REAL-TIME CARBON NEUTRALITY MANAGEMENT AND OPTIMIZAION USING NATURAL LANGUAGE PROCESSING

Project ID: 2022-175

Project Proposal Report

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Declaration

I declare that this is my own work, and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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The supervisor/s should certify the proposal report with the following declaration.
The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor: …………………………. Date: …………………

Abstract

Carbon emission reduction is necessary all around the world because human activities produce large amounts of greenhouse gases, which cause climate change. As a result, nations throughout the world have formed rules and agreements to restrict rising greenhouse gas emissions. Governments defined a limit for carbon emissions to each organization which is called carbon credit. Every organization must carry out reducing carbon emissions. This is a critical task for each organization, in some cases, it is still not possible to explore other sustainable options. there are many emission sources in an organization that can be reduced to achieve their desired emission goal. Organizations want to keep emissions as less than carbon credits. To overcome these issues a carbon neutrality management system that will gather the usage constraints of several emission sources. For these constraints and the emission limit, an optimum minimum solution will be provided using optimization algorithms. This can be customized by the business analyst based on their changing requirement. When the carbon emission optimum solution is confirmed, the maximum emission value is given by the solution for several emission sources will be set as the maximum thresholds and if these values are exceeded alerts will be sent. By finding the minimum optimal emission values of each emission source, organizations can maintain carbon emissions without exceeding the carbon credit. If carbon emissions reduce gradually, it mitigates the effects of global climate change, improves public health, boosts the global economy, and would maintain biodiversity.

Key words – carbon emissions, carbon credit, emission constraints, emission sources, optimization

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List of abbreviations

Abbreviation	Description
GHG	Greenhouse Gas
SMS	Short Message Service
API	Application Programming Interface
BA	Business Analyst
IOS	iPhone OS
GB	Giga Bytes
RAM	Random Access Memory
MB	Mega Bytes
ROM	Read Only Memory
USD	United States Dollar
LKR	Sri Lankan Rupee
AWS	Amazon Web Services
EnOpt	Ensemble Based Closed-Loop Optimization Scheme
UK	United Kingdom
BMRS	Balancing Mechanism Reporting System
EnKF	Ensemble Kalman Filter
CO_2	Carbon dioxide
MGA	Modeling to Generate Alternatives
CCR	complete coke ratio

BPNN	back-propagation neural networks
IOCSCE	intelligent optimization and control system for carbon efficiency

1. INTRODUCTION

1.1. Background

Greenhouse gas (GHG) emissions have continuously grown since the 19th century [1]. Greenhouse gases trap heat and raise global temperatures. Almost the rise in greenhouse gases in the atmosphere over the last decades has been caused by human activities. The burning of fossil fuels for power, heat, and transportation is the world's greatest source of greenhouse gas emissions from human activity. Human activity contributes to climate change by releasing greenhouse gases (GHG).

Nowadays, Governments around the world enforce many regulations to control GHG emissions. As a result, organizations must track and report their greenhouse gas emissions to their governments. Furthermore, to achieve carbon neutrality, organizations need restrict their emissions to the allowed level (Carbon credit).

Climate change caused by carbon emissions has become a global nontraditional security issue [2]. According to the Greenhouse Gas Bulletin (GHG Bulletin) issued by the World Meteorological Organization in 2020, the increasing growth of GHG in the atmosphere has become a long-run trend. Strict and efficient measures are required to ensure that the necessary ecological goals are achieved within the planned time horizon. If existing controls appear to be insufficient in light of new forecasts, emission regulations may be enacted into legislation. This could entail enormous payments in connection with non-compliance with emission standards. As a result, firms should take transportation-related greenhouse gas emissions carefully.

Many businesses in most sectors now accept that they must address the issue of climate change in order to survive and grow in ever-changing entangled business economies. Due to mounting pressure from stakeholders, top executives of many organizations are now implementing various carbon emissions reduction strategies. However, the extent to which businesses embrace climate change and carbon management as an integral pillar of their business models remains unclear and poorly understood.

