1.INTRODUCTION

1.1 Project Overview:

Reliable Energy Consumption Analysis System for Energy-Efficient Appliances

Introduction:

The Reliable Energy Consumption Analysis System for Energy-Efficient Appliances is a machine learning project aimed at analyzing and predicting the energy consumption patterns of residential buildings. The project's goal is to help homeowners and utility companies better manage their energy usage, reduce waste, and lower costs.

Description:

The project involves collecting data on energy consumption and related factors such as weather, time of day, and occupancy. This data is then used to train machine learning models to make accurate predictions of future energy consumption based on these factors. The models can identify patterns in energy usage and provide recommendations for ways to reduce energy waste and improve efficiency.

Objectives:

- Provide homeowners with insights into their energy consumption patterns.
- Assist utility companies in optimizing energy distribution and reducing waste.
- Promote energy-efficient practices among users.
- Lower energy costs for homeowners and utility companies.

Features and Functionalities:

- Data Collection: Collecting energy consumption data from residential buildings along with additional factors such as weather conditions, time of day, and occupancy.
- Machine Learning Models: Training models to predict energy consumption based on collected data.
- Energy Usage Analysis: Analyzing energy consumption patterns and identifying trends.
- Recommendations: Providing recommendations and suggestions to reduce energy waste and optimize consumption.
- User Interface: Developing a user-friendly web interface using Flask to access energy consumption reports, analysis results, and recommendations.

Benefits:

- Energy Efficiency: Assisting users in identifying areas for energy efficiency improvement.
- Cost Savings: Optimizing energy consumption to lower costs for homeowners and utility companies.
- Sustainability: Contributing to sustainable energy usage and reducing carbon footprints.

Conclusion:

The Reliable Energy Consumption Analysis System for Energy-Efficient Appliances is an important application of machine learning that aims to improve energy management in residential buildings. By analyzing energy consumption patterns and providing recommendations, the system can help homeowners and utility companies make informed decisions to reduce waste and lower costs. The project's user interface, built with Flask, provides a convenient and accessible way for users to interact with the system and access energy consumption reports and recommendations. The project has the potential to make a significant impact on energy usage and promote sustainability.

1.2 Purpose

1. The purpose of the project is to develop a Reliable Energy Consumption Analysis System for Energy-Efficient Appliances. The system utilizes machine learning algorithms to analyze and predict the energy consumption patterns of residential buildings. The main objectives of the project are as follows:

2. Energy Management: The project aims to assist homeowners and utility companies in effectively managing their energy usage. By analyzing energy consumption patterns and identifying areas of improvement, the system helps users optimize their energy consumption and reduce waste.

3. Cost Reduction: By providing insights into energy consumption patterns and offering recommendations for energy-efficient practices, the project helps homeowners and utility companies lower their energy costs. This can result in significant savings over time.

4. Sustainability: The project promotes sustainable energy usage by identifying energy wastage and suggesting measures to improve efficiency. By reducing energy waste,

5. the project contributes to environmental sustainability and the reduction of carbon footprints.

6. Decision-Making Support: The system provides users with valuable information and analysis regarding their energy consumption patterns. This empowers homeowners and utility companies to make informed decisions about energy usage, implement energy-saving measures, and optimize energy distribution.

7. User-Friendly Interface: The project incorporates a user interface built with Flask, providing a user-friendly and intuitive platform for users to access energy consumption reports, analysis results, and recommendations. The interface enhances the user experience and makes it convenient for users to interact with the system.

Overall, the purpose of the project is to create a reliable and efficient energy consumption analysis system that benefits homeowners, utility companies, and the environment. By leveraging machine learning techniques and a user-friendly interface, the project aims to improve energy management, reduce costs, promote sustainability, and support informed decision-making.

2. IDEATION AND PROPOSED SOLUTION

2.1 Problem Statement Analysis

IDEATION PHASE

DEFINE THE PROBLEM STATEMENT

DATE	**12 MAY 2023**
TEAM ID	**NM2023TMID01575**
PROJECT NAME	**PROJECT - A Reliable Energy Consumption Analysis System for Energy-Efficient Appliance**
MAXIMUM MARKS	

CUSTOMER PROBLEM STATEMENT :-

Energy efficient companies — can gain a competitive advantage over less efficient companies, allowing them to increase their profits at current product prices, or lower their prices to gain market share, or a combination of these items.

For heating and cooling services — use of efficient equipment, building adjustments in use patterns (behavioural changes, temperature modifications, etc.) and good maintenance.

Lighting — using efficient light-bulbs, changing types of light sources, maximum use of natural lighting, behavioural changes

Construction materials—ensuring that appropriate materials and controls are utilized in new and retrofitted buildings

Consumer of Appliances — High consumption of electrical appliances increases the volatility and fluctuation of power increasing the amount of power to be generated high.

2.2 Empathy Map Canvas

IDEATION PHASE

EMPATHIZE AND DISCOVER

DATE	**12 MAY 2023**
TEAM ID	**NM2023TMID01575**
PROJECT NAME	**PROJECT - A Reliable Energy Consumption Analysis System for Energy-Efficient Appliance**
MAXIMUM MARKS	

EMPATHY MAP CANVA:-

1. This tool is useful for helping us understand about the users.
2. Creating effective solution require understanding about users, their problem, the true problem, and the person who is experiencing it.

BRAINSTORMING:-

1. The goal of brainstorming is to generate many ideas quickly, and "out-of-the-box" thinking can be encouraged.
2. The ideas are then discussed, merged, and refined.
3. The group eventually works to achieve a consensus on the final list or best approach to solve the problem.

