and curbside pickup (Singh et al., 2021). A business may use either type based on the material's size and the waste volume. There are also limitations on what these companies will collect from a business. In most cases, the collected materials are only office equipment, such as small electronics and computers, not commercial items such as microwaves and refrigerators.

In some cases, companies such as P5's will destroy security items on site. Once the items are collected, the first option P7's and P8's companies use is to resell them or repurpose them for other industries. If there are broken items or items that have no resale value, then dismantling the items is the recourse. According to P10, manual dismantling is the most efficient way to prevent the loss of precious metals. Manual dismantling reduces the size of materials from their original size via an assembly line or dedicated workspaces (Jaunich et al., 2020). Once P1's company completes manual dismantling, the items are categorized. Once categorized, e-waste businesses can sell the items to other industries for their use. Recovering e-waste is a critical aspect of e-waste management, which impacts social, financial, and environmental regions (Shahabuddin et al., 2022). Shahabuddin et al. (2022) also acknowledged that e-waste has many precious materials, but the realization of benefits occurs only when collected and recycled. Shahabuddin et al. also noted that the concentration of precious metals in e-waste far exceeds that in traditional ore mining; for example, the amount of gold in urban mining is 300 times higher than in mined ores.

In some cases, companies like P5 will destroy security items on site. Once the items are collected, the first option P7 and P8 companies use is to resale them or repurpose them for other industries. If there are broken items or items that have no resale value, then dismantling the items is the recourse. According to P10, manual dismantling is the most efficient way to prevent the loss of precious metals. Manual dismantling reduces the size of materials from their original size via an assembly line or dedicated workspaces (Jaunich et al., 2020).

In my study, handling methods were one of the major themes I identified during my interviews. I also researched the handling of e-waste and found 62 articles on dismantling e-waste in the Walden University library. In the Google Scholar search for e-waste dismantling, over 7K articles were found. I also found 25 articles on sorting and collecting e-waste in the Walden Library, but I found over 27K articles on sorting and collecting in Google Scholar.

Theme 3: Selling Materials

Once P1 completes manual dismantling, the items are categorized. Once categorized, e-waste businesses can sell the items to other industries for their use. Recovering e-waste is a critical aspect of e-waste management, which impacts social, financial, and environmental regions (Shahabuddin et al., 2022). Shahabuddin et al. also acknowledged that e-waste has many precious materials, but the realization of benefits occurs only when collected and recycled. Shahabuddin et al. also noted that the concentration of precious metals in e-waste far exceeds that in traditional ore mining; for example, the amount of gold in urban mining is 300 times higher than in mined ores (Shahabuddin et al., 2022).

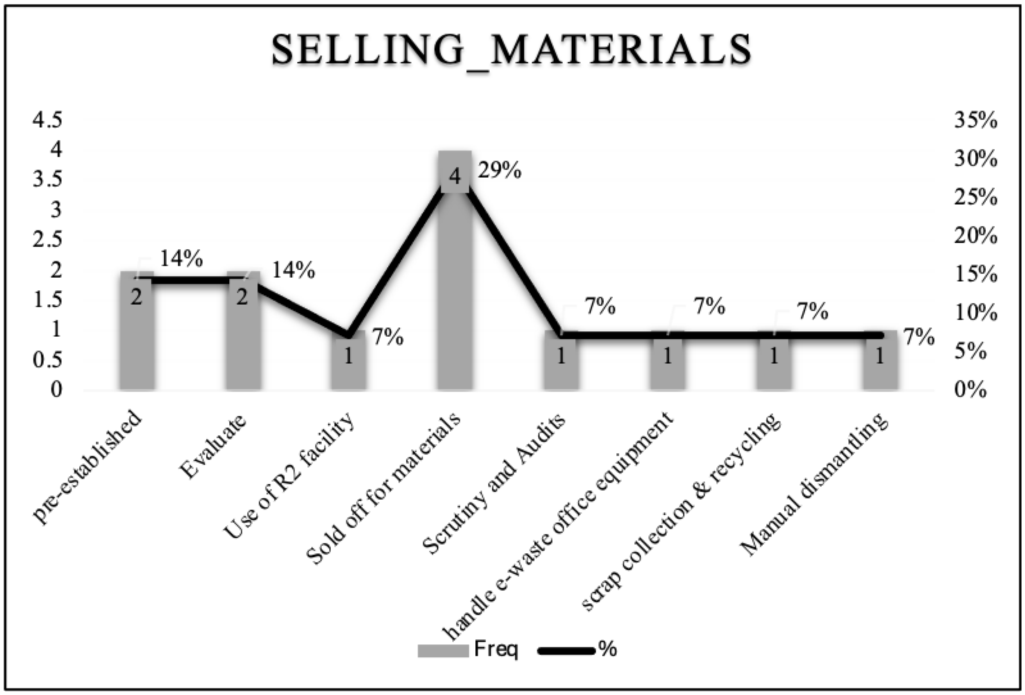
Companies face a dilemma of what to do with their outdated IT materials and office equipment. Several businesses answered this call by initiating a collection of EOL materials. Businesses like P1, P5, P8, P10, and P13 are longevity-based companies with initial startups in the IT sector. P13, for example, has over 30 years as a recycling company, which then transitioned into an e-waste company. P9 was a scrap collection company that incorporated operations with a recycling function to capitalize on different skills and capabilities.