Carbon neutrality management and optimization using natural language processing system seeks to address these issues. This real time system to explore ways to optimize carbon emission transfers between industrial sectors. To achieve the dual goals of carbon emission reduction and economic development, this strategy is proposed to optimize carbon emission transfer structures in different industries. This carbon calculation system measures the amount of greenhouse gas emission. It also considers equipment used and waste disposal management. It helps to highlight where you can make better carbon savings on specific emission sources. It additionally contributes to the overall emissions and quantification in the savings with carbon emissions. Identify the optimum solution for the given emission source constraints using Optimization Algorithms and sent alert about any violations of the optimal solution.

1.2. Research Gap and Research Problem

1.2.1. Research Gap

Research A[3]: Optimization of carbon emissions in smart grids

The carbon emissions in smart grids are optimized in this research. This is accomplished by applying an Ensemble Based Closed-Loop Optimization Scheme to perform dynamical modeling with uncertainty analysis of smart grids (EnOpt). The Monte Carlo approach is used to assess uncertainties such as changes in consumer energy demand and generating fuel mix. The carbon factor for the UK power system is derived using energy statistics from the Balancing Mechanism Reporting System (BMRS). For forecasting and prediction of energy output, consumption, and carbon emissions, they use the Ensemble Kalman Filter (EnKF). Then they use EnOpt to maximize the system's carbon savings. Finally, this research gives the results of the EnOpt carbon emission optimization, together with predicted carbon savings.

Research B [4]: Stabilization wedges as a tool of engineering optimization, with an example of CO_2 emission control

This study shows how to utilize stabilization wedges as an engineering optimization tool for stabilizing carbon dioxide levels using the best tactics for reducing carbon emissions. Stabilization wedges are a method for determining the best solution to a carbon emission problem. In addition, this work promotes the usage of wedges as a tool. A certain set of objectives can be met in a variety of ways. The Modeling to Generate Alternatives (MGA) approach, may be used to prove the efficiency of recommended optimal techniques.

Research C [5]: Optimization Method for Carbon Efficiency in the Green Manufacturing of Sinter Ore and its Application

This research is significant since it aims to enhance carbon efficiency to save energy and reduce unwanted emissions. The complete coke ratio (CCR) is used as a measure of carbon efficiency in this study. To investigate the CCR's effects, a mechanism analysis was performed, and a CCR predictive model based on back-propagation neural networks (BPNN) was created, which includes a state parameter predictive model and a CCR predictive model. The CCR optimization approach is then developed, with the goal of lowering the CCR by improving the operational parameters. Finally, the technology was applied in an iron and steel plant's intelligent optimization and control system for carbon efficiency (IOCSCE). The running results show that the method can reduce the CCR by an average of 1.98 kg/t and effectively reduce the energy consumption of the sintering process.

Related works	Research A [3]	Research B [4]	Research C [5]	"Carbonis" proposed system
Find optimum minimum carbon emission value to reduce emission	✓	✓	✓	✓
customized by the BA according to their requirement changes.	✗	✗	✗	✓
Find threshold values for each emission sources	✗	✗	✗	✓
Real time carbon emission monitoring	✗	✗	✗	✓
Sent alert to user when emission violate threshold	✗	✗	✗	✓

Table 1.1: Previous research and products comparison

As per the analyzation, few other research has conducted on carbon emission optimization. Given all three research had focused on specific source or industry. Those conducted research only for find the optimum minimum value of carbon emission to reduce carbon emissions. But we are focused on an innovative solution to all business firms. Get usage constraints from BA. Then using those constraints find optimal emission values using optimization algorithms. From that optimal solution find maximum thresholds on each emission sources. This value can be customized by BA according to their requirements. When breaching the threshold values, alert will be sent to BA. Also, BA can compare in real time current emission with defined threshold values.

1.2.2. Research Problem

Governments all around the world have enacted legislation requiring a substantial reduction in greenhouse gas (GHG) emissions in order to implement the Paris Agreement to mitigate the effects of climate change [6]. Many rules are enforced by countries around the world to control GHG emissions. As a result, businesses must keep track of their GHG emissions and report them to their governments and organizations must publicly declare their GHG emissions as part of this measure [7]. Some governments use carbon credit (total GHG emissions that businesses are allowed to emit) as a strategy to achieve carbon neutrality.

Even though reducing carbon emission is a crucial task every organization must carry out, there are occasions in which it is still not possible to consider alternative sustainable options yet. Most of these emission sources are related directly to the business process and there will be no alternative option that will not affect the business effectiveness. However, there are many emission sources (e.g.: electricity, transport, generator, equipment and etc.) in an organization that can be reduced to achieve their desired emission goal [9]. There should be a way to find an optimal solution for these kinds of constraints on emission sources [10].

