Carbonis
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Real-time Carbon Neutrality Management And Optimization Using Natural Language Processing

Project ID: 2022-175

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This is our team

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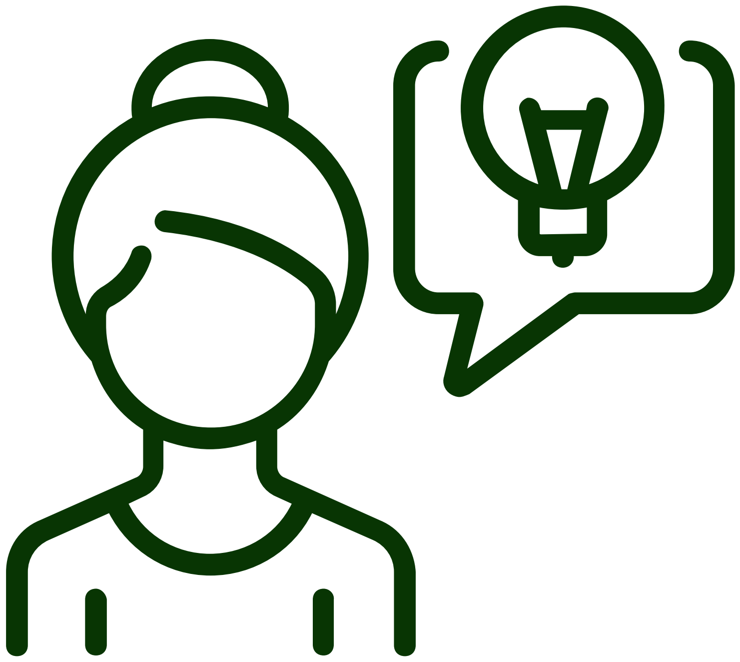
Content

01

Overall Introduction



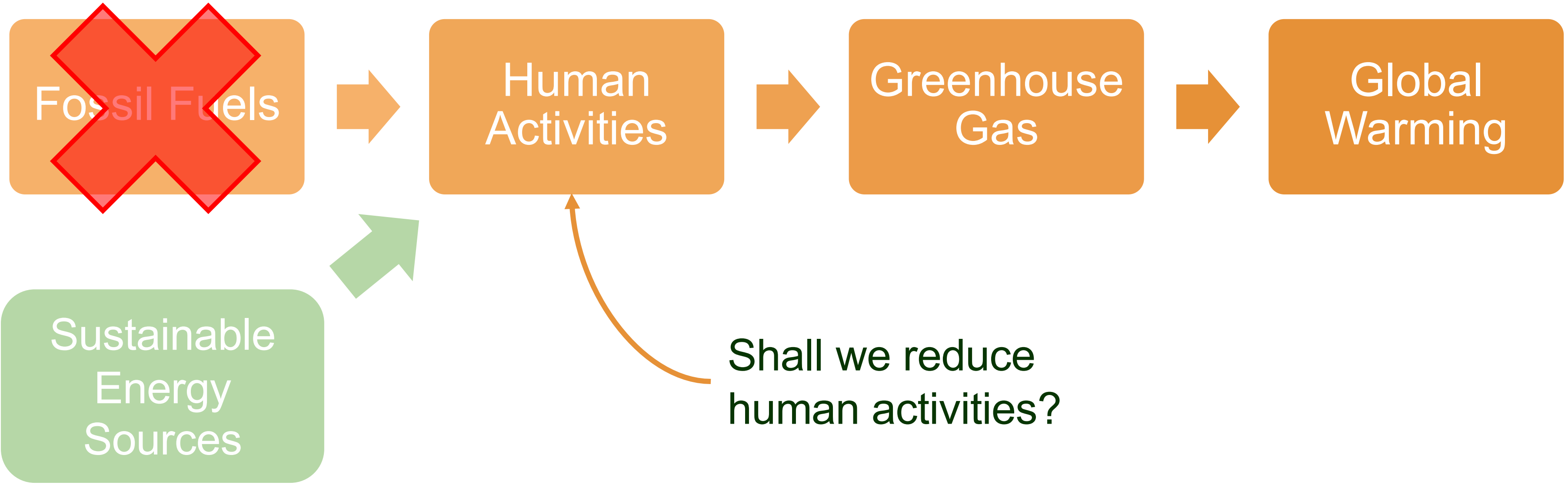
Domain Background - Cause

How does global warming occur?

Fossil Fuels → Human Activities → Greenhouse Gas → Global Warming

Domain Background - Remedy

How to reduce global warming?



Domain Background– Current Measures

What are we doing now to reduce Global Warming?

International Treaties and Agreements
- Kyoto Protocol
- Paris Agreement

National Contribution by Countries
- **NDC** – Nationally Determined Contribution

National Laws and Policies
- Mandatory Carbon Reporting
- Carbon Disclosure Project (CDP)
- Emission cap

Carbon Trading Schemes by Firms and Industries
- Carbon Reporting or Accounting
- Cap-and-trade

Firms Achieving Carbon Neutrality
- Using sustainable Alternatives.
- Offset for green projects

Countries Achieving Carbon Neutrality

Achieving Global Carbon Neutrality

Reduce Global Warming

Why target firms and industries?

Domain Background– Our Focus

What is our project focus area?

International Treaties and Agreements
- Kyoto Protocol
- Paris Agreement

National Contribution by Countries
- **NDC** – Nationally Determined Contribution

National Laws and Policies
- Mandatory Carbon Reporting
- Carbon Disclosure Project (CDP)
- Emission cap

Carbon Trading Schemes by Firms and Industries
- Carbon Reporting or Accounting
- Cap-and-trade

Firms Achieving Carbon Neutrality
- Using sustainable Alternatives.
- Offset for green projects

Why focus carbon reporting?

Countries Achieving Carbon Neutrality

Achieving Global Carbon Neutrality

Reduce Global Warming

Domain Background - Benefits

What are the benefits carbon reporting and carbon trading?

- Urges firms to go Carbon Neutral
- Encourages the usage of sustainable energy sources
- Promotes Innovation in developing green solutions

Terminology

- **Carbon Credits**
- **Carbon Neutrality**
- Carbon Offsetting
- **Carbon Reporting or Carbon Accounting**
- **Carbon Trading**
- CO_2 Equivalent
- Consumption
- Emission Activity
- Emission Factor
- Emission Source
- Emission Technology
- Global Warming Potential
- Greenhouse Gas (GHG) – Carbon dioxide, Methane, Nitrous oxide, Hydrofluorocarbons, etc.

Current Approaches

What are the current methods of carbon reporting?

1. Manual reporting
   - Ledgers and hard copies.
2. Spreadsheets
   - Using spreadsheet tools such as MS Excel, etc.
3. Emission calculators
   - Commercial emission calculators such as CarbonView, etc.

Current Approaches – Issues

What are the issues of current approaches?

- Data logging happens at once.
  - No real-time emission status
  - Chances for unexpected results
  - No time to correct mistakes
- Usually done by a single individual or small group of personals
  - Large workload
  - Not Scalable
  - Human error
  - Delay

02

Research Question

Research Question

How to implement

- a **real-time** carbon neutrality management system for corporate organizations and
- help these organizations **optimize** their emissions to achieve desired emission target?

03

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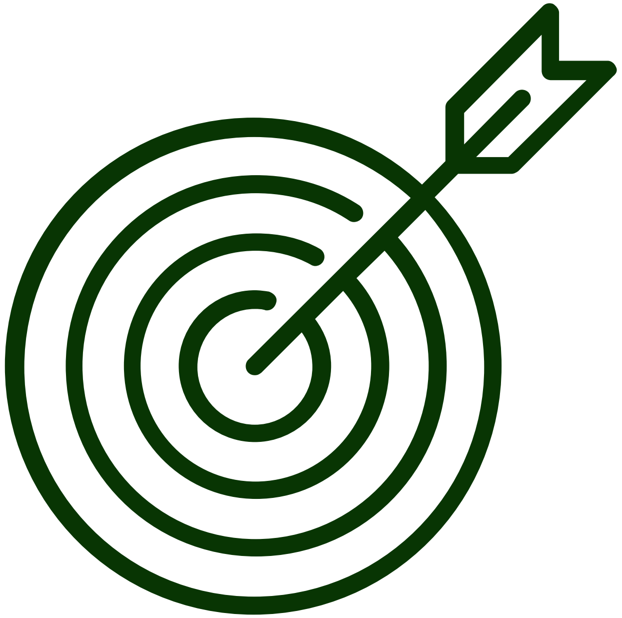
Objectives



Objectives

Main Objective:

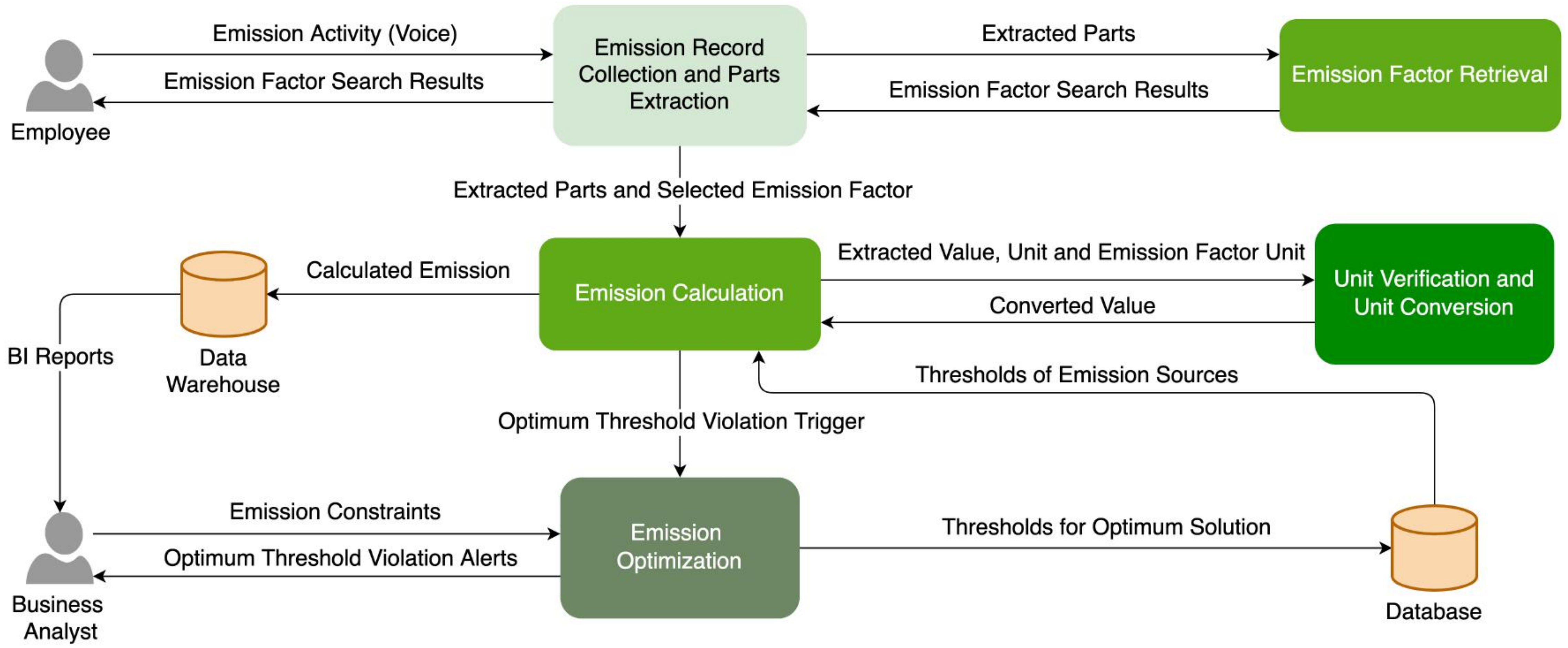
Create a cross-platform mobile application platform for organizations to **manage** and **optimize** their carbon emissions.

