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Smart Contract Implementation E-waste Collection Tracking and Tracing

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ABSTRACT: The proposed system includes a smart contract-based e-waste collection tracking and tracing system through blockchain technology to provide secure, transparent, and tamper-proof data management. E-waste products are stored as blockchain blocks through SHA-256 cryptographic hashing. If there are any changes in the data, the hash value also changes. This provides security against unauthorized changes and ensures the authenticity of the data. The proposed system includes three main entities: Admin, Seller, and User. The admin entity manages the sellers, while the Seller entity manages the e-waste and ownership transfer. The proposed system provides a secure and transparent e-waste management system through blockchain technology. The proposed system is implemented through JSP and Servlet technologies for server-side programming, MySQL for backend data storage, and HTML/CSS for frontend interface development. The ownership transfer and purchase verification are done through cryptographic hash keys. This provides transparency and traceability for the users.

KEYWORDS: Blockchain, Smart Contracts, E-Waste Management, Tracking, Tracing, Ethereum.

I. INTRODUCTION

Electronic waste or e-waste is a big problem. It is growing fast because new technology is coming out all the time and people are using more electronic devices like smartphones, laptops and home appliances. When we throw away these devices in the way it is very bad for the environment and our health. This is because they have things like lead, mercury and cadmium inside them.

The old ways of dealing with e-waste have a lot of problems. There is not transparency it is hard to track things people can cheat with the data and nobody is really in charge. A lot of the time e-waste gets dumped in the places or recycled in bad ways. This makes the environment dirty. We lose things that are valuable.

To make these problems go away people are looking at something. They are looking at using blockchain technology and smart contracts. A smart contract is like an agreement that can do things on its own when certain things happen. It is stored on a blockchain, which's, like a big book that keeps all the data safe and makes sure nobody can cheat. The blockchain makes sure all the data is secure. Nobody can change it. Electronic waste is an issue and blockchain technology can help with electronic waste management. Electronic waste needs to be dealt with in a way and blockchain technology can help with that.

The system they are talking about uses contracts to take care of the whole e-waste process. This means smart contracts manage e-waste from when it's collected to when it is transported and finally to when it is recycled.

Everything that happens to the e-waste is written down on the blockchain. This way people can see what is happening to the e-waste at all times.



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This makes the process more open and honest. People who are involved in the process trust each other more. There is also chance of someone doing something bad. If we use contracts to track e-waste we can make the whole process better. The process will be more efficient, safer and better for the environment. This way people will be more responsible, for what they do. It will also help the earth because e-waste will be recycled and thrown away properly.

II. LITERATURE SURVEY

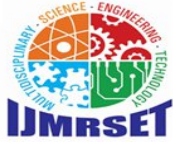
S.no	Title	Author(s) And Year	Journal /Conference	Methodology Used	Advantages	Drawbacks
1	E - waste Management Using Blockchain-Based Smart Contracts	N. Gupta, P. Bedi-2018	Proc. Int. Conf. on Advanced Computing, Communication and Informatics (ICACCI), IEEE	Ensures transparency, immutability, and automated compliance through smart contracts	Limited scalability analysis; lacks real-world deployment validation	Ensures transparency, immutability, and automated compliance through smart contracts
2	Blockchain- Based IoT Enabled System for Smart Cities	Atta Ur Rehman Khan, Raha Wasim-2022	IEEE Transactions	Provides decentralized traceability and secure data sharing among stakeholders	Does not explicitly address pricing regulation and e-waste resale control	Provides decentralized traceability and secure data sharing among stakeholders
3	Blockchain- Based Smart Contracts in Waste Management: A Silver Bullet?	A. G. Ongena et al-2018	Bled eConference	Use of blockchain smart contracts for waste tracking and cross-border waste flow management	Enhances trust, transparency, and accountability in waste management systems	High implementation cost and technical complexity for large-scale adoption
4	A Smart E-waste System Utilizing Supply Chain Participants and Interactive Online Maps	T. Shevchenko et al-2021	Recycling Journal	Smart reverse logistics system using IT tools, local delivery services, and interactive maps	Reduces transportation cost, CO ₂ emissions, and improves collection efficiency	Does not use blockchain; limited data security and tamper resistance

PROPOSED SYSTEM

The new system uses blockchain technology and smart contracts to manage e-tracking. This system makes sure that every step of handling e-waste is recorded in an transparent way.