There is no way of knowing the current emission compared to their target (emission gap). If the business analyst does not know about their current carbon emission, It will be very hard to manage without exceeding the emission limit. Therefore, there is a need for real-time monitoring and optimization of the organizations' GHG emissions on each emission source according to given usage constraints[8] and when emission exceeds the limit, it should be notified to the business analyst.

2. OBJECTIVES

2.1 main objectives

Create a cross-platform mobile application platform for organizations to manage and optimize their carbon emissions. An innovative solution proposed for the above scenario would be to implement a real-time platform that can provide insights on the most up-to-date emission statistics of the organization. Emission activity data will be directly gathered from the employees. For each emission activity input, relevant emission factors will be found with the help of an information retrieval process. Before proceeding, any misinformation will be clarified with the employee. To avoid miscalculations, units of inputs will be checked by using text classification with natural language processing and values will be converted before emission calculation. calculated emission values will be stored for analysis purposes and business analysts can access this real-time data using any business intelligence tool. For the constraints provided on the emission sources and emission cap, an optimal solution would be generated by using optimization algorithms and alerts will be sent if there is any breach of the optimal solution.

2.2 Specific objectives

Identify the optimum solution for the given emission source constraints using **Optimization Algorithms** and sent alert about any violations of the optimal solution.

> Details on usage constraints on several emission sources will be provided by the business analyst. For these constraints and emission cap, a minimal optimal solution will be provided using optimization models. This can be customized by the business analysts according to their requirement changes. Once an optimal solution is confirmed, the maximum emission value provided by the solution for various emission sources will be set as the maximum thresholds and if these values are exceeded alerts will be sent using SMS API gateways.

3. METHODOLOGY

3.1 Complete System Architecture Overview

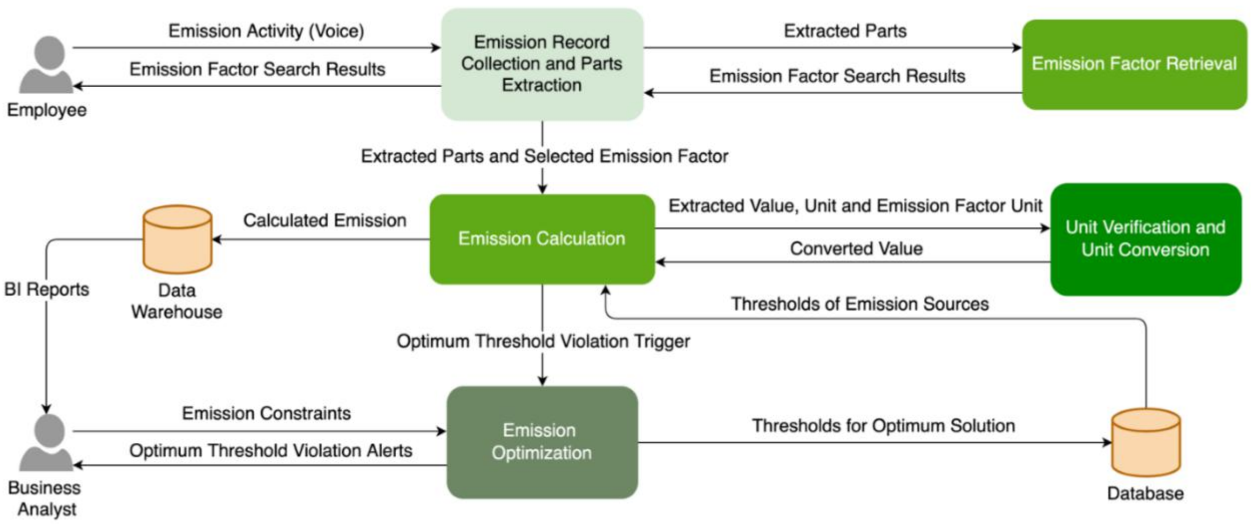

Figure 3.1: complete system architecture

Implementing a real-time platform that can give insights into the organization's most up-to-date emission information is an innovative solution provided for the mentioned scenario. Employees' emission activity data will be collected directly from them via a digital assistant. Relevant emission factors will be determined using an information retrieval procedure for each emission activity input. Any misconception will be cleared with the employee before proceeding. To avoid errors, input units will be examined using text categorization and natural language processing, and values will be translated before emission calculations are made. Calculated emission levels will be saved for examination, and business analysts can use any business intelligence platform to retrieve this real-time data. For the constraints provided on the emission sources and emission cap, an optimal solution would be generated by using optimization algorithms and alerts will be sent if there is any breach of the optimal solution.