Specific Objectives:

- Gather employee **emission activity** details from employees using a voice assistant.
- Search **emission factors** and provide ranked results for the emission details gathered.
- Verify and convert values for **units** provided by the employees to match the units of the selected emission factor.
- Identify the **optimum solution** for the given emission source constraints and alert about any violations of the optimal solution.

04

Overall System Architecture



Overall System Architecture

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Individual Components

Component 1

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Emission Records Collection And Parts Extraction

Mathanika M.
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Data Science

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Component 1

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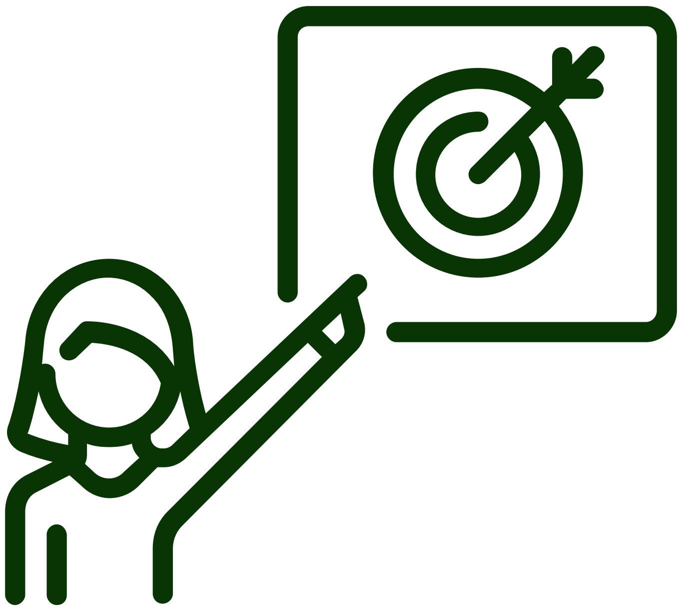

Background

- What is Voice Assistant ?
- What is Custom Named Entity Recognition (NER)?
- How does Voice Assistant and NER relate to our system?

Research Gap

	Research 1 [1]	Research 2 [2]	Research 3 [3]	Research 4 [4]	Our Proposed System
Gather daily emission activity	✗	✗	✗	✗	✓
Calculate real-time emission value	✗	✗	✗	✗	✓
Emission data collection from employees	✗	✓	✗	✗	✓

Research Problem

- How to gather daily emission data from employees?
- How to generate emission report daily?

Specific And Sub Objectives

Main Objective

- Develop a system that can calculate daily emission value from the real-time emission data of the organization.

Sub Objective

- Provide the real-time emission gathering feature.

Component 1

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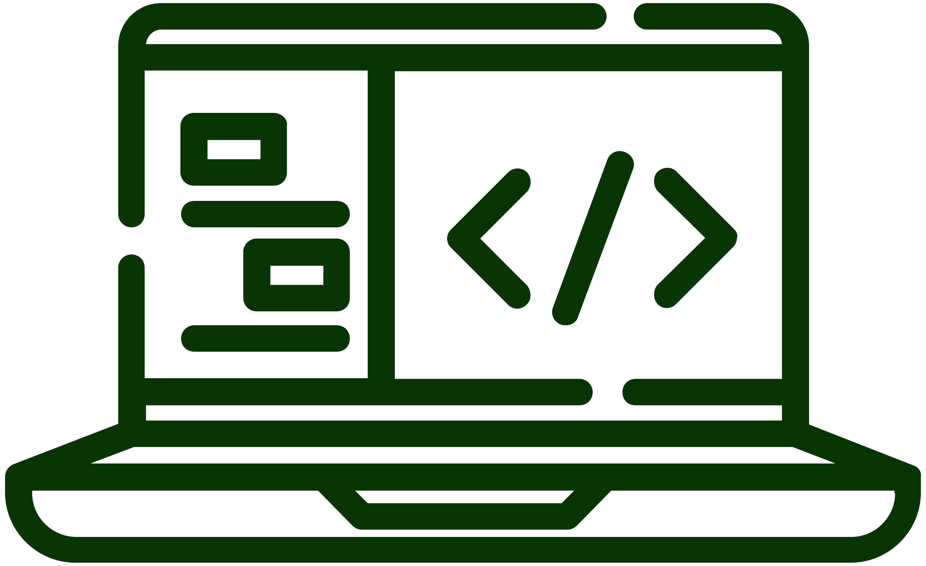

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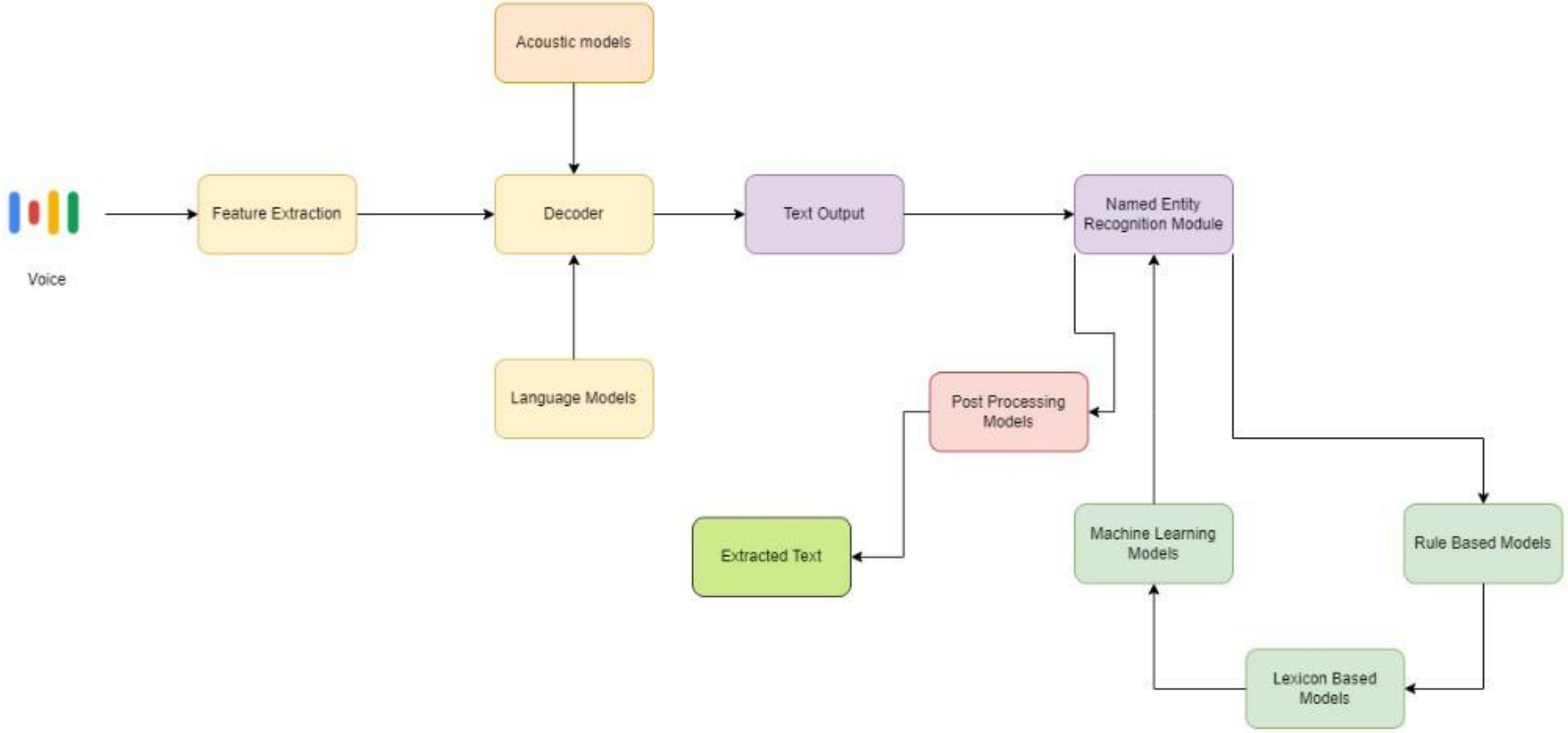
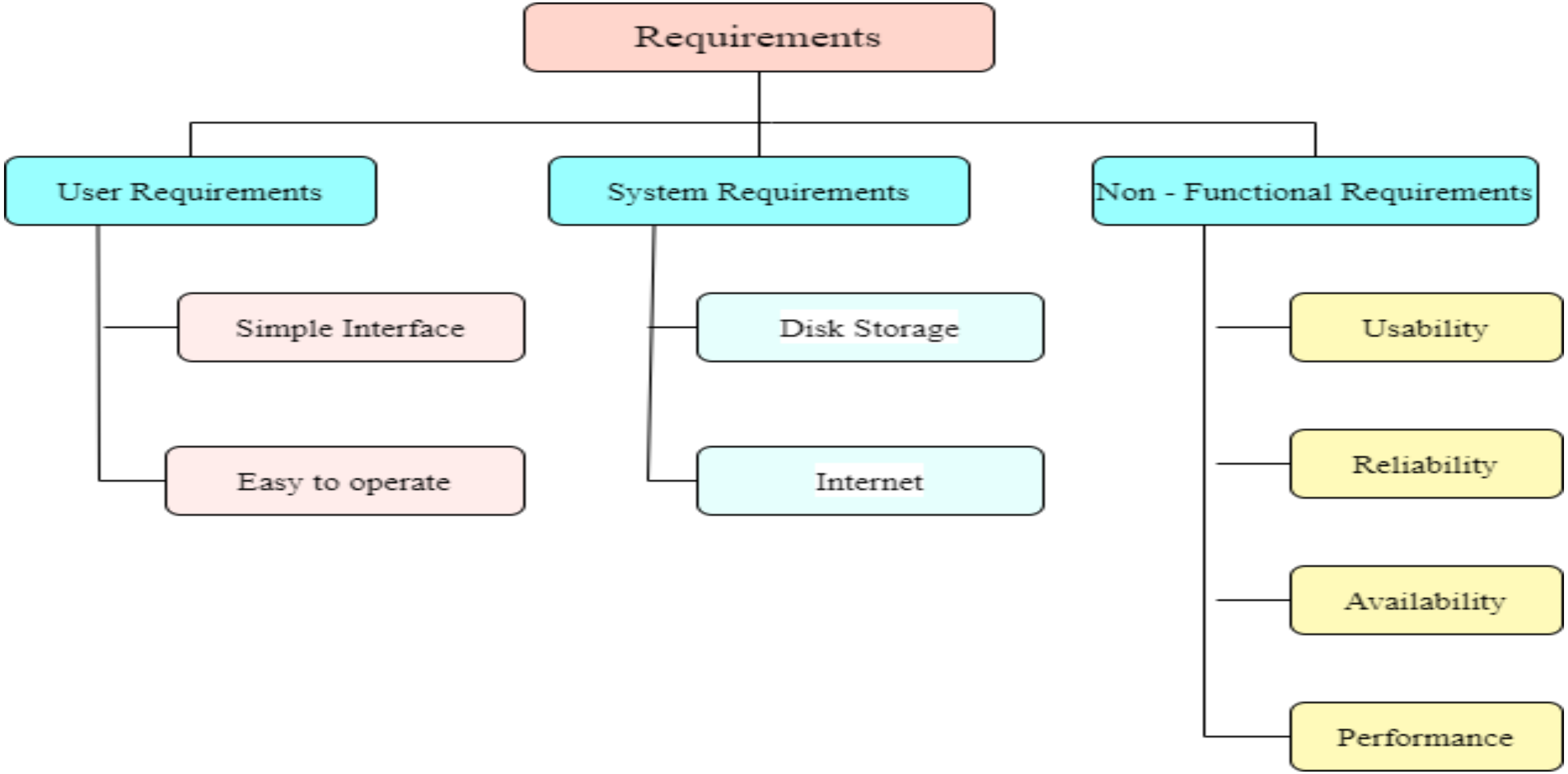


