Trash to Cash using Machine Learning and Blockchain

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Abstract - *Globally, 53.6 million tonnes of electronic garbage were produced in 2019, according to the Global e-waste Monitor 2020, with just 17.4 percent of that being recycled. India is the world's third largest producer of e-waste, with 3.2 million tonnes created annually. Increases in industrialization, living standards, and discretionary money have led in an increase in the volume of electrical and electronic equipment (EEE) on the market, as well as a growth in e-waste, which is currently the world's fastest increasing waste source. It causes CO2 emissions, which contribute to global warming and climate change, with serious effects for both humans and the environment. To build a sustainable environment, increased efforts are needed to improve present practices such as collection schemes and management methods in order to eliminate illegal e-waste trafficking and legacy waste management systems.*

Key Words: Blockchain, Carbon emission, Circular economy, E-waste, CO_2 forecasting, Incentives, NetZero target

1. INTRODUCTION

In 2019, humans generated 53.6 million tonnes of e-waste. Only about 20% of this is collected and professionally recycled. It's unclear what happened to the remainder. However, it is anticipated that many electronics end up in garages or basements and are never recycled. We also know that businesses resell e-waste on a large scale. There, e-waste is dumped in landfills, where it is improperly managed, poisoning persons and the environment. Old electronics, on the other hand, are gold mines: smartphones, computers, and refrigerators contain rich metals and rare earths, and recycling them is both commercially and environmentally beneficial. It is critical to properly manage the waste that is generated. Consumption of goods or the minimization of waste are not extremely important to humans. Therefore, it is necessary to manage garbage generation so that people can reuse recycled waste. The idea of Trash to Cash is based on this fundamental concept. Electronic waste contaminates the land, air, water, and living things in the environment. It's toxic and non-biodegradable. Toxic pollutants are released into the environment when open-air burning and acid baths are employed to recover precious elements from electronic components. Workers may also be exposed to high levels of contaminants such as lead, mercury, beryllium, thallium, cadmium, and arsenic, as well as brominated flame retardants (BFRs) and polychlorinated biphenyls, all of which can cause irreversible health effects such as cancer, miscarriages, neurological damage, and IQ decline.

Informal waste collectors help to clean up India's cities by recycling around 20% of the waste created. On the other side, these waste pickers lack formal recognition, equal rights, stable and secure livelihoods, and dignity. As spending patterns evolve with a flourishing economy, their labour exposes them to ever higher levels of pollution and dangerous chemicals.

It's also crucial to consider how technological advancements effect climate change. Every electrical item ever created has a carbon footprint that contributes to human-caused global warming. When it comes to the amount of carbon dioxide released over the course of a device's lifetime, the majority of it happens during production, before customers buy it. As a result, low-carbon manufacturing processes and inputs (such as the utilisation of recycled raw materials) as well as product longevity are important elements in overall environmental effect. Globally, recycling rates are poor. The global average is 20%; the remaining 80% is undocumented, with much of it ending up buried beneath the ground for generations as waste. E-waste is not biodegradable. The global electronic sector is experiencing a recycling crisis, which is worsening as gadgets get more numerous, smaller, and complicated. Some types of e-waste are now too expensive to recycle and recover materials and metals from. The remaining e-waste, which mostly consists of plastics containing metals and chemicals, is a more challenging challenge to manage.

Current problems in the e waste recycling methodology have been identified and the E-waste management process should include the following steps

To increase the transparency along all the steps of the trash chain to improve waste management processes.

Encourage more people to start recycling by making recycling simpler and rewarding.

Helping recyclers and manufacturers choose products and foresee what will likely fall out of the recycling supply chain.

Reduce CO2 emission and help achieve Net-Zero Carbon target.

2. RELATED WORK

In [1], Supply Chain Management is regarded as one of the most important and valuable applications of Blockchain technology, since it allows organisations and businesses to handle products at numerous levels, from the producer to the client. A 5G ecosystem powered by blockchain may give a safe and accurate record of user data, as well as the guarantee that it has not been tampered with.

a) This will enable smart contracts to explicitly specify collection targets and penalize parties if needed. It is also proposed that customers be included as members of this blockchain.

b) E-waste incentives can help reduce the dominance of the unorganized sector in EWM. A stakeholder list can include producers, retailers, collection centers, and recycling units.

c)The participants of the EWM include government agencies and consumers.

d)The goal is to make the process of generating goods and disposing of them more stimulating for everyone involved, including dealers and producers.

e) OWASP is a published non-profit organisation whose mission is to recommend impartial and actionable data on application safety to developers, as well as to easily understand and analyse security experts for potential impact, to assess web security, web service security, and the security of the DISV central server. The digitisation of plastic recycling can assist in ensuring material traceability.

