HIGH SCHOOL EDITION
Journal of Student Research
Volume 11 Issue 4 (2022)

Implementation of Modern Technology on Battery Recycling Habits

Zixi Wang

Plano East Senior High School, Plano, Texas, USA

ABSTRACT

Due to the lack of education and misinformation, most people throw away batteries in their homes, including Zinc Carbon, Alkaline, and lithium-ion batteries. Consequently, more than 300 million batteries are thrown away as household waste each year, ending up in landfills. This paper used the survey to collect a diverse group of people's cognition and understanding of recycled batteries to seek a novel solution to a common problem. There is a strong need to develop economically feasible technology that could efficiently help recycle batteries. One of the goals of this project was to look into how different people will affect their knowledge about battery recycling. My team's hypothesis is that by creating a novel battery recycling infrastructure to generate an innovative incentive for consumers, we will increase the recycling rate of alkaline, lithium-ion, and rechargeable batteries. The experiment results show that our infrastructure is favorable towards the general public, which proves our hypothesis is right.

Introduction

The main objective of our research is to identify and create innovative ways to lessen misinformation and improve battery recycling habits through the implementation of modern technology. There has been a surge in battery usage in recent years and the uphill climb is not going to slow down anytime soon. The growing use of various batteries has led to an increase in the number of disposed of batteries. Finding an effective recycling infrastructure for batteries will mitigate the environmental impact by reusing batteries' valuable components, helping us reach a more sustainable future.

Table 1: Co2 emission per capita in 2017 by regions. (Average CO2 emissions per capita measured in tons/year)

Region	Tons/year
North America	20-25T
Europe	2-5T

Because of the European Union's successful legislation regarding recycling overall, the European Union's greenhouse gas emissions were reduced by 24% between 1990 and 2019, while the economy grew by around 60% over the same period.

Background

More than 300 million batteries are thrown away as household waste each year, all of which will end up in landfills. Recycling these batteries will help save finite natural resources and prevent contamination of groundwater with the

toxic substances. A study done by The Harris Poll helped reveal the conundrum of recycling of everyday household items. American public is always trying to figure out whether to recycle or throw away household items, like consumer batteries. According to the poll, 42% of the American population are so-called “wishful recyclers”, who want to recycle items like batteries but don’t know how. Over 30% of Americans don’t believe that single use batteries cause environmental harm and another 30% don't know anything about battery recycling. Due to a lack of consumer education and misinformation, most consumers throw away Zinc Carbon, Alkaline and even lithium-ion batteries. With a wide range of battery types, many batteries contain toxic materials such as cadmium, mercury and lead. Other batteries, like alkaline batteries, contain extremely valuable minerals like magnesium, cobalt, zinc, and lithium.

Table 2: Projected cumulative world battery material demand to 2025 (1000 tons)

Element	Projected Demand	USGS Reserve
Lithium	230	16,000
Cobalt	910	7,100
Nickel	580	74,000

Note: Reserves from U.S. Geological Survey (USGS)

Alkaline batteries

180 thousand tons of spent Alkaline batteries will end up in landfills. This is a huge loss of natural resources and landfills will eventually pose long term threats to the environment as rainwater will dissolve these metals in batteries, which will end up in groundwater and even drinking water. Even though the Duracell website states that “Alkaline batteries can be safely disposed of with normal household waste, there are now novel recycling technologies that could prevent these valuable earth metals from ending up in a landfill. Up to 97% of Alkaline batteries aren’t recycled in the United States and we hope to reduce that number. Most retailers that are selling batteries are required to set up collection points. However, most of the collection bins and cans are not very conspicuous, causing less people to recycle the batteries. The alkaline battery is a metal tube coated with paper and plastic. Inside of it, there is a zinc anode and a manganese cathode.

The Reluctance Problem

Another big problem that often arises with battery recycling is that most people don’t see their action generated into a result. Waste advantage surveys show that 39% of people choose not to recycle because it's inconvenient and 23% of the people choose not to recycle because they don’t think it makes a difference. This paper will address both of these solutions and propose a plausible solution to promote sustainability by building good recycling habits of one of the most used items in the modern world.

Methods

In this methods section, we will discuss the methodology of our survey on battery education. The survey study originated from the need to explain the poor rates of battery recycling in the United States. Ten questions were finally chosen as the most appropriate source for the information required for our research. This selection not only focuses on the respondent’s demographics, but also provides specific data behind why people don’t recycle batteries. We have

collected 52 valid data points by distributing surveys on social media platforms such as Instagram, Facebook, and WeChat. The survey had 10 questions in total and all of the questions helped us answer our 9 key research questions of battery recycling. We also collected people's personal information (email) to ensure that the data we collected is authentic. In order to assess the demographics of our respondents, we included questions about people's age group, education level, and residing State. These data can help us easily distinguish and compare whether these individual differences will lead to differences in people's perception of battery recycling. After inquiring about their personal information, we began to test people's basic understanding of batteries. In our survey, we asked people "are alkaline batteries recyclable?", and" how much do you know about battery recycling or recycling overall?" Through the basic tests of these two questions, we can determine whether the level of education, age, and location will affect people's perception of battery environmental protection. The resulting data from these questions would prove one of our research goals: how different people will affect their knowledge about battery recycling. Furthermore, we collected people's knowledge about the type of batteries people would recycle the longest and the factors influencing people to recycle. These questions and results would let us grasp the current people's knowledge of battery recycling. In addition, after receiving the result from the last two questions, we would be able to determine whether the hypothesis "by creating a novel battery recycling infrastructure to generate an innovative incentive for consumers, we will increase the recycling rate of alkaline, lithium-ion, and rechargeable batteries" is correct.

