Carbon Footprint Tracking App

Gaius Jacob Philip Sundar [*1]S Adithyasankar [*2]Safwan M Shereef [*3]S Govind [*4]Sharon Sabu [*5]Athira S Nath [*6]
College of Engineering, Kidangoor
Department of Computer Science& Engineering
Kottayam, Kerala, India

gaiussundar7@gmail.com, adithyasankar882@gmail.com,safwanmshereef7@gmail.com,govindsuresh78@gmail.com, sharonsabu12@gmail.com, athiranath695@gmail.com

***Abstract*—The development of an Android application designed to help users monitor and reduce their carbon footprint presents a powerful solution for promoting sustainable living. This app places a strong emphasis on transportation and digital emissions, recognizing these as significant contributors to an individual's environmental impact. By leveraging machine learning algorithms, the app predicts CO2 emissions based on user-provided data such as vehicle type, fuel efficiency, and travel patterns. Additionally, the app considers digital activities such as streaming, gaming, and internet browsing, which contribute to indirect carbon emissions through data center usage. By combining these insights, the app provides users with a comprehensive view of their environmental impact, enabling them to make informed decisions. One of the app's key features is real-time emission tracking, which allows users to visualize their carbon footprint as they engage in daily activities. This immediate feedback highlights areas where users can reduce emissions, encouraging proactive steps toward sustainability. To further motivate eco-friendly choices, the app integrates a reward system that incentivizes positive behavior changes, such as choosing public transport, carpooling, or reducing digital consumption. Users earn points or achievements, fostering engagement and encouraging consistent improvements.In addition to personalized insights and actionable recommendations, the app provides educational resources to enhance environmental awareness. These materials offer practical advice on adopting sustainable practices, empowering users to implement lasting lifestyle changes. Furthermore, social features like leaderboards and community challenges inspire users to participate actively, creating a sense of accountability and shared responsibility. By combining technology with behavioral science, the app empowers individuals to reduce their carbon footprint and collectively contribute to a greener, more sustainable future.**

***Index Terms*—Carbon Footprint, Sustainable Living, Digital Emissions, Fuel Efficiency, Predictive Capability, Behavioral Science**

I. INTRODUCTION

The rise in carbon emissions due to transportation has raised concerns over its contribution to global warming. This project aims to leverage machine learning techniques to estimate CO2 emissions based on data collected from users regarding vehicle type, fuel efficiency, and travel distances. The Android-based application allows users to log vehicle and trip details, visualize their carbon emissions, and receive suggestions for alternative, eco-friendly travel options.

The application not only promotes sustainable practices but also includes a reward system to foster long-term user engagement. As the global community grapples with the effects of climate change, the importance of reducing carbon emissions has become increasingly urgent. Transportation is a significant contributor to greenhouse gas emissions, making it essential for individuals to understand their environmental impact. The challenge lies not only in raising awareness but also in providing practical tools that empower users to make informed decisions about their travel choices. This project aims to address this need by developing an Android application that helps users track and reduce their carbon footprint associated with transportation.

The application utilizes machine learning algorithms to estimate carbon dioxide emissions based on user-provided data, including vehicle type, fuel efficiency, and travel distance. By inputting these details, users can gain insights into their personal emissions and receive tailored rec ommendations for more sustainable travel options. This interactive approach not only enhances user engagement but also fosters a deeper understanding of the consequences of their transportation choices. By presenting complex data in a user-friendly format, the app aims to motivate individuals to adopt eco friendly practices in their daily lives.

Moreover, the project incorporates a gamification element through a reward system, incentivizing users to engage with the app consistently. This feature encourages users to log their travel habits regularly, participate in friendly competitions, and share their progress with others. To further motivate eco-friendly choices, the app integrates a reward system that incentivizes positive behavior changes, such as choosing public transport, carpooling, or reducing digital consumption. Users earn points or achievements, fostering engagement and encouraging consistent improvements. By creating a community focused on sustainability, the application not only promotes personal ac countability but also builds collective momentum toward reducing carbon emissions on a larger scale. Ultimately, this project seeks to empower users with the knowledge and tools necessary to make a meaningful impact on their carbon footprint

II. Literature Review

N. Subramaniam et al.[1] An ensemble machine learning approach was developed to enhance the accuracy of CO2 emission predictions from vehicles. This technique combines multiple algorithms, including decision trees, random forests, and neural networks, to capture complex emission patterns and adapt to real-time driving conditions like speed, acceleration, and fuel efficiency. By reflecting different driving behaviors,the model addresses the limitations of static estimations and is adaptable to various vehicle types.

