PROFESSIONAL TRAINING REPORT - II

entitled

Carbon Credit Trading platform using Blockchain

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering with
specialization in Blockchain Technology

by

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SCHOOL OF COMPUTING

SATHYABAMA

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Professional Training Report is the bonafide work of **Ms. Grandhi Harshini** who carried out the project entitled **"Carbon Credit Trading platform using blockchain"** under my supervision from January 2024 to April 2024.

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Ms. Lekshmi S Raveendran, M.Tech.,

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Submitted for Viva voce Examination held on ___________________

Internal Examiner **External Examiner**

DECLARATION

I, **Grandhi Harshini (41613009),** hereby declare that the Professional Training Report-II entitled **"Carbon credit Trading platform using blockchain"** done by me under the guidance of **Ms. Lekshmi S. Raveendran, M.Tech,** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Computer Science and Engineering with specialization in Artificial Intelligence.

DATE: 7-05-2024

PLACE: **SIGNATURE OF THE CANDIDATE**

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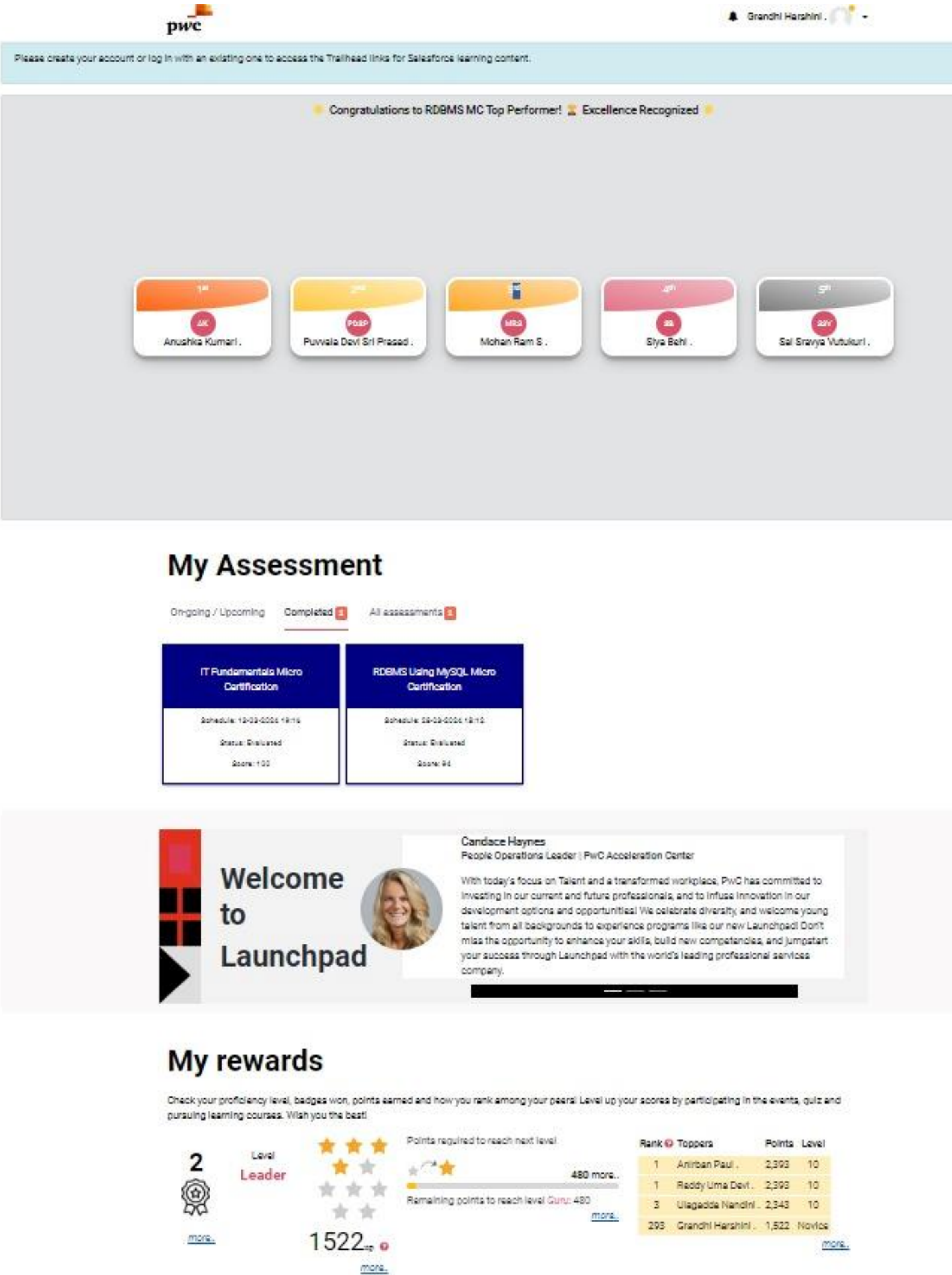
COURSE CERTIFICATE



ABSTRACT

The Carbon Credit Trading Platform is a crucial initiative aimed at curbing the detrimental impact of excess greenhouse gas emissions, particularly carbon dioxide, starting from industries surpassing regulated limits. Carbon credits signify authorization to emit carbon dioxide and other greenhouse gases within specified thresholds, typically capped at 1 tonne of greenhouse gas emissions. This project's core objective revolves around facilitating the seamless buying, selling, and trading of these carbon credits within a blockchain network. Moreover, the platform places significant emphasis on fostering the production of renewable energies and rebalancing greenhouse gas levels to mitigate environmental harm. The utilization of blockchain networks is pivotal, leveraging features such as smart contracts, wallets, and cryptocurrencies to ensure transparent, immutable, and secure transactions. By incentivizing emission reduction and advocating sustainable practices, this platform plays a pivotal role in combatting climate change and promoting environmental conservation efforts. The output of this project will include the development and deployment of a functional carbon credit trading platform, integration of blockchain technology, promotion of renewable energy production, environmental impact monitoring features, and user engagement and adoption initiatives to ensure its effectiveness in addressing climate change challenges.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Carbon credits have emerged as a pivotal tool in combating the adverse effects of greenhouse gas (GHG) emissions on our planet. Originating from the Kyoto Protocol of 1992, carbon credits serve as tradable permits aimed at reducing the emission of six key GHGs: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. In the face of escalating climate change, characterized by melting ice caps, rising sea levels, and erratic weather patterns, it is imperative to take proactive measures to mitigate these impacts.

Our project seeks to establish a firm footing in the realm of carbon credit trading, bridging the gap between suppliers and buyers within a transparent and secure platform. By leveraging blockchain technology, we aim to revolutionize the carbon credit market, ensuring seamless transactions and enhanced accessibility for all stakeholders. The incorporation of Ethereum blockchain adds an extra layer of credibility and efficiency to the trading process, thereby enhancing trust and reliability.

In the current environmental landscape, characterized by escalating climate change and the urgent need for sustainable solutions, our carbon credit trading platform aims to establish itself as a leader by focusing on sustainability and innovation. Unlike conventional systems that are often marred by issues such as lack of transparency and security vulnerabilities, our platform offers a transparent and decentralized approach to carbon credit trading.

One of the key features of our platform is the utilization of blockchain technology, which ensures that each carbon credit transaction is securely tokenized and recorded on the blockchain. This provides immutable records, meaning that once a transaction is recorded, it cannot be altered or tampered with. This not only enhances the security of the platform but also fosters accountability among participants, as all transactions are transparent and verifiable by anyone on the blockchain network. Blockchain technology was included in this project for several key reasons:

Transparency: Blockchain provides a transparent and immutable ledger where all transactions are recorded. This transparency ensures that carbon credit trading activities are visible to all participants, promoting trust and accountability in the market.

Security: Blockchain's decentralized and cryptographic nature enhances security by reducing the risk of fraud and tampering. Transactions on the blockchain are cryptographically secured and cannot be altered once recorded, mitigating the risk of unauthorized modifications.

Decentralization: By utilizing a decentralized blockchain network, the carbon credit trading platform reduces reliance on centralized authorities, such as banks or governments. This decentralization fosters resilience against single points of failure and reduces the risk of manipulation or censorship.

Efficiency: Blockchain enables faster and more efficient transactions compared to traditional centralized systems. Smart contracts, programmable self-executing contracts deployed on the blockchain, automate the execution of transactions, reducing the need for intermediaries and streamlining processes.

Accessibility: Blockchain technology provides global accessibility, allowing stakeholders from diverse geographical locations to participate in carbon credit trading. This inclusivity opens up new opportunities for market participation and promotes broader adoption of sustainable practices.

Innovation: Integrating blockchain into the carbon credit trading platform fosters innovation by enabling the development of novel features and functionalities. Smart contracts, for example, can facilitate automated verification and execution of transactions, reducing administrative overhead and increasing efficiency.

Overall, by leveraging blockchain technology, the project aims to revolutionize the carbon credit trading industry, fostering transparency, security, and sustainability in environmental initiatives.

Moreover, our platform places a strong emphasis on the utilization of carbon credits for the development of renewable resources. By incentivizing the investment of carbon credits into renewable energy projects, reforestation efforts, and other green initiatives, we aim to foster a circular economy where resources are used and reused in a sustainable manner. This not only helps to mitigate carbon emissions but also promotes economic growth and job creation in the renewable energy sector.