This starts from when e-waste's generated and goes all the way to when it is recycled. The system is secure. Cannot be tampered with.

Each person involved with e-waste like the user, the collection center, the transporter and the recycler uses an app to interact with the blockchain network. This app is called a decentralized application or DApp for short.



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Smart contracts make the workflow automatic by checking and recording each step without needing a person to do it. When someone gets rid of e-waste it gets an ID in the system.

As the e- moves from one place to another like from collection to transportation, to recycling its status is updated on the blockchain all the time. This means we can track the e-waste in time and know where it is all the time.

The new system gets rid of work reduces cheating and makes everyone involved more accountable. It also helps the government keep an eye on e- activities.

A. ARCHITECTURE DIAGRAM

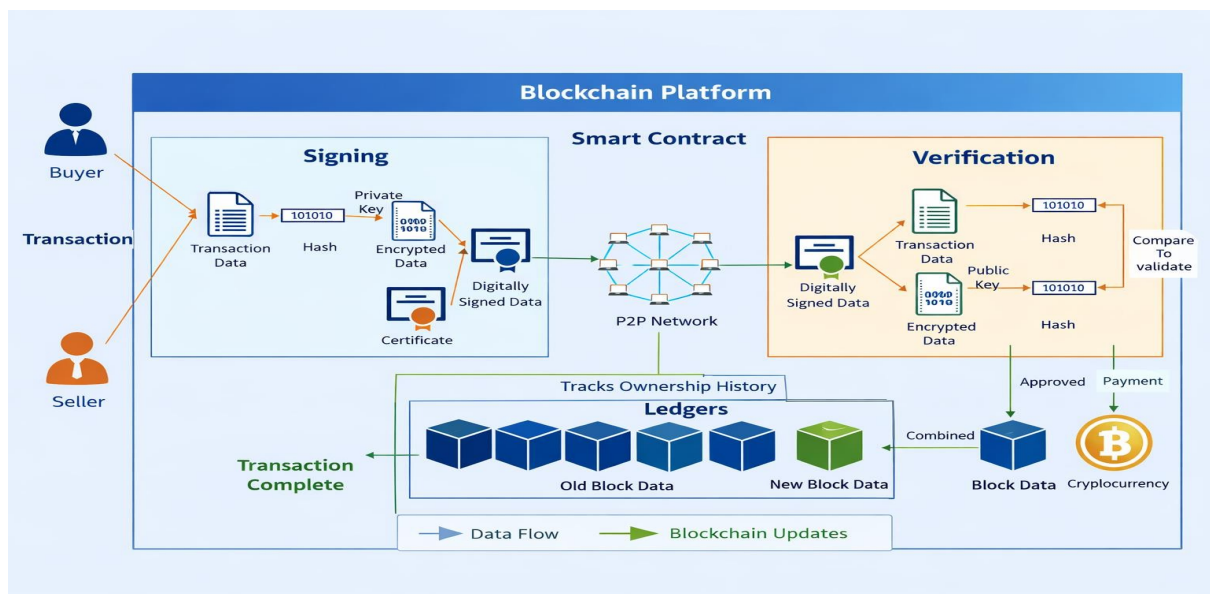


Figure 3:1

B. MODULES

1. Admin Module

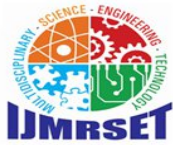
- Manage users and sellers
- Authorize login access
- View all products
- Track purchase status
- Monitor total products purchased

2. Seller Module

- Register and login (after admin approval)
- View and search products
- Send purchase request
- Receive hash key
- Dummy bank payment
- View purchased products
- Add product review

3. User Module

- Register and login (after admin approval)
- View and search products
- Send purchase request
- Receive hash key



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- Dummy bank payment
- View purchased products
- Add product review

III. METHODOLOGY

1. Requirement Analysis

First we need to figure out what the system needs to do. We do this by looking at the problems with the way of handling e-waste. The old way has issues like we cannot see what is going on it is hard to keep track of things and people can easily change the data. We need a system that is safe, automatic and not controlled by just one person.