Template

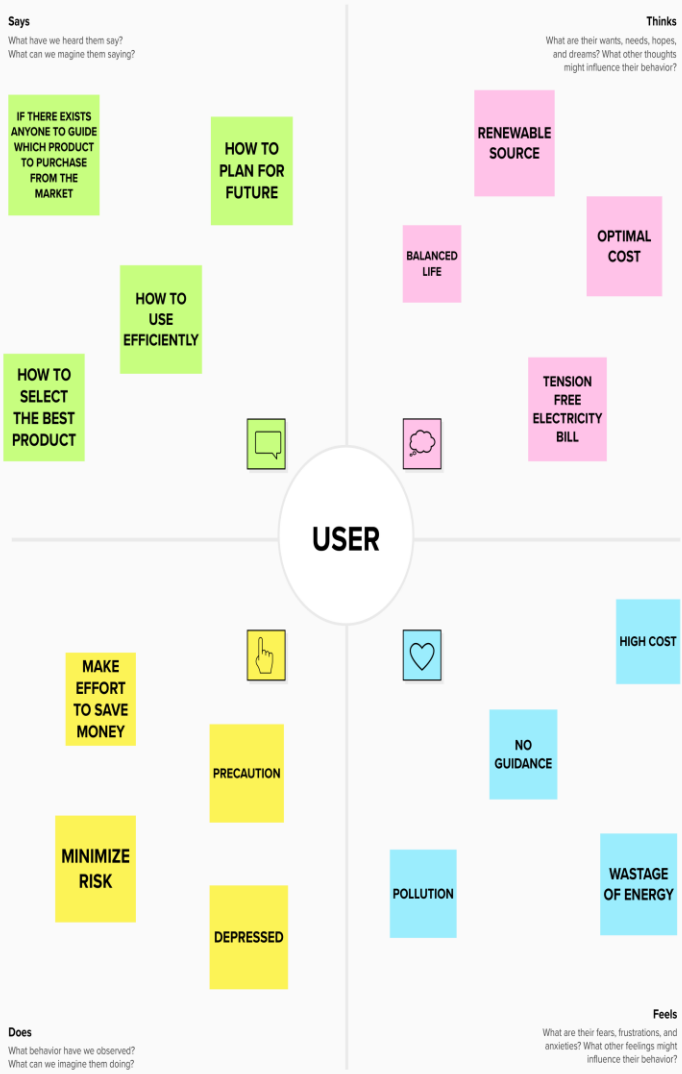
Empathy map

Use this framework to develop a deep, shared understanding and empathy for other people. An empathy map helps describe the aspects of a user's experience, needs and pain points, to quickly understand your users' experience and mindset.

Share template feedback

Build empathy

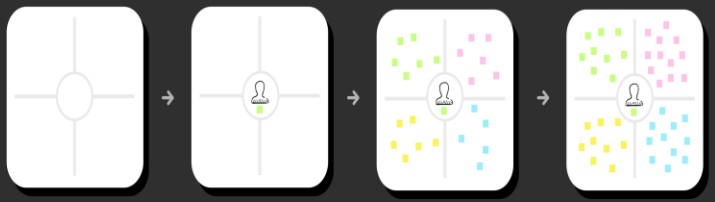
The information you add here should be representative of the observations and research you've done about your users.



Need some inspiration?

See a finished version of this template to kickstart your work.

Open example →



2.3 IDEATION AND BRAINSTORMING

Template

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

Share template feedback

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A **Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B **Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.

C **Learn how to use the facilitation tools**
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1 Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

IDENTIFY PATTERNS IN ENERGY USAGE AND MAKE RECOMMENDATIONS FOR WAYS TO REDUCE ENERGY WASTE AND IMPROVE EFFICIENCY

Key rules of brainstorming
To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

Need some inspiration?
See a finished version of this template to kickstart your work.

Open example →

2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

3

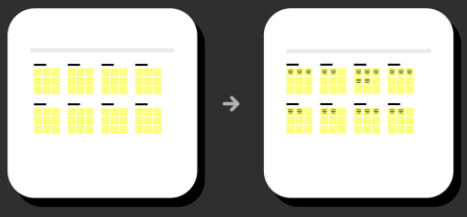
Gro

Take sticky bigge

20

FIZA	ADNAN	HAKEEM	RASHMI
Creating a model which will calculate the maximum income of the user and monthly expense to determine the cost effective way to use resources	Alerting the user when the power usage is exceeded than the one day amount	Need for appliances is very necessary or not.	Minimize the use of energy by alternating the use of Appliances twice in a week.
Use less power adapting resources	Check and Control power when the appliance is Off.	How to purchase which kind of product at the best efficient price and level of capacity it hold	List the method to produce solar way of electricity and use renewable source of energy sometimes
Should provide the need for any appliances if it really required			

Lis pr o u sc



3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

Alerting the user when the power usage is exceeded than the one day amount

Creating a model which will calculate the maximum income of the user and monthly expense to determine the cost effective way to use resources

List the method to produce solar way of electricity and use renewable source of energy sometimes

Minimize the use of energy by alternating the use of Appliances twice in a week.

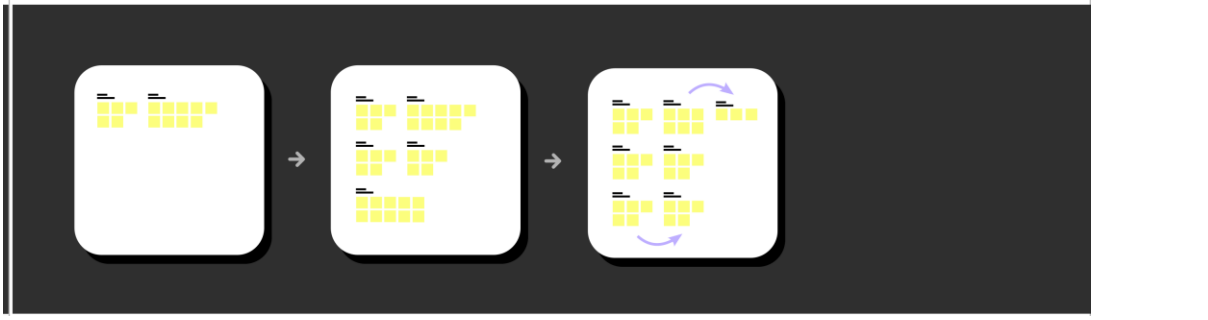
List the method to produce solar way of electricity and use renewable source of energy sometimes

Check and Control power when the appliance is Off.

Need for appliances is very necessary or not.