Overall, our platform represents a paradigm shift in the carbon credit trading industry, offering a transparent, secure, and sustainable solution to address the pressing challenges of climate change. By prioritizing sustainability and innovation, we are committed to driving positive change and making a meaningful impact in the fight against climate change and environmental degradation. At the core of our endeavor lies the development of an intuitive and user-friendly platform, designed to democratize access to carbon credit trading for a wide spectrum of stakeholders. Through streamlined interfaces and simplified processes, our platform seeks to break down barriers to entry, empowering individuals and entities of all sizes to actively engage in environmental conservation efforts.

Furthermore, our platform boasts a robust security infrastructure, leveraging the inherent resilience of blockchain technology to safeguard transactions and data integrity. By employing cryptographic protocols and decentralized architecture, we bolster trust and confidence among users, ensuring the confidentiality and immutability of their interactions.Beyond its technological prowess, our platform delivers tangible environmental benefits by incentivizing investments in renewable energy projects and other green initiatives. By directing carbon credits toward sustainable development, we not only mitigate carbon emissions but also catalyze economic growth and prosperity in the burgeoning renewable energy sector.

In essence, our platform serves as a dynamic catalyst for driving positive change, bridging the gap between environmental sustainability and economic viability. In essence, our project represents a paradigm shift in the carbon credit market, ushering in a new era of transparency, accountability, and environmental stewardship. With the support of blockchain technology and a dedicated community of stakeholders, we are poised to make a meaningful impact in the global effort to combat climate change and create a more sustainable future for generations to come.

CHAPTER 2

LITERATURE REVIEW

2.1 SURVEY

The primary objective of this project is to combat climate change by reducing carbon levels in the environment, ultimately aiming to decarbonize the ecosystem. To achieve this goal, our literature survey employed a comprehensive approach, leveraging research papers and reputable websites to gather relevant information. The scope of the survey encompassed topics related to carbon credit trading platforms, blockchain technology, and their potential applications in environmental sustainability efforts.

The literature survey aimed to address several key questions, including:

- What are the existing carbon credit trading platforms and their adoption rates globally?
- How can blockchain technology, specifically Ethereum and Polygon (formerly Matic), contribute to the development of carbon credit trading platforms?
- What are the challenges and opportunities associated with implementing carbon credit trading platforms in regions like India?

Our search strategy involved conducting extensive searches on academic databases, such as PubMed, Google Scholar, and IEEE Xplore, to identify relevant research papers and articles. Additionally, we explored reputable websites and industry reports to gather insights from experts in the field.

We included sources that provided insights into carbon credit trading platforms, blockchain technology, and their potential synergy in environmental sustainability efforts. We excluded sources that were outdated, irrelevant, or lacked credibility.

In the paper, The AI gambit: leveraging artificial intelligence to combat climate change—opportunities, written by Cowls, J., Tsamados, A., Taddeo, M, summarizes that the significance of AI in combatting climate change and achieving sustainable development goals. It underscores the need for concerted efforts from governments, academia, industry, and civil society to harness the full potential of AI in addressing the urgent challenges posed by climate change.

In the paper, the concept of “Carbon Credit” in the construction industry: A case study of viAct’s scenario-basedscenario-based AI in carbon credit management, the case study concludes by highlighting the potential of AI-driven solutions, such as viAct's scenario-based AI, to revolutionize carbon credit management in the construction industry. It underscores the importance of innovation and collaboration in achieving sustainability goals and encourages further research and development in this area.This literature survey provides an overview of the paper's contribution to the field of AI and climate change, focusing on the opportunities, challenges, and recommendations for leveraging AI technologies in combatting climate change.

From the article released in coindesk, it concludes by speculating on the future outlook of crypto carbon credits exchanges, suggesting that they could play a significant role in accelerating the transition to a low-carbon economy. It highlights the potential of blockchain technology to disrupt traditional carbon markets and drive innovation in sustainability finance. This brief overview summarizes the key points discussed in the news article about the creation of a crypto carbon credits exchange in Germany and its potential implications for the carbon market and climate change mitigation efforts.

The paper with topic, Blockchain for Energy Credits and Certificates: A Comprehensive Review, it concludes by summarizing the key findings and highlighting the importance of blockchain technology in revolutionizing GHG emission reduction strategies. It underscores the need for further research and development to address the challenges and maximize the potentials of blockchain in sustainable energy management. This literature survey provides an overview of the paper's contribution to the field of blockchain technology in GHG emission reduction, highlighting its significance, challenges, and future research directions.

In the paper, The Impact of Cap-and-Trade Mechanisms and Bank Credit on Renewable Energy Investment, author concludes by emphasizing the critical role of policy mechanisms such as cap-and-trade and bank credit in driving renewable energy investment and accelerating the transition towards a low-carbon economy. It underscores the importance of evidence-based policy design and continuous evaluation to maximize the effectiveness of renewable energy policies. This literature survey provides an overview of the paper's contribution to the field of renewable energy investment and policy analysis, highlighting the interplay between cap-and-trade mechanisms, bank credit, and investment decisions in the renewable energy sector.

In the paper which is published as Decentralized Energy to Power Rural Homes Through Smart Contracts And Carbon Credit, says that by highlighting the transformative potential of decentralized energy systems powered by smart contracts and carbon credits. It underscores the importance of innovation and collaboration in advancing renewable energy technologies and accelerating the transition towards a sustainable energy future for all. This literature survey provides an overview of the paper's contribution to the field of decentralized energy and blockchain technology, focusing on the development and implementation of innovative solutions to provide clean and affordable energy access to rural communities.

In the topic, Analysis of carbon electricity coupled market modeling method based on carbon credit trading mechanism, it summarizes that, Wang et al. (2024) provide a comprehensive analysis of carbon electricity coupled market modeling methods, shedding light on the opportunities and challenges associated with integrating carbon credit trading mechanisms within electricity markets. Their study contributes to advancing our understanding of the complex interactions between carbon emissions, energy generation, and market dynamics, offering valuable insights for policymakers, industry stakeholders, and researchers in the field of energy economics and environmental management.

heavily on theoretical frameworks and conceptual models, with limited empirical evidence to support their findings. There is a need for more empirical research that examines real-world implementation and outcomes of carbon

In conclusion, our literature survey provided valuable insights into the landscape of carbon credit trading platforms and the role of blockchain technology in environmental sustainability efforts. By addressing key research questions and identifying gaps in the literature, we laid the groundwork for future research endeavors aimed at advancing our understanding of these important topics and driving positive change in the fight against climate change.

CHAPTER 3

REQUIREMENTS ANALYSIS

3.1 OBJECTIVE OF THE PROJECT

The primary objective of this project is to mitigate climate change by reducing carbon emissions and fostering environmental sustainability. Specifically, the project aims to develop and implement a blockchain-based carbon credit trading platform in India, leveraging innovative technologies and strategies to enhance transparency, efficiency, and accessibility in carbon credit trading practices. By facilitating the adoption of sustainable practices and promoting the decarbonization of the environment, the project seeks to contribute to global efforts to combat climate change and create a more sustainable future.

3.2 REQUIREMENTS

3.2.1 *HARDWARE REQUIREMENTS*

- **Computer**: A desktop or laptop computer capable of running development tools and software.
- **Processor**: A modern multi-core processor (e.g., Intel Core i5 or AMD Ryzen series) for smooth performance.
- **RAM**: At least 8GB of RAM for running development environments and compiling smart contracts.
- **Storage**: Sufficient storage space (at least 100GB) for storing development tools, libraries, and project files.
- **Internet Connection:** A stable internet connection for downloading dependencies, accessing APIs, and deploying smart contracts.

3.2.2 *SOFTWARE REQUIREMENTS*

- **Operating System**: Windows, macOS, or Linux operating system.
- **Development Environment**: An integrated development environment (IDE) such as Visual Studio Code, Atom, or Sublime Text for writing and editing code.
- **Node.js**: Node.js runtime environment installed on the computer for running JavaScript-based applications.

- **Ganache**: Ganache CLI or Ganache GUI for running a local Ethereum blockchain network for development and testing purposes.
- **Truffle**: Truffle framework for Ethereum smart contract development, testing, and deployment.
- **OpenZeppelin**: OpenZeppelin library for writing secure and scalable smart contracts.
- **Infura**: Infura API key for connecting to the Ethereum blockchain network, particularly useful for deploying smart contracts to the Ethereum mainnet or testnets.
- **Web3.js or Ethers.js**: JavaScript libraries for interacting with Ethereum smart contracts from frontend applications.
- **Polygon (formerly Matic) Network**: Optionally, the Polygon network can be used as a scaling solution for deploying smart contracts and executing transactions with lower fees and faster confirmation times.

By fulfilling these hardware and software requirements, developers can set up their development environment and begin building the blockchain-based carbon credit trading platform effectively.

CHAPTER 4
DESIGN DESCRIPTION OF PROPOSED PROJECT

4.1 PROPOSED METHODOLOGY

The proposed methodology for this project revolves around leveraging blockchain technology to revolutionize carbon credit trading. It involves the development of a secure and transparent platform where companies can tokenize, trade, and transfer carbon credits seamlessly. The methodology encompasses several key steps, including:

1. *Research and Analysis*: Conducting comprehensive research to understand the current landscape of carbon credit trading, including existing challenges and opportunities.

2. *Design and Development:* Designing and developing smart contracts and frontend interfaces using Solidity and other relevant technologies to create a user-friendly platform.

3. *Testing and Optimization:* Conducting thorough testing to ensure the security, efficiency, and reliability of the platform, followed by optimization to enhance performance.

4. *Integration and Deployment:* Integrating the platform with blockchain networks and deploying it to the target environment, ensuring compatibility and scalability.