Individual System Architecture

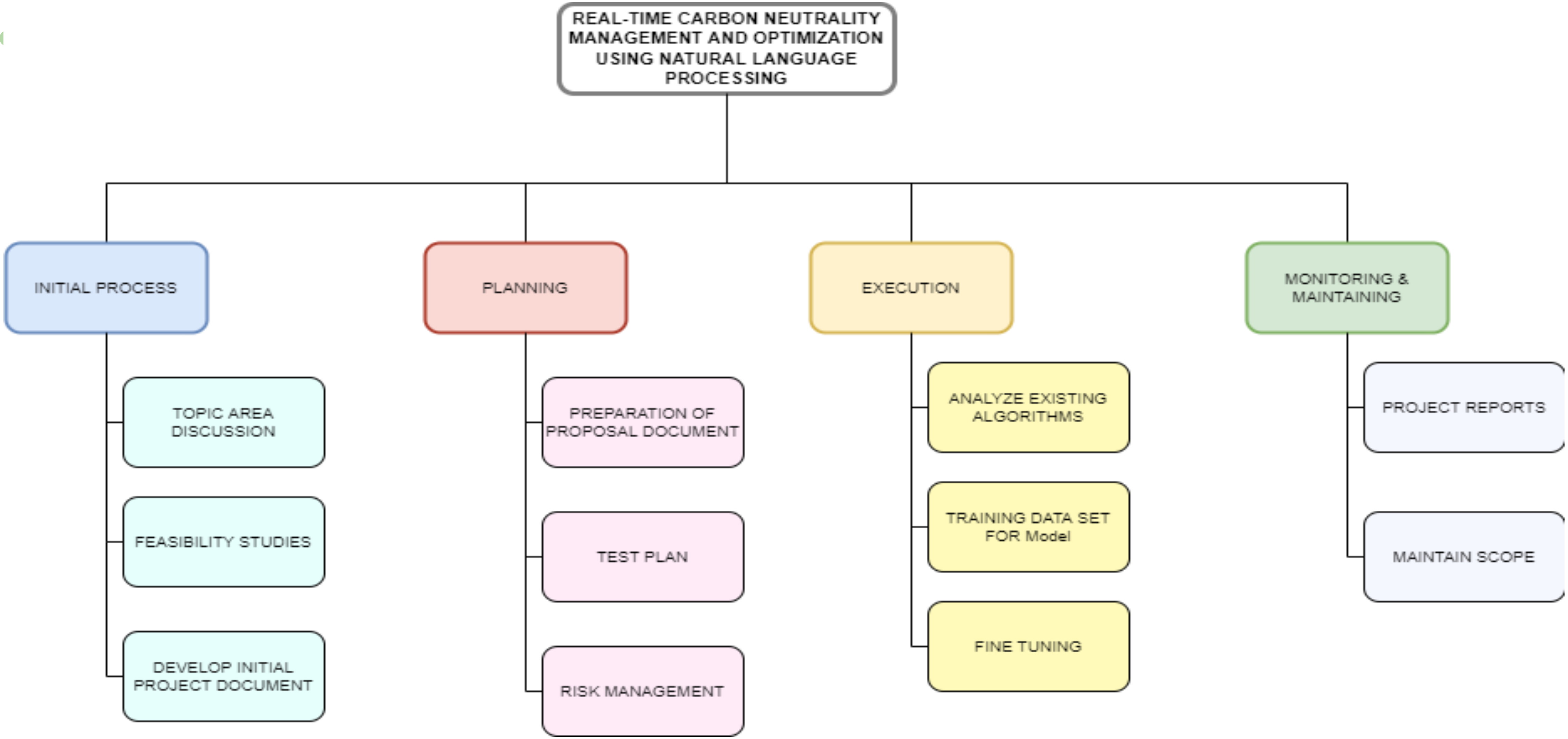
Technologies

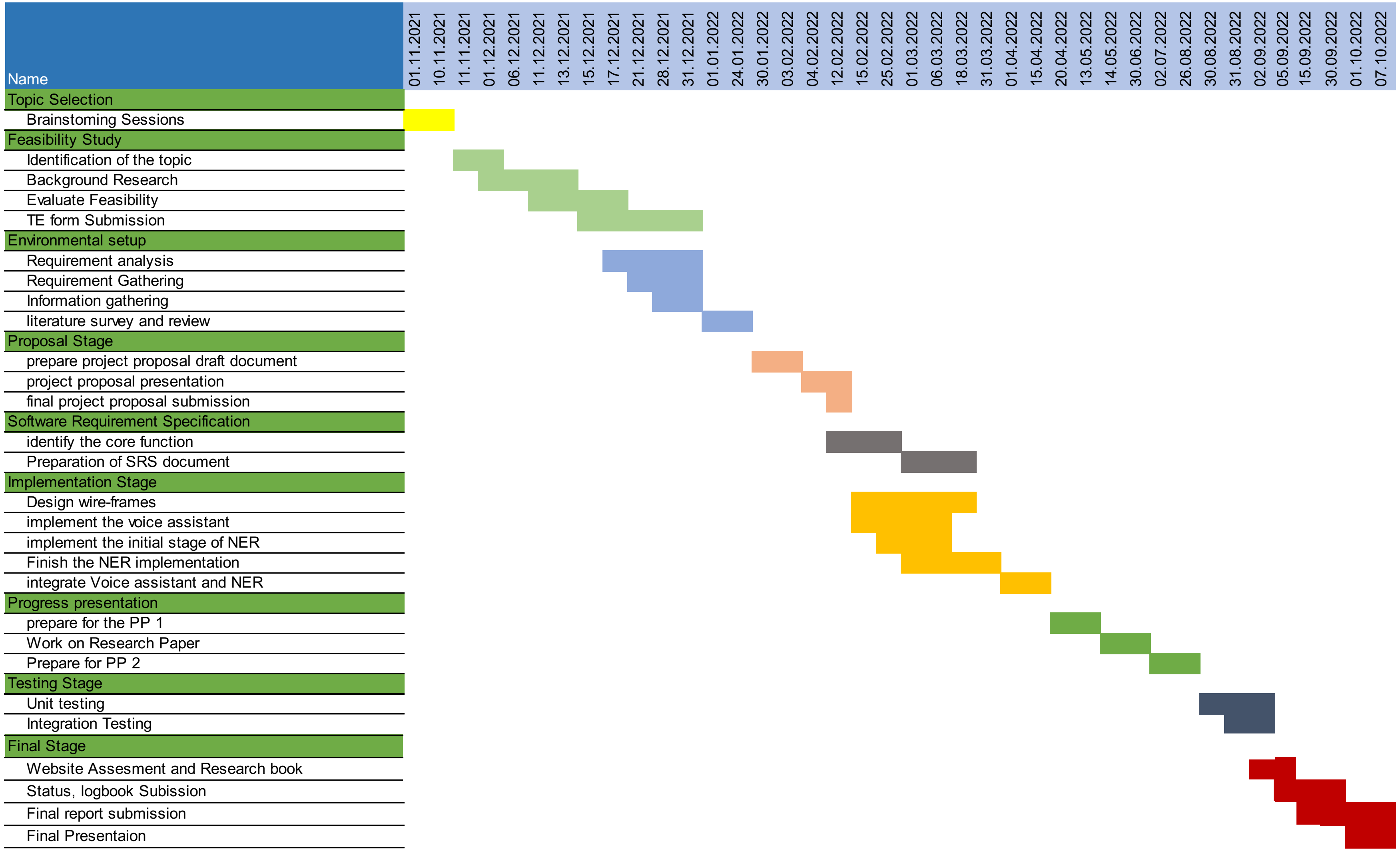
Research Part	Technology
Voice Assistant	Python
NER	SpaCy
Deployment	AWS
Communication	Slack, Zoom

Requirements



Work Breakdown Structure

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Topic Selection
Brainstoming Sessions
Feasibility Study
Identification of the topic
Background Research
Evaluate Feasibility
TE form Submission
Environmental setup
Requirement analysis
Requirement Gathering
Information gathering
literature survey and review
Proposal Stage
prepare project proposal draft document
project proposal presentation
final project proposal submission
Software Requirement Specification
identify the core function
Preparation of SRS document
Implementation Stage
Design wire-frames
implement the voice assistant
implement the initial stage of NER
Finish the NER implementation
integrate Voice assistant and NER
Progress presentation
prepare for the PP 1
Work on Research Paper
Prepare for PP 2
Testing Stage
Unit testing
Integration Testing
Final Stage
Website Assesment and Research book
Status, logbook Subission
Final report submission
Final Presentaion

Gantt Chart

Component 1

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References

References

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[3] Edurne Loyarte-López 1,*, Mario Barral 1 and Juan Carlos Morla 2, "Methodology for Carbon Footprint Calculation Towards Sustainable Innovation in Intangible Assets," Received: 30 January 2020; Accepted: 19 February 2020; Published: 21 February 2020

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Component 2

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Emission Factor Retrieval And Emission Calculation

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Component 2

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Supporting Items

References

Background - Emission Factors

What are emission factors?