N. Zheng et al. [2] Adapting a machine learning model originally designed for power systems, researchers incorporated unit coal consumption data to refine realtime emission predictions. Although developed for power plant emissions, this model's dynamic adjustment capability translates well to vehicle emissions by accounting for variables like speed, fuel quality, and driving conditions. Such adaptability highlights the importance of real-time inputs for precision, paving the way for more accurate and responsive vehicle-based CO2 emission monitoring.

S. Ramesh et al.[3] CO2 emission ratings tailored to specific vehicles are achieved using supervised machine learning algorithms that analyze unique vehicle attributes, including engine capacity, fuel efficiency, and travel distance. Unlike generic emission calculators, this model personalizes results, enhancing accuracy by utilizing training data from diverse vehicle types. This individualized approach makes the system especially relevant for users looking to monitor their specific carbon output, contributing to precision in personal carbon footprint assessments.

S. B. Rao et al.[4] A focus on predictive analysis techniques for vehicle emissions has led to models that dynamically adapt to driving patterns. By leveraging historical data and real-time inputs, the system identifies factors—such as speed variability and fuel use—that most influence emissions. This data-driven model provides a significant upgrade over traditional static methods, enabling more accurate, situationspecific forecasts. The study emphasizes the importance of flexible, adaptable prediction models that account for individual driving habits, enhancing accuracy in carbon footprint tracking.

R. Zhi et al.[5] Examining the role of electric vehicles (EVs) in reducing CO2 emissions, researchers compared emission levels from EVs and traditional gasoline-powered vehicles. Findings show that EVs significantly lower emissions, particularly when charged using renewable energy sources. This insight supports the integration of EV data in emission tracking systems, offering users a comprehensive view of their carbon footprint and highlighting the environmental benefits of alternative transportation.

A. Gupta et al.[6] A machine learning-powered CO2 emission model optimized for mobile use enhances real-time tracking and user engagement. By instantly processing data on vehicle speed, fuel efficiency, and distance traveled,the mobile app provides instant feedback, helping users make eco-friendly decisions like reducing speed or choosing more sustainable routes. This accessible, user-friendly design promotes increased awareness of individual carbon emissions, making the application a valuable tool for fostering sustainable transportation practices.

J. L. Fernandez et al.[7] An ensemble approach for estimating carbon emissions in urban transport networks combines data from multiple sources—such as vehicle sensors and traffic monitors—to offer high-accuracy, real-time emission estimates. This model, adaptable to personal vehicle tracking, demonstrates potential for large-scale applications in smart cities. For individual users, this approach means access to location-specific, detailed emission insights, encouraging eco-conscious travel choices in urban areas while contributing to broader environmental goals.

M. A. Khan et al.[8] Deep learning is utilized to track emissions from electric vehicles (EVs), enabling the model to process large datasets specific to EV characteristics such as battery efficiency, charging cycles, and power consumption. This model enhances traditional emission tracking systems by offering precise CO2 estimations for EV users, providing an essential tool for monitoring emissions as electric vehicle adoption grows. Integrating this data supports a comprehensive view of emissions from both conventional and electric vehicles, aligning with trends in sustainable transportation.

K. P. Lee et al.[9] Combining supervised learning and clustering algorithms, hybrid machine learning models are created to predict CO2 emissions in smart city environments. These models consider various factors—like weather, traffic density, and vehicle types—allowing for robust, context-aware predictions. Such adaptability is crucial for urban emission tracking, as it reflects the real-world conditions that affect CO2 output. The model provides users with accurate emissions data relevant to their specific environment, supporting informed, sustainable travel choices.

A. B. Singh et al.[10] AI models are applied to assess and suggest low-emission public transport options, helping users choose the most eco-friendly routes. By monitoring emissions across public transit systems and comparing them with other modes of transport, the model encourages sustainable travel. This system offers real-time recommendations, reducing individual carbon footprints by guiding users toward public transport options that align with lower emission targets,contributing to a more sustainable urban mobility framework.