Hard-drive destruction is necessary to ensure information security. P11 may wipe and resale hard drives, but in some instances, companies require destruction to ensure no information leakage. P2 is one of the companies that sort and separate items at the intake dock as items are separated and evaluated to determine the handling of the items. P2 also researches the equipment to determine if the item has value as a resale or if it will be dismantled and recycled. Other industries purchased collected items after removing any sensitive or secure data. P3 identified that OSHA and other local environmental agencies scrutinized and audited all their processes. Transporting items to R2 companies for recycling is one-way businesses like P11 earn funds through e-waste collection.

Interviewees in my study identified the selling of materials as one of the critical themes for e-waste (see Figure 3). Recycling e-waste is a vital process with valuable undertones; this occurs by reinserting minerals into the production sector (Xavier et al., 2023). Xavier et al. also stated that the limited nature of natural resources is the basis for recycling materials and conducting urban mining. As noted by Xavier et al., the circular economy allows for the recycling and selling of urban mined materials instead of mined ore.

Figure 3

Selling Materials

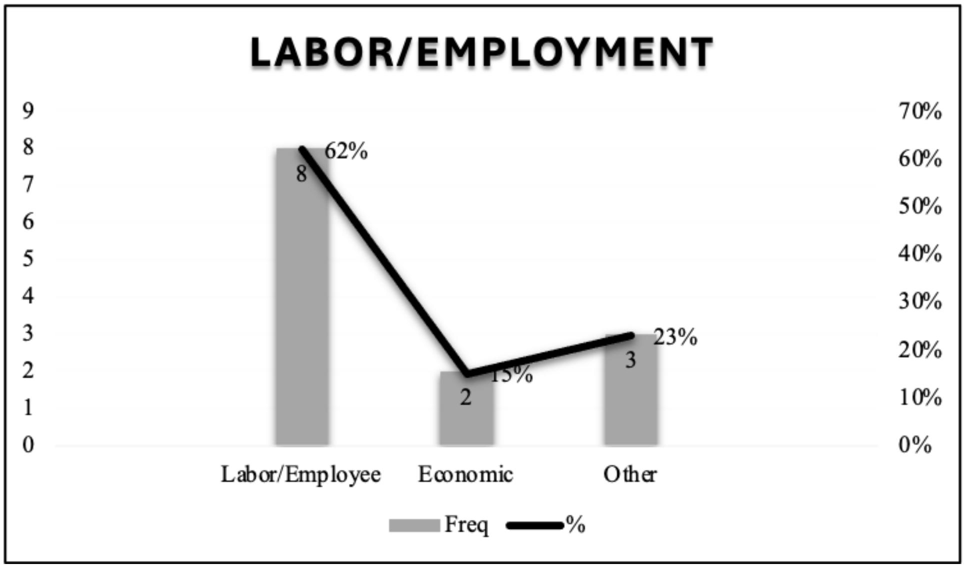


Selling materials is an avenue for e-waste recyclers to generate revenue. In the Walden Library, 5 articles focused on the sale of materials, and 31 articles focused on urban mining. In addition, a search in Google Scholar resulted in over 9K articles selling e-waste in the title or body of the work and over 9K titles with urban mining as part of the articles.