3.2 Component Architecture

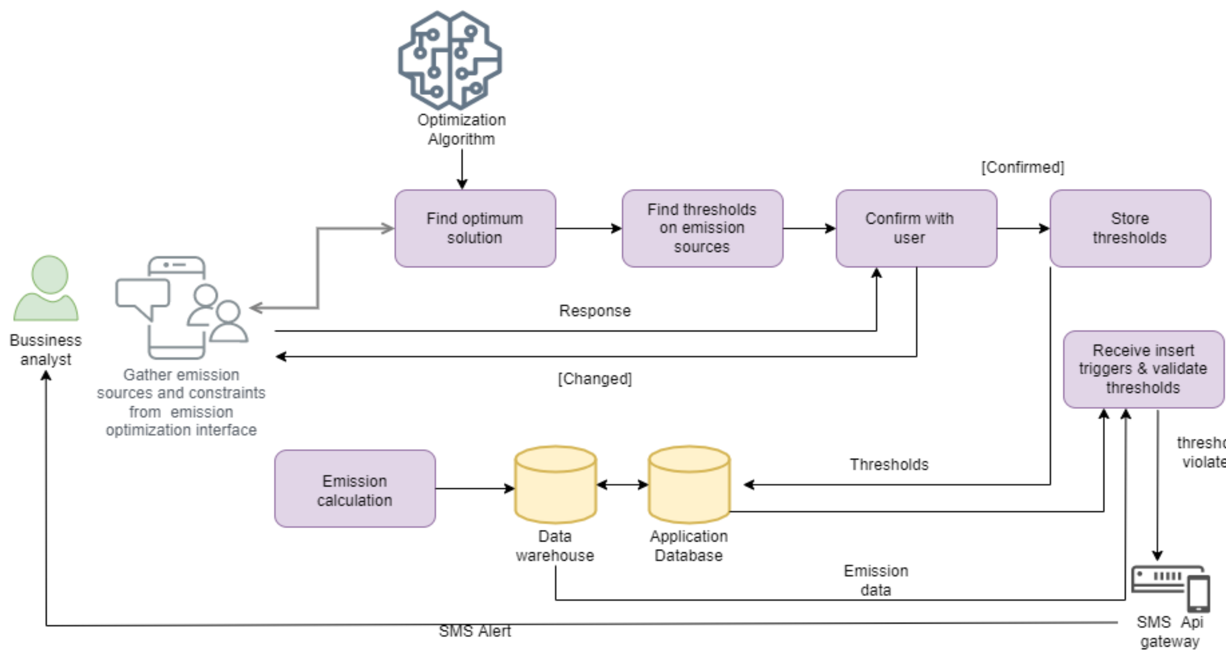

Figure 3.2: specific components diagram

Usage constraints on each emission sources will be gathered using emission optimization interface from mobile application. Then using those given constraints, An optimum solution will be find using optimization algorithms. Maximum threshold values for each emission sources will be set using minimum optimum solution. According to the business requirement maximum threshold values will be check with business analyst. Once business analyst confirmed those threshold values will be stored on application database. Then the each emission source threshold values will be compared with each emission from different sources. If emission violated the threshold, alert will be sent to BA using SMS API gateway.

3.3. Tasks And Sub-tasks

1. Implementing a custom emission optimization module for the given constraints on different sources.
   - Using the constraints on emission sources as the input, this component will return an optimal solution to minimize the emission.
     - Obtain usage constraints on different emission sources of the organization from the business analyst (BA).
     - Implement an optimization model using an appropriate optimization algorithm to find the minimum solution for the given emission sources constraints and total emission cap of the organization.
     - Let BA configure and choose a suitable optimal solution.
     - Create thresholds on different emission sources according to the chosen optimal solution.
2. Creating an alert framework to provide alerts about the breaches of the thresholds added by the optimal solution.
     - During the addition of a new emission record, check whether any thresholds provided by the optimal solution are violated.
     - Send alerts to the BAs about any threshold violations.
3. Implement a mobile application using React Native and expo cli. React Native will be used to implement a cross-platform mobile application and expo cli will be used to access get hardware components such as mic and speaker.