Results

After gathering all of our data from our survey and compiling it into a chart, we were able to find out information about the misinformation surrounding battery recycling. According to our polls, less than 42% of the surveyed people from all demographics knew that most batteries are made of extremely valuable metals. Lead, mercury, cadmium, zinc, and manganese are among the most common heavy metal materials used to construct metal. Some of these batteries contain extremely toxic chemicals and contents that could potentially be hazardous to the environment. Yet over 82% of people who received our survey responded that they throw away batteries in household waste bins. Because of the misinformation regarding battery recycling, our research indicates that millions of batteries are thrown into landfills as the result.

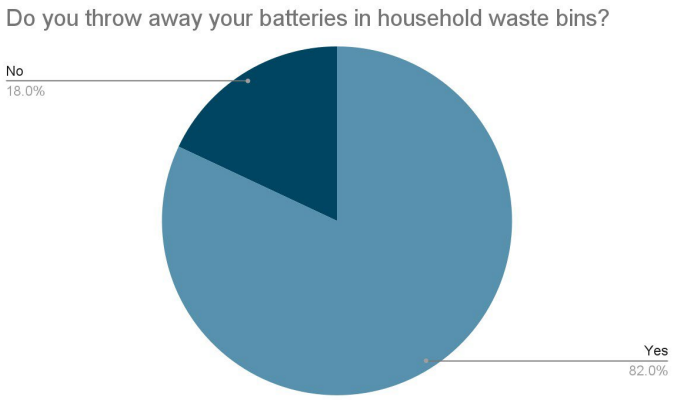

Chart 1

These batteries could have the potential to degrade into the ground and pollute our water resources if they are not recycled properly. When asked "If you do recycle batteries, how and where do you recycle them?", only 4% of the respondents replied that they do recycle batteries at their local stores like Walmart and Target. An overwhelming 76% of the respondents stated that they are "wishful recyclers" who place batteries in small bins or plastic bags. However, research shows that placing batteries in these materials will actually result in more harm than good.

Exploring Possible Solutions

How to create incentive?

According to our poll responses, one of the main reasons that customers choose not to recycle their batteries is because battery recycling spots aren't usually convenient, which reduces incentive for people to recycle. Implementation of a 3D display on top of the recycling bin will also incentivize people to recycle. The 3D display will first show the negative ramifications of batteries on the environment. When a battery is dropped through the hole in the bin, a special mechanism will trigger a change of the 3D display, changing the display into a picture showing the effect the consumer made by recycling the battery.

Implementation of AI technology to improve battery recycling habits

The aforementioned technology can also be combined with recycling output technology like precise weight sensors that could calculate precise environmental impacts and present it on the screen. Stats should be tangible and interesting things like "you saved this rabbit", "you prevented 0.2% of pollution of this river." There could also potentially be an app where we allow users to track their battery recycling practices every time they recycle. The app will display the user's environmental impact and perhaps gives points to them for specific amounts of batteries recycled. Based on the statistics, the app could also include a friend leaderboard where you compete with others in your community. As there are thousands of different kinds of batteries, it is extremely hard for consumers to know the differences between them. Current strategies to educate the public about battery recycling include online website blogs, community events, and government legislation. To render battery recycling more convenient, we could utilize machine learning artificial intelligence object recognition and cloud computing to maximize battery recycling and increase efficiency and minimize erroneous recycling practices. A small, high-definition camera can take pictures of batteries placed on a platform in the bin. These data will then be sent to cloud platforms to calculate using an intelligent battery classification algorithm. Once the calculations are finished, the 3D display on the bin will tell the user what type of battery they have and instruct them to put it into the correct bin.

What about Alkaline batteries?

Because of their low environmental damage and the high cost of recycling alkaline batteries, corporations usually encourage customers to throw away alkaline batteries as household trash. However, recent technology found a new way to reuse alkaline batteries in a cost-efficient way. It uses a unique mechanical method to salvage 92% of alkaline batteries and then turn them into fertilizer supplements for crops like corn. Their studies show that the same material that is used for batteries could also energize corn growth.