5. *Evaluation and Feedback:* Continuously evaluating the platform's performance and gathering feedback from users and stakeholders to identify areas for improvement.

Through this proposed methodology, the project aims to establish a cutting-edge carbon credit trading platform that addresses existing challenges, promotes transparency, and fosters environmental sustainability.

4.1.1 *Ideation Map/System Architecture*

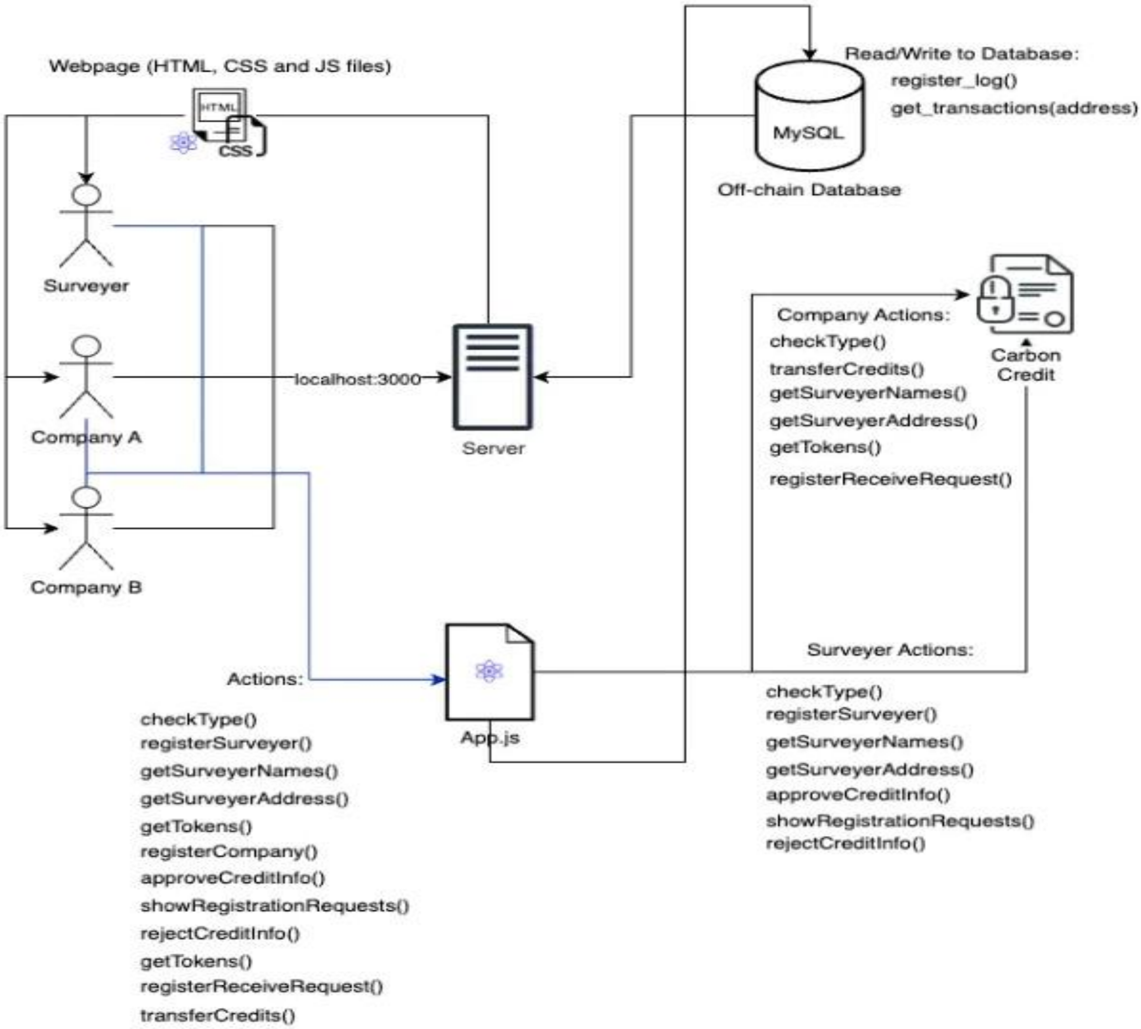

Fig 1: System Architecture

We have companies, who buy carbon credits, suppliers and the database in the architecture of this project.

4.1.2 *Various Stages*

Here's a high-level algorithm for the carbon credit trading platform:

1. Initialization:

- Initialize the smart contract with necessary parameters such as name, symbol, and initial supply of carbon credits.
- Define data structures to store information about companies, surveyors, and carbon credit transactions.

2. Registration:

- Companies register on the platform by providing necessary details such as name, total credits, and survey reference.
- Surveyors register on the platform by providing their details.

3. Verification:

- Surveyors review registration requests from companies and approve or reject them based on predefined criteria.
- Upon approval, companies are verified and issued a set number of carbon credits.

4. Credit Request:

- Verified companies can request additional credits by specifying the number of tokens needed.
- Each request is associated with a cost per credit, calculated based on factors such as remaining requests and total credits.

5. Credit Transfer:

- Companies can transfer credits to other verified companies by specifying the recipient's address and the number of tokens to transfer.
- Transfer requests are processed securely using blockchain technology, ensuring immutability and transparency.

6. Utilization of Credits:

- Companies can utilize carbon credits for various purposes such as offsetting emissions, investing in renewable energy projects, or participating in carbon offset programs.

7. Monitoring and Reporting:

- The platform provides tools for monitoring carbon credit transactions and generating reports on carbon credit utilization.
- Users can track their carbon credit balance, transaction history, and environmental impact through the platform interface.

8. Continuous Improvement:

- Regular updates and enhancements are implemented to improve platform functionality, security, and user experience.
- Feedback from users and stakeholders is collected and incorporated into future iterations of the platform.

This algorithm outlines the core functionalities and processes of the carbon credit trading platform, providing a framework for its implementation and operation.

4.1.4 *working principles*

1. *Transparency*:

   The blockchain-based carbon credit trading platform ensures transparency by recording all transactions on the blockchain in an immutable and transparent manner. This transparency fosters trust among users and stakeholders, as all transactions are verifiable and traceable.

2. *Security:*

Blockchain technology provides a high level of security by utilizing cryptographic techniques to secure transactions and data. Smart contracts govern the trading process, ensuring that transactions are executed according to predefined rules and conditions, thereby reducing the risk of fraud and manipulation.

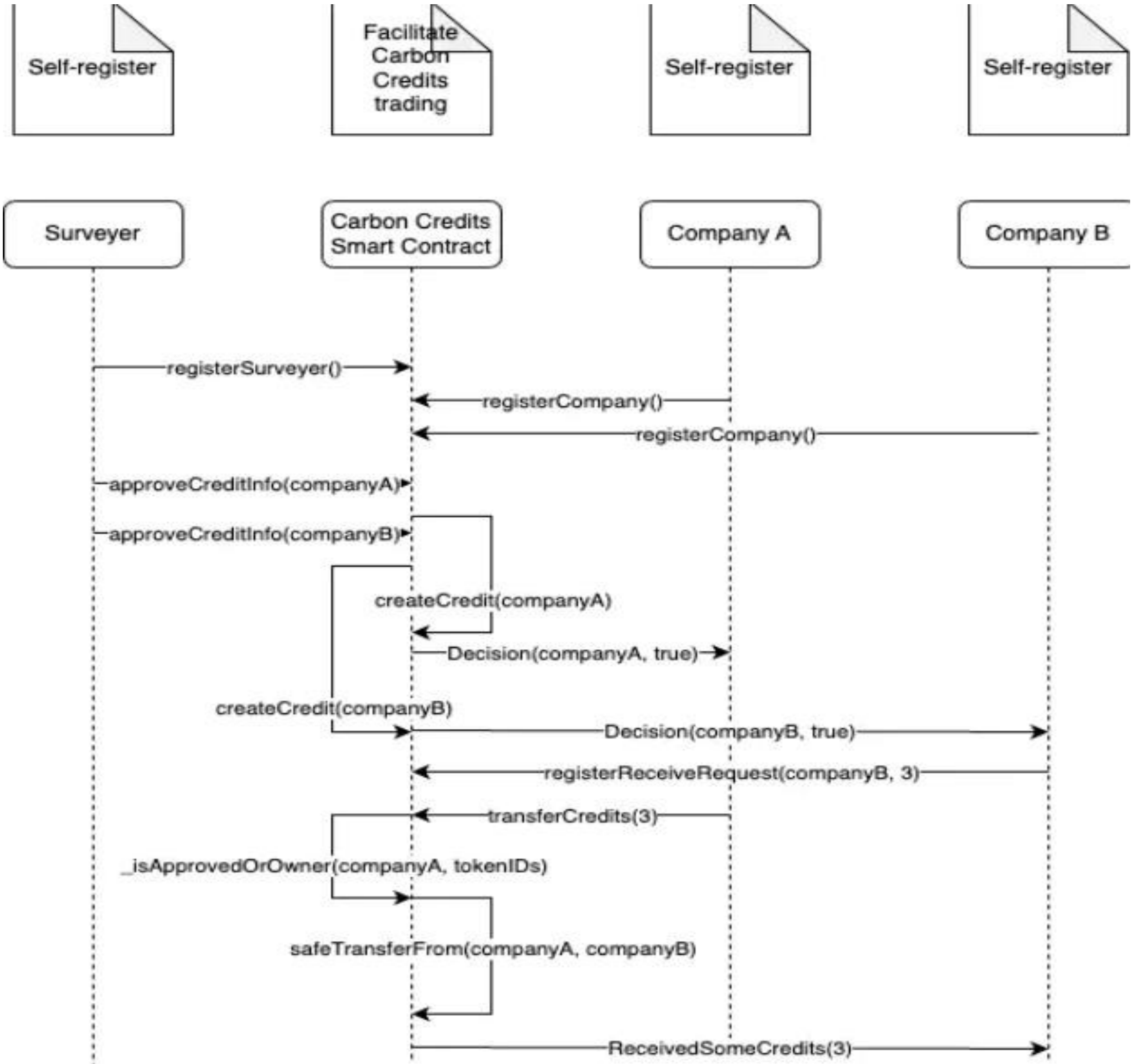

Fig 2: Working of platform

3. *Efficiency*:

By leveraging blockchain technology, the platform streamlines the carbon credit trading process, eliminating the need for intermediaries and reducing transaction costs and processing times. This efficiency benefits both buyers and sellers, enabling them to conduct transactions quickly and cost-effectively.