Use less power adapting resources

Should provide the need for any appliances if it really required



4

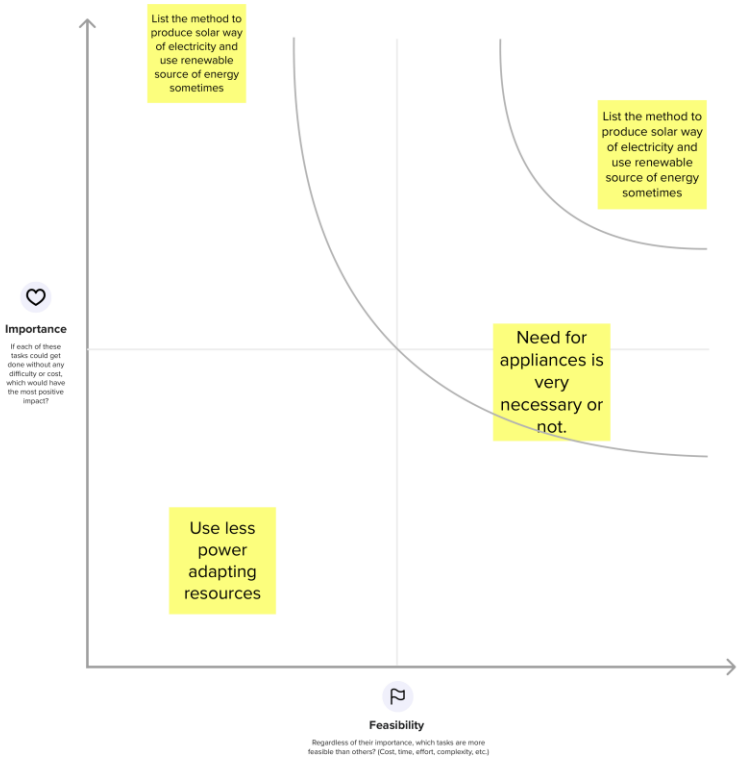
Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

TIP

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the **H key** on the keyboard.



After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

A **Share the mural**
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

B **Export the mural**
Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.
Open the template →

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template →

Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
Open the template →

Share template feedback

2.4 PROPOSED SOLUTION

Project Design Phase-I
Proposed Solution Template

Date	15 May 2023
Team ID	PNT2022TMID01575
Project Name	**Project** - A Reliable Energy Consumption Analysis System For Energy-Efficient Appliances

Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Lack of access to accurate and reliable data on energy usage based on incomplete or inaccurate information, is to help homeowners and utility companies better manage their energy usage, reduce waste, and lower costs.
2.	Idea / Solution description	By creating a Classification Model, we segregate appliances into three core based categories and calculate power invested
3.	Novelty / Uniqueness	Out of 5 papers obtained for Literature Survey, Our Concept differs by segregation apt.
4.	Social Impact / Customer Satisfaction	Customers will know which domain generates more Electricity and the order on which we can reduce the Electricity.
5.	Business Model (Revenue Model)	If we expand this project to Company level at Electricity department to detect which area contains heavy flow of energy and also to replace fuse cases and also high power indication.
6.	Scalability of the Solution	It is a minimum Scalable Project. It is a three - tier architecture with least prioritized in two tier.

3. REQUIREMENT ANALYSIS

3.1 Functional Requirement

Functional Requirement Analysis is the process of identifying and documenting the specific functionalities and capabilities that a software system or application should possess to meet the needs of its users. In the context of a Reliable Energy Consumption Analysis System for Energy-Efficient Appliances, the following functional requirements can be considered:

1. User Registration and Authentication:
    a. Users should be able to register an account with the system.
    b. The system should authenticate and authorize users to access their account and relevant features.

2. Data Collection and Storage:
    a. The system should provide a mechanism to collect and store energy consumption data from residential buildings.
    b. Data related to weather conditions, time of day, and occupancy should also be collected and associated with energy consumption data.

3. Data Preprocessing and Feature Engineering:
    a. The system should preprocess the collected data by handling missing values, outliers, and data normalization.
    b. Feature engineering techniques can be applied to derive meaningful features from the collected data.

4. Machine Learning Model Training and Evaluation:
    a. The system should include functionality to train machine learning models using the preprocessed data.
    b. The trained models should be evaluated for accuracy and performance using appropriate evaluation metrics.

5. Energy Consumption Prediction:
    a. The system should utilize the trained machine learning models to make accurate predictions of future energy consumption based on input data.
    b. Users should be able to request energy consumption predictions for specific time periods or scenarios.

6. Energy Usage Analysis and Visualization:
    a. The system should analyze the energy consumption patterns and provide visualizations or reports to users.
    b. Users should be able to explore and analyze the data to gain insights into their energy usage patterns.

7. Recommendations and Energy Efficiency Tips:
    a. Based on the analysis results, the system should generate recommendations and energy efficiency tips for users.
    b. Recommendations can include suggestions to optimize energy usage, reduce waste, and improve efficiency.

8. User Interface:
    a. The system should have a user-friendly web interface that allows users to interact with the system easily.
    b. The interface should provide access to energy consumption reports, analysis results, and recommendations.
    c. Users should be able to customize their preferences, view historical data, and manage their account settings.

9. Integration with External Systems:
    a. The system may need to integrate with external systems or APIs to fetch additional data sources such as weather information or occupancy data.

10. Security and Data Privacy:
    a. The system should implement appropriate security measures to protect user data and ensure data privacy.
    b. User authentication and authorization should be handled securely.
    c. Compliance with data protection regulations should be ensured.

11. System Administration and Maintenance:
    a. The system should include administrative functionality for system administrators to manage user accounts, perform system maintenance, and monitor system performance.

These functional requirements provide a high-level overview of the desired functionalities for the Reliable Energy Consumption Analysis System for Energy-Efficient Appliances. They serve as a starting point for further detailed analysis, requirement elicitation, and system design.

3.2 Non-Functional Requirements:

1. Usability:
    a. The system should have a user-friendly interface that is easy to navigate and understand.
    b. The UI should have clear and intuitive controls and actions.
    c. The system should provide informative and helpful error messages in case of user input errors.

2. Performance:
    a. The system should be responsive and provide fast loading times for data and visualizations.
    b. The UI should handle a large volume of data without significant performance degradation.
    c. The system should be able to handle multiple user requests simultaneously without slowdowns or crashes.

3. Security:
    a. The UI should implement secure authentication and authorization mechanisms to ensure that only authorized users can access and modify data.
    b. User passwords should be securely stored using hashing and encryption techniques.
    c. The system should protect against common security vulnerabilities, such as cross-site scripting (XSS) and SQL injection.

4. Scalability:
    a. The UI should be designed to handle a growing number of users and increasing amounts of data.
    b. The system should be able to scale horizontally by adding more server resources if needed.

