EcoPackAI – AI-Powered Sustainable Packaging Recommendation System

A PROJECT REPORT

submitted by

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Infosys Springboard Virtual Internship 6.0

Artificial Intelligence (AI) Domain

under the supervision of

Mentor

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Infosys Springboard

Internship Duration:

8 Weeks

Staring Date:

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Completion Date:

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Infosys Springboard Virtual Internship 6.0

CERTIFICATE

This is to certify that **Abrar H** has successfully completed the project titled **"EcoPack AI – AI Powered Sustainable Packaging Recommendation System"** as part of the **Infosys Springboard Virtual Internship (AI Domain)** during January 2026. The project work has been carried out under my guidance and supervision.

Guide Name: Mr. Shubham Lad

Date: 21/01/2026

DECLARATION

I hereby declare that the project entitled **"EcoPack AI – AI Powered Sustainable Packaging Recommendation System"** is an original work carried out by me, **Abrar H**, as part of the **Infosys Springboard Virtual Internship (AI Domain)** during **January 2026**, under the guidance and supervision of the concerned mentor.

Place: Kochi

Date: 21-01-2026

DEDICATION

To

My parents, Mentor and the eternal God.
Thank you for believing in us and encouraging us throughout.

Acknowledgement

I would like to express my sincere gratitude to **Infosys Springboard Virtual Internship Program** for providing this opportunity to work on an AI-based real-world project. I would also like to thank my mentor Mr. Shubham Lad for providing guidance and feedback throughout the project.

I am thankful to my mentor for their continuous support. This project helped me gain practical knowledge in **Machine Learning, Data Processing, Database Management, API Development, Dashboard Analytics, and Cloud Deployment.**

Name: Abrar H

Date: January 2026

ABSTRACT

The growing concern over environmental sustainability has highlighted the need for eco-friendly alternatives in packaging systems. Conventional packaging selection methods often prioritize cost and convenience, leading to excessive plastic usage and increased environmental impact. To address this challenge, **EcoPack AI – AI Powered Sustainable Packaging Recommendation System** has been developed as an intelligent, data-driven solution.

EcoPack AI is a web-based application that leverages artificial intelligence logic to recommend sustainable packaging materials based on user-defined requirements such as cost and environmental impact. The system processes inputs through a Flask-based backend, interacts with a cloud-hosted PostgreSQL database, and generates optimized packaging recommendations with higher eco-scores and cost efficiency. A Business Intelligence (BI) dashboard is also integrated to provide insights and visual analysis of recommendations and material usage.

The application is built using HTML, CSS, and Bootstrap for the frontend, Python and Flask for the backend, and PostgreSQL for database management. It follows a RESTful API architecture and is deployed on cloud platforms such as Render/Heroku. By promoting sustainable material selection, EcoPack AI assists businesses in reducing their carbon footprint while maintaining operational efficiency.

This project demonstrates the practical application of AI-driven decision support systems in sustainability-focused domains and highlights the role of technology in enabling environmentally responsible business practices.

Contents

1. Introduction

Environmental sustainability has become a critical concern for industries across the globe, particularly in the area of packaging. Traditional packaging solutions often rely on non-biodegradable materials such as plastics, which contribute significantly to environmental pollution and increased carbon footprints. Businesses face challenges in selecting packaging materials that balance sustainability, cost efficiency, and functionality.

EcoPack AI – AI Powered Sustainable Packaging Recommendation System is designed to address these challenges by providing intelligent, data-driven recommendations for eco-friendly packaging materials. The system leverages artificial intelligence logic and cloud-based technologies to assist businesses in making informed packaging decisions that reduce environmental impact while maintaining operational efficiency.

2. Problem Statement

Conventional packaging selection methods prioritize cost and availability over environmental sustainability. This results in excessive plastic usage, inefficient material choices, and limited awareness of eco-friendly alternatives. Additionally, organizations lack decision-support tools that provide data-backed insights into sustainable packaging options.

The problem addressed by this project is the absence of an intelligent system that recommends sustainable packaging materials based on business requirements, environmental impact, and cost considerations.

