# Project Report Format

1. **INTRODUCTION**
   - **1.1 Project Overview**
     This project combines a VGG16 model with a Flask web app, allowing users to upload waste images and get instant classification results through a user-friendly UI.
   - **1.2 Purpose**
     The goal is to automate waste segregation, aiding smart city waste management and reducing environmental harm through proper classification.
2. **IDEATION PHASE**
   - **2.1 Problem Statement**
     Manual waste segregation is time-consuming, error-prone, and inefficient. There's a need for an automated, accurate, and real-time classification solution.
   - **2.2 Empathy Map Canvas**
     Initially, no predefined workflows existed. The system was built from scratch, identifying pain points in manual classification to derive a structured approach.
   - 2.3 **Brainstorming**
     Ideas centered around using image recognition models and web apps to make waste classification accessible, efficient, and adaptable for everyday use.
3. **REQUIREMENT ANALYSIS**
   - **3.1 Customer Journey map**
     Users upload an image via the web app → Image is analyzed by the model → Category prediction is shown → Informs user on disposal method.
   - **3.2 Solution Requirement**
     Requires an accurate model (VGG16), Flask backend, HTML/CSS frontend, a reliable dataset, and integration mechanisms between UI and ML model.
   - **3.3 Data Flow Diagram**
     User → UI (HTML) → Flask Server → VGG16 Model → Prediction Result → Display to User (UI).
   - **3.4 Technology Stack**

- **Front end**: HTML and CSS used to build user interface pages like index.html and result.html.

- **Back end**: Python with Flask handles model serving, routing, and HTTP requests for user inputs and predictions.

- **Model**: Pre-trained VGG16 CNN model used for image classification, fine-tuned on waste images from Kaggle.

- **Storage**: Model saved as vgg16.h5; image data handled during runtime with temporary storage through Flask.

- **Tools**: Anaconda, Jupyter Notebook, TensorFlow, Flask, NumPy, Pandas, Matplotlib, Seaborn, OpenCV.

4. **PROJECT DESIGN**
   - **4.1 Problem Solution Fit**

Problem of inefficient waste segregation is solved by automating classification using AI, offering speed and consistency**.**

### 4.2 Proposed Solution

Build a transfer learning-based model (VGG16) deployed via Flask to predict waste categories in real-time through a web interface**.**

### 4.3 Solution Architecture

UI (HTML) ↔ Flask Backend ↔ VGG16 Model ↔ Result Display; a simple client-server architecture integrated with deep learning**.**

## 5. PROJECT PLANNING & SCHEDULING

### 5.1 Project Planning

Steps include data collection, preprocessing, model building, training, testing, and app deployment, completed in defined milestones**.**

## 6. FUNCTIONAL AND PERFORMANCE TESTING

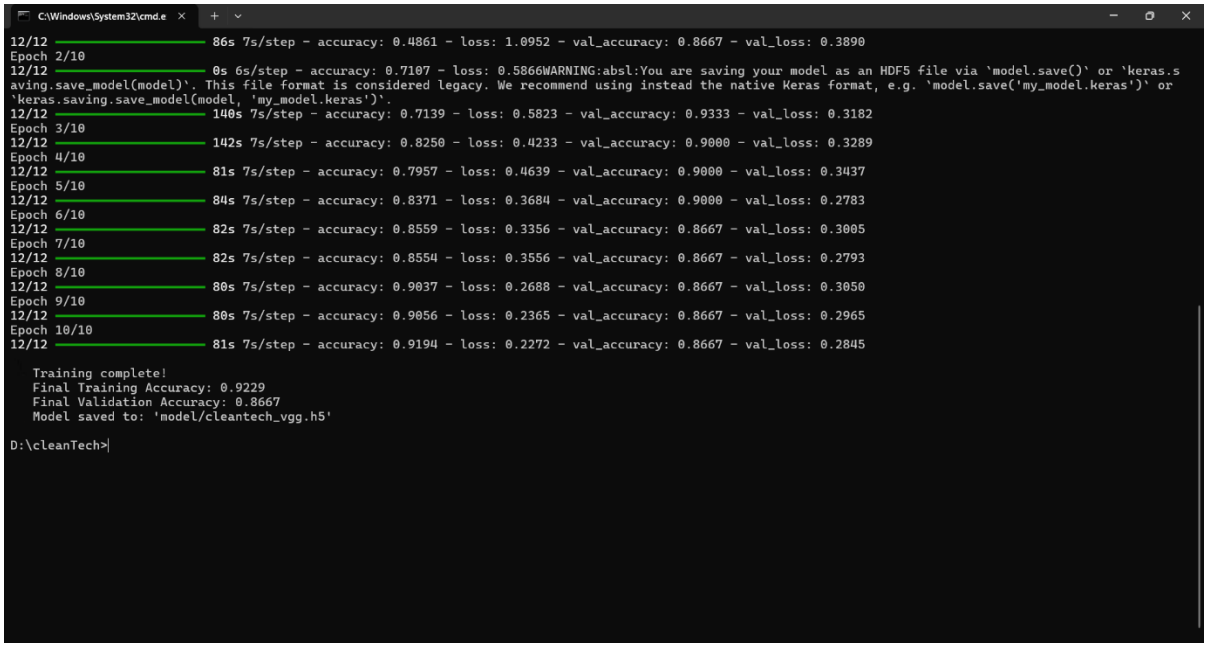
### 6.1 Performance Testing

Model performance evaluated using accuracy, loss curves, and test data; prediction speed and model response also tested**.**

## 7. RESULTS

The model successfully classified waste images with high accuracy, proving transfer learning's effectiveness on small datasets.

### 7.1 Output Screenshots




## 8. ADVANTAGES & DISADVANTAGES

**Advantages**:

- Fast and automated waste classification
- High prediction accuracy
- Easy web-based access

**Disadvantages**:

- Limited to 3 waste categories
- Performance may vary on poor-quality or ambiguous images

## 9. CONCLUSION

Clean Tech provides an efficient AI-based solution for automatic waste classification using transfer learning. It enhances accuracy and simplifies waste segregation.

## 10. FUTURE SCOPE

Future improvements include adding more waste categories and integrating the system with smart bins and mobile applications for broader usability**.**

## 11. APPENDIX

Source Code(if any)

Dataset Link

GitHub & Project Demo Link

https://github.com/kirran8/transforming-waste-management-with-transfer-learning/blob/main/project/index.html

https://github.com/kirran8/transforming-waste-management-with-transfer-learning/blob/main/project/glass_bottle.webp

https://github.com/kirran8/transforming-waste-management-with-transfer-learning

https://drive.google.com/file/d/1MfLTwax2BsGROR7QzAbILZLDgL7YS1Ub/view?usp=sharing