The motive of [1]is to discover the use of NFC and RFID-enabled devices to obtain real-time data on manufactured goods with complete transparency via a centralised cloud database, right on the spot.

Limitations: It's never easy to manage resources in an organised manner and reduce waste. The current recycling management system isn't considered transparent.

In [2], Carbon emissions are a significant factor to climate change. To achieve common CO2 emission reductions, companies must work closely together across the supply chain. Blockchain is one of the most significant emerging technologies in the Industry 4.0 era, with numerous uses for supply chain collaboration and integration. Blockchain technology is being used in logistics and supply chains, but we are still in the early stages of realising its full potential. While industrial and commercial e-waste collection receives a lot of attention, alternatives for e-waste collection from residential homes are scarce. This paper proposes the development of a mobile robot that uses transfer learning to identify common e-waste and can be attached to existing municipal rubbish vehicles. The robot walks around, identifies e-waste, and uses an arm-based lifting and storing mechanism to separate the identified material. With 96 percent accuracy, an identification method based on a convolutional neuron network was employed to classify e-waste.

Result: The study framework, Developing a Blockchain-Enabled Low Carbon Supply Chain Framework, proposes research propositions linking blockchain, supply chain integration capability, and carbon emission using the Socio-Technical Theory and Resource-Based View.

Limitations: Influence the way that organizations collaborate and interact with one another is difficult. Flaws in improving the productivity and sustainability of the supply chain.

[3] Implementation of blockchain technology to set up an automatic payment system for collecting waste from anyone. A person processes payments to a local government account via a mobile app.

a) An architecture that intervenes IoT-compatible hardware and SWM blockchain has been proposed.

b) Hardware adaptation is implemented on the sensor nodes and gateways.

c) Using the Python-based Flask framework, I created a Web API to implement the proposed reward system.

d) This study shows verification of a private blockchain miner with a trust point.

e) Security is now an important component of increasing importance in all technologies. In the case of blockchain, security features have been differentiated, encouraging researchers to integrate blockchain technology. The security features of blockchain technology are robust because each block is associated with a public key cryptographic framework.

Result: A mechanism has been implemented to integrate cloud servers into the blockchain network via the Flask server-based API. In a real-time implementation, container weights are observed to generate new transactions on the blockchain network using sensor nodes that send real-time data over the gateway to the cloud server.

Limitations: There is currently a lack of accurate information on the amount and characteristics of waste as local governments struggle to effectively manage waste to reduce its impact on the environment.

In [4] By implementing a circular economy, this method can promote a collaborative digital consortium for effective plastic waste management, which can bring together numerous stakeholders, including plastic manufacturers, government bodies, retailers, suppliers, garbage collectors, and recyclers.

a) Blockchains are extremely useful for tracking materials across all types of supply chains.

b) Blockchain can help connect major refining companies with a new mode of plastic recycling to reinvent current supply chains.

c) With this technology, plastic recycling can be refined by feeding back the raw materials to the manufacturing process. This creates a complete CE of the earth's tragic waste.

d) Blockchain can be used to track individual items through the recycling supply chain create physical marks such as QR codes and digital badges on plastic products.

e) This strategy of full transparency with the adoption of blockchain allows consumers and investors to understand and easily analyze the potential impact. Digitization of the plastic recycling industry can support traceability.

Result: A mechanism has been implemented to integrate cloud servers into the blockchain network via the Flask server-based API. In a real-time implementation, container weights are observed and new transactions are generated on the blockchain network. Use a sensor node that sends real-time data to the cloud server over the gateway.

Limitations: The disposal percentages were decreased and replaced with recycling and incineration.

Implementation of [5] Researchers have traditionally been valuable in discovering ways to reduce environmental effect and boost innovation by modifying product designs, enhancing recycling, or conserving energy and resources. We created a life cycle analysis (LCA) technique as a tool. To achieve the sought circular economy, electronics makers must collaborate to better understand and implement patent and copyright rules to all post-consumer products. To be sustainable, this process must benefit all parties involved, but potential buyers must be convinced that the pricing differential between new and refurbished products will continue to provide incentives. Before and after the supply chain, all product transfers can be accompanied by vital, transparent data. Even without the ability to recycle and correctly manage electronic trash around the world where electronic items are sold and consumed, blockchain solutions are electronic while safeguarding the economic value manufacturers desire to protect. You have the option to broaden the scope of your waste management efforts.

Results: LCA techniques have become commonplace and used to quantitatively assess environmental impacts at each stage of the product life cycle.