2. System Design

Now we design the system. We break it down into parts like the user part the application part, the blockchain part and the storage part. We also make sure we know what each persons job is, like the users, the people who collect e-waste the people who transport it the people who recycle it and the administrators who are, in charge of the e-waste management system the collection centers, the transporters, the recyclers and the administrators.

3. Smart Contract Development

We develop contracts using the Solidity programming language. These contracts outline the rules for

- waste registration
- Updating the status
- Transferring ownership
- Verifying transactions

4. Blockchain Integration

The smart contracts are deployed on a blockchain like Ethereum. All e-waste tracking transactions are recorded on the blockchain. This ensures that the transactions can't be changed and are transparent.

5. Frontend and Backend Development

We create an interface using HTML, CSS and JavaScript. The backend services use Node.js to help the application talk, to the blockchain using Web3.js.

6. Data Storage using IPFS

- We store files, like images and documents using IPFS. The IPFS system helps us keep these files safe.
- We only save the IPFS hash on the blockchain to save money on storage.

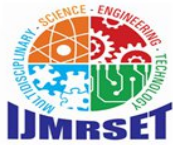
7. Testing and Validation

- We test our system to make sure it works right.
- We check that smart contracts work correctly.
- We verify that tracking and tracing are accurate.
- We also check for security and performance.
- We use test cases to make sure our system works as expected.

IV. RESULT AND DISCUSSION RESULT

The new e-waste tracking system uses blockchain technology to see how well it works for managing e-waste. This system uses blockchain to record everything that happens with e-waste from when it's collected to when it is recycled. Each piece of e-waste gets its special number so we can track it every step of the way. The system takes care of some tasks on its own like updating the status of e-waste and who owns it so people do not have to do it. This system shows what is happening with e-waste at all times so people can check on it whenever they want. The information on the blockchain is safe. Cannot be changed without permission. The e-waste tracking system also uses something called storage, which is, like a big file cabinet to store big files and keep them safe. This helps the blockchain by not making it store much information. The e-waste tracking system is a way to manage e-waste.

The implementation results show:



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We need to keep track of e-waste in a way that's accurate and happens in real time. This means everyone involved with e-waste can see what is going on.

We have to store the information about e-waste in a place where it cannot be changed. E-waste management can be made easier with automation using contracts.

The way we manage e-waste can be made efficient which is good, for e-waste management.

DISCUSSION

The results show that using blockchain and smart contracts makes e-waste management systems work better and more reliably. Blockchain is decentralized so it does not need an authority, which makes users trust it more. Smart contracts are very important because they automate the workflow. This means that each step in handling e-waste only happens when certain conditions are met. This reduces mistakes made by people. Makes the whole process work better. The system also helps stop dumping and unauthorized recycling by keeping a clear record of everything that happens. Government authorities and regulatory bodies can use this system to check if people are following the rules.

However some problems were found when this system was being set up:

- * Higher costs for transactions on blockchain networks like gas fees

- * Problems with handling a lot of data at the time

- * Small delays when transactions are being confirmed which takes a little more time than expected. Blockchain and smart contracts are still useful for e-waste management systems with these issues. Blockchain and smart contracts can make a difference, in how we manage e-waste.