5. Compatibility:
    a. The UI should be compatible with popular web browsers, such as Chrome, Firefox, and Safari.
    b. The system should be compatible with different operating systems, including Windows, macOS, and Linux.

6. Reliability:
    a. The UI should have a high level of availability, with minimal downtime for maintenance and updates.
    b. The system should be able to recover gracefully from failures, such as server crashes or network disruptions.
    c. Regular backups of data should be performed to prevent data loss.

7. Accessibility:

a. The UI should follow accessibility guidelines, such as providing alternative text for images and supporting keyboard navigation.
b. The system should be usable by users with disabilities, such as visual impairments or mobility limitations.

8. Maintainability:
    a. The UI code should be well-structured, modular, and easy to maintain and update.
    b. The system should have proper documentation, including code comments and user manuals, to aid in future maintenance and enhancements.

These non-functional requirements ensure that the system is not only functionally capable but also performs well, is secure, scalable, compatible, reliable, accessible, and maintainable.

4. PROJECT DESIGN

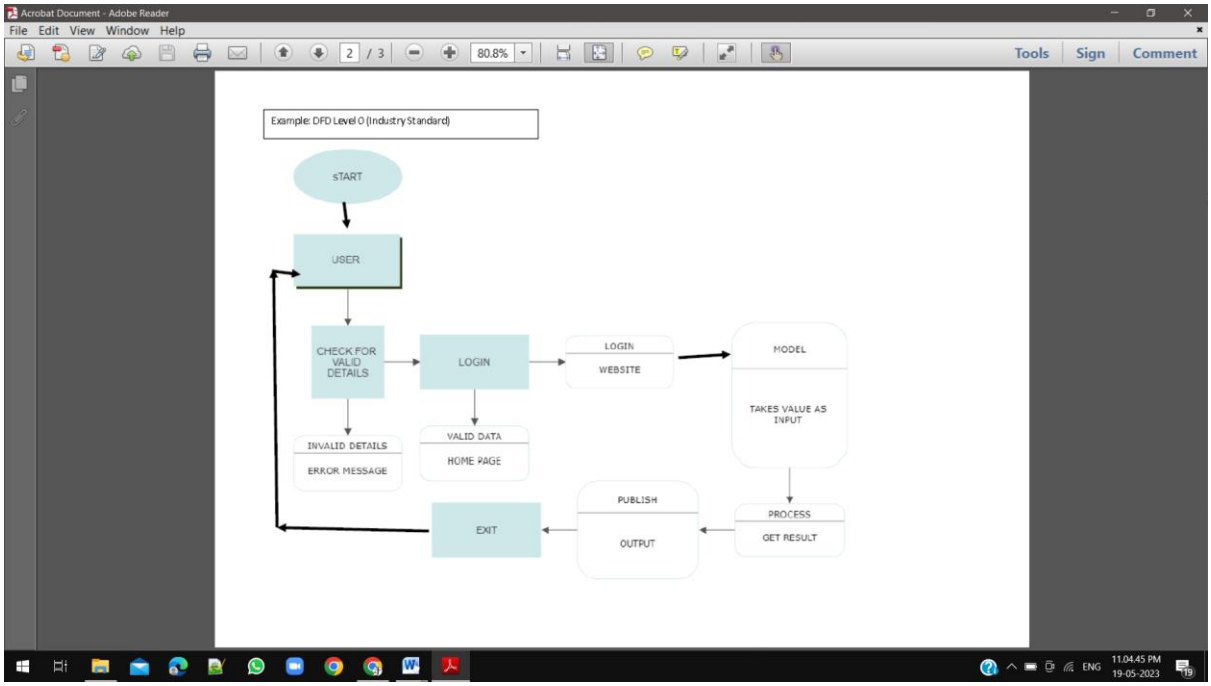
4.1 DATA FLOW DIAGRAMS.

Project Design Phase-II
Data Flow Diagram & User Stories

Date	15 May 2023
Team ID	PNT2022TMID01575
Project Name	**Project** - A Reliable Energy Consumption Analysis System For Energy-Efficient Appliances

Data Flow Diagrams:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.


Acrobat Document - Adobe Reader
File Edit View Window Help
2 / 3
80.8%
Tools
Sign
Comment
Example: DFD Level 0 (Industry Standard)
START
USER
CHECK FOR VALID DETAILS
LOGIN
LOGIN
WEBSITE
MODEL
TAKES VALUE AS INPUT
INVALID DETAILS
ERROR MESSAGE
VALID DATA
HOME PAGE
PUBLISH
OUTPUT
PROCESS
GET RESULT
EXIT
ENG
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4.2 Solution & Technical Architecture

Project Design Phase-I
Solution Architecture

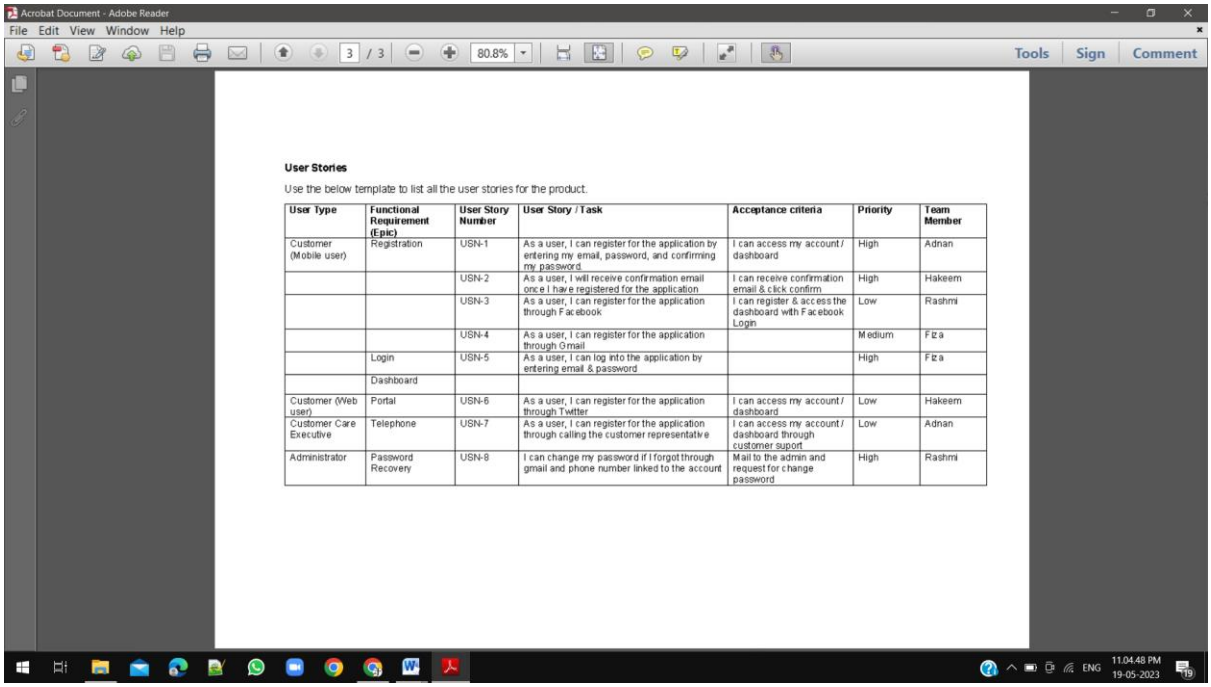
Date	15 May 2023
Team ID	PNT2022TMID01575
Project Name	Project – A Reliable Energy Consumption for Energy Efficient Appliances

Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

4.3 User Stories



User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Team Member
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Adnan
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Hakeem
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Rashmi
		USN-4	As a user, I can register for the application through Gmail		Medium	Fiza
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Fiza
	Dashboard					
Customer (Web user)	Portal	USN-6	As a user, I can register for the application through Twitter	I can access my account / dashboard	Low	Hakeem
Customer Care Executive	Telephone	USN-7	As a user, I can register for the application through calling the customer representative	I can access my account / dashboard through customer suport	Low	Adnan
Administrator	Password Recovery	USN-8	I can change my password if I forgot through gmail and phone number linked to the account	Mail to the admin and request for change password	High	Rashmi

5. CODING & SOLUTIONING

```
# -*- coding: utf-8 -*-
"""Energy Consumption Analysis System.ipynb

Automatically generated by Colaboratory.

Original file is located at

https://colab.research.google.com/drive/10scNo9_2rpnFzbvRSpMx8fGF5E1uRfDX

# A Reliable Energy Consumption Analysis System for Energy-Efficient Appliances

## Importing Packages
"""

import matplotlib.pyplot as plt # plotting
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import matplotlib.pyplot as plt # this is used for the plot the graph
import seaborn as sns # used for plot interactive graph.
from sklearn.model_selection import train_test_split # to split the data into two parts
from sklearn.linear_model import LinearRegression
from xgboost import XGBRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.linear_model import Ridge
from sklearn import metrics
from sklearn.model_selection import cross_val_score
import pickle
from flask import Flask,request,render_template
```

"""## importing Dataset"""

```
dt =
pd.read_csv('/content/drive/MyDrive/household_power_consumption.txt',sep
= ';',
            parse_dates={'dt':['Date','Time']},
            infer_datetime_format=True,
            low_memory=False, na_values=['nan','?'],
            index_col='dt')

dt.info()

dt.isnull().sum()

dt.replace('?',np.nan,inplace=True)

dt.loc[dt.Sub_metering_3.isnull()].head

dt = dt.dropna(how = 'all')

for i in dt.columns:
  dt[i] = dt[i].astype("float64")

values = dt.values
dt['Sub_metering_4'] = (values[:,0]*1000/60)-(values[:,4]+
values[:,5]+values[:,6])
dt.shape

dt.dtypes

dt.corr()

dt.describe()

"""## Uni-Variate"""

sns.displot(dt['Global_active_power'])

sns.distplot(dt['Global_reactive_power'],kde=False,bins=30)
```

```
sns.distplot(dt['Global_active_power'],kde=False,bins=30)

"""## Bivariate Analysis"""

sns.jointplot(x = 'Global_reactive_power',y = 'Global_active_power',data = dt,kind = 'scatter')

sns.jointplot(x = 'Voltage',y = 'Global_active_power',data = dt,kind = 'scatter')

sns.jointplot(x = 'Global_intensity',y = 'Global_active_power',data = dt,kind = 'scatter')

sns.jointplot(x = 'Sub_metering_1',y = 'Global_active_power',data = dt,kind = 'scatter')

sns.jointplot(x = 'Sub_metering_3',y = 'Global_active_power',data = dt,kind = 'scatter')

sns.jointplot(x = 'Sub_metering_4',y = 'Global_active_power',data = dt,kind = 'scatter')

"""## Multivariate analysis"""

pearson = dt.corr(method='pearson')
mask = np.zeros_like(pearson)
mask[np.triu_indices_from(mask)] = True
sns.heatmap(pearson,
vmax=1,vmin=0,square=True,cbar=True,annot=True,cmap="YlGnBu",mask=ma
sk)

X = dt.iloc[:,[1,3,4,5,6]]
y = dt.iloc[:,0]
X.head()

y.head()

"""## Splitting train and test Dataset"""

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,
random_state=42)
```

```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

"""## Training The Model In Multiple Algorithms

Linear Regression model

```
"""

lm=LinearRegression()
lm.fit(X_train,y_train)
predictions = lm.predict(X_test)

predictions

"""### XGB Regressor


"""

import xgboost as xgb
model2 = xgb.XGBRegressor()
model2.fit(X_train,y_train)
y_predict2 = model2.predict(X_test)

y_predict2

"""### Random Forest Regressor Model"""

model3 = RandomForestRegressor()
model3.fit(X_train,y_train)
y_predict3 = model3.predict(X_test)

y_predict3

"""### Ridge Regressor Model
```

"""

model4 = Ridge()
model4.fit(X_train, y_train)
y_pred_ridge = model4.predict(X_test)

y_pred_ridge

"""## Prediction LINEAR"""

y_p1 = lm.predict([[0.148,18.4,0.0,1.0,17.0]])
y_p1

"""Random Forest Regressor Model"""

y_p3 = model3.predict([[0.148,18.4,0.0,1.0,17.0]])
y_p3

y_p4 = model4.predict([[0.148,18.4,0.0,1.0,17.0]])
y_p4

"""## Testing Model With Multiple Evaluation Metrics

LINEAR
"""

print('MAE:' ,metrics.mean_absolute_error(y_test,predictions))
print('MSE:',metrics.mean_squared_error(y_test,predictions))
print('RMSE:' ,np.sqrt(metrics.mean_squared_error(y_test,predictions)))
print('RSquarevalue:' ,metrics.r2_score (y_test,predictions))

"""XGB Regressor

"""