4. *Accessibility*:

The platform enhances accessibility by providing a user-friendly interface that enables users to easily buy, sell, and trade carbon credits. Additionally, the platform is accessible to users worldwide, enabling participation in carbon credit trading regardless of geographical location or financial status.

5. Environmental Sustainability:

The project contributes to environmental sustainability efforts by incentivizing the adoption of carbon offset initiatives. By enabling the trading of carbon credits on the blockchain, the platform encourages investment in renewable energy projects, reforestation efforts, and other green initiatives, ultimately helping to reduce carbon emissions and combat climate change.

6. *Global Impact:*

The platform's implementation on the blockchain allows for global participation, enabling users from different regions and industries to collaborate and contribute to environmental sustainability efforts on a larger scale. This global impact is essential in addressing the pressing challenges of climate change and environmental degradation.

7. *Decentralization*:

The decentralized nature of blockchain technology eliminates the need for a central authority to oversee transactions, thereby democratizing the carbon credit trading process. This decentralization promotes inclusivity and reduces the risk of censorship or manipulation, ensuring a fair and equitable trading environment for all participants.

8. *Smart Contract Automation:*

Smart contracts automate the execution of transactions based on predefined conditions, eliminating the need for manual intervention and reducing the potential for human error. This automation streamlines the trading process, enabling faster and more efficient transactions while minimizing operational costs.

9. *Tokenization of Carbon Credits*:

Carbon credits are tokenized and represented as digital assets on the blockchain, allowing for fractional ownership and easy transferability. This tokenization enhances liquidity in the carbon credit market, enabling users to buy, sell, and trade credits with ease.

10. *Immutable Audit Trail*:

Every transaction on the blockchain is recorded in a tamper-proof and immutable ledger, providing an auditable trail of all carbon credit transactions. This audit trail enhances accountability and transparency, allowing users to track the history of each credit and verify its authenticity.

11. *Integration with External Systems*:

The platform can be integrated with external systems, such as IoT devices or satellite imagery, to verify and validate carbon offset projects. This integration enhances the credibility of carbon credits by providing real-time data and evidence of emissions reductions.

12. *Community Engagement*:

The platform fosters community engagement by allowing users to participate in discussions, vote on governance proposals, and contribute to the development of the platform. This community-driven approach promotes collaboration and innovation, driving continuous improvement and growth within the carbon credit trading ecosystem.

In summary, the working of the project revolves around leveraging blockchain technology to create a decentralized, transparent, and efficient platform for carbon credit trading. By automating transactions, tokenizing carbon credits, and providing an immutable audit trail, the platform enhances accessibility, security, and trust in the carbon credit market. Integration with external systems and community engagement further enrich the platform, making it a powerful tool for combating climate change and promoting environmental sustainability on a global scale.

4.2 FEATURES

1. Secure Transactions:

   Transactions are executed securely through smart contracts on the blockchain, ensuring trust and transparency.

2. Transparent Record-Keeping:

   All transactions are recorded transparently on the blockchain, providing a verifiable and immutable record of carbon credit trading activities.

3. User-Friendly Interface:

   The platform offers a user-friendly interface for traders to buy, sell, and transfer carbon credits easily.

4. Efficient Trading:

   Carbon credit trading is conducted efficiently on the platform, with streamlined processes and low transaction costs.

5. Scalability:

   The platform is designed to scale effectively, accommodating a growing number of users and transactions without compromising performance.

6. Integration with Blockchain Networks:

   Integration with blockchain networks like Ethereum or Polygon Network (formerly Matic) ensures compatibility and interoperability with existing blockchain ecosystems.

7. Security Measures:

   Robust security measures are implemented to protect user data, prevent unauthorized access, and ensure the integrity of transactions.

8. Regulatory Compliance:

The platform adheres to relevant regulations and standards governing carbon credit trading, ensuring compliance and legality.

9. Environmental Impact:

By facilitating carbon credit trading, the platform contributes to environmental sustainability efforts, helping to reduce carbon emissions and combat climate change.

10. Community Engagement:

The platform fosters community engagement and collaboration, bringing together stakeholders to participate in carbon credit trading and promote environmental stewardship.

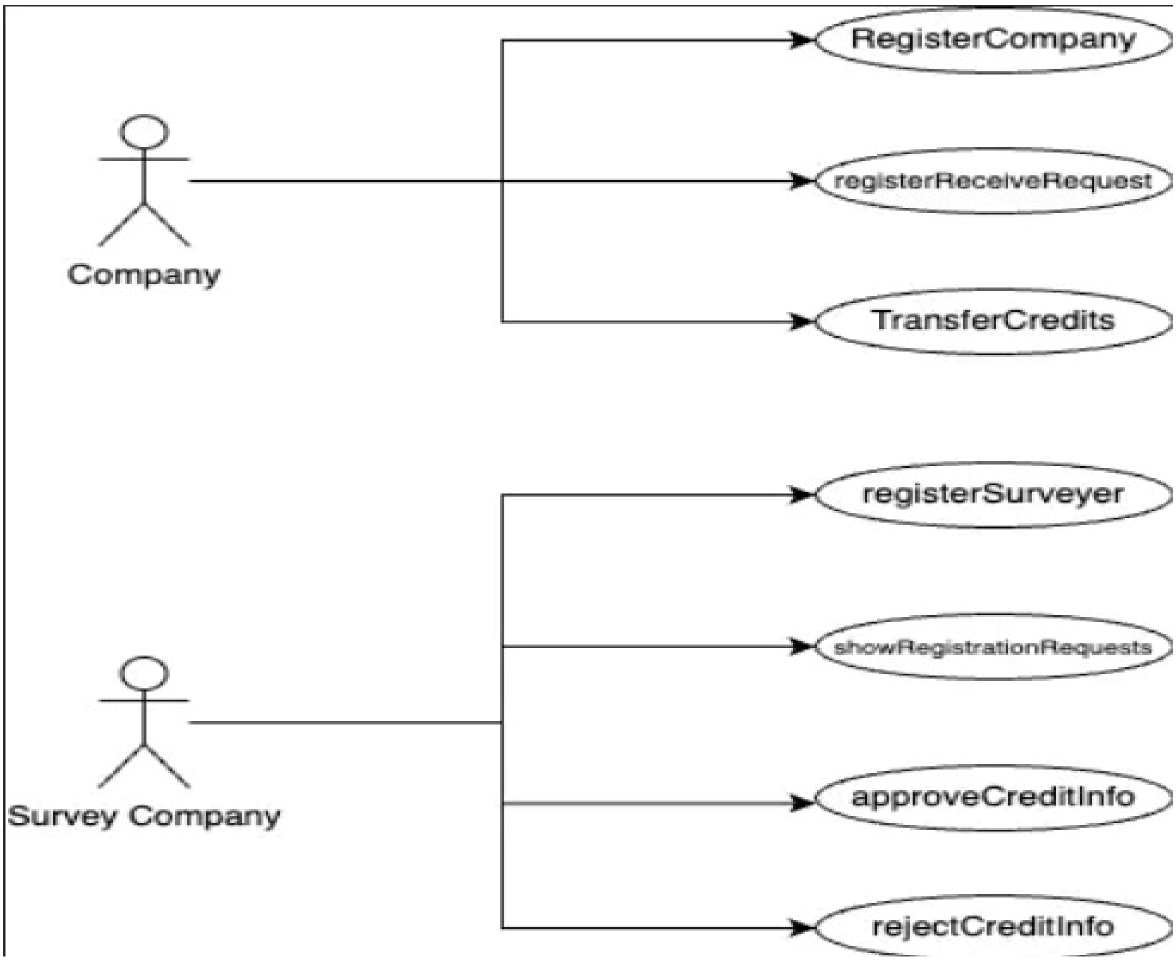

Fig 3: Use case diagram

These features collectively make the blockchain-based carbon credit trading platform a valuable tool for traders, businesses, and organizations seeking to participate in carbon credit markets and contribute to global efforts to address climate change.

4.2.1 *Novelty of the proposal*

The proposal introduces a groundbreaking approach to carbon credit trading by integrating blockchain technology, specifically Ethereum, Polygon, Sepolia, IRC20, IERC17, and IERC20 Networks, into the ecosystem. This innovative market entry targets the underrepresented Indian market, aiming to provide transparency, security, and efficiency in trading. By harnessing blockchain's transparency and decentralized governance, the platform builds trust among stakeholders and advances environmental impact through emissions reduction and renewable energy investment.

This pioneering strategy revolutionizes traditional carbon credit trading methods by leveraging blockchain technology's inherent properties. The transparent and tamper-proof nature of distributed ledger systems ensures that all transactions are recorded securely and accessible to all parties. This transparency fosters trust among buyers, sellers, and regulatory bodies, mitigating the risks of fraud and manipulation often associated with conventional trading platforms.