In accomplishing the interviews, many respondents provided information on additional areas where they had to adjust for continued success. The next area I address is the additional areas identified by the interviewees. The main items in this area dealt with labor/employment and restrictions dealing with the handling of e-waste. The labor/employment area had the highest frequency of occurrence in the study, which also incorporated COVID-19 and its impact on labor (see Figure 4).

Figure 4

Labor/Employment



Theme 4: Labor/Employment

Labor/Employment

Labor/employment and restrictions accounted for 43% of the respondents' responses. The strategy P4 used to overcome the unavailability of labor is to decrease the number of items requiring handling. Many companies opted not to receive televisions or CRTs for processing. Both require additional safety precautions and training, and the training and protective equipment would also require other expenditures. There are several valuable items in e-waste, but also many hazardous materials. Companies can file subsidy funds, obtain incentives, and adjust the tax system for the handling of e-waste (Xiao & Wang, 2022).

COVID-19

Leaders from P3 and P4 identified the impact of COVID-19 on the workplace and the workforce. COVID-19 was a complex issue that required various corrective actions and preventative measures (Hossny et al., 2022). The impact of COVID-19 was widespread, with over 1.7 million people infected and over 85,000 deaths (Hossny et al., 2022). The Centers for Disease Control established guidelines to mitigate the spread of COVID. The rules included social or physical distancing, wearing masks, and remote working (Gerace et al., 2022). Due to changing requirements, some employers faced difficulty with maintaining operations. Some industries had to close due to exposure cases within the workplace. In addition to social distancing restrictions that forced some employees to work from home, many left the workforce. One of the core parts of recycling e-waste is using manual labor to sort and dismantle the items, and the decreased labor pool leads to limitations within the industry. Another impact of COVID-19 was the increased use of electronic items such as smartphones, computers, and laptops for teleworking and online education (Murthy & Ramakrishna, 2022).

Restrictions

Some items collected for e-waste handling require specialized handling. E-waste contains toxic substances that can negatively impact the environment and human health, as seen in Table 1. E-waste disposal in landfills leaches acids and heavy metals into the soil and groundwater (Patil & Ramakrishna, 2020). Patil and Ramakrishna (2020) also noted that improper e-waste disposal causes chronic or lethal conditions.

Table 1

Significant Health Impact of E-Waste

Substance	Source/type of e-waste example	Health impact
Cadmium (Cd)	Semiconductors Infrared detectors Chip resistors	Neural damage Irreversible impacts on human health substance accumulation on the kidneys
Lead (Pb)	Cathode ray tubes Printed circuit boards solder	Nervous system damage Kidney damage Blood disorders Chronic impacts on human health Negative effect/damage on the children's brain development
Barium (Ba)	Fluorescent bulbs Front panel of CRT	Risks caused by the short-term exposure to Ba: Muscle weakness Heart and liver damage Spleen damage Brain swelling
Mercury (Hg)	Printed circuit boards Batteries Relays and switches Flat-panel display	Brain damage Kidney damage fetuses Damage
Nickel (Ni)	Printed circuit boards Cathode ray tubes Batteries	Lung damage Decreased lung function Lung cancer Bronchitis
Polyvinyl chloride (PVC)	Keyboards Computer housing Cabling Monitors	Respiratory problems due to the formation of hydrochloric acid when PVC is not completely combusted. Immune system damage and reproductive issues due to the formation of dioxin when PVC is burned
Polychlorinated biphenyls (PCBs)	Transformers Capacitors Condensers	Liver damage Type 2 diabetes
Brominated flame retardants (BFRs)	Plastic housing of electronic devices/equipment	Endocrine system function disruption