The general process is described below:

1. Transport the collected batteries and load them to the sorting station (80% are alkaline batteries (non-toxic)).
2. Forklift dumps the batteries into a hammer mill, which strips away the batteries' plastic and metal casings, making it into metal dust.
3. Paper, plastic, and minerals will be dropped onto the conveyor. It then lands on a vibrating screen and magnets attract the metal particles. Then eddy current repels copper and brass and pushes them off the conveyor. The zinc and manganese powder will be then dropped into a box, where they are the only part of the battery left.
4. Potassium compound powders are then mixed with zinc and manganese powder.
5. Zinc and Manganese oxide converted into sulfate micronutrients and packed into fertilizers.

There are many benefits to these fertilizers as they increase production, aid photosynthesis and strengthen root systems. Studies show that they are especially beneficial to corn fields because corn fields are usually deficient in Manganese and Zinc, which makes these fertilizers extremely valuable. Only 2% of these growth boosters will make a huge difference in harvest production. Corn fields that are treated with these fertilizers will produce an additional 1000 husks of corn per acre.

Conclusion

There is no single simple solution to this complex problem that is currently plaguing our world. There is no single simple solution to this complex problem that is currently plaguing our world. Based on the surge in battery usage in recent years, there is currently a strong need to develop economically feasible technology that could efficiently help recycle batteries. The experimental results proved that our hypothesis was right. The survey shows that based on misinformation, over 82% of people throw away batteries in household waste bins which indicates that millions of batteries are thrown into landfills. These batteries could have the potential to degrade into the ground and pollute our water resources. In addition, the waste advantage surveys show that most people don't see their actions generated as a result. Our experiments have told all readers that the implementation of AI technology and 3D display can improve battery recycling habits. We could utilize machine-learning artificial intelligence object recognition to render battery recycling more convenient and minimize erroneous recycling practices. Even though Alkaline batteries have low environmental damage and corporations usually encourage customers to throw away alkaline batteries as household trash, recent technology uses a unique mechanical method to turn the alkaline batteries into fertilizer supplements for crops like corn. Furthermore, in the following actions, we will use the 3D display technology to lessen misinformation and improve battery recycling habits through the implementation of modern technology.

Acknowledgments

We thank the numerous kind people who took time out of their day to partake in our survey. We are also extremely grateful for Nancy and Dr. Wang's help throughout our research process.

Reference

Bernhart, W. (2019, November 14). Battery recycling is a key market of the future: Is It also an opportunity for Europe? Retrieved June 14, 2021, from https://www.rolandberger.com/en/Insights/Publications/Battery-recycling-is-a-key-market-of-the-future-Is-it-also-an-opportunity-for.html

Cucchiella, F. (2013, January 21). Implementation of a real option in a sustainable supply chain: an empirical study of alkaline battery recycling. Taylor & Francis. https://www.tandfonline.com/doi/abs/10.1080/00207721.2012.761458

Colthorpe, B., & Colthorpe, A. (2019, July 5). Lithium batteries: Far more widely RECYCLED than second-hand Statistics imply. Retrieved June 14, 2021, from https://www.energy-storage.news/news/batteries-all-active-materials-including-lithium-ca n-be-recycled-with-high

U.S. Geological Survey (USGS). 2018. "Cobalt." U.S. Geological Survey, Mineral Commodity Summaries, January. https://minerals.usgs.gov/minerals/pubs/commodity/cobalt/mcs-2018-cobal.pdf [8] U.S.

Geological Survey (USGS). 2018a. “Nickel.” U.S. Geological Survey, Mineral Commodity Summaries, January. https://minerals.usgs.gov/minerals/pubs/commodity/nickel/mcs-2018-nicke.pdf

Fred Pearce • November 2, Fred Pearce, Getting the lead out: Why battery recycling is a global health hazard. Retrieved June 14, 2021, from https://e360.yale.edu/features/getting-the-lead-out-why-battery-recycling-is-a-global-health-hazard

Gaines, L. (2014, November 15). The future of automotive lithium-ion battery recycling: Charting a sustainable course. Retrieved June 14, 2021, from https://www.sciencedirect.com/science/article/pii/S2214993714000037

LibGuides: Battery RECYCLING: Battery Recycling facts. (2021, April 29). Retrieved June 14, 2021, from https://guides.library.illinois.edu/battery-recycling

McCarthy, N., & Richter, F. (2018, October 29). Infographic: Belgians top In Europe for recycling batteries. Retrieved June 14, 2021, from https://www.statista.com/chart/15921/the-share-of-batteries-sold-collected-for-recycling/

Pagliaro, M., & Meneguzzo, F. (2019, June 15). Lithium battery reusing and recycling: A circular economy insight. Retrieved June 14, 2021, from https://www.sciencedirect.com/science/article/pii/S2405844019347012

Used household batteries. (2021, April 15). Retrieved June 14, 2021, from https://www.epa.gov/recycle/used-household-batteries

Walford, L. (2020, December 14). The future of electric vehicle batteries - recycle, reuse OR REDESIGN? A special report. Retrieved June 14, 2021, from https://www.autofutures.tv/2020/12/14/battery-recycling/