Furthermore, the decentralized architecture of blockchain eliminates the need for intermediaries, reducing transaction costs and streamlining processes. Smart contracts automate agreement executions, enhancing efficiency and minimizing human error in carbon credit trading.

The project's focus on the Indian market is strategically significant, addressing a notable gap in the carbon credit trading ecosystem. By targeting an underrepresented market, the project expands the reach of carbon credit trading and encourages greater participation from emerging economies in global climate change mitigation efforts.

The strategic focus on the Indian market holds significant implications for the global carbon credit trading ecosystem. India, as one of the world's largest and fastest-growing economies, represents a crucial market for carbon credit trading initiatives. By targeting this market, the project not only addresses a notable gap in the ecosystem but also expands the reach of carbon credit trading to a region with significant emissions potential.

Furthermore, the project's emphasis on the Indian market fosters greater inclusivity and participation in global climate change mitigation efforts. By encouraging engagement from emerging economies like India, the project promotes collaboration and collective action towards achieving sustainable development goals on a global scale. Overall, the project's strategic alignment with the Indian market underscores its commitment to fostering sustainability and driving positive environmental impact on a broader scale.

Moreover, by promoting environmental impact through emissions reduction and renewable energy investment, the project aligns with broader sustainability goals. Transparent and efficient trading mechanisms incentivize stakeholders to adopt environmentally friendly practices, driving tangible impact and facilitating the transition to a low-carbon economy.

In summary, the project's novelty lies in its integration of blockchain technology into carbon credit trading, its focus on the underrepresented Indian market, and its commitment to fostering transparency, security, and efficiency in environmental impact initiatives. This innovative approach has the potential to catalyze positive change in both the carbon credit market and the broader fight against climate change.

CHAPTER 5

CONCLUSION

In conclusion, the blockchain-based carbon credit trading platform marks a pivotal advancement in combating climate change and advancing environmental sustainability. By harnessing cutting-edge technologies like blockchain, smart contracts, and decentralized governance, the platform offers a transparent, secure, and efficient solution for carbon credit trading. Notably, it utilizes various blockchain networks for transaction purposes, ensuring flexibility, scalability, and interoperability. The integration of blockchain guarantees transparency, immutability, and accountability in transactions, while smart contracts automate and optimize the trading process. Through the platform, users can seamlessly engage in buying, selling, and trading carbon credits, incentivizing the adoption of sustainable practices and investment in carbon offset projects. Furthermore, the platform's commitment to promoting environmental stewardship and decarbonization aligns with global efforts to combat climate change and achieve carbon neutrality. As we propel forward, we envisage significant positive impacts, both environmentally and economically, as the platform facilitates the transition to a low-carbon economy and fosters sustainable development practices. Our dedication to innovation and sustainability underscores our mission to forge a more sustainable future for generations to come.

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APPENDIX

A. OUTPUT:

```
Carbon Credit
--------------------------------------------------------------
struct Company {
 string name,
 uint totalCredits,
 uint creditsUsed,
 string surveyReference,
 uint remainingRequests,
 bool isVerified,
 address surveyCompany,
 uint[] tokenIds,
 uint[] costPerCredit
}

struct surveyer {
 string name;
       address[] requests;
}

mapping (address => Company) companies

mapping (address => surveyer) surveyerCompanies

mapping (address => uint[]) creditRequests

string[] surveyerName

address[] surveyerAddress
--------------------------------------------------------------
event Decision(address company, bool verification)

event ReceivedSomeCredits(address company, string from, uint creditCount)
```

Fig 4:: Contract diagram

This smart contract, named "CarbonCredit," facilitates the trading of carbon credits on the blockchain. It inherits functionality from the ERC721 standard for non-fungible tokens (NFTs) and incorporates features from the OpenZeppelin library for added security and functionality. The contract allows companies to register and request carbon credits, which are minted as unique tokens on the blockchain. Additionally, it enables the approval of credit requests by designated surveyors, ensuring verification and validity. Companies can then transfer credits to other verified entities, facilitating transparent and secure transactions. The contract also includes mechanisms for tracking credit requests, managing token ownership, and handling transaction costs. Overall, it provides a robust framework for carbon credit trading, promoting transparency, accountability, and sustainability in environmental initiatives.

modifier notZeroAddress modifier onlySpecificSurveyer modifier onlyOwnerCompany
getCreditRequests(address company) checkType(address company) registerSurveyer(address company, string memory name) payable notZeroAddress(company) getCompanyAddresses() getSurveyerNames() getSurveyerAddress() getTokens(address company) registerCompany(address company, string memory name, uint totalCredits, uint creditsUsed, string memory surveyReference, address surveyCompany) payable notZeroAddress(company) approveCreditInfo(address company) payable onlySpecificSurveyer(company) showRegistrationRequests(address company) rejectCreditInfo(address company) onlySpecificSurveyer(company) createCredit(address to) registerReceiveRequest(address company, uint numberOfTokens) payable onlyOwnerCompany(company) transferCredits(address to, address payable from, uint numberOfTokens, uint cost, uint index) public payable notZeroAddress(to) notZeroAddress(from)

fig 5: contract diagram

to execute node.js, these commands have been used:

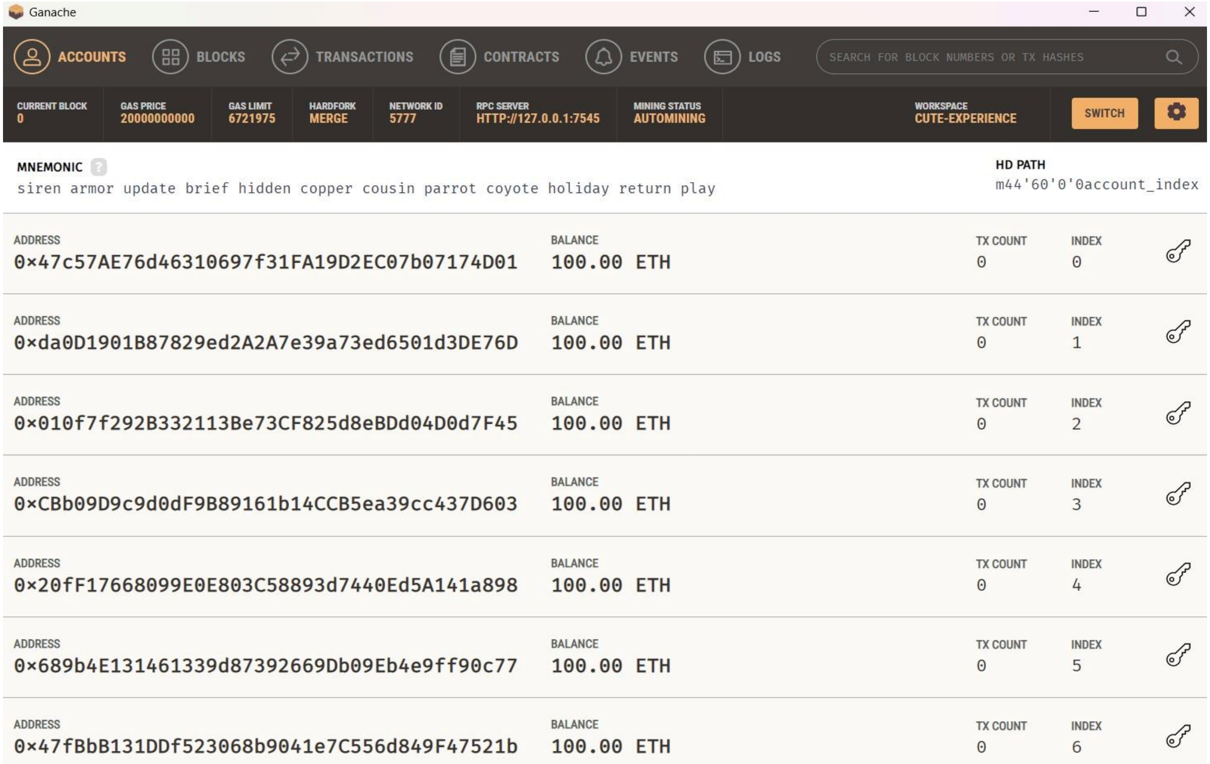
- npm install
- npm –version
- npm install -g npm
- truffle test
- truffle migrate

```
PS C:\Users\athee\OneDrive\Desktop\polymatic project\tokenized-carbon-credit-marketplace-main\carbon-credits-contract-master> npm install

up to date, audited 768 packages in 16s

113 packages are looking for funding
  run `npm fund` for details

21 vulnerabilities (2 low, 17 moderate, 1 high, 1 critical)

To address issues that do not require attention, run:
  npm audit fix

To address all issues (including breaking changes), run:
  npm audit fix --force

Run `npm audit` for details.
PS C:\Users\athee\OneDrive\Desktop\polymatic project\tokenized-carbon-credit-marketplace-main\carbon-credits-contract-master> npm --versio
n
10.6.0
PS C:\Users\athee\OneDrive\Desktop\polymatic project\tokenized-carbon-credit-marketplace-main\carbon-credits-contract-master> npm install
-g npm

changed 13 packages in 3s

24 packages are looking for funding
  run `npm fund` for details
```