Figure 4.1

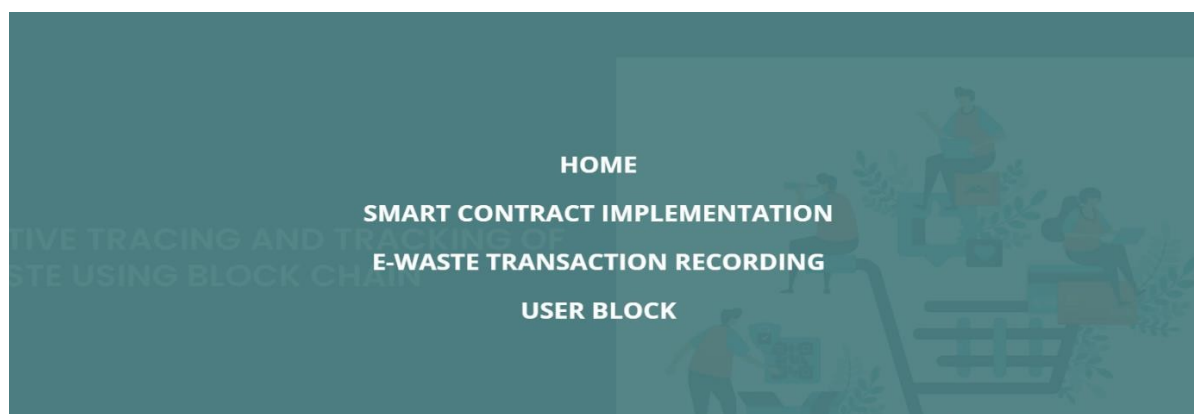


Figure 4.2



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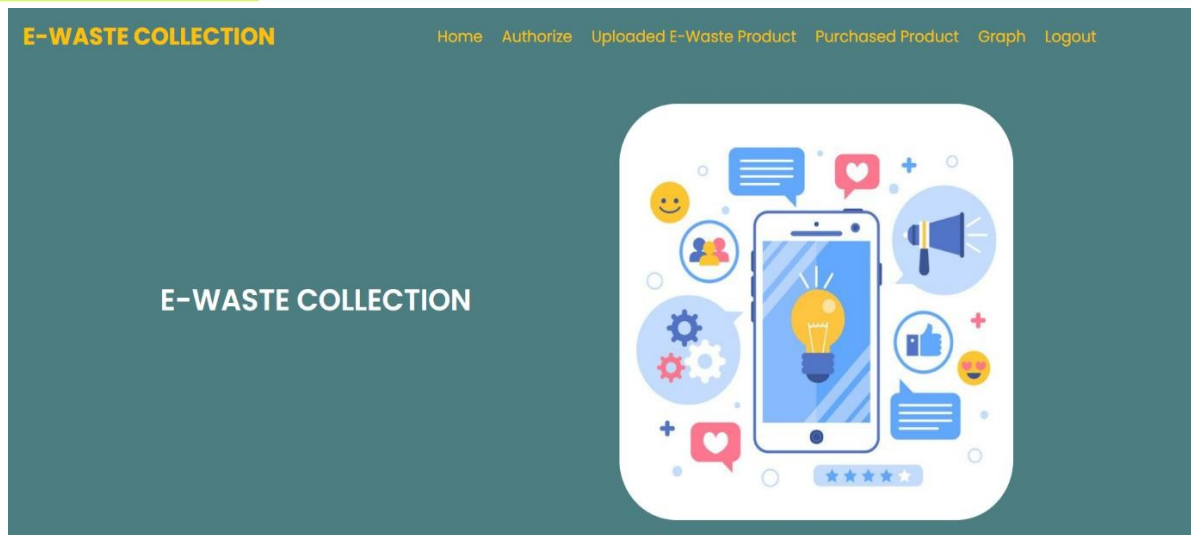


Figure 4.3

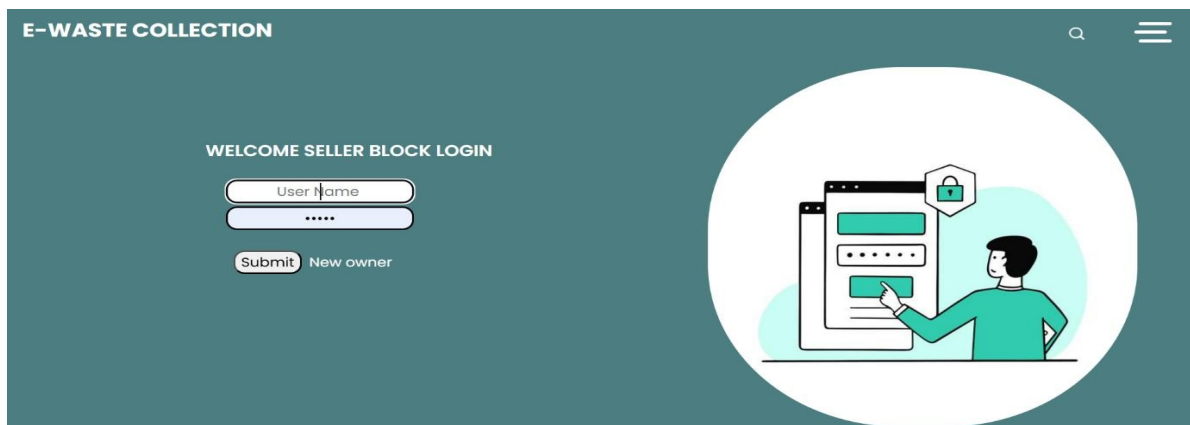
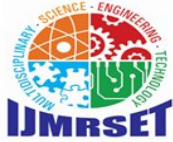