Limitations: Workers and the environment are exposed to toxins during the mining of e-waste for such materials. The patent and copyright policy, which has emerged as a viable solution for the use of digital ledgers, is a key open limitation in applying 3re to e-waste.

[6] Apply artificial intelligence to improve e-waste collection: Possible solutions for household WEEE collection and separation in India-AV: Shreyas Madhav, Raghav Rajaraman, S. Harini, Cinu C. Kiliroor. The deep learning garbage classification method was analyzed on the garbage net dataset to determine the most appropriate modeling approach. The dataset contains the Trashnet dataset. This dataset contains images of recyclable materials such as glass, paperboard, plastic, metal, and paper. Implements an algorithm that includes an integrated detection system with deep learning Densenet 21.

Result: Recycle Cube Robot: A new e-waste robot system for identifying and collecting e-waste in the home. The functioning of the system begins at each collection point on the move of the city's garbage truck. Robots run around all home collection points, take pictures of individually disposed waste, and use deep learning to identify e-waste. The identified e-waste is collected and placed on the robot's storage platform.

Limitation: Different accuracy is observed for each dataset.

Irjet Template sample paragraph .Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

3. PROBLEM STATEMENT

Electronic trash is hazardous, non-biodegradable, and accumulates in the environment, including soil, air, water, and living things. The influence of electronic waste on climate change should be assessed. Every piece of technology ever created has a carbon footprint and contributes to human-caused global warming.

There are no clear criteria for how electronic trash should be handled in the unorganised sector. There are no incentives given to encourage consumers to handle electronic garbage in a more formal manner. Working conditions in the informal recycling sector are comparable to those in the legal recycling sector, and there are no incentive systems in place to motivate producers to take action to deal with e-waste.

Climate change is caused by human-generated carbon emissions that are increasing at a rapid pace, and are already threatening various life forms on Earth. The level of greenhouse gas emissions in 2020 was significantly higher than ever before. Scientists agree that reducing emissions by

85% below 2000 levels is the best way to avoid the many devastating consequences of global warming. There is an urgent need for emissions from all industrial sectors to be reduced, and corporate innovation and initiative are necessary to achieve this goal.

4. PROPOSED SOLUTION

The project's main goal is to provide a software tool that integrates carbon footprint and industry statistics so that businesses can estimate the environmental benefits of reusing IT equipment by selling it off as ewaste before the expiry of lifetime of the product.

The specific Research Objectives (ROs) that shaped the project towards achieving the aforementioned aim, were:

- Identify and review environmental impacts, carbon emissions and life cycle indicators of IT equipment, that can be utilized when developing the tool.
- Research company specific data regarding carbon emissions and materials used in IT equipment. Analyse Co2 emissions from various countries over the span of years till date.Perform visualization on this data and generate reports.
- Create a Machine Learning application to forecastt the amount of Co2 emission produced by year 2030 when a raw material /product would reach zero C02 target
- Develop and implement the carbon calculation tool,and reward the users and make recycling simpler.