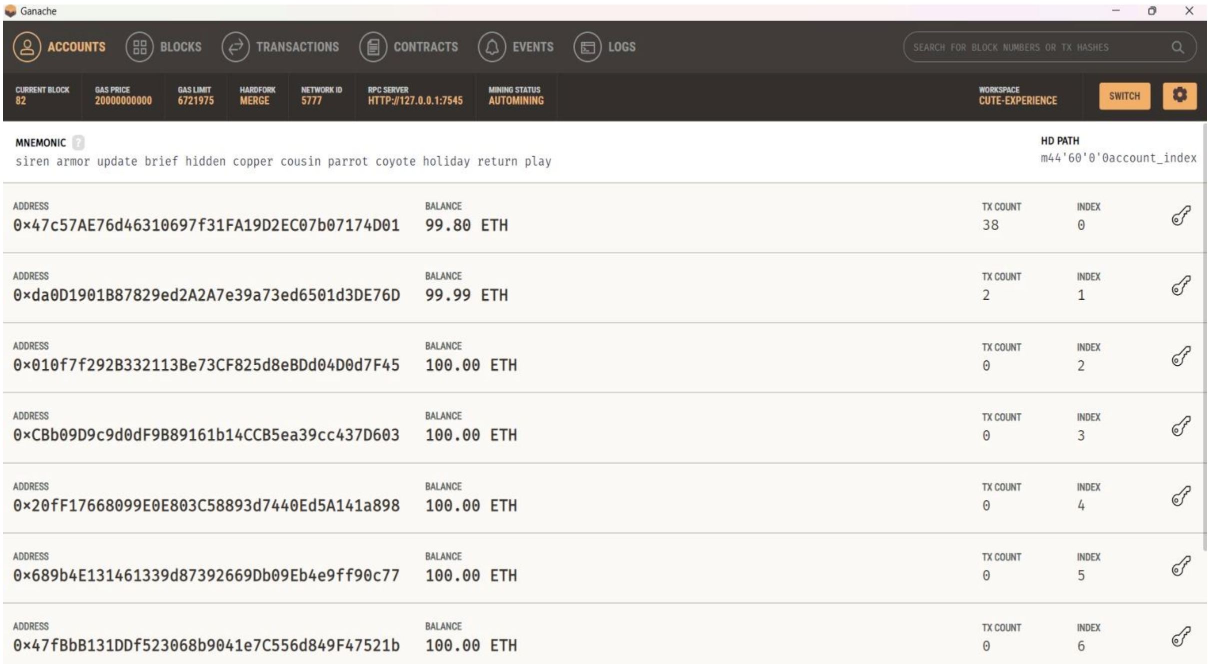
```
PS C:\Users\athee\OneDrive\Desktop\polymatic project\tokenized-carbon-credit-marketplace-main\carbon-credits-contract-master> truffle migrate

Compiling your contracts...
===========================
> Compiling @openzeppelin\contracts\access\Ownable.sol
> Compiling @openzeppelin\contracts\token\ERC721\ERC721.sol
> Compiling @openzeppelin\contracts\token\ERC721\IERC721.sol
> Compiling @openzeppelin\contracts\token\ERC721\IERC721Receiver.sol
> Compiling @openzeppelin\contracts\token\ERC721\extensions\IERC721Metadata.sol
> Compiling @openzeppelin\contracts\utils\Address.sol
> Compiling @openzeppelin\contracts\utils\Context.sol
> Compiling @openzeppelin\contracts\utils\Counters.sol
> Compiling @openzeppelin\contracts\utils\Strings.sol
> Compiling @openzeppelin\contracts\utils\introspection\ERC165.sol
> Compiling @openzeppelin\contracts\utils\introspection\IERC165.sol
> Compiling @openzeppelin\contracts\utils\math\Math.sol
> Compiling .\contracts\CarbonCredits.sol
> Artifacts written to C:\Users\athee\OneDrive\Desktop\polymatic project\tokenized-carbon-credit-marketplace-main\carbon-credits-contract-master\build\contracts
> Compiled successfully using:
   - solc: 0.8.19+commit.7dd6d404.Emscripten.clang


Starting migrations...
======================
> Network name:    'development'
> Network id:      5777
> Block gas limit: 6721975 (0x6691b7)
```

```
Starting migrations...
======================
> Network name:    'development'
> Network id:      1714403185975
> Block gas limit: 6721975 (0x6691b7)


1_deploy_contracts.js
=====================

   Deploying 'CarbonCredit'
   ------------------------
   > transaction hash:    0x9143a485089b6aee75eeb03a95f018ce08c6b55b0f6fe7c8650b3c839e38aca7
   > Blocks: 0            Seconds: 0
   > contract address:    0x7cD6Cf45C6e7B4998E69DC1BbE08C4930C598B8C
   > block number:        1
   > block timestamp:     1714419823
   > account:             0xEcE734B5C4f7b4F85b2c18c57A2Aa2503f7E90c8
   > balance:             99.89215234
   > gas used:            5392383 (0x5247ff)
   > gas price:           20 gwei
   > value sent:          0 ETH
   > total cost:          0.10784766 ETH

   > Saving artifacts
   -------------------------------------
   > Total cost:          0.10784766 ETH

Summary
=======
> Total deployments:   1
> Final cost:          0.10784766 ETH
```

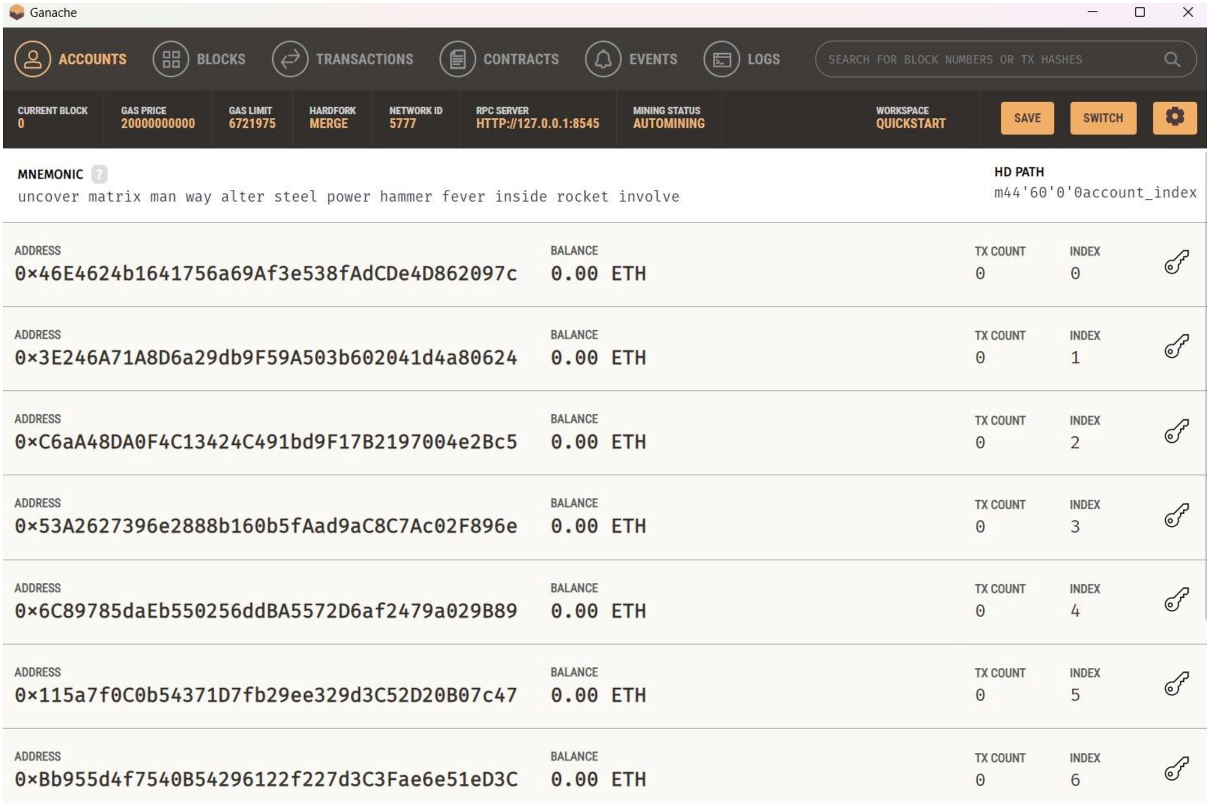
In ganache, before transaction there was 100 ETH in each wallet, there is port number and network ID mentioned in the screenshot,