- An emission activity can emit different types of GHGs.
    - Carbon dioxide, Methane, Nitrous oxide, Hydrofluorocarbons, etc.
- These have different **Global Warming Potential**.
- A standard value makes reporting easier.
- **CO2 Equivalent** is calculated for various **Emission Technologies**.
- These estimated values are published (Emission standards) by different environmental entities.
- These are usually published every year.
- Firms adopt one of these standards depending on their reporting authority.

Background - Emission Factors

Some popular **Emission Standards**

- Department for Environment, Food and Rural Affairs (DEFRA) – UK
- Climate Registry Information System (CRIS) – USA and Canada
- Environmental Protection Agency (EPA) – USA
- National Greenhouse Accounts (NGA) – Australia

UK Government GHG Conversion Factors for Company Reporting

Factors by Category

	Category							
Scope	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Column Text**	**UOM**	**GHG**	**GHG Conversion Factor 2021**
Scope 1	Fuels	Gaseous fuels	Butane		Energy - Gross CV	kWh (Gross CV)	kg CO2e	0.22240
Scope 1	Fuels	Gaseous fuels	Butane		Energy - Gross CV	kWh (Gross CV)	kg CH4	0.00017
Scope 1	Fuels	Gaseous fuels	Butane		Energy - Gross CV	kWh (Gross CV)	kg CO2	0.22210
Scope 1	Fuels	Gaseous fuels	Butane		Energy - Gross CV	kWh (Gross CV)	kg N2O	0.00013
Scope 1	Fuels	Gaseous fuels	Butane		Energy - Net CV	kWh (Net CV)	kg CO2e	0.24106
Scope 1	Fuels	Gaseous fuels	Butane		Energy - Net CV	kWh (Net CV)	kg CH4	0.00018
Scope 1	Fuels	Gaseous fuels	Butane		Energy - Net CV	kWh (Net CV)	kg CO2	0.24074
Scope 1	Fuels	Gaseous fuels	Butane		Energy - Net CV	kWh (Net CV)	kg N2O	0.00014
Scope 1	Fuels	Gaseous fuels	Butane		Volume	litres	kg CO2e	1.74529
Scope 1	Fuels	Gaseous fuels	Butane		Volume	litres	kg CH4	0.00129
Scope 1	Fuels	Gaseous fuels	Butane		Volume	litres	kg CO2	1.74296
Scope 1	Fuels	Gaseous fuels	Butane		Volume	litres	kg N2O	0.00104
Scope 1	Fuels	Gaseous fuels	Butane		Tonnes	tonnes	kg CO2e	3033.32000
Scope 1	Fuels	Gaseous fuels	Butane		Tonnes	tonnes	kg CH4	2.25000
Scope 1	Fuels	Gaseous fuels	Butane		Tonnes	tonnes	kg CO2	3029.26000
Scope 1	Fuels	Gaseous fuels	Butane		Tonnes	tonnes	kg N2O	1.80000
Scope 1	Fuels	Gaseous fuels	CNG		Energy - Gross CV	kWh (Gross CV)	kg CO2e	0.18316
Scope 1	Fuels	Gaseous fuels	CNG		Energy - Gross CV	kWh (Gross CV)	kg CH4	0.00025
Scope 1	Fuels	Gaseous fuels	CNG		Energy - Gross CV	kWh (Gross CV)	kg CO2	0.18282
Scope 1	Fuels	Gaseous fuels	CNG		Energy - Gross CV	kWh (Gross CV)	kg N2O	0.00010
Scope 1	Fuels	Gaseous fuels	CNG		Energy - Net CV	kWh (Net CV)	kg CO2e	0.20297

Sample Emission Standard – DEFRA 2021

Source: *https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting*

Background - Emission Calculation

Consumption × Emission Factor = Emission

- Emission for an emission activity can be calculated using the above formula [1], [2].

  E.g., Assume the emission factor for a car is 0.1500 $kgCO_2e/km$ and we have traveled 4 km using this car,

  Emission for this activity = 4 km × 0.1500 kgCO2e/km
  = 0.6 kgCO2e

Research Gap

Researches or Products	Emission Factor Searching	Ad-hoc Emission Factor Searching (Tolerance to Term Variances)	Emission Factor Ranking using Term Similarity	Emission Factor Ranking using Personalization	Emission Calculation
Research A [3]	X	X	X	X	✓
Product A [4]	X	X	X	X	✓
Product B [5]	X	X	X	X	✓
Product C [6]	X	X	X	X	✓
Carbonis	✓	✓	✓	✓	✓

Research Problem

How to implement **an emission factor search system ?** that is**,**

- Tolerant to **variations** in the terms,
- Ranks results based on the **term similariy**, and
- Ranks results based on the **personalization** (user search history).

Specific And Sub Objectives

- **Specific Objective:**
  - Search emission factors and provide ranked results for the emission details gathered
- **Sub Objectives:**
  - Collect and process emission standard documents
  - Create a common emission factor representation
  - Implement an emission factor search feature with ranking
  - Calculate emission of the emission activities

Component 2

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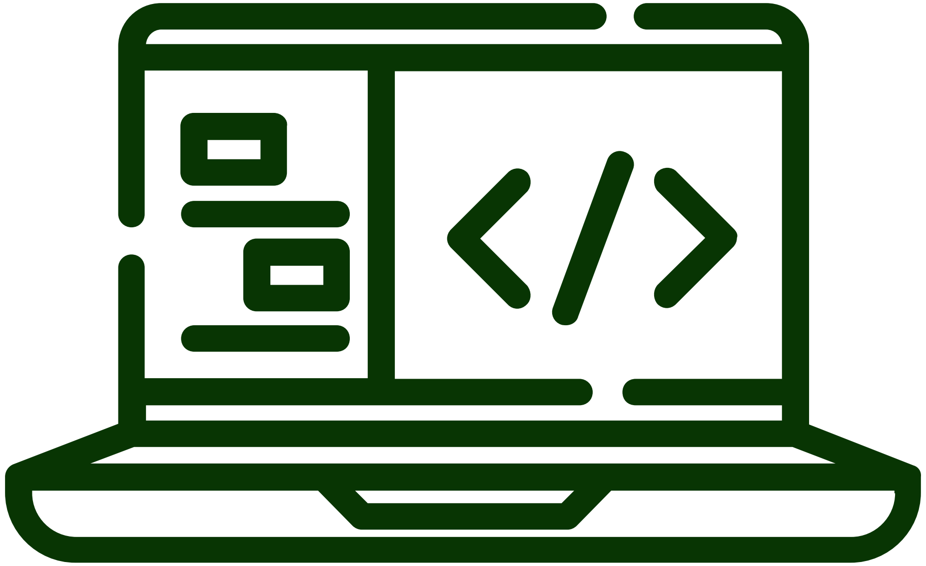
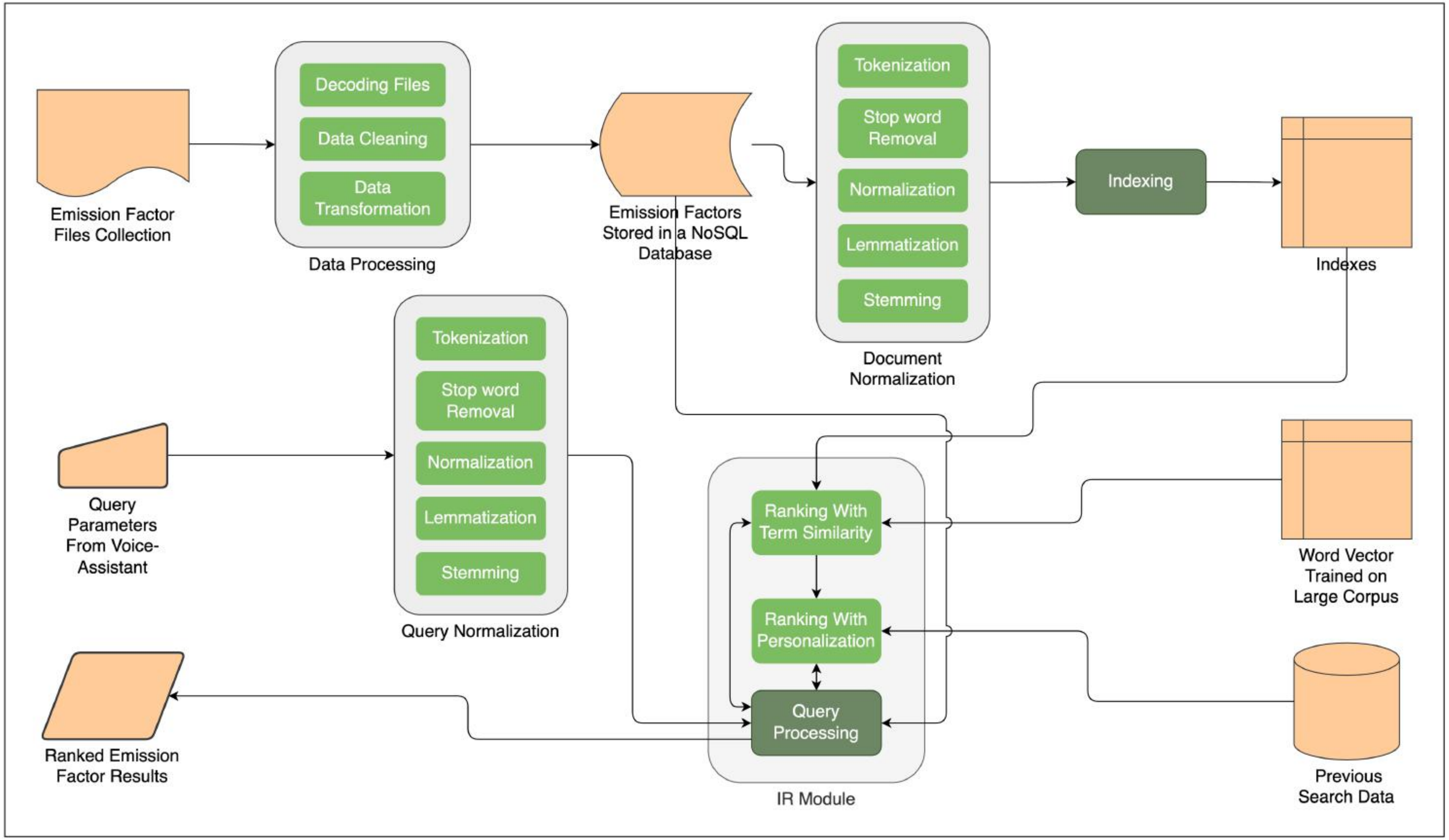
References





Individual System Architecture – Emission Factor Retrieval

Technologies – Available Approaches

- Technical areas – Data Science, Natural Language Processing (NLP), and Information Retrieval (IR).
- Information Retrieval (IR) algorithms
  - Boolean model : precise queries with operators
  - Extended Boolean model : Boolean model + proximity operators
  - Vector space model (tf-idf) : ranking with the importance of terms
  - Probabilistic model (Bayesian networks)
  - Vector space classification (KNN)
  - Machine learning (SVM)
  - **Word embeddings (Word vectors)** [7] – [10] **:** State-of-the-art, used with word2vec, GloVe Algorithms [8]
- Personalization approaches
  - **Score-based algorithms** – good for starting
  - Machine learning models

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Technologies – Critical Analysis

Technologies	Ad-hoc Searching	Ranking with Term Similarity	Ranking with Personalization	Development Time	Startup Friendly (Cost, Need for Previous Data)
Boolean model	X	X	X	Manageable	✓
Extended Boolean model	X	X	X	Manageable	✓
Vector space model	X	X	X	Manageable	✓
Probabilistic model	X	X	X	High	✓
Vector space classification	✓	X	X	High	X
Machine learning models	✓	X	X	High	X
Word embeddings [7] – [10]	✓	✓	X	Manageable	✓

Technologies – Languages, Platforms, And Tools.