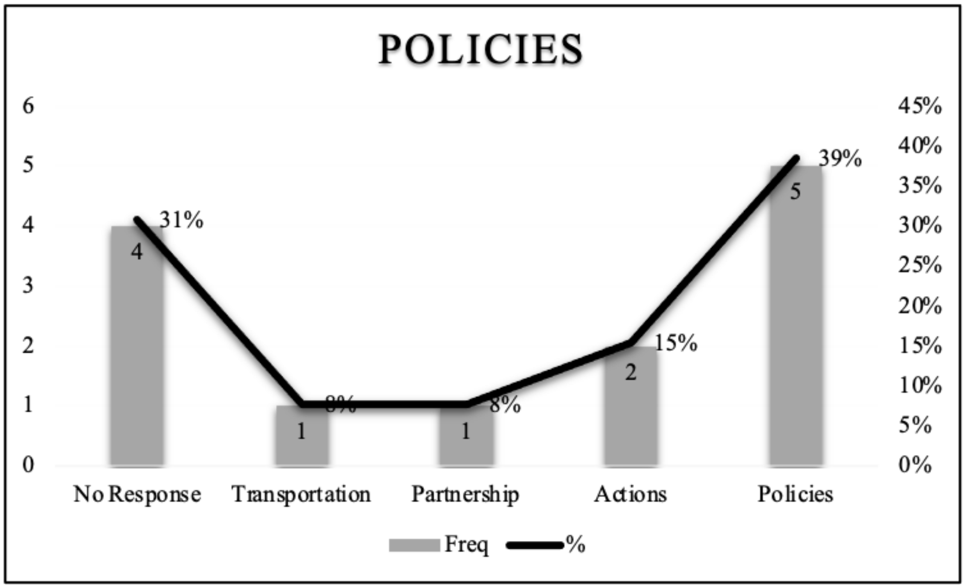
Note. From Attia et al. (2021).

The significance of the labor force in e-waste recycling is crucial, as respondents in various studies highlighted. Labor and employment were essential components for facilitating the e-waste recycling process. The abundance of scholarly literature on terms such as “e-waste labor/employment” and “e-waste job creation,” with over 4K and 8K responses on Google Scholar, underscores the substantial attention given to this aspect. This wealth of research further solidifies the centrality of labor in e-waste recycling.

Moreover, in the final interviews, respondents were given the opportunity to provide additional insights about their companies, revealing a diversity of perspectives. While some respondents had no further thoughts, others shared valuable information, with policies emerging as the most frequently discussed aspect among transportation, partnerships, additional actions, and policies, as illustrated in Figure 5.

Figure 5

Policies



Theme 5: Policies

Improper disposal and mishandling of e-waste (e-waste) pose significant challenges to formal recycling efforts, often resulting in the landfilling of these items, as highlighted by Patil and Ramakrishna (2020). Ahmad Khan (2020) addressed these challenges, as many nations have introduced e-waste directives, with the Basel Convention of 1989 being a notable example of regulating hazardous waste export to developing countries (Ahmad Khan, 2020).

Legislative restrictions present formidable obstacles for businesses in the e-waste recycling sector. In the United States, manufacturers are held accountable for managing end-of-life electronics responsibly (Jaunich et al., 2020). Companies such as P7 navigate these legislative requirements by obtaining certifications from reputable organizations like the International Organization for Standardization (ISO) for safety compliance.

Additionally, P7 has earned the Responsible Recycling (R2) certification, signifying adherence to rigorous standards for recycling and repurposing operations (Kumar & Singh, 2019). For companies lacking R2 certification, collaboration with R2-certified entities allows them to collect e-waste items and send them for processing, ensuring compliance with regulations and ethical recycling practices.

The culmination of the study allowed participants to contribute additional insights, with their responses reflecting the policies within their organizations. Notably, critical responses from P7 emphasized the importance of flexibility and market expansion, particularly in plastic recycling. P9 implemented a community outreach program to raise awareness about recycling, while P10 engaged in sponsorship at the zoo to educate visitors about e-waste recycling. Providing customers with information about the items submitted for recycling emerged as a crucial endeavor, with P2 even supplying data to source companies to demonstrate compliance with legislative or contractual destruction requirements.

The overarching theme of “Policies” encompasses various aspects of e-waste recycling, including corporate and governmental regulations. In interviews, nearly one-third of respondents identified policies as crucial, reflecting the significant emphasis on regulatory frameworks. A search of scholarly databases revealed an extensive body of literature, with 281 items in the Walden Library and over 17,000 items on Google Scholar, underscoring the importance of governance in safeguarding workers and the environment in the e-waste recycling industry.

Applications to Professional Practice

The significance of waste electrical and electronic equipment (WEEE) lies in its multitude of materials with financial value, as emphasized by Petridis et al. (2020). According to the Global E-waste Monitor, the escalating generation of e-waste, projected to surpass 74 Mt by 2030 (Forti et al., 2020), underscores companies' need to harness available opportunities to extract value from recycling.