III. Methodology

The proposed Carbon Footprint Tracking System leverages advanced machine learning tech niques to provide precise CO2 emission predictions and promote sustainable practices. The system employs ensemble methods, dynamic adjustment models, and personalized algorithms to adapt to real-time driving conditions and individual vehicle characteristics. By integrating data from vehicle sensors, traffic monitors, and user driving behavior, the system generates comprehensive insights into emissions patterns. This system features a mobile application designed for real-time emission tracking. Users can input vehicle data such as fuel efficiency, engine

type, and driving habits to receive personalized emission estimates. The app also leverages electric vehicle (EV) data, promoting renewable energy charging and guiding users towards environmentally friendly driving decisions. To encourage sustainable practices, the system integrates a reward-based gamification model that motivates users to adopt eco-friendly habits. The platform supports community engagement through leaderboard rankings, encouraging users to compete in reducing their carbon footprint. This adaptable framework is ideal for urban environments, where emission tracking needs to account for varying traffic conditions, weather factors, and public transport options. The system empowers individuals, organizations, and city planners with actionable insights to implement eco conscious choices and reduce overall carbon footprints.

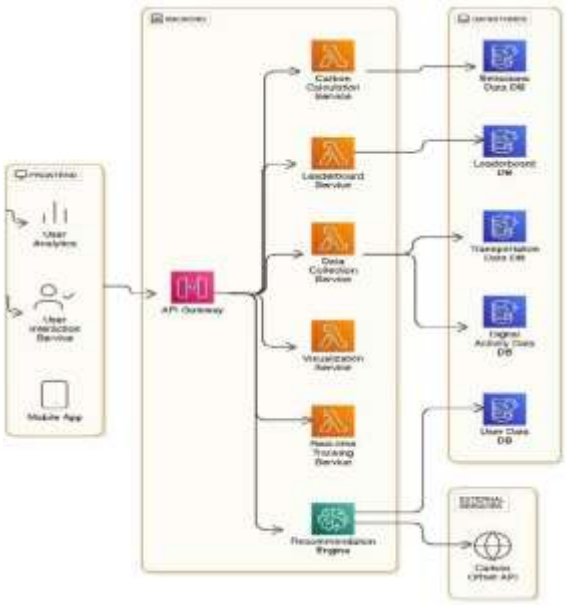

Fig. 1: System Architecture

The Carbon Calculation module is a core component designed to estimate users' carbon footprints by analyzing their daily activities. This module leverages machine learning algorithms to predict CO2 emissions accurately by examining various data points related to transportation and digital consumption. For transportation, it considers factors such as the type of vehicle used, its fuel efficiency, and the travel distance. In parallel, it assesses digital activities such as video streaming, online gaming, and internet browsing, as these contribute to indirect carbon emissions through data centers and energy consumption. By combining these data points, the module offers precise insights into the environmental impact of a user's lifestyle. This calculated information is essential as it helps users identify the primary contributors to their carbon footprint. With this awareness, individuals can make informed decisions, adjust their behaviors, and adopt greener practices. The accuracy and personalized nature of this feature ensure that users receive meaningful insights that align with their unique routines, forming a crucial foundation for tracking and reducing their environmental impact. Moreover, this module continuously improves its predictions by learning from user feedback and data trends, enhancing the accuracy of emission estimates over time. By integrating real-time updates on transportation patterns and digital activity, the Carbon Calculation module empowers users with up-to-date insights, encouraging immediate and impactful behavior changes.

The Leaderboard Service module is designed to foster community engagement by introducing an element of competition that motivates users to adopt eco-friendly behaviors. This module actively tracks and ranks users based on their ability to reduce carbon emissions. By highlighting top-performing individuals or groups, it encourages users to take greater initiative in minimizing their environmental impact. The leaderboard serves as a dynamic platform that inspires positive behavioral change, reinforcing sustainable habits through competition. Users are motivated to outperform their peers by improving their travel choices, adopting energy-efficient practices, or reducing unnecessary digital consumption. The leaderboard not only rewards individuals who excel but also creates a sense of shared responsibility, encouraging participants to inspire and challenge one another. This social element enhances user engagement and helps cultivate a proactive community dedicated to promoting environmental sustainability. By integrating achievements, badges, and progress milestones, the module keeps users motivated while building a strong network of environmentally conscious individuals. The combination of competition, rewards, and peer recognition strengthens user involvement, driving continuous commitment to carbon reduction efforts.