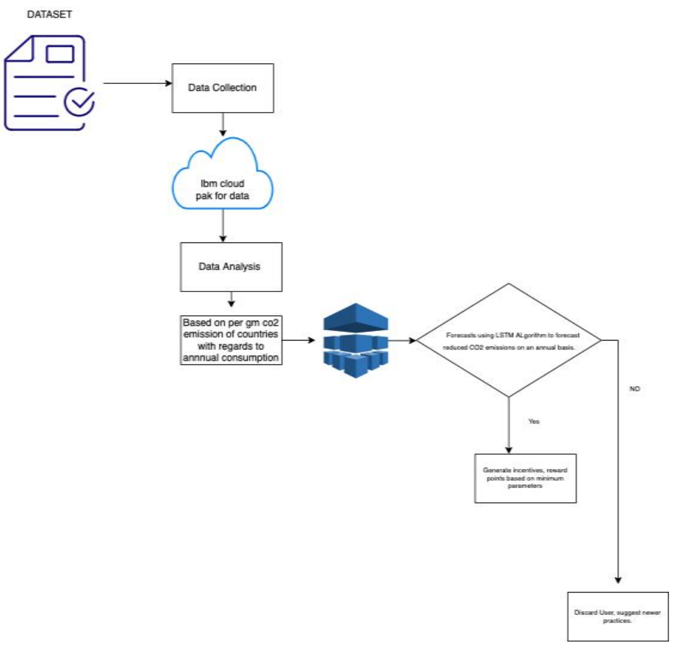

Fig – 1: System Architecture Diagram

A. CIRCULAR ECONOMY FOR ELECTRONICS

Various economic theories, such as the steady state economy or degrowth, have attempted to suggest a solution for a green and sustainable economic future in response to today's economic model. Circular economy, being the most popular theory aimed at overthrowing today's dominant economic model and addressing environmental concerns, opens the way for long-term economic growth and development. CE aspires to change a linear economic model into a circular, closed loop economy, where the stakes between economy, environment, and society are balanced, based on three primary principles (The Three Rs) of Reducing, Reusing, and Recycling.For the manufacturing and use of electronic and electrical items, a new perspective is required. E-waste is commonly thought of as a post-consumption issue, although the issue extends throughout the device's life cycle. Designers, manufacturers, investors, merchants, miners, commodity producers, consumers, policymakers, and others all have a role to play in reducing waste, preserving system value, and extending the economic and physical lifetimes of commodities. They can also aid in the repair of items. It will be recycled and utilised. As a result of the rise of service business models and improved product tracking and takeback, global circular value chains may emerge. To address the needs of electronics supply chains, material efficiency, recycling infrastructure, and scaling up the amount and quality of recycled materials will all be necessary. If the right policy combination is in place and the sector is handled properly, it has the potential to create millions of excellent employments around the world.

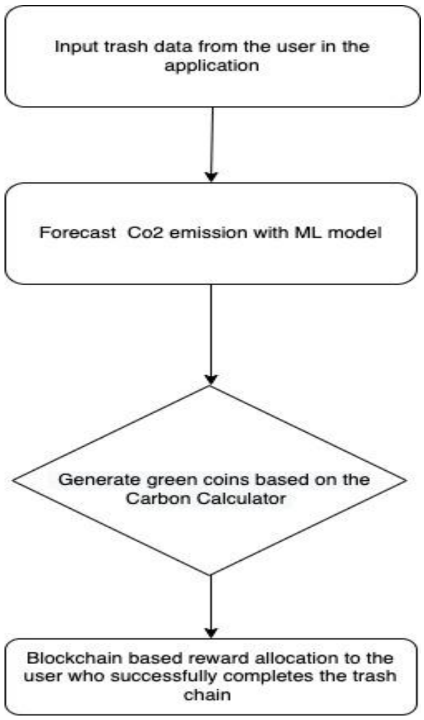

Fig - 2: Data Flow Diagram

In order to create an ML application to predict the amount of Co2 emission produced by year 2030 when a raw material /product would reach zero C02 target we have made use of the ARIMA model.

B. CO2 FORECASTING

ALGORITHM: **Auto Regressive Integrated Moving Average Model.**

ARIMA is a method for locating models that employ an iterative process. A model was chosen, and its suitability was tested using new historical data. The model would have been appropriate if the residual (the difference between the results of forecasting with historical data) was scattered at random, moderate, and independent of each other. Only a stationary temporal frame can be used with ARIMA. To begin, we must assess whether or not our data is stationary. If our data isn't stationary, we can look for data differentiation that will become stationary, or we can look for the d value. This procedure can make use of ACF (Auto Correlation Function), unit roots test, and Integration Degree.

A dataset and a validation set are created from the data. After generating the model using the dataset, the validation set is used to verify how well it works. We choose to use the period 1960-1999 for the dataset, and 2000-2018 for the validation set.

We evaluate ARIMA models with different parameters and looks for the optimal combination of parameters by making use of our observations. The values of the parameters have to be in a certain range. P has to be between 0 and 5, d between 0 and 3, and q between 0 and 5.

For the other parameters of the ARIMA model, we used two graphs, one for autocorrelation and one for partial autocorrelation. If we compare these graphs to this example, we assume that we need to correct for autocorrelation, when looking at the first graph. The second graph can be used to see whether there is seasonality. In this case, the data is yearly, and seasonality would not be an issue. Therefore, the resulting ARIMA model might have the parameters (1,1,0). Then we load and predict the model.

C.INCENTIVE GENERATION BY BLOCKCHAIN

Crypto is a new digital technology that is gaining interest from financial institutions, investors, businesses, and fintech. In 2022, consumer acceptance will increase, enabling businesses to accept bitcoin as payment and incorporate it into their loyalty programmes. The Covid shutdowns have significantly altered the everyday routines of consumers. The usage of the internet to make purchases of goods and services has grown significantly. The current environment is perfect for the proliferation of digital assets. Digital currencies have quickly gained favour with both consumers and businesses. A recent Gartner study predicts that by 2024, 20% of large organisations will be using digital currency.