- Languages
  - Python
- Python libraries
  - Numpy, Pandas, NLTK, Jupyter, etc.
- Cloud services (AWS)
  - Database (AWS RDS, AWS DocumentDB)
  - Compute (AWS EC2)
  - Backend API (AWS Lambda)
  - File Storage (AWS S3) – optional
- IDE and code editors
  - Visual Studio Code and Pycharm
  - Dbeaver or DataGrip - optional

Requirements – Software Requirements

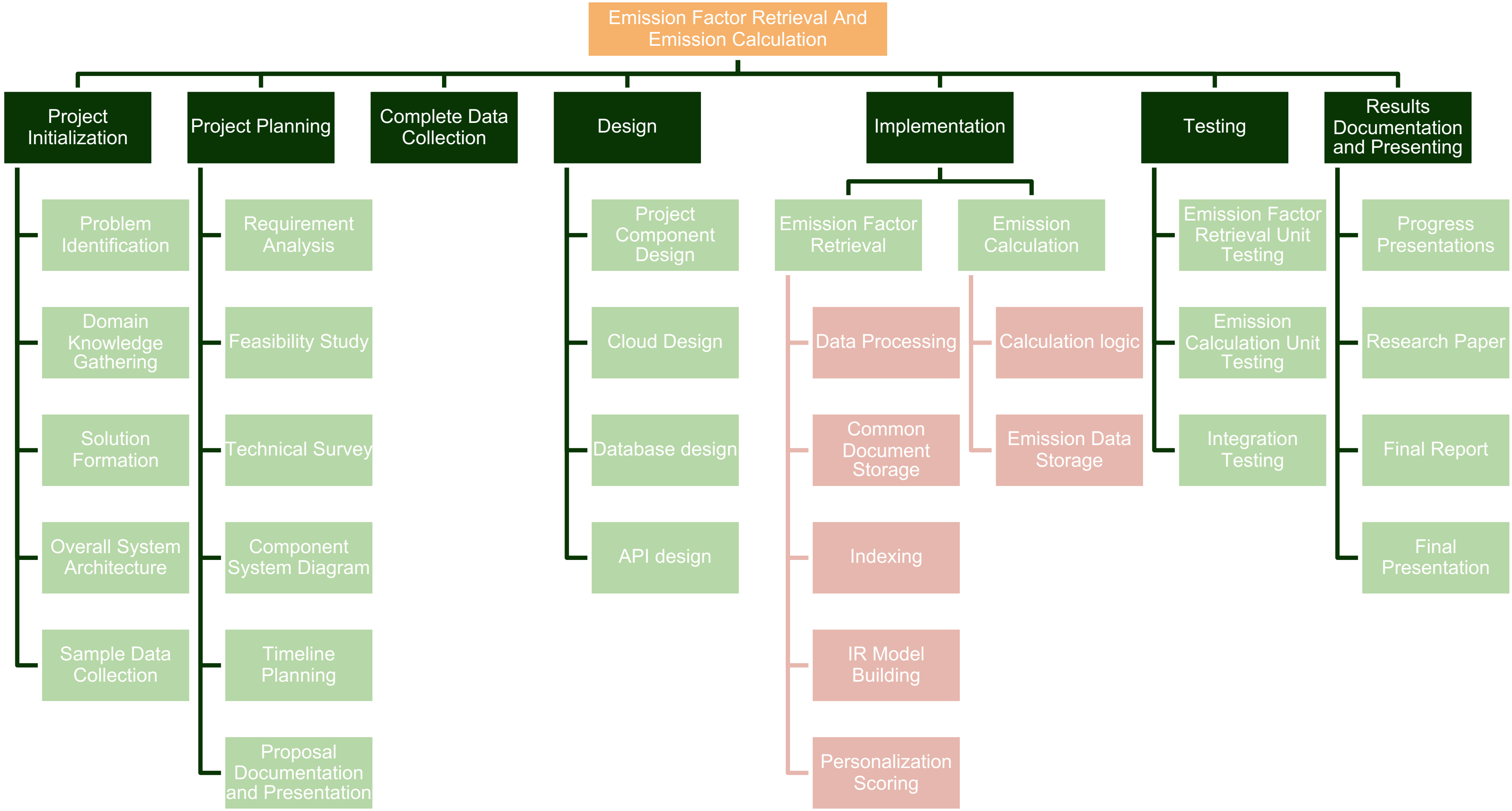
- **Functional Requirements (User Stories):**
  - As an **employee** I want to **retrieve ranked matches of the emission factors** so that I can save time when adding my emission data.
  - As an **employee** I want to **get personalized emission factor search results** so that I can get emission factors for my frequent activities faster.
  - As an **employee** I want to **calculate my emission** so that I can save time.
- **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
  - Reliablity – Available as much as possible

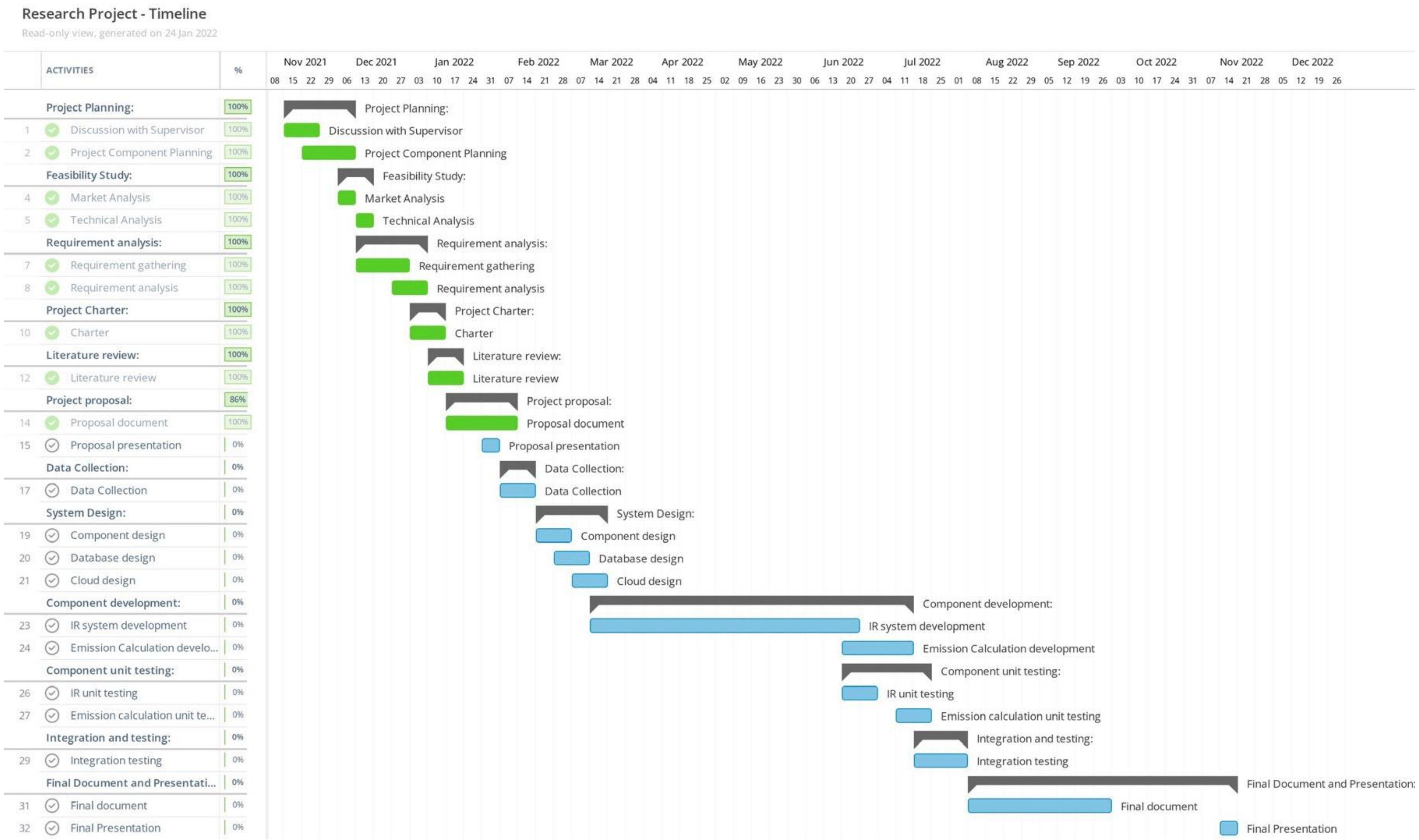
Requirements – System & personal Requirements

- **System Hardware Requirements (Minimum):**
  - 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.