The Data Collection module is critical to ensuring the app's accuracy and effectiveness by gathering detailed information from multiple sources. This module collects data related to transportation habits, including vehicle details, travel routes, and distances covered, alongside digital consumption behaviors such as media streaming, cloud storage usage, and internet browsing patterns. By integrating diverse data points, the app develops a comprehensive understanding of each user's environmental impact. This collected data is securely stored in a dedicated database, enabling further analysis and accurate emission calculations. Additionally, the collected information plays a vital role in providing personalized recommendations and visual insights. As this module forms the backbone of the app's functionality, ensuring the data is accurate, relevant, and up-to-date is crucial for delivering reliable insights. By consolidating a rich dataset, the Data Collection module empowers the app to deliver tailored advice and meaningful results that help users adopt sustainable practices. Furthermore, the module is

designed to integrate with third-party services such as GPS data providers, public transport networks, and smart home systems, enhancing data precision and improving the overall user experience.

The Visualization module plays a crucial role in helping users comprehend their environmental impact through clear and engaging visual analytics. By transforming complex data into digestible visual formats, this module makes it easier for users to understand their carbon footprint and identify high-impact behaviors. It generates detailed reports, graphs, and charts that showcase emission trends, consumption patterns, and overall environmental impact. For example, users can view insights such as the carbon cost of frequent driving versus public transportation or the energy consumption linked to their digital activities. These visual representations are designed to be intuitive, ensuring that users of all backgrounds can easily interpret the information. By presenting data in an accessible and visually appealing way, this module empowers individuals to recognize unsustainable habits and adjust their behavior accordingly. This improved awareness encourages consistent engagement, motivating users to actively reduce their carbon footprint while tracking their progress over time. The module also offers customization options, allowing users to filter data by specific activities, timeframes, or geographic locations, providing deeper insights into personal carbon patterns and supporting informed decision-making.

The Real-Time Tracking module is a powerful feature that provides immediate insights into a user's carbon emissions, enabling instant awareness of their environmental impact. By continuously monitoring transportation behaviors and digital activity, this module offers live feedback, allowing users to understand how their actions contribute to CO2 emissions in real time. For instance, as users travel by car, bike, or public transport, the module calculates emissions dynamically, helping them make informed decisions on the go. Similarly, during digital activities like streaming or browsing, the module identifies high-consumption behaviors and provides instant insights. This proactive approach allows users to see the immediate effect of their choices, encouraging adjustments such as choosing energy-efficient travel routes, reducing excessive digital use, or shifting to environmentally conscious alternatives. By empowering users with instant data, the Real-Time Tracking module drives timely and effective behavior changes that contribute to reducing carbon footprints. Additionally, this module can integrate with wearable devices and fitness trackers to further enhance real-time feedback, allowing users to monitor carbon data seamlessly as part of their daily routine.

The Recommendation Engine module is designed to provide users with personalized guidance for reducing their environmental impact. Using insights gathered from the Data Collection module, this engine analyzes user-specific behavior patterns and generates actionable suggestions that align with their lifestyle. For instance, if a user frequently commutes by car, the engine may recommend alternative travel options such as carpooling, cycling, or public transportation. For those with heavy digital consumption, it may suggest reducing video streaming quality, switching to energy-efficient devices, or utilizing cloud services with lower carbon footprints. Additionally, the engine integrates with external services to recommend carbon offset options, allowing users to compensate for unavoidable emissions. The engine continuously refines its suggestions based on evolving user data, ensuring that recommendations remain relevant and effective. By offering practical, data-driven advice, the Recommendation Engine empowers users to adopt eco-friendly habits and actively contribute to a sustainable future. Moreover, the engine can prioritize suggestions based on factors like cost-efficiency, convenience, or environmental impact, ensuring that users receive practical and achievable recommendations tailored to their preferences.