```
print('MAE:' ,metrics.mean_absolute_error(y_test,y_predict2))
print('MSE:',metrics.mean_squared_error(y_test,y_predict2))
print('RMSE:' ,np.sqrt(metrics.mean_squared_error(y_test,y_predict2)))
print('RSquarevalue:' ,metrics.r2_score (y_test,y_predict2))

"""Random Forest Regressor Model"""

print('MAE:' ,metrics.mean_absolute_error(y_test,y_predict3))
print('MSE:',metrics.mean_squared_error(y_test,y_predict3))
print('RMSE:' ,np.sqrt(metrics.mean_squared_error(y_test,y_predict3)))
print('RSquarevalue:' ,metrics.r2_score (y_test,y_predict3))

"""Ridge model"""

print('MAE:' ,metrics.mean_absolute_error(y_test,y_pred_ridge))
print('MSE:',metrics.mean_squared_error(y_test,y_pred_ridge))
print('RMSE:' ,np.sqrt(metrics.mean_squared_error(y_test,y_pred_ridge)))
print('RSquarevalue:' ,metrics.r2_score (y_test,y_pred_ridge))
```

"""## Comparing Model Accuracy Before & After Applying Hyperparameter Tuning"""

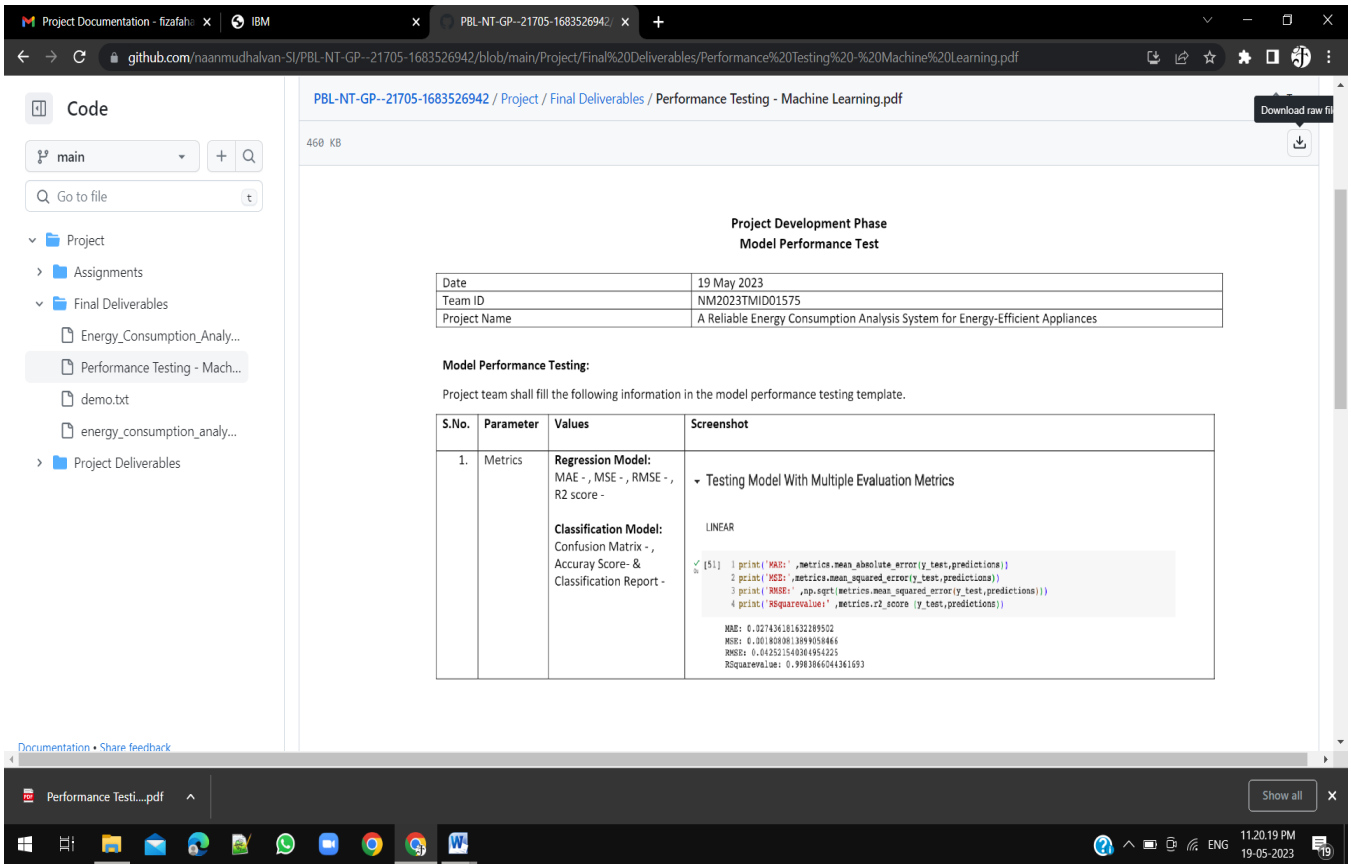
```
cv = cross_val_score(lm,X,y,cv=5)

np.mean(cv)

"""## Save The Best Model

"""

filename = 'PCASSS_model.pkl'
pickle.dump(lm,open(filename,'wb'))
```

"""## Integrate With Web Framework"""

```
model = pickle.load(open('PCASSS_model.pkl','rb'))
app = Flask(__name__)

@app.route("/")
def f():
  return render_template("index.html")

@app.route("/inspect")
def inspect():
  return render_template("inspect.html")