This doctoral study identified five primary themes crucial for successful e-waste recycling and handling: communication, handling methods, selling materials, labor/employment, and policies. Communication emerges as a pivotal theme, with successful companies leveraging social media and targeted advertising to educate consumers and industries about recycling opportunities. Lee and Haley (2022) underscored the transformative potential of digital media in facilitating targeted campaigns that communicate the economic and environmental benefits of recycling. Moreover, in today's socially conscious landscape, consumers expect brands to engage in social causes (Chan, 2022), making advertising a crucial avenue for companies to showcase their sustainable practices. This doctoral research provides valuable insights for businesses entering the e-waste recycling sector, offering a blueprint for success gleaned from established companies' experiences and enabling newcomers to emulate proven strategies rather than starting from scratch.

Companies can evaluate the innovations of other companies and choose to use the same processes, or they can decide to improve or modify those processes (Duffy & Ralston, 2020). The second of the primary themes was handling methods. The process of dismantling occurs at different degrees in different countries, with Brazil and Australia utilizing WEEE recyclers in the initial recycling processes. (Dias et al., 2022). The last resort for collected items is to shred them. Shredding is a crucial step in the mechanical separation of scrap metals from electronic items (Gollakota et al., 2020). Shredding typically occurs for non-valued items such as DVDs and CD players, while dismantling occurs for computers and laptops.

The third of the primary themes was selling materials. P2 also researches the equipment to determine if the item has value as a resale or if it will be dismantled and recycled. Other industries purchased collected items after removing any sensitive or secure data. Transporting items to R2 companies for recycling is one-way businesses like P11 earn funds through e-waste collection. The fourth strategy is labor/employment and restrictions. The strategy P4 used to overcome the unavailability of labor is to decrease the number of items requiring handling. Many companies opted not to receive televisions or CRTs for processing. Both require additional safety precautions and training, and the training and protective equipment would also require other expenditures. One of the core parts of recycling e-waste is using manual labor to sort and dismantle the items, and the decreased labor pool leads to limitations within the industry. Some items collected for e-waste handling require specialized handling. E-waste contains toxic substances that can negatively impact the environment and human health, as seen in Table 1. E-waste disposal in landfills leaches acids and heavy metals into the soil and groundwater (Patil & Ramakrishna, 2020). The final strategy is policies. Patil and Ramakrishna (2020) stated that many nations pioneered e-waste directives to overcome these hindrances. The Basel

Convention adopted in 1989 is a legislation meant to curb and or control the export of many categories of hazardous waste to developing countries (Ahmad Khan, 2020). The United States holds manufacturers accountable for adequately managing end-of-life electronics (Jaunich et al., 2020). Companies like P7 overcome legislative requirements by seeking certification from the International Organization of Standards (ISO) for safety.

Implications for Social Change

The implications for social change for this study include the protection of the environment by reducing the amount of waste loaded into landfills, which also decreases the likelihood of toxic materials leaching into the groundwater and reduces the number of raw materials mined. In addition, manual dismantling has low expenses and is an easy-to-implement procedure, but the work is challenging and requires more significant workforce numbers to accomplish tasks (Baker & Handmann, 2022). The use of recycling reduces the need for the mining of raw materials (Skeete et al., 2020). One way to improve e-waste recycling is to provide accessible recycling centers for waste electronics. Waste collection for other waste streams includes containers that can separate waste items (Heydari et al., 2021). Providing collection bins for old mobile phones and other small electronic items can increase the collection rate for recycling. Supporting recycling in the e-waste stream can also generate jobs for handlers and separators.

Recommendations for Action

E-waste is the fastest-growing waste stream, driven by the rapid development of technology (Mandić et al., 2019). Recycling waste electronic and electrical equipment represents an opportunity for businesses (Mandić et al., 2019). Business managers need to focus on using a circular economy instead of a linear one. The circular economy is restorative and regenerative (Shaw et al., 2021). A circular economy aims to improve resource and production efficiency. A linear economy flows from initial production and ends with selling the produced items. In a circular economy, businesses maintain responsibility from initiation to recycling or repurposing. The economic developers in the company and the management staff will need involvement in the changeover from a linear economy to a circular one.