IV. RESULTS

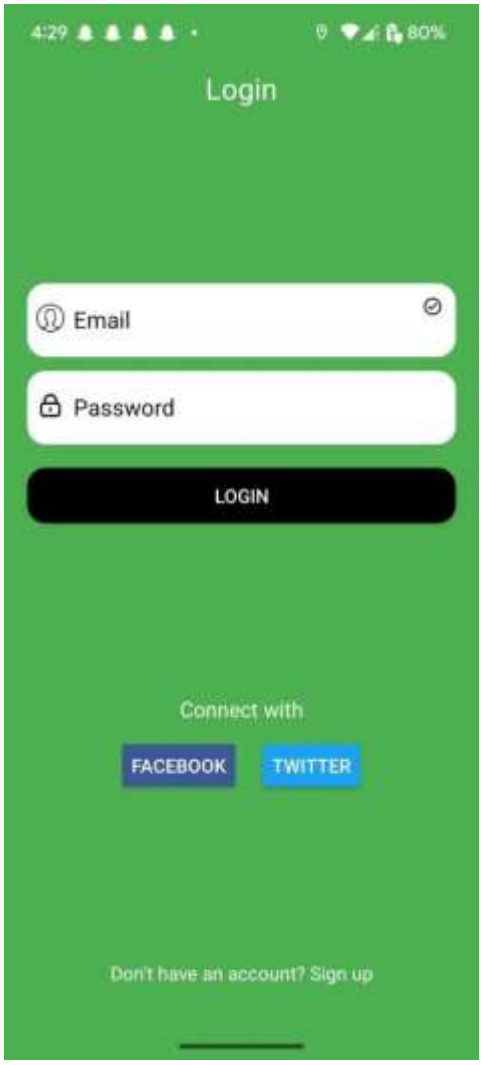

Fig. 2: Log In

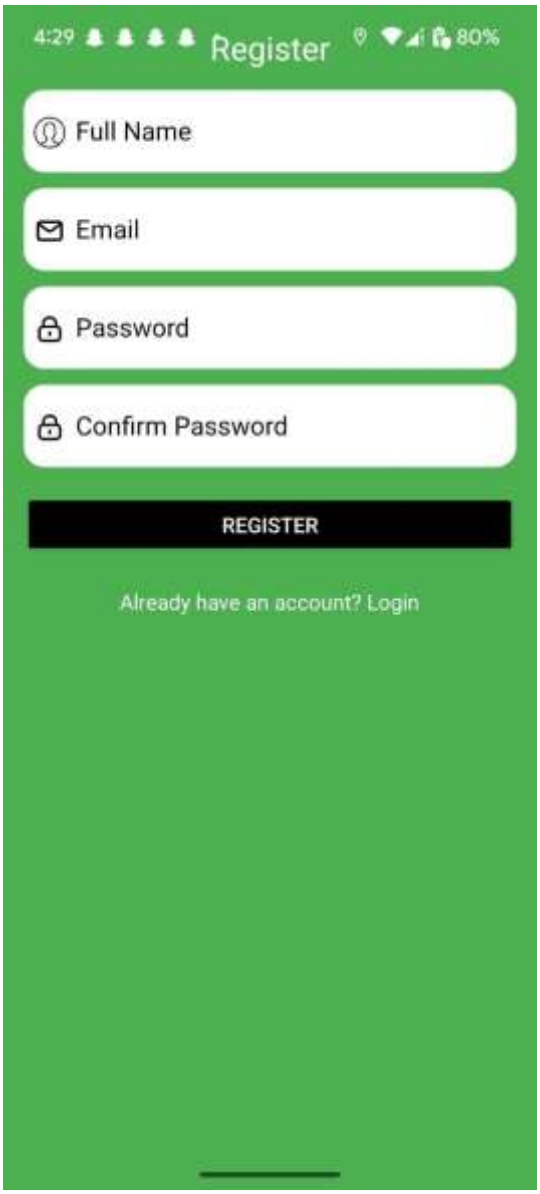

Fig. 3: Sign Up

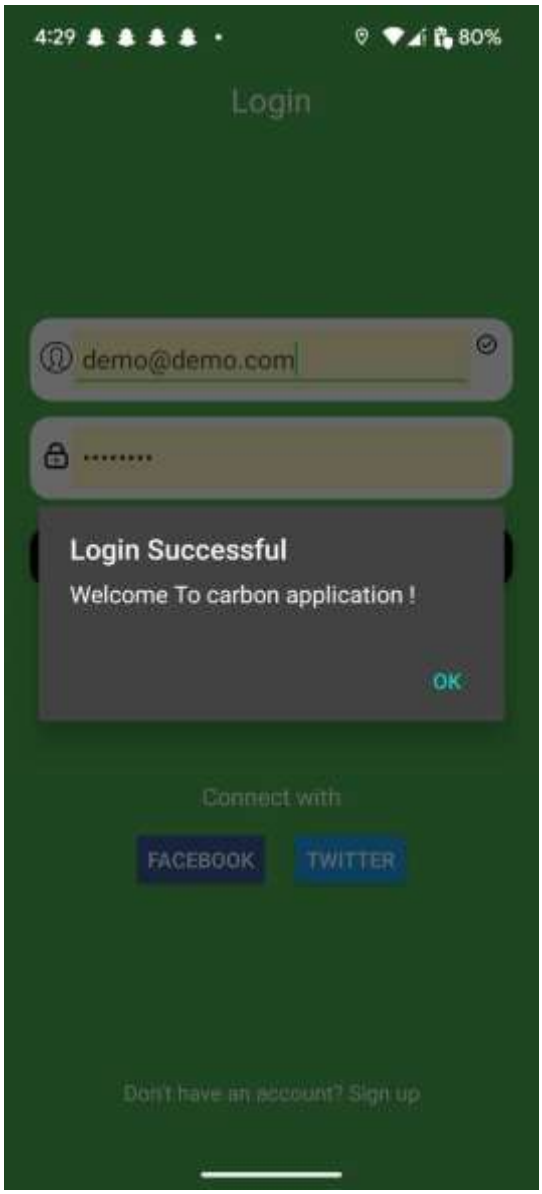

Fig. 4: Successful Login

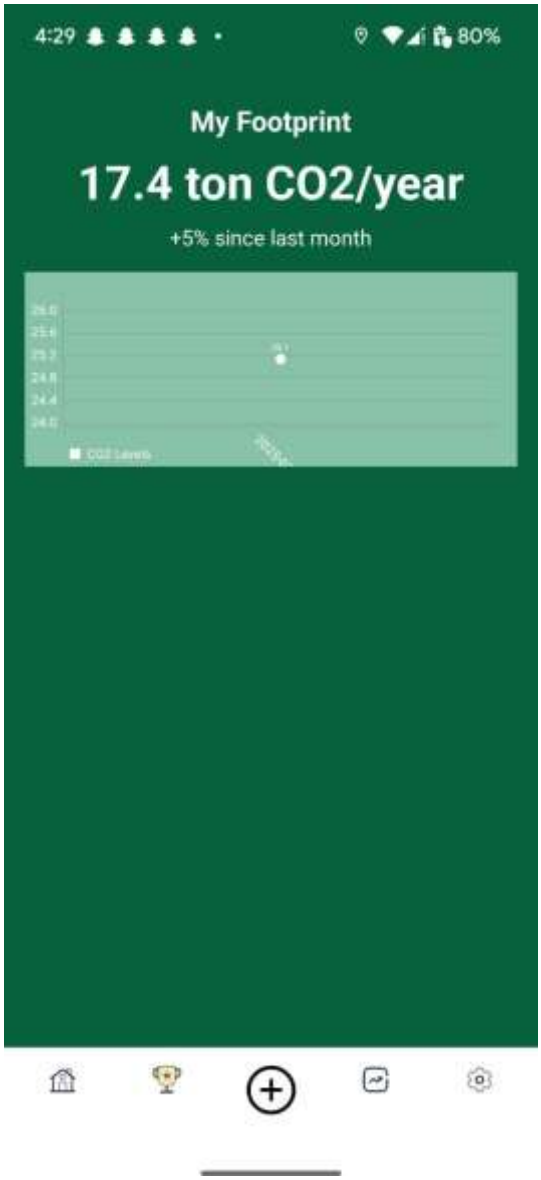

Fig. 5: Home Page

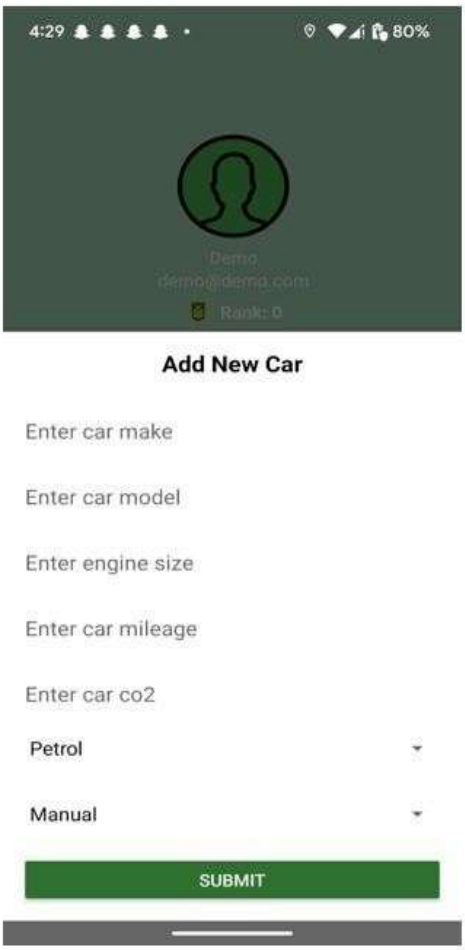

Fig. 6: Vehicle Menu

Fig. 7: Emission Data

Fig. 8: Leaderboard

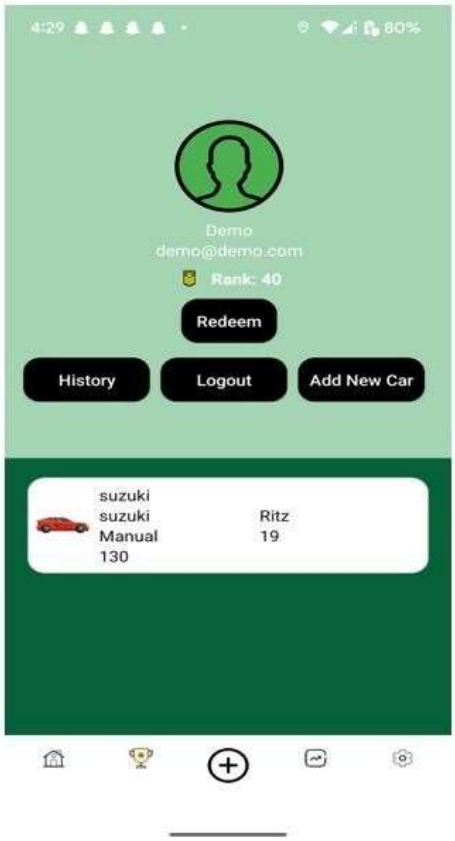

Fig. 9: Redeem and History

Fig. 10: Admin A

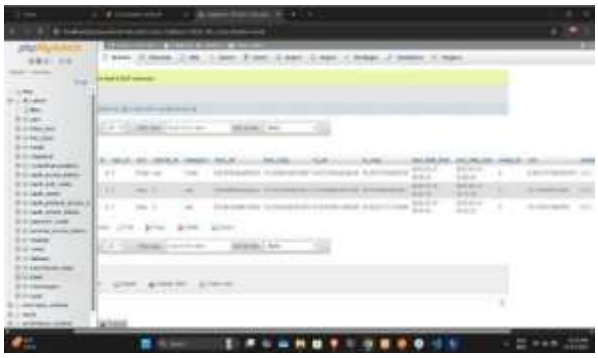

Fig. 11: Admin B

V. Conclusion

A Carbon Footprint Tracking System powered by machine learning significantly enhances environmental sustainability by providing precise and real-time insights into CO2 emissions. This system leverages advanced machine learning techniques, including supervised learning and ensemble methods, to improve the accuracy of carbon footprint predictions. By analyzing user data such as travel patterns, vehicle types, and digital consumption habits, the system generates tailored insights that empower individuals to make informed decisions that reduce their environmental impact. The integration of real-time tracking models ensures that users receive immediate feedback on their activities, allowing them to adjust behaviors on the go. For instance, real-time tracking can highlight high-emission travel choices, prompting users to switch to greener alternatives. Additionally, the system incorporates electric vehicle (EV) data to promote the adoption of renewable energy-based transportation. By showcasing the environmental benefits of EV usage, the system encourages users to make eco-conscious travel decisions.To further engage users, the system offers personalized recommendations that align with their lifestyle and habits. It may suggest sustainable practices such as carpooling, using energy-efficient devices, or exploring carbon offset options. Gamification elements, like achievement badges and leaderboards, motivate users by rewarding progress and fostering friendly competition. This combination of accurate insights, real-time feedback, and interactive engagement effectively drives behavioral change, empowering users to adopt sustainable practices and reduce their carbon footprint in their daily lives.

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