@app.route("/home", methods=["GET", "POST" ])
def home():
  GlobalReactivePower = float(request.form['GlobalReactivePower'])
  Global_intensity - float(request.form['Global_intensity'])
  Sub_metering_1 - float(request.form['Sub_metering_1'])
  Sub_metering_2 - float(request.form['Sub_metering_2'])
  Sub_metering_3 = float(request.form['Sub_metering_3'])
  X =
[[GlobalReactivePower,Global_intensity,Sub_metering_1,Sub_metering_2,Sub
_metering_3]]
  output = round(model.predict (X) [0], 3)
  return render_template('output .html',output=output)

if __name__ == "__main__":
  app.run(debug=True)
```

6. RESULTS

6.1 Performance Metrics



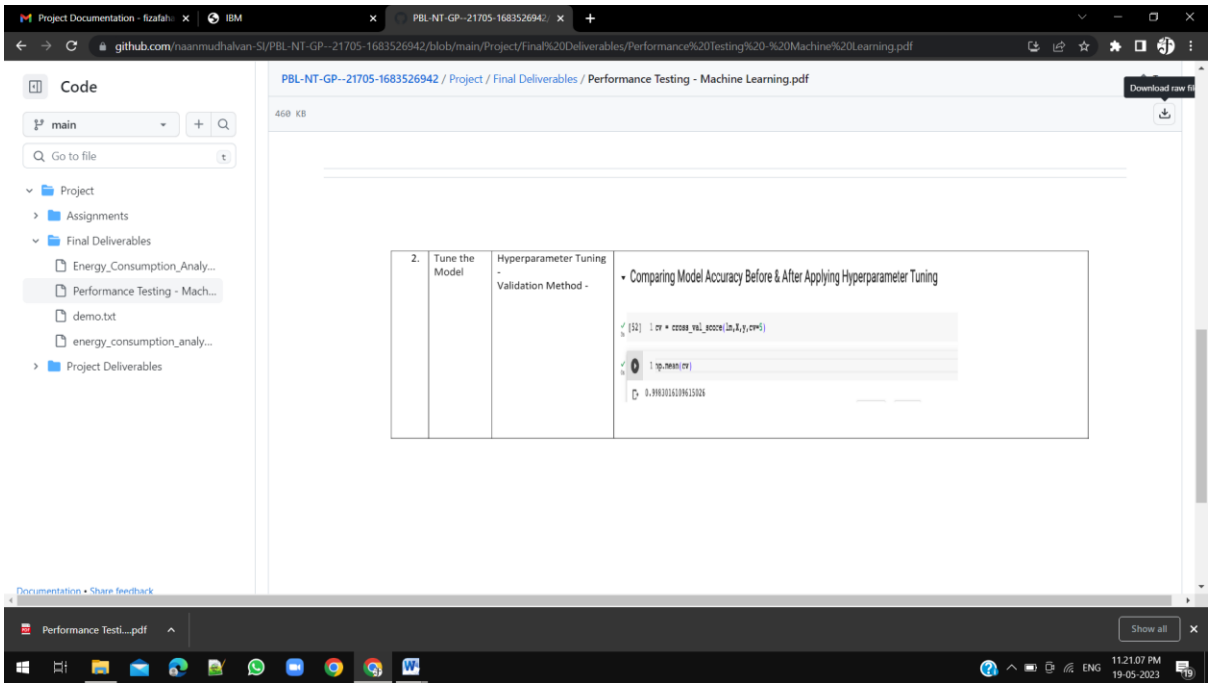
Project Development Phase
Model Performance Test

Date	19 May 2023
Team ID	NM2023TMID01575
Project Name	A Reliable Energy Consumption Analysis System for Energy-Efficient Appliances

Model Performance Testing:

Project team shall fill the following information in the model performance testing template.

S.No.	Parameter	Values	Screenshot
1.	Metrics	**Regression Model:** MAE - , MSE - , RMSE - , R2 score - **Classification Model:** Confusion Matrix - , Accuray Score- & Classification Report -	Testing Model With Multiple Evaluation Metrics LINEAR MAE: 0.027436181632189502 MSE: 0.0018080813899058466 RMSE: 0.042521540304954225 RSquarevalue: 0.9983866044361693



2.	Tune the Model	Hyperparameter Tuning - Validation Method -	Comparing Model Accuracy Before & After Applying Hyperparameter Tuning 0.9983016109615026

7. ADVANTAGES & DISADVANTAGES

Advantages of the Energy Consumption Analysis System:

1. Energy Efficiency: The system helps homeowners and utility companies better manage energy usage, reduce waste, and lower costs by providing insights into energy consumption patterns.

2. Data-Driven Insights: By analyzing energy consumption data and related factors, the system offers valuable insights and trends, enabling users to make informed decisions about energy usage.

3. Cost Savings: Users can identify energy-saving opportunities and implement strategies to reduce their energy bills, resulting in long-term cost savings.

4. Environmental Impact: The system promotes sustainability by encouraging energy-efficient practices, reducing carbon footprint, and contributing to a cleaner environment.

5. Predictive Analytics: By utilizing machine learning algorithms, the system can predict future energy consumption based on historical data, enabling proactive planning and resource allocation.

Disadvantages of the Energy Consumption Analysis System:

1. Data Privacy Concerns: Collecting and analyzing energy consumption data may raise privacy concerns, requiring robust security measures to protect sensitive information.

2. Data Availability and Accuracy: The accuracy of predictions and recommendations depends on the availability and accuracy of input data. Inaccurate or incomplete data may impact the effectiveness of the system.

3. Initial Setup and Configuration: Implementing the system may require initial setup, data integration, and configuration efforts, which can be time-consuming and resource-intensive.

4. Dependency on Data Sources: The system relies on accurate and reliable data sources for energy consumption and related factors. Data availability and integration challenges may affect the system's performance and accuracy.

5. User Adoption and Behavior Change: The effectiveness of the system depends on user adoption and willingness to change energy consumption habits based on the system's recommendations. User resistance or lack of engagement may limit the system's impact.

Overall, the advantages of the Energy Consumption Analysis System include energy efficiency, data-driven insights, cost savings, environmental impact, and predictive analytics. However, challenges related to data privacy, data availability and accuracy, setup and configuration, dependency on data sources, and user adoption should be considered during system implementation and usage.

8. CONCLUSION

The Energy Consumption Analysis System is an advanced and reliable solution designed to analyze and predict energy consumption patterns in residential buildings. Through the utilization of machine learning algorithms and data analysis techniques, the system provides valuable insights and recommendations to homeowners and utility companies, enabling them to effectively manage their energy usage, reduce waste, and lower costs.

One of the key advantages of the system is its ability to improve energy efficiency. By analyzing data on energy consumption and related factors such as weather conditions, time of day, and occupancy, the system identifies patterns and trends that can help users optimize their energy usage. This not only leads to cost savings but also promotes a more sustainable approach to energy consumption.

The system operates by collecting and analyzing large volumes of energy consumption data. This data is then used to train machine learning models that can accurately predict future energy consumption based on various input parameters. By utilizing predictive analytics, the system enables proactive planning and resource allocation, allowing users to anticipate energy demands and make informed decisions.

Furthermore, the system offers data-driven insights that empower users to make informed decisions about their energy usage. By providing visualizations, reports, and recommendations, the system presents users with a clear understanding of their energy consumption patterns. This information can help identify energy-saving opportunities, highlight areas of improvement, and guide users towards more sustainable practices.

While the Energy Consumption Analysis System presents numerous advantages, it is important to address certain challenges. Data privacy is a critical concern, as the system requires access to personal energy consumption data. Robust security measures must be implemented to ensure the confidentiality and integrity of the data, protecting user privacy.

Additionally, the system relies on the availability and accuracy of data sources. Ensuring the data used for analysis is reliable and up-to-date is crucial for generating accurate predictions and recommendations. Data integration and data quality processes need to be in place to address any challenges related to data consistency and completeness.

In conclusion, the Energy Consumption Analysis System provides a comprehensive and reliable solution for analyzing and managing energy consumption in residential buildings. With its ability to improve energy efficiency, offer data-driven insights, and facilitate proactive decision-making, the system empowers users to reduce waste, lower costs, and contribute to a more sustainable future. However, addressing data privacy concerns and ensuring data availability and accuracy are essential for the successful implementation and adoption of the system.