In a variety of ways, blockchain technology is being used for incentive programmes. Blockchain-based rewards systems, for example, can track and distribute points, vouchers, and other loyalty programme perks. Furthermore, blockchain technology can be used to authenticate customers and prevent fraud. Because it is liquid and global, cryptocurrency is quickly becoming the most desired digital prize. Thus, we would be rewarding the users who contribute to the circular trash chain with trash coins generated on blockchain.

5. IMPLEMENTATION

Literature review, algorithm development, and testing were among the strategies employed to complete the planned project.

The modules were implemented in three phases namely:

Data storage and Analysis: Usage of IBM Cloud Pak for Data as a service, we are able to make predictive analysis and generate a report to country wise results.

Prediction Model and carbon calculator: The Carbon emission calculator would be done on the basis of ARIMA forecasting model, displayed on the front end of our website.

Incentive application to generate reward points: Based on the predictive analysis, reward points would be generated and would be assigned to user taking part, who would be benefited in the long run else the user is discarded but with valuable suggestions to improve the process in the future.

6. RESULTS

Table 1: Results Obtained

<table>
<tr><th rowspan="2">SL.NO</th><th colspan="3">ALGORITHMS</th></tr>
<tr><th>Model</th><th>Accuracy</th><th>RMSE</th></tr>
<tr><td>1</td><td>ARIMA</td><td>88.9</td><td>0.2544</td></tr>
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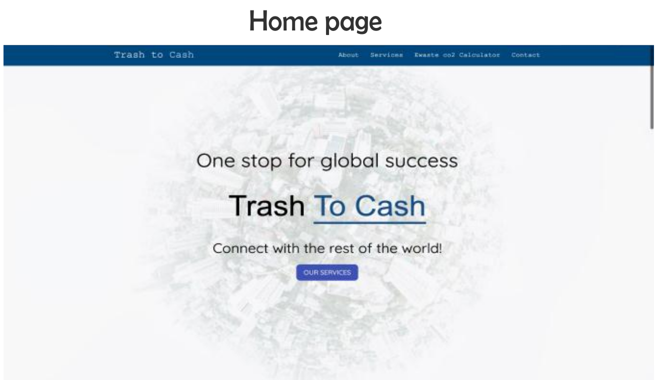

Fig - 3: Home page of trash selling platform

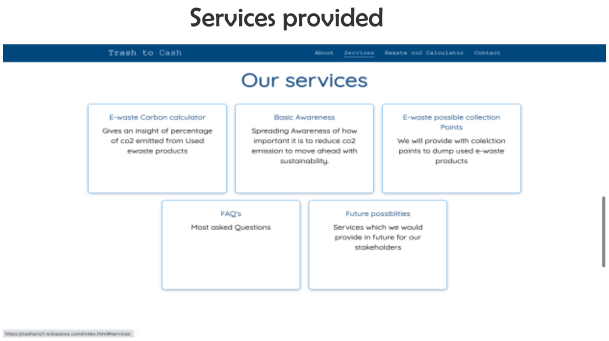

Fig - 4: Sustainability services provided by our platform

Fig - 5: Carbon Calculator

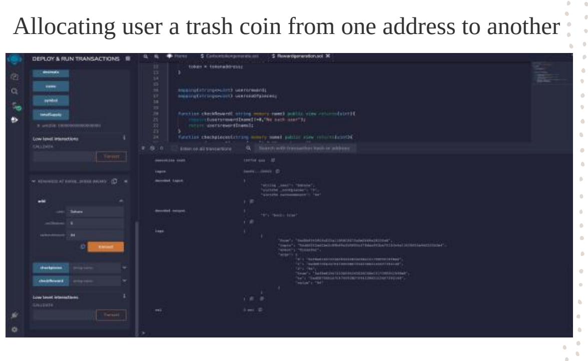

Fig - 6: Reward allocation to user participating in circular economy

6. CONCLUSIONS

The Trash to Cash initiative encourages all stakeholders to join a special circular chain that contributes to environmental sustainability. Our service will compute the Co2 emission created by each product and how much co2 may be avoided in order to achieve it, allowing users to be profitable stakeholders by lending away the used E-waste products. Blockchain is a system for storing data in a way that makes system changes, hacking, and cheating difficult or impossible. Blockchain is essentially a network of computer systems that duplicates and distributes a digital log of transactions across the network. A combination of these technologies help our user to be granted with reward points for successfully being a holder in the chain and who is contributing in their own ways to reduce co2 Emission to minimal amount and help us achieve Net zero target. Being involved in the development of Carbon calculators, this project is of great interest to environmental assessment professionals and engineers looking to develop standardized tools for assessing the environmental impact of various human activities.

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