- **Personal Requirements:**
  - Domain knowledge from industry expert
  - Guidance and support from supervisor, co-supervisor, and lecturers

Work Breakdown Structure




Research Project - Timeline
Read-only view, generated on 24 Jan 2022
ACTIVITIES
%
Nov 2021 Dec 2021 Jan 2022 Feb 2022 Mar 2022 Apr 2022 May 2022 Jun 2022 Jul 2022 Aug 2022 Sep 2022 Oct 2022 Nov 2022 Dec 2022
Project Planning: 100%
1 Discussion with Supervisor 100%
2 Project Component Planning 100%
Feasibility Study: 100%
4 Market Analysis 100%
5 Technical Analysis 100%
Requirement analysis: 100%
7 Requirement gathering 100%
8 Requirement analysis 100%
Project Charter: 100%
10 Charter 100%
Literature review: 100%
12 Literature review 100%
Project proposal: 86%
14 Proposal document 100%
15 Proposal presentation 0%
Data Collection: 0%
17 Data Collection 0%
System Design: 0%
19 Component design 0%
20 Database design 0%
21 Cloud design 0%
Component development: 0%
23 IR system development 0%
24 Emission Calculation develo... 0%
Component unit testing: 0%
26 IR unit testing 0%
27 Emission calculation unit te... 0%
Integration and testing: 0%
29 Integration testing 0%
Final Document and Presentati... 0%
31 Final document 0%
32 Final Presentation 0%
Emission Calculation development
Emission calculation unit testing
Final Document and Presentation:

Gantt Chart

Component 2

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Proposed Methodology

Supporting Items

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Commercialization

- Can be sold as a separate module
- Target Clients – small, medium, large scale business firms and industries
- Marketing paradigm - B2B marketing
- How can we promote this product?
    - Content based inbound marketing
    - Social media marketing
    - Search engine optimization (SEO)
    - Search engine marketing (Google Adsense)
    - Industry events (expos)
    - Referral programs (affiliate programs)

Budget – Development Expenses

Component	Cost (USD)	Cost (LKR)*
Cloud compute server (AWS EC2)	25.00	4950.00
Serverless Backend service (AWS Lambda) – free tier	0.00	0.00
NoSQL document database (AWS DocumentDB) – free tier	0.00	0.00
Relational database (AWS RDS) – free tier	0.00	0.00
Other cloud services - shared	30.00	5940.00
Total	**55.00**	**10890.00**

*Used USD to LKR conversion rate of 198 Rs. on 3/2/2022

Budget – Operational Expenses

Component	Cost (USD)	Cost (LKR)*
Cloud compute server (AWS EC2)	30.00	5940.00
Serverless Backend service (AWS Lambda)	20.00	3960.00
NoSQL document database (AWS DocumentDB)	25.00	4950.00
Relational database (AWS RDS)	15.00	2970.00
Total	**90.00**	**17820.00**

*Used USD to LKR conversion rate of 198 Rs. on 3/2/2022

Component 2

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Supporting Items

References

References

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Component 3

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Unit Verification And Unit Conversion

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Component 3

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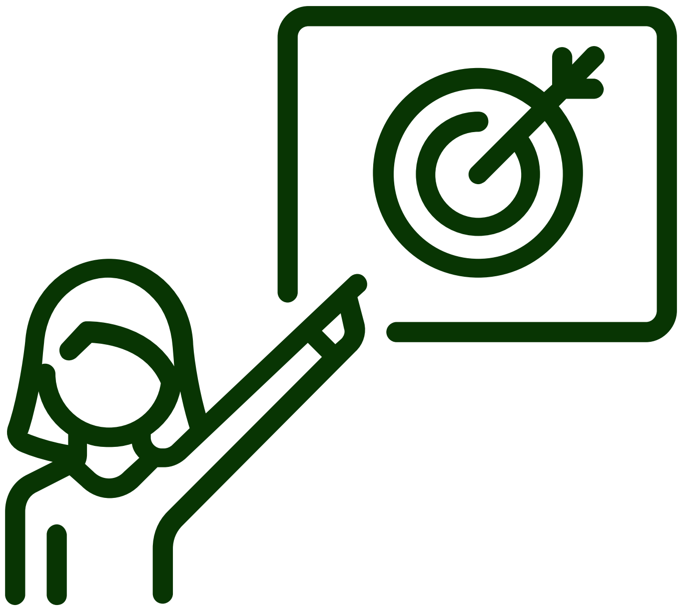
References



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Background

- What is unit verification?
- What is unit conversion?
- How do unit verification and conversion work?
- What role does unit verification and conversion play in calculating the carbon emission rate?

Research Gap

	Unit Convertor	Research A	Research B	Our Proposed System
Unit verification	✗	✗	✗	✓
Calculate real-time emission value	✗	✓	✓	✓
Conversion user friendliness	✓	✗	✗	✓
Input data via voice	✗	✗	✗	✓
Emission data collection from employees	✗	✓	✗	✓
Low budget	✓	✗	✗	✓

Research Problem

- How can we identify whether the input is an emission factor unit or not?

- What should we need to do if the input is not in an emission factor unit?

Specific And Sub Objectives

Main objective

- Verify and convert values for units provided by the employees to match the units of the selected emission factor.

Sub objectives

- Implementing text classification model with natural language processing to verify the difference in input units and units in the emission factor.
- Creating a unit conversion system if the provided units’ classes are different.

Component 3

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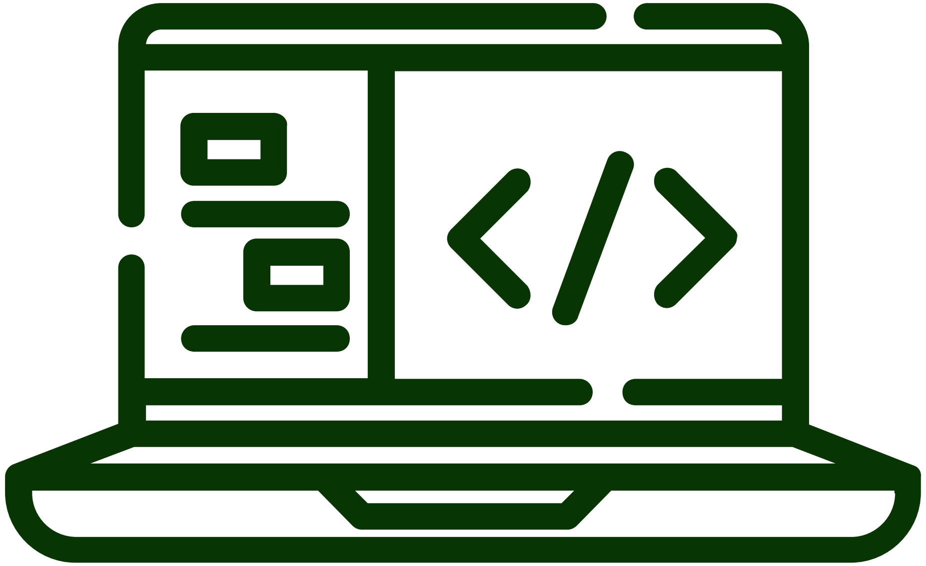
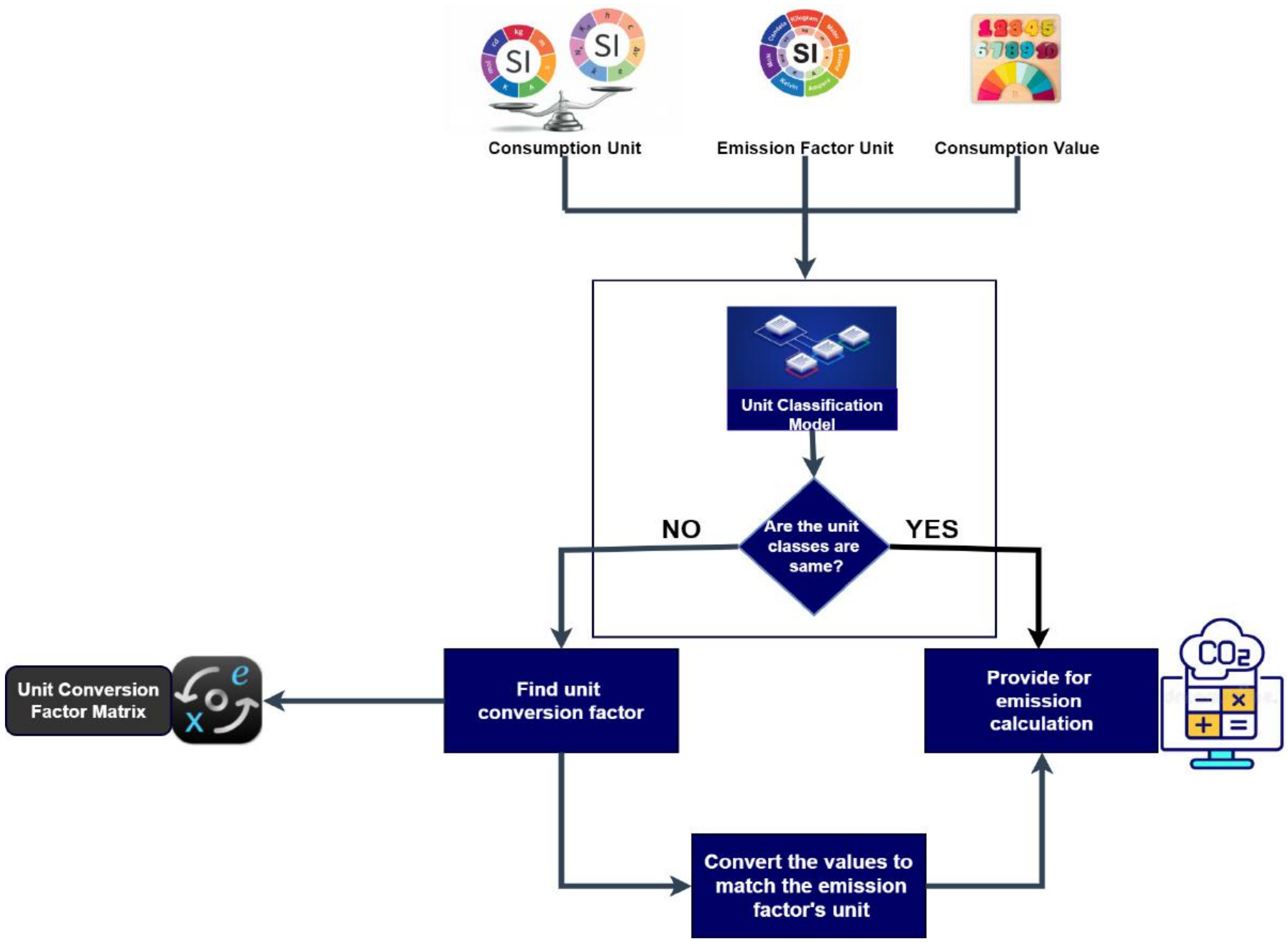
Introduction