3.4 Work Breakdown Structure

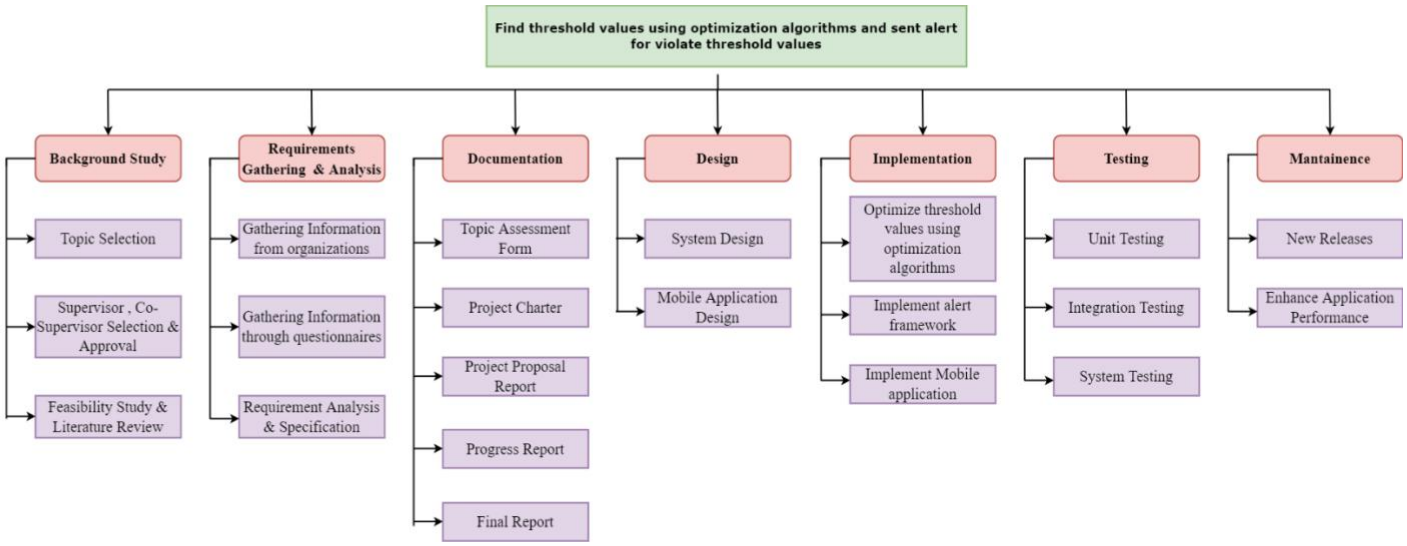

Figure 3.3: work breakdown structure

3.5. Gantt Chart

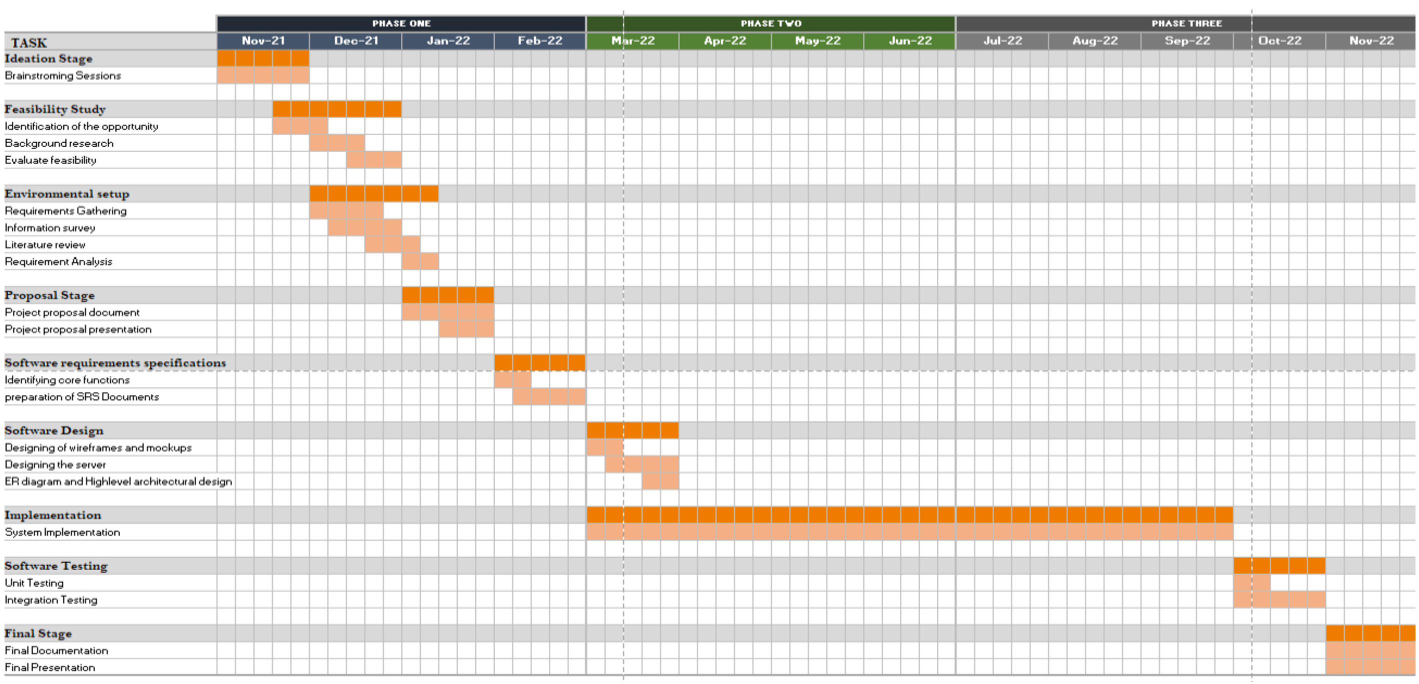

Figure 3.4: Gantt chart

4. PROJECT REQUIREMENT

4.1. Functional Requirements

- Find optimal solution using given usage constraints.
- Create thresholds on different emission sources according to the chosen optimal solution.
- Implement alert framework to notify to the BA when emission exceed the limit
- Build a cross platform mobile application

4.1.1. User Stories

Story Id	User story
01	As a business analyst I want to, find optimum emission values So that, I can be able to manage the emission with in allocated credit.
02	As a business analyst I want to, find threshold on each emission sources So that, I can be able to allocate limit to each sources.
03	As a business analyst I want to, change the threshold values according to requirement changes So that, I can be able to manage emission according to organization requirements.
04	As a business analyst I want to, get alert when breaching the threshold limit So that, I can be able to manage without exceeding the limit.

Table 4.1: User stories

4.2. User Requirements

- An android or IOS smartphone with microphone
- Internet connectivity

4.3. System Requirements

- User device – Any IOS or Android devices with 1GB of RAM, 200MB of ROM, microphone, and internet connectivity.
- Backend Server – Windows or Linux servers with 8GB RAM, and 30GB storage.
- Databases – 200MB storage

4.4. Non-functional Requirements

- Speed or performance – response time
- Size – Use less resources
- Scalability – Scaled to new factor standards
- Ease of use – No need of training or education
- Reliability – Available as much as possible

5. BUDGET AND BUDGET JUSTIFICATION

Resource Type	Amount (USD)	Amount (LKR)
Hosting mobile App	$30	6060.00
Internet usage	$25	5050.00
AWS	$20	4040.00
Other costs	$15	3030.00
Total	$90	18,180.00

Table 5.1: Budget for the component

*Used USD to LKR conversion rate of 202 Rs. on 11/2/2022

6. COMMERCIALIZATION

For this research product mainly, we are targeting business firms and industries in abroad and local. In developed countries, carbon emission reduction is necessary to all organizations. So most the organization looking for a good product. There is competitive marketplace in developed countries. So that we need attract them with some business strategies.

The following are some effective marketing methods that might be utilized to commercialize this product:

- Develop a public relations and news media strategy.
- Develop a pricing strategy with packages.
- Use social media marketing strategies.
- Google ad-sense strategies.
- Arrange the events (virtual and in-person).

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