Figure 4.4



Figure 4.5



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Figure 4.6

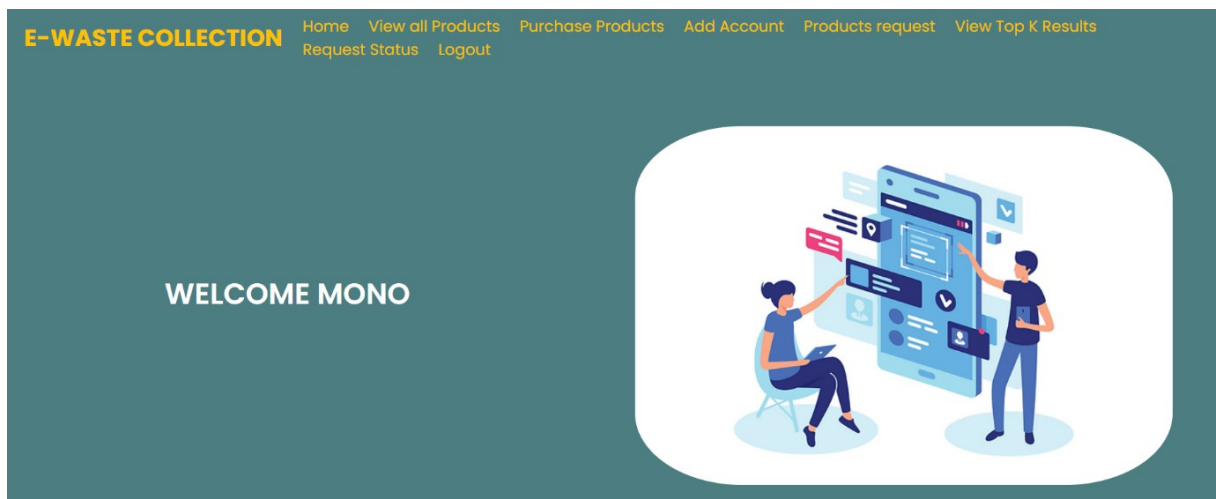


Figure 4.7

V. CONCLUSION AND FUTURE ENHANCEMENT

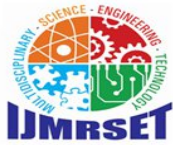
CONCLUSION

The Smart Contract Implementation for E- Waste Collection Tracking and Tracing system is a way to manage electronic waste using blockchain technology. It helps to track e-waste from the time it is bought to when it is thrown away. This system makes sure that all information is transparent secure and can be tracked. It records all transactions on a kind of computer ledger that can't be changed. Using contracts the process of tracking e-waste is automated. This means that it is less prone to errors and can't be altered easily. The system reduces the need for tracking and third-party helpers. This makes the process more efficient and trustworthy. The system helps to prevent cheating and builds trust among users, sellers and administrators. It also helps the environment by encouraging people to dispose of e-waste recycle. The Smart Contract Implementation for E-Waste Collection Tracking and Tracing system is a solution, to the problems of traditional e-waste management. It improves how e-waste is managed and supports sustainability. The E-Waste Collection Tracking and Tracing system and Smart Contract Implementation make it all work together smoothly.

FUTURE ENHANCEMENTS

To further improve the system and expand its capabilities, the following enhancements can be considered:

Integration with IoT Technology



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IoT devices can be used to automatically track the location and condition of e-waste in real time.

Artificial Intelligence Integration

Machine learning algorithms can predict e-waste generation trends and optimize collection and recycling processes.

Mobile Application Development

A user-friendly mobile app can be developed for easy access, real-time tracking, and notifications.

Multi-Factor Authentication (MFA)

Enhance system security by implementing advanced authentication methods like OTP or biometrics.

Government and Recycling Agency Integration

Connecting the system with authorized recycling centers and government bodies for better compliance and monitoring.

Scalability Improvements

Support for multiple blockchain platforms to handle large-scale data and transactions efficiently.

Reward-Based System

Introduce incentives or rewards for users who responsibly dispose of e-waste.

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