Proposed Methodology

References



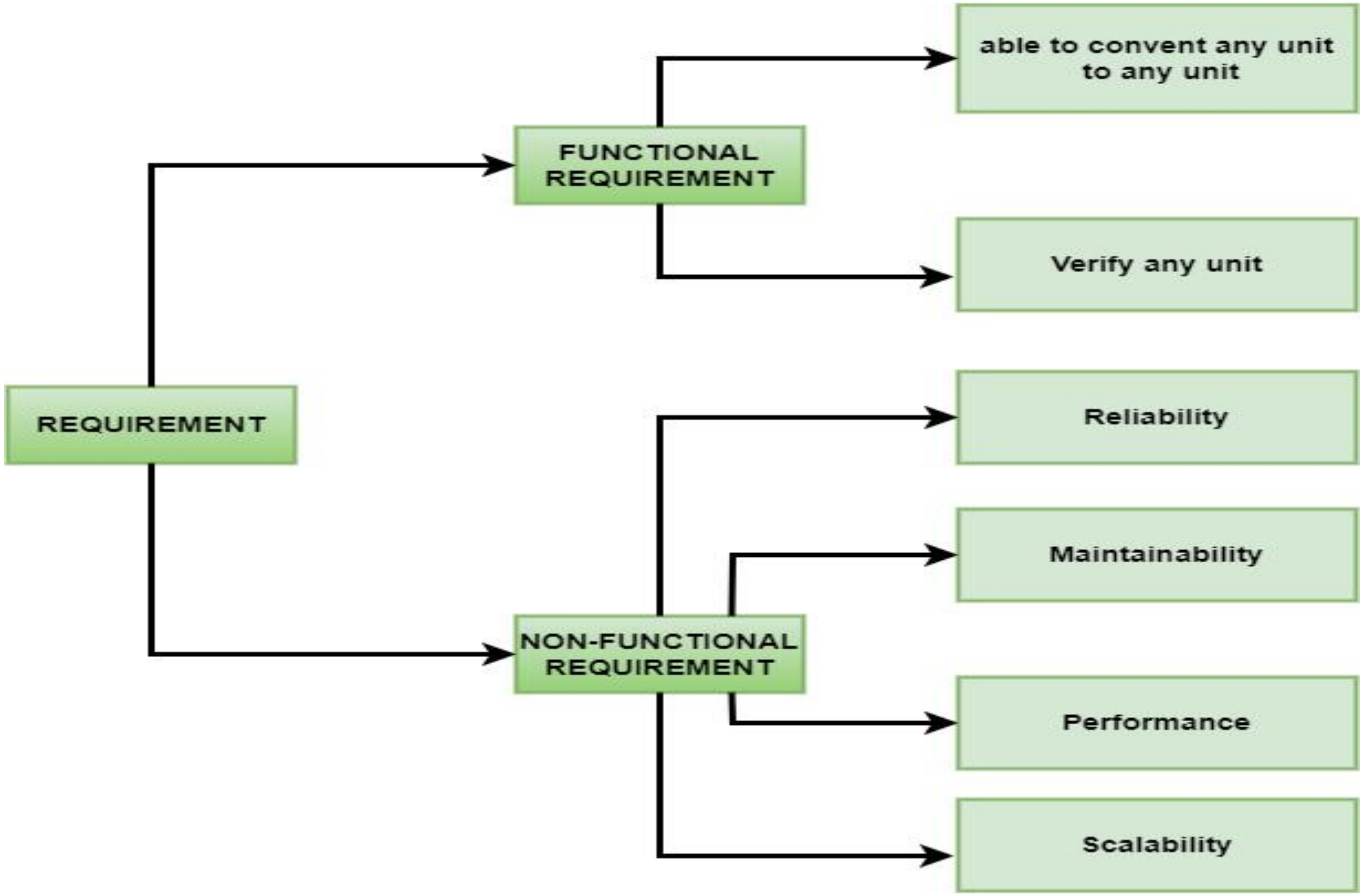


Individual System Architecture

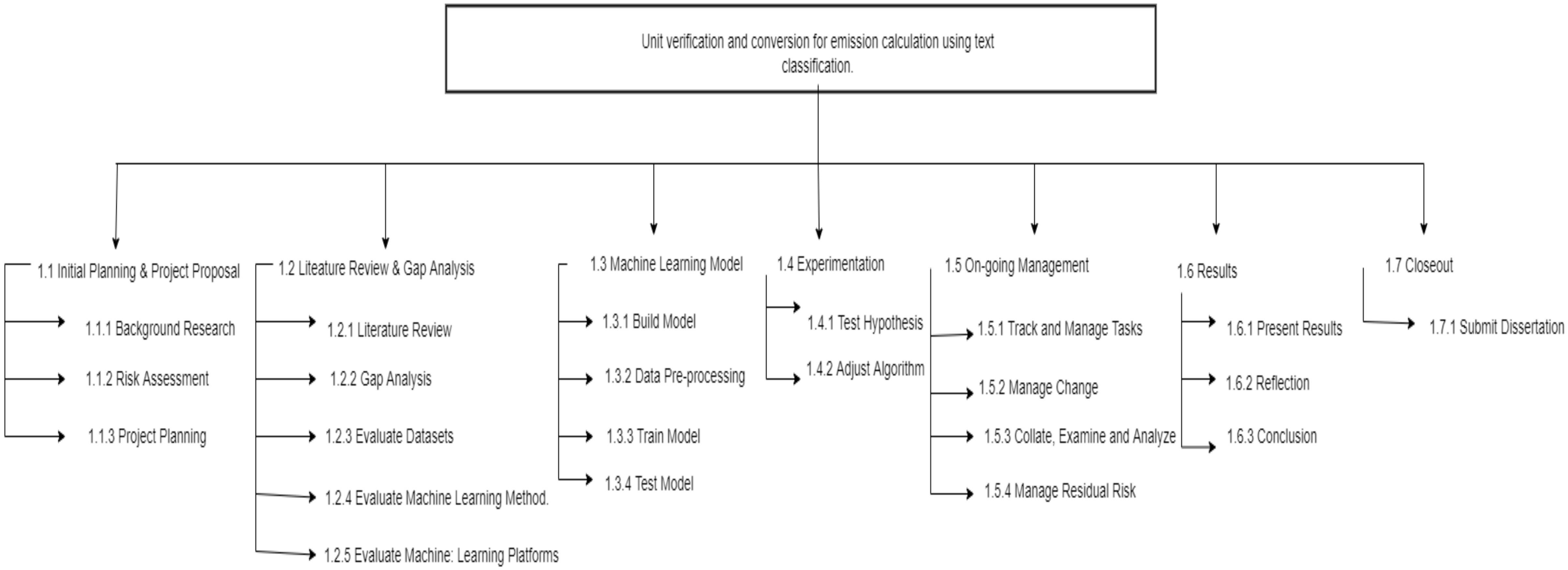
Technologies

- PYTHON
- AWS
- KERAS
- TENSORFLOW

Requirements



Work Breakdown Structure



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Gantt Chart

Component 3

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References

References

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Component 4

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Emission Optimization

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IT19033174
Software Engineering

Component 4

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Introduction

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Supporting Items

References

Background

- Greenhouse gas (GHG) emissions have continuously grown since the 19th century [1].
- Every country around the world have formed policies and agreements to limits the increasing emissions of greenhouse gases.
- As well as every organization must carry out reducing carbon emission. They have many emission sources and also have a desired emission goal for reducing emission.

Research Gap

	Research A (EnOpt)[5]	Research B [4]	Research C [6]	Proposed system
Sent alert to user when emission violate threshold	✗	✗	✗	✓
Find optimum threshold value	✓	✓	✓	✓
customized by the user according to their requirement changes.	✗	✗	✗	✓

Research Problem

- How to find the threshold values for each emission sources?
- How to maintain the carbon emission level without exceeding the limit?
- How to notify to Business Analyst when carbon credit exceed?

- Governments defined a limit for carbon emissions to each organization called as carbon credit [2] . It's a difficult task to them maintain that carbon credit limit continuously.

- No way to identify whether each emission sources exceed the carbon credit or not [3]. So need to compare carbon emission and target emission.

Specific And Sub Objectives

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

- Sub Objectives
  1. Implementing a custom emission optimization module Using the constraints on emission sources as the input.
     - 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.
     - 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.

Component 4

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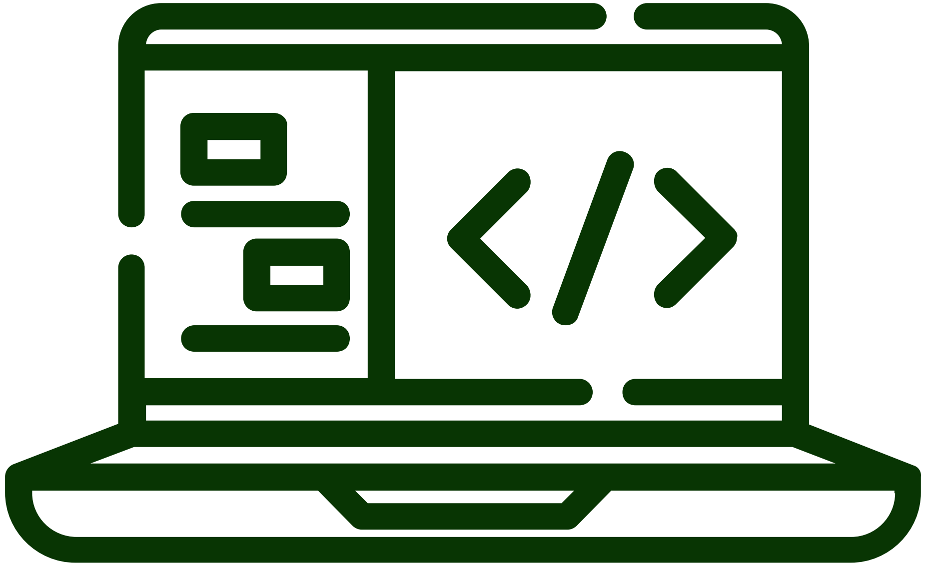