Recommendations for Further Research

The current doctoral study focused on small e-waste equipment like mobile phones, tablets, and computers. In the realm of e-waste, there are many different categories. Printed circuit boards (PCBs) represent one of the additional categories of e-waste. Another category of e-waste is large bulk electronic items such as refrigerators, ovens, and washing machines. Future studies can include large waste electronic equipment like refrigerators and stoves. Large bulk electrical and small electronics items house recyclable resources (X. Yang et al., 2020). The demand for environmentally friendly vehicles, like electronic vehicles (EVs), continues to increase. A process to handle these EV batteries as they reach the end of life, handling and disposal operations become necessary (Sanclemente et al., 2022). The increased demand for EVs also resulted in the need to handle EV batteries. Electrical industries account for the significant demand for metals and precious metals (Hao et al., 2020). The electronic sector can benefit from future studies on large electronic items, printed control boards, and EV batteries.

Reflections

The current doctoral study focused on small e-waste equipment like mobile phones, tablets, and computers. In the realm of e-waste, there are many different categories. Printed circuit boards (PCBs) represent one of the additional categories of e-waste. Another category of e-waste is large bulk electronic items such as refrigerators, ovens, and washing machines. Future studies can include large waste electronic equipment like refrigerators and stoves. Large bulk electrical and small electronics items include many recyclable resources (X. Yang et al., 2020). The demand for efficient vehicles like electronic vehicles (EVs) continues to increase. As the batteries in these EVs reach their end of life, handling and disposal operations become necessary (Sanclemente et al., 2022). The increased demand for EVs also resulted in the need to handle EV batteries. Electrical industries account for the significant demand for metals and precious metals (Hao et al., 2020). The electronic sector can benefit from future studies on large electronic items, printed control boards, and EV batteries.

Conclusion

The final takeaway from this study is that the value of precious metals in e-waste is enormous, but only if collected and recycled. The facts of the study reflect the use of e-waste recycling to capture funds from disposed items. The estimated amount of WEEE exported globally per hour is nearly 4000 tons (X. S. Yang et al., 2021). With most WEEE exported to Asia for handling, the collection of precious metals occurs outside the USA, and the loss of these precious metals equals a missed opportunity for US-based companies. There are inherent risks with collecting, dismantling, and processing WEEE, and many problems occur because of companies' temptations to seek huge profits (X. S. Yang et al., 2021). This doctoral study spotlighted the essential strategies businesses used for recycling e-waste and established an educational legacy for future generations to strive to meet.

This journey toward completing this degree has been an adventure of patience and dedication. This process was characterized by feeling overwhelmed and uncertain about its completion. This degree program provided a rewarding and insightful experience in recycling waste electronic and electrical equipment. Identifying that communication is one of the key strategies successful e-waste companies use makes sense. Providing advertising and education that impacts the masses increased the likelihood of communities and businesses recycling. Following communication, identifying the handling methods used to break down or disassemble e-waste to collect recyclable materials was also critical. Once the e-waste handling methods led to ready recyclable materials, the next step was to sell the recovered precious metals. The breakdown and disassembly of materials require labor to accomplish this step, but all these processes fall under the purview of policies meant to protect employees and the environment.

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Appendix A: Interview Protocol

Research Question:

What strategies do some leaders from Southern United States. companies use to recover funds from e-waste recycling?

Volunteer Requirements:

- Must be age 21 or over
- Participate in recycling in the solid waste industry
- Knowledgeable in recycling e-waste with at least 3-years of practical experience

Interviews- Teams, Zoom, or Telephone

Allotted Time: 15-25 Minutes

- Teams
- Zoom
- Telephone

Recruitment:

- Participants were contacted by phone, social media (Linked In) and email
- Interviewees were provided a copy of the consent form

Interview:

- Introduced myself and what I was requesting
- Confirmed participant availability
- Explained the process and reasoning for the interview
- Commenced interview with 1st question
- Documented responses

- Completed interview question with question 6
- Reviewed responses with interviewees
- Responded to interviewees with questions, responses, informed consent, and participation invitation
- Thanked participants

Appendix B: Interview Strategies

Strategy

Communication	Org-Based	Collections	Dismantle	Customer Service
email	Primarily use the R2 sites	collect	dismantled and then sold off	Customer based
Website based	R2-Top level audits able to bid for government contract, schools, hospitals	Open to the public	destroyed.	No charge for residential pickup no minimum or maximum amount
Advertise, social media, Cold-call (Prospecting)	Primarily works with schools.	Maintain various recycling locations	Manual Dismantling	Conduct local drives for e-waste
Uses phone inquiry and social media to drum up business	Based on established contact with recuring customers/businesses	Centers buy from other companies and the public		full-service recycler
Social Media	Business to Business services for EOL Assets including data destruction	Pick up e-waste country wide		Reuse, recycle, repurpose actions offered based on the type of equipment
Cold -Calls	Deals with financial, educational, medical and law firms.			sold
No real advertising				resold
Marketing				
Advertise				