After transaction, the ETH is used,

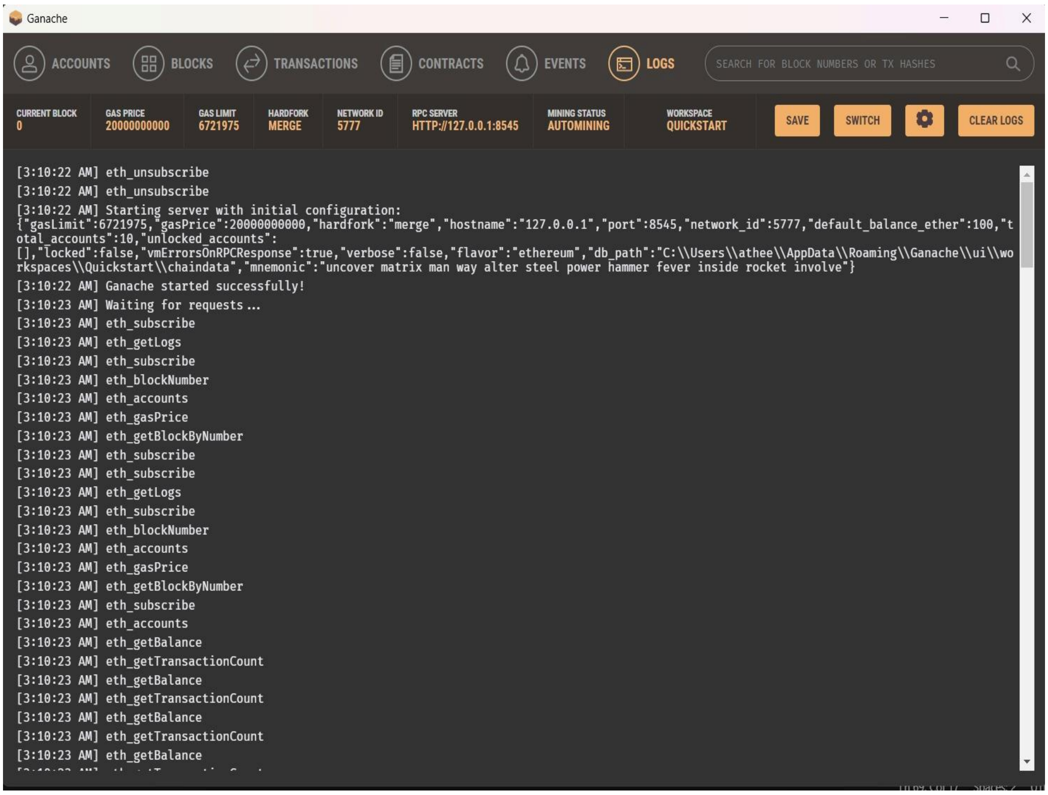


If at all there is no ETH in the wallet, it will show as insufficient balance in the output.




```
> Compiled successfully using:
   - solc: 0.8.19+commit.7dd6d404.Emscripten.clang


Starting migrations...
======================
> Network name:    'development'
> Network id:      5777
> Block gas limit: 6721975 (0x6691b7)


1_deploy_contracts.js
=====================

   Deploying 'CarbonCredit'
   ------------------------
 *** Deployment Failed ***

"CarbonCredit" could not deploy due to insufficient funds
   * Account:  0x46E4624b1641756a69Af3e538fAdCDe4D862097c
   * Balance:  0 wei
   * Message:  insufficient funds for gas * price + value
   * Try:
      + Using an adequately funded account
      + If you are using a local Geth node, verify that your node is synced.


Exiting: Review successful transactions manually by checking the transaction hashes above on Etherscan.
```

In the transaction log, we can find every transaction we did,



B. Source code

Smart contract

```
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.9;

import "@openzeppelin/contracts/token/ERC721/ERC721.sol";
import "@openzeppelin/contracts/access/Ownable.sol";
import "@openzeppelin/contracts/utils/Counters.sol";

contract CarbonCredit is ERC721, Ownable {
    using Counters for Counters.Counter;

    Counters.Counter private _tokenIdCounter;

    constructor(string memory name, string memory symbol) ERC721(name, symbol)
{}
```

```
    event Decision(address company, bool verification);
    event ReceivedSomeCredits(address company, string from, uint creditCount);

    struct Company {
        string name;
        uint totalCredits;
        uint creditsUsed;
        string surveyReference;
        uint remainingRequests;
        bool isVerified;
        address surveyCompany;
        uint[] tokenIds;
        uint[] costPerCredit;
    }

    struct surveyer {
        string name;
        address[] requests;
    }

    string[] surveyerName;
    address[] surveyerAddress;
    address[] companyAddress;

    mapping (address => Company) public companies;
    mapping (address => surveyer) public surveyerCompanies;
    mapping (address => uint[]) public creditRequests;

    modifier notZeroAddress(address value) {
        require(value != address(0), "Address cannot be a 0 address");
        _;
    }

    modifier onlySpecificSurveyer(address company) {
        require(companies[company].surveyCompany == msg.sender, "Only revelant
Surveyer can perform this action");
        _;
    }

    modifier onlyOwnerCompany(address company) {
        require(msg.sender == company, "Only the company owner can request
credits");
        _;
    }

    function getCreditRequests(address company) public view returns (uint[]
memory) {
        return creditRequests[company];
```

```
    }

    function checkType(address company) public view returns (uint) {
        if(companies[company].totalCredits > 0) {
            return 1;
        }
        if(surveyerCompanies[company].requests.length > 0 ) {
            return 2;
        }
        return 0;
    }

    function registerSurveyer(address company, string memory name) public
payable notZeroAddress(company) {
        surveyerCompanies[company].name = name;
        surveyerName.push(name);
        surveyerAddress.push(company);
    }

    function getCompanyAddresses() public view returns (address[] memory) {
        return companyAddress;
    }

    function getSurveyerNames() public view returns (string[] memory) {
        return surveyerName;
    }

    function getSurveyerAddress() public view returns (address[] memory) {
        return surveyerAddress;
    }

    function getTokens(address company) public view returns (uint[] memory) {
        return companies[company].tokenIds;
    }

    function getCostPerCredit(address company) public view returns (uint[]
memory) {
        return companies[company].costPerCredit;
    }

    function registerCompany(address company, string memory name, uint
totalCredits, uint creditsUsed, string memory surveyReference, address
surveyCompany) public payable notZeroAddress(company) returns (string memory)
{
        bytes memory tempEmptyStringTest = bytes(surveyReference);
        require(tempEmptyStringTest.length != 0, "Please provide a reference
number");
        uint[] memory tokens;
```

```
        uint[] memory cost;
        companies[company] = Company(name, totalCredits, creditsUsed,
surveyReference, 5, false, surveyCompany, tokens, cost);
        surveyerCompanies[surveyCompany].requests.push(company);
        return "Awaiting approval from Surveyer";
    }

    function showRegistrationRequests(address company) public payable returns
(address[] memory) {
        require(surveyerCompanies[company].requests.length > 0, "Only
surveyers can have approval requests");
        return surveyerCompanies[company].requests;
    }

    function approveCreditInfo(address company) public payable
onlySpecificSurveyer(company) {
        require(companies[company].isVerified == false, "Company is already
verified");
        companies[company].isVerified = true;
        companies[company].remainingRequests = 5;
        for(uint i = 0; i < (companies[company].totalCredits -
companies[company].creditsUsed); i++) {
            uint tokenId = createCredit(company);
            companies[company].tokenIds.push(tokenId);
        }
        companyAddress.push(company);
        emit Decision(company, true);
    }

    function rejectCreditInfo(address company) public payable
onlySpecificSurveyer(company) {
        companies[company].isVerified = false;
        emit Decision(company, false);
    }

    function createCredit(address to) private returns(uint256) {
        uint256 tokenId = _tokenIdCounter.current();
        _tokenIdCounter.increment();
        _safeMint(to, tokenId);
        return tokenId;
    }

    function registerReceiveRequest(address company, uint numberOfTokens)
public payable onlyOwnerCompany(company) {
        require(companies[company].isVerified, "Only verified companies can
request for credits");
        require(numberOfTokens > 0, "Number of tokens requested should be >
0");
```

```
        require(companies[company].remainingRequests > 0, "You do not have
enough requests remaining");
        creditRequests[company].push(numberOfTokens);
        companies[company].costPerCredit.push(475 + ((5 -
companies[company].remainingRequests - ((companies[company].totalCredits -
companies[company].creditsUsed) - companies[company].tokenIds.length)) * 17));
        companies[company].remainingRequests--;
    }

    function transferCredits(address to, address payable from, uint
numberOfTokens, uint cost, uint index) public payable notZeroAddress(to)
notZeroAddress(from) {
        require(companies[from].isVerified == true, "Only verified companies
can transfer credits");
        require(companies[to].isVerified == true, "Only verified companies can
receive credits");
        require(companies[from].tokenIds.length > 0, "Only available credits
can be transfered");
        require(companies[from].tokenIds.length >= numberOfTokens, "Not enough
credits to be transfered");
        for( uint i = 0; i < numberOfTokens; i++) {

            uint tokenId =
companies[from].tokenIds[companies[from].tokenIds.length - 1];
            // require(_isApprovedOrOwner(msg.sender, tokenId), "Only approved
operators can transfer a credit");

            safeTransferFrom(from, to, tokenId);

            companies[to].tokenIds.push(tokenId);
            companies[from].tokenIds.pop();
        }

        bool success = from.send((cost * 1 ether) / 10000);
        require(success, "Transfer failed");

        creditRequests[to][index] =
creditRequests[to][creditRequests[to].length - 1];
        creditRequests[to].pop();
        companies[to].costPerCredit[index] =
companies[to].costPerCredit[companies[to].costPerCredit.length - 1];
        companies[to].costPerCredit.pop();

        emit ReceivedSomeCredits(to, companies[from].name, numberOfTokens);
    }

}
```

Carbon-credit Trading platform using Blockchain technology

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Abstract— The Carbon credit trading platform mainly aims at reducing carbon dioxide and other greenhouse gas levels in the environment which is produced by any industries beyond the limit. carbon credit means granting permission to produce carbon dioxide and other greenhouse gases up to a certain limit (generally up to 1 ton of GHG). This project mainly aims to buy, sell, and trade carbon credits in the blockchain network and also focuses on producing renewable energies, rebalancing enough amount of GHG to other gases, etc. The usage of blockchain networks includes working on smart contracts, wallets, cryptocurrencies, etc.

keywords: carbon credits, permissions, greenhouse gases, blockchain, smart contracts.