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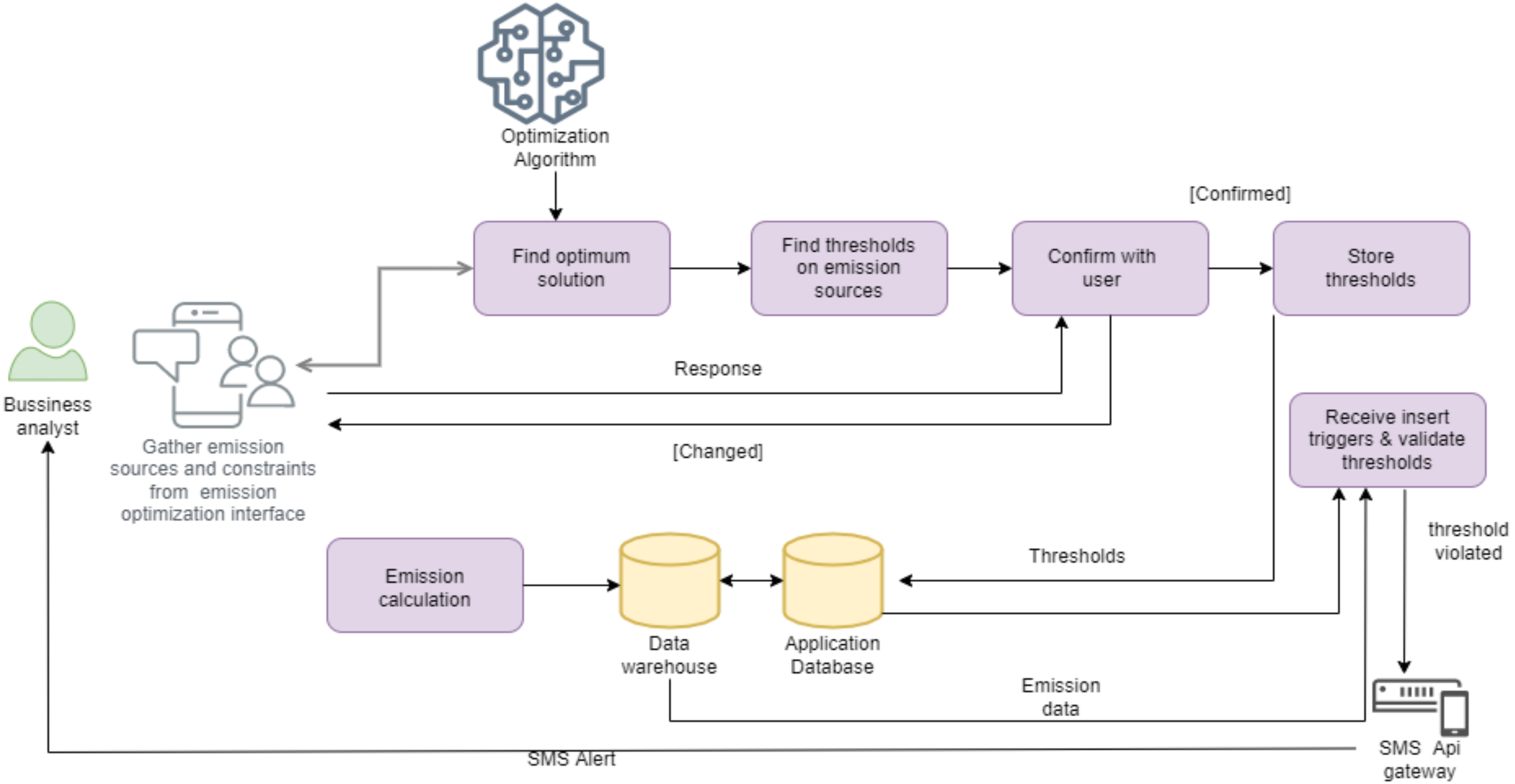

Individual System Architecture

Technologies

- React Native
- Python
- AWS

Requirements

Functional Requirements

- Mobile application with voice recognition features
- Optimize thresholds values for each emission sources
- Store threshold values in database
- Sent an alert to the user when emission violate the threshold

Non-Functional Requirements

- Security
- Availability
- Usability
- Performance

System Requirements

- Storage
- Good microphone

User Requirements

- An android smartphone with microphone
- Internet connectivity

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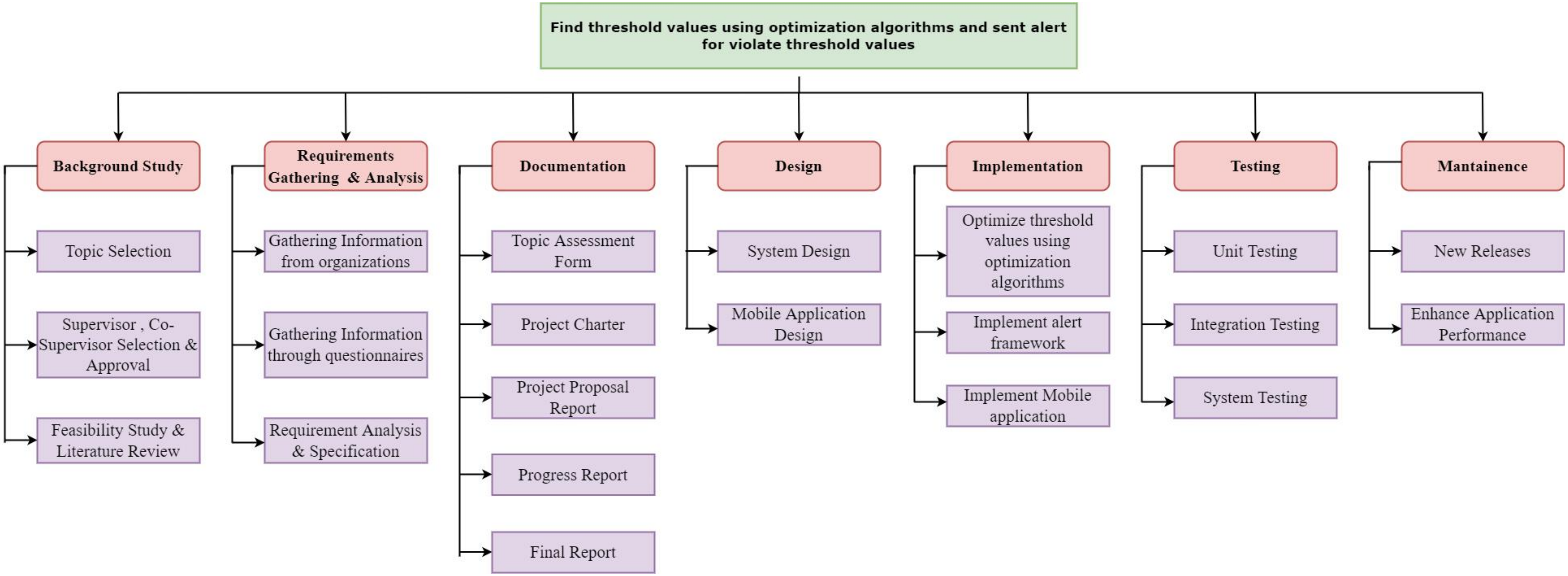
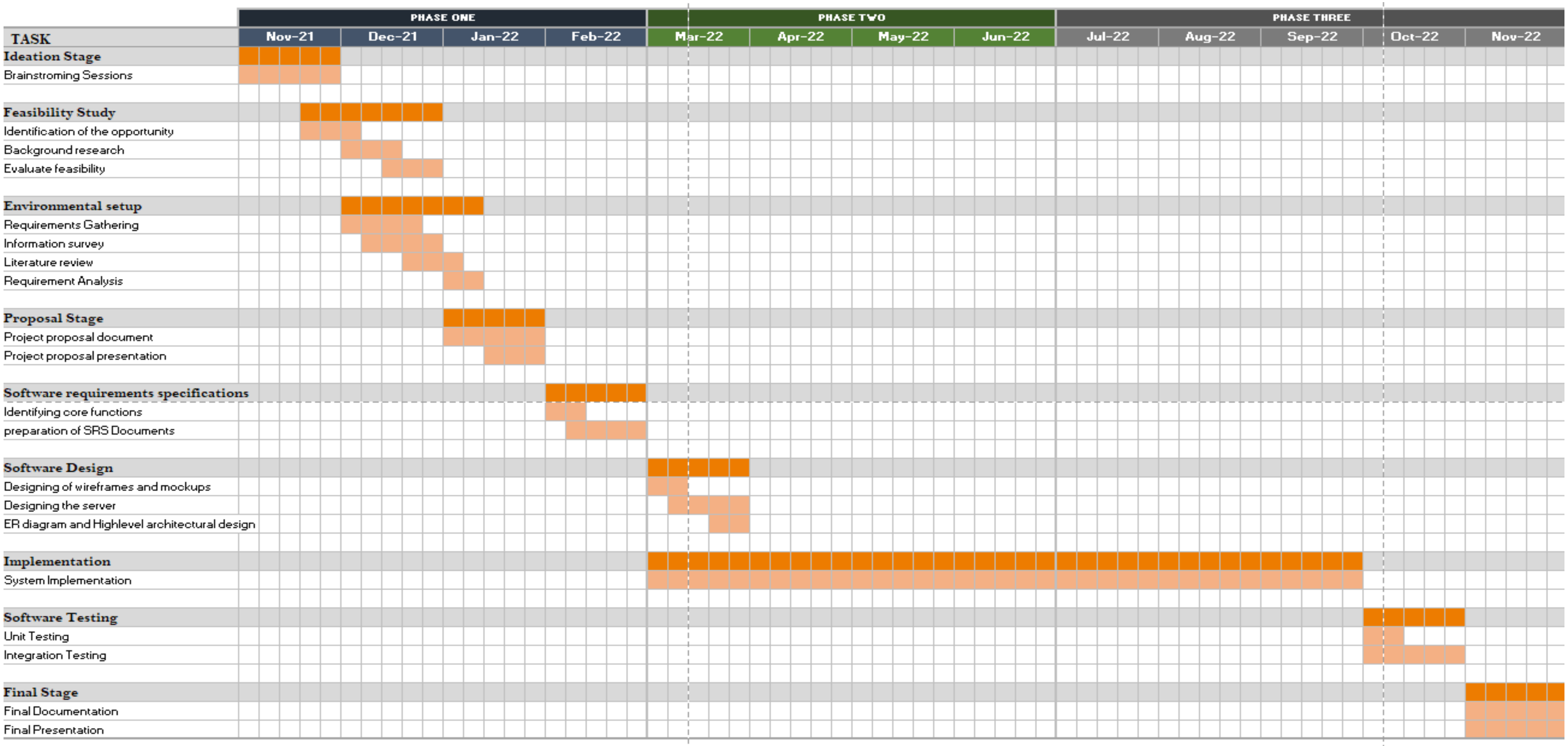
Work Breakdown Structure




TASK
PHASE ONE
PHASE TWO
PHASE THREE
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Ideation Stage
Brainstroming Sessions
Feasibility Study
Identification of the opportunity
Background research
Evaluate feasibility
Environmental setup
Requirements Gathering
Information survey
Literature review
Requirement Analysis
Proposal Stage
Project proposal document
Project proposal presentation
Software requirements specifications
Identifying core functions
preparation of SRS Documents
Software Design
Designing of wireframes and mockups
Designing the server
ER diagram and Highlevel architectural design
Implementation
System Implementation
Software Testing
Unit Testing
Integration Testing
Final Stage
Final Documentation
Final Presentation

Gantt Chart

Component 4

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Commercialization

- Targeting market in developed countries.
- Develop a public relations and news media strategy.
- Develop a pricing strategy with packages.
- Use social media marketing strategies

Budget

Resource Type	Amount (USD)	Amount (LKR)
Hosting mobile App	$50	10000.00
Internet usage	$25	5000.00
AWS	$20	4000.00
Other costs	$15	3000.00
Total	$110	22000.00

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References

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References

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Wrap-up

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Thanks!

Do you have any questions?