9. FUTURE SCOPE

The Energy Consumption Analysis System has significant potential for future advancements and enhancements. Here are some areas that can be explored to further improve the system:

1. Integration with Smart Home Technology: The system can be integrated with smart home devices and automation systems to enable real-time monitoring and control of energy-consuming appliances. This integration would allow users to remotely manage their energy usage, receive alerts about energy-saving opportunities, and optimize energy consumption based on occupancy and user preferences.

2. Expansion to Commercial and Industrial Sectors: While the current system focuses on residential energy consumption, there is scope for expanding its application to commercial and industrial sectors. By adapting the algorithms and data analysis techniques to suit the specific energy profiles of businesses and industries, the system can provide insights and recommendations for optimizing energy usage in commercial buildings, factories, and other non-residential settings.

3. Renewable Energy Integration: The system can be extended to incorporate renewable energy sources such as solar panels and wind turbines. By analyzing energy production from renewable sources and correlating it with energy consumption patterns, the system can help users maximize their utilization of clean energy and reduce reliance on traditional energy sources.

4. Demand Response Management: Implementing demand response strategies can be a valuable addition to the system. By analyzing energy consumption patterns and considering factors like peak demand periods and electricity pricing, the system can help users optimize their energy usage and participate in demand response programs. This can result in cost savings and a more efficient utilization of the electrical grid.

5. Energy Efficiency Recommendations: Expanding the system to provide personalized energy efficiency recommendations can further empower users to adopt sustainable practices. By considering factors like user preferences, appliance efficiency ratings, and historical usage data, the system can suggest energy-saving measures tailored to individual users' needs.

6. Collaborations with Utility Companies: Collaborating with utility companies can enhance the system's capabilities. By accessing utility data and combining it with user-specific information, the system can provide more accurate predictions and recommendations. This collaboration can also facilitate the implementation of energy-saving incentives and programs offered by utility companies.

7. Continuous Model Training and Improvement: The system's machine learning models can be regularly retrained and updated with new data to improve prediction accuracy and adapt to changing consumption patterns. Continuous improvement of the models will ensure that the system remains effective and reliable over time.

In conclusion, the Energy Consumption Analysis System has a promising future with various avenues for further development. By exploring these future scopes, the system can continue to contribute to energy efficiency, sustainability, and cost savings for both residential and non-residential sectors.

10. APPENDIX

In the appendix section of the documentation, additional information and supporting materials related to the Energy Consumption Analysis System can be included. This section provides supplementary details that may be helpful for understanding and implementing the system. Here are some components that can be included in the appendix:

1. Data Collection and Preprocessing: Provide details about the sources of data used for training the machine learning models, including information on data collection methods, data formats, and any preprocessing steps applied to the data. This can include sample data records or data schemas.

2. Model Architecture and Algorithms: Include more technical information about the machine learning models used in the system, such as the architecture of the models, details about the algorithms employed, and hyperparameter settings. This can be useful for developers or data scientists who want to delve deeper into the technical aspects of the system.

3. User Interface Screenshots: Include screenshots or mockups of the user interface screens to provide a visual representation of how the system looks and functions. This can help readers understand the user experience and the various features available in the interface.

4. System Architecture Diagram: Provide a high-level system architecture diagram that illustrates the different components of the Energy Consumption Analysis System, including the data flow, integration points, and interactions between different modules or layers. This can give readers a clear overview of the system's structure and how different components are connected.

5. Code Snippets: Include relevant code snippets or snippets of configuration files that demonstrate important parts of the system's implementation. This can help developers understand specific implementation details and provide a starting point for further customization or modification of the system.

6. Performance Metrics: Present detailed performance metrics and evaluation results of the machine learning models used in the system. This can include metrics such as accuracy, precision, recall, and F1 score, along with any specific evaluation methodologies employed. This information provides insights into the effectiveness and reliability of the system.

7. User Guides and Documentation: Include user guides, tutorials, or documentation that provide step-by-step instructions on how to use the system, interpret the results, and configure system settings. This can help users or system administrators navigate the system and make the most of its features.

8. References and Citations: Include a list of references and citations for any external sources, research papers, frameworks, or libraries used in the development of the Energy Consumption Analysis System. This helps acknowledge the contributions of others and provides readers with additional resources for further exploration.

The appendix section should be organized in a structured and easily navigable manner, with clear headings and references to the main documentation for context. It serves as a supplementary resource for readers who require more detailed information about specific aspects of the system.

GITHUB LINK:-

https://github.com/naanmudhalvan-SI/PBL-NT-GP--21705-1683526942/tree/39becb27bea9d56b56bf2a3eb273d8f7c59563fb/Project/Final%20Deliverables

THANKYOU

A RELIABLE ENERGY CONSUMPTION ANALYSIS SYSTEM FOR ENERGY-EFFICIENT APPLIANCES