I. Introduction

A Carbon credit is a thing where the supplier sells to the voluntary (at times involuntary too) buyer of carbon credit by giving some money. This can also be traded between parties. Carbon credits aim to reduce the emission of GHG by increasing its absorption. As a responsible person, we must aim to keep the earth's temperature low to survive and ensure life in the future. According to the Kyoto Protocol of 1992, carbon credits came into function. Which overall aims at reducing the emission of 6 GHG – carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride

These days there is a drastic change in the climate, it is not what it used to be like, large ice-caps at the poles are melted down, implying an increase in the sea level, change in humidity, varied raining timings, etc. This is due to an increase in GHG in the atmosphere. Although this is happening because of large industries, vehicles, etc. Also, we cannot avoid them as they have become essential parts of life. We can't spend our time going to the office by walking or through public transport (minimal GHG release).

So, we can alternately increase the absorption of CO2 or other GHG by some positive activities like initiating afforestation, usage of renewable energies, etc. As someone who is concerned about the environment, we are introducing the carbon credit trading platform where anyone can trade the carbon credit. The existing system has some limitations like lacking transparency and some security concerns which means the major industries may have limited accessibilities where they may not be allowed to buy as a single person or may have any other restrictions.

The specialty of our carbon credit trading platform is that it uses blockchain, where when each carbon credit is bought, we tokenize it and then use it for building renewable resources. This trading platform works on the Ethereum blockchain network which makes it more unique and increases the easiness of the transaction. This work contributes to sustainable practices and tries to combat climate challenges.

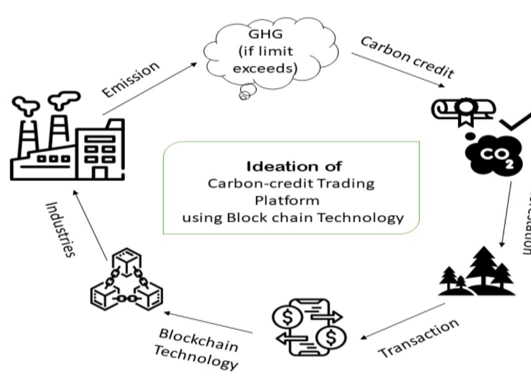

Figure 1-Ideation of Carbon credit trading platform

II. METHODOLOGY

A. Requirement Analysis

There are certain requirements to this trading platform, some of the hardware and software requirements are:

- Processor: A modern multi-core processor (e.g., Intel Core i5 or AMD Ryzen series) for smooth performance.
- RAM: At least 8GB of RAM for running development environments and compiling smart contracts.
- Storage: Sufficient storage space (at least 100GB) for storing development tools, libraries, and project files.
- Internet Connection: A stable internet connection for downloading dependencies, accessing APIs, and deploying smart contracts.
- Operating System: Windows, macOS, or Linux operating system.
- Development Environment: Here we are using Visual Studio code to run the applications.
- Node.js: It is used to run applications based on JavaScript.
- Ganache: This GUI has servers to connect to the Ethereum blockchain.
- Truffle: Truffle framework for Ethereum smart contract development, testing, and deployment.
- OpenZeppelin: this provides libraries to write smart contracts in more efficiently.
- Infura: Infura produces the API key to connect to the blockchain network.
- Web3.js or Ethers.js: JavaScript extension provides libraries to connect with the meta world.
- Various blockchain Networks: Optionally, the Polygon network or Sepolia can be used because they make the fastest transactions and have transactions with lower fees and faster confirmation times.

B. System Architecture

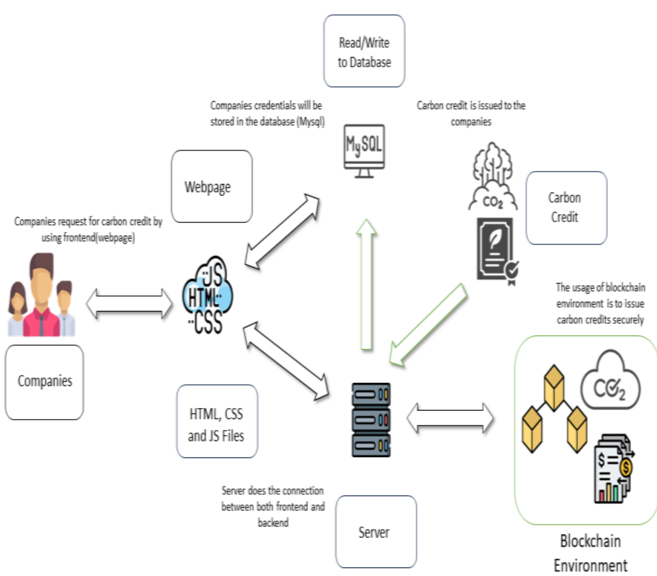

Figure 2 - System architecture

This architecture involves lots of procedures. Let's suppose some x company wants to buy carbon credit. The x company would approach the website which is frontend built up with HTML, CSS, JavaScript, and react.js. This website is attached with a server which is attached with the backend. Backend has interesting plots where we use some techniques like PHP, react.js, MySQL, smart contracts, ganache, truffle etc.

Developing all these has various stages to look upon. Let's dive into it.

C. Various Stages

Developing any platform needs lots of research and planning. The ideology behind this project should be brought up as such, without any mutations in the ideology and the working, so we need to develop so much knowledge on topics like carbon credits, climate change, the impact of industries on the environment, geography, and technologies like react.js, node.js, blockchain, etc.

Later, drawing is a blue-print is must to execute any ideology in any form. That should look like the system architecture mentioned above. Choosing the correct platform is very much essential thing to develop any project properly. A proper development tool will allow us to develop the best software on our own. The environment that we use should be compatible to work in blockchains such as Ethereum or Polygon, etc., that is the development platform should be able to develop smart contracts, make transactions, set up and develop API and ABI for the websites, and so on.

Planning and writing the smart contract's need on a paper with pen is essential before directly deploying the smart contract. Because it will be a waste to deploy before knowing what to do and how to do it on an original platform. Even though we are going to deploy using a test net (i.e.) using a testing network, it is advised to do rough work on a paper. Later, develop the smart contract using any of the languages you are familiar with such as – Solidity, Vyper, and even Python. Later attach this work to the frontend where we have lots of functionalities for the end users(clients).

Continuous testing and development of the website and the working of the networks should be done in to achieve the perfection of the website and smart contract.

The customer's feedback is an important factor for the development of the website and the smart contract.

These stages outline the key steps in developing and implementing the blockchain-based carbon credit trading platform efficiently.

D. Working principles

Let's discuss the working of the backend in this project. The backend of this trading platform is based on blockchain. We very well know that blockchain makes P2P transactions where there are no intermediaries to hold the money. It is like giving money to another person directly from your pocket. Here we call the pocket in the shirt as a wallet that has some x money in different forms, we call them tokens (NFT- Non-Fungible Tokens).

Through this blockchain technology, we learned that we can make numerous amounts of transactions where it will be stored in a distributed ledger. In the environment where we develop this platform, we should have already installed Node.js, Truffle, Ganache, Open Zeppelin, etc.

The working of transactions will be in the following way, let’s say some A wants to send ETH to some B. A will initiate the transaction, and both A and B will have their wallet address through which money should be transacted. A will be receiving the Wallet address of B. To store A’s transaction a block will be created, other peers that are nodes will validate the transaction then, B will receive money. The transaction is ended. The transaction is stored in the block and the block is added to the blockchain.

Now to do this transaction in the ERC network, the network will have a smart contract in default. This smart contract is immutable once it is deployed into the network. After deploying our needed smart contract into any network, we have to test it using the test net.

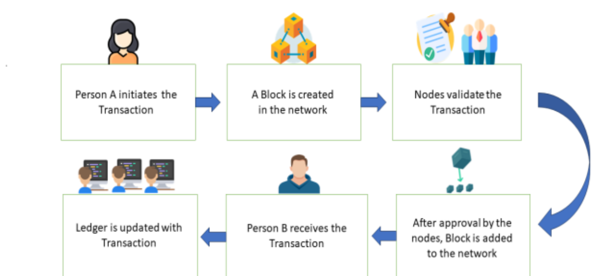

Figure 3 - P2P Transaction in Blockchain

Now the carbon credit trading platform smart contract should be added to the frontend using any database server like MySQL or PHP. Now every part of the application should be continuously tested and developed to maintain integrity. The backend doesn’t only contain smart contracts as the whole thing, we have to run ganache cli, truffle, and run in Node.js. while executing the truffle we can use many commands to shift through networks in which the smart contract should be executed.

E. Novelty of the proposal

The proposal introduces a novel approach to carbon credit trading by integrating blockchain technology, specifically, this platform will allow anyone to execute the smart contract in any network, mostly through sepolia, polygon, ERC20, etc.,

This unique market entry targets the underrepresented Indian market, offering transparency, security, and efficiency in trading.

By leveraging blockchain's transparency and decentralized governance, the platform fosters trust among stakeholders and promotes environmental impact through emissions reduction and renewable energy investment.

III. CONCLUSION

As we reach the conclusion point, we can summarize that there are several networks available to execute the smart contract we want. Here, through this project, we are trying to rebalance the carbon levels in the atmosphere just by using renewable energy or any carbon-absorbing activities through the incentives provided by the companies who buy these credits through blockchain technology, while they produce too much GHG into the atmosphere.

This would impact both the environment and the industries' development in a better way. This sustainable management would need not compromise any development as well as pollution in the atmosphere.

ACKNOWLEDGMENT

We want to express our gratitude to our professor and the Institute, who guided us through this project. Their technical skills and approach towards innovation have transformed abstract ideas into a real-time platform.

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