Methods

Actions	Procedures	Processes
advertising used	drop-off locations	Business is based on used computer sales moved from IT based sales.
Collection	collected sold back for reuse	Filled a vacancy based on customer question of what are they to do with old electronic materials.
shredded, separated and divided	All items graded by analyst	service oriented
Manual Dismantling	Remarket/ resale if possible	Recycle at no charge.
divided and shredded	Dismantle if not possible for resale as a unit	No value items such as (Shredded)
ensuring proper disposal and disposal certificates	Shredding last resort for items with little value	Valuable items (Dismantled by Hand)
destroyed on-site if necessary	Resale more than recycle	Paid by the pound of scrap/ scrap computers smelted
transported for dismantling or repurposing	Document destruction information provided back to originator company	Items are parted out for recycling
Separate and send to different recyclers	Evaluate items (track/sort) Industry standard wipe all drives and provide certificate of destruction	Will accomplish some minor breakdown (manually)
Breakdown items separate as scrap or resale(wholesale)	Hard drives may be destroyed Primarily Urban recycling	Sort and categorize
Manual breakdown	Hazardous materials require additional gear and training	Repackage for shipment for sale
Then sort by components Dismantle team handles the interior of units	Hard drives (information Items) are shredded (certificates of destructions provided)	Repurpose Recycle
Downstream for each items First sort by customer	Collection point will send materials to a R2 certified facility	Category Based Ensure no liabilities for companies

Key Process

Legislation	Actions	Restrictions	Excepted Practices
Legislation based	Separation. Evaluate the equipment Research the use of the equipment	certified handled and tracked	Apple items are set aside and handled separately to other items
R2 certified	Determine item value and its use Dismantled scrutinized and audited for compliance.	Not all items can be recycled in a cost-efficient means TVs and computer monitor cost for recycling	honesty
Some R2 companies purchase the waste, but this is not a guarantee	Reset items are resold if there are any values Reset items are resold if there are any values	Maintain a 0-landfill policy. Most classes are accepted	Exceptions: alkaline batteries and household items
	Will pick up items Maintains a facebook page and sale items on ebay	Buy back has a very low return on investment	
	Some cold-calls to business to inquire if they are in need of services.	No resale of hard drives	
	Recognized the growth potential of ewaste. Company started out with office equipment sales. Offered services for handling of ewaste to	Common to wipe and resale, but some large customers state no resale and all hard drives must be shredded	

	office equipment customers		
	Hardware resale Scrap side only Ship to downstream		
	Recover funds from precious metals		
	based on customer stream (circular handling sale-collect-recycle)		
	Recovered items from customers Manual dismantling		

Challenges

Labor/Employment	Restrictions	Economic	COVID	Other
Training procedures	Audit controls and legislation	provide free pick-up service, but rising fuel cost are becoming an issue The price of oil impacts the cost of some of the items which can be sold.	COVID COVID created some challenges which resulted in a slowdown of operations	Contact Cutting corners (Improper handling/actions, half measures)
Reduced labor pool has led to decreased capabilities	Regulations at all levels Export restrictions	The main challenge is the changing market for	The biggest challenge is COVID.	A large amount of the items collected are plastics.

	No reuse for batteries no real return on investment	petroleum-based products.	Because cheap labor has been reduced because of COVID.	The facility is a manual disassembly factory
Company success is based on cheap labor	CRT's (leaded glass) No TVs dismantlers would have to wear hazmat suits	Warehousing these items until a more beneficial time for sale is counterproductive and more costly in the long run.	COVID requirements	Pace of technology New electronics are smaller Easier to shred whole boards instead of just the hard drive
This includes employ training and certification for safety and security		The biggest issue with the corporation is dealing with growth & expansion the public Company charges a pick-up fee based on mileage		Additional concerns solar panel battery issued Car batteries (scooter batteries) Small quantities only
Finding reliable help		Pick-up cost can be offset based on the value of the collected items		
		Prices (Stocks, economy) 20-40 % resale value drop		