3. Objectives

3.1 Main Objectives

- To develop an AI-powered system for recommending sustainable packaging materials
- To reduce environmental impact by promoting eco-friendly alternatives
- To provide data-driven insights through dashboards and analytics
- To support informed decision-making for businesses using intelligent recommendations

4. Scope of the Project

4.1 In Scope

- Web-based application for packaging input and recommendations
- AI-driven logic for ranking sustainable packaging materials
- Integration with a cloud-hosted PostgreSQL database
- Business Intelligence dashboard for visualization and insights
- Deployment on cloud platforms such as Render/Heroku

4.2 Out of Scope (Future)

- Advanced machine learning model optimization
- Real-time integration with global sustainability datasets
- User authentication and role-based access control
- Mobile application support

5. System Requirements

5.1 Hardware Requirements

- Laptop or Desktop Computer
- Minimum 8 GB RAM
- Internet Connectivity

5.2 Software Requirements

- Operating System: Windows / Linux / macOS
- Programming Language: Python
- Backend Framework: Flask
- Frontend Technologies: HTML, CSS, Bootstrap
- Database: PostgreSQL (Cloud)
- Development Tools: VS Code, GitHub

6. Methodology

The project follows a modular and incremental development approach. User inputs are collected through a web interface and processed by a Flask backend API. The backend applies AI-based recommendation logic using stored data from a PostgreSQL cloud database. Results are displayed to users along with analytical insights via a BI dashboard.

7. Module-wise Implementation

7.1 Module 1: Data Collection and Management

This module involves collecting data related to packaging materials, including cost, eco-scores, and sustainability factors. The data is stored in a structured PostgreSQL database.

7.2 Module 2: Data Cleaning and Feature Engineering

Collected data is cleaned to remove inconsistencies and enhanced by generating meaningful features such as eco-rankings and cost-effectiveness scores.

7.3 Module 3: Dataset Preparation

Prepared datasets are structured to support efficient querying and recommendation generation by the backend system.

7.4 Module 4: ML Prediction Models and Ranking System

AI-driven logic is used to rank packaging materials based on environmental impact and cost constraints, ensuring optimal recommendations.

7.5 Module 5: Flask Backend API

This module handles request processing, database interaction, and recommendation logic through RESTful API endpoints.

7.6 Module 6: Frontend UI

A user-friendly web interface is developed using HTML, CSS, and Bootstrap to capture user inputs and display recommendations.

7.7 Module 7: Business Intelligence Dashboard

The BI dashboard provides visual insights into material usage, eco-scores, and recommendation trends to support strategic decision-making.

7.8 Module 8: Deployment and Documentation

The application is deployed on cloud platforms such as Render/Heroku, and comprehensive documentation is prepared for installation, usage, and future enhancements.

8. Machine Learning Models and Results

This project incorporates supervised machine learning models to predict packaging cost and carbon emission values, which are later used for intelligent ranking and recommendation. Separate models were trained and evaluated to ensure accuracy and reliability in decision-making.

8.1 Evaluation Metrics

The performance of the machine learning models was assessed using standard regression evaluation metrics:

- **Root Mean Squared Error (RMSE):** Measures the average magnitude of prediction error
- **Mean Absolute Error (MAE):** Calculates the average absolute difference between actual and predicted values
- **R^2 Score:** Indicates how well the model explains the variance in the target variable

8.2 Model Performance Results

Random Forest Model (Cost Prediction):

- RMSE: 0.03425175
- MAE: 0.01396171
- R^2 Score: 0.98610537

XGBoost Model (CO_2 Emission Prediction):

- RMSE: 0.00118505
- MAE: 0.00099652
- R^2 Score: 0.99998250

The results indicate that both models achieved high prediction accuracy, validating their effectiveness for sustainable packaging recommendation and ranking.

9. Backend API Implementation

The backend of EcoPack AI is implemented using the Flask framework and follows a RESTful architecture. It handles user input processing, model inference, database interaction, and response generation.

9.1 API Endpoints

Method	Endpoint	Description
GET	/	Backend service status check
POST	/materials	Generates best packaging recommendation along with ranking

10. Frontend User Interface Implementation

The frontend of the application is developed using HTML, CSS, and JavaScript to provide an intuitive and responsive user experience. It enables users to input product parameters and view intelligent recommendations.

Key UI components include:

- Input form for product specifications
- Display of the best recommended packaging option
- Tabular view showing ranked packaging alternatives

11. Deployment

The complete EcoPack AI system has been deployed on the Render cloud platform to ensure accessibility and scalability.

Deployment details include:

- Flask backend deployed as a Render Web Service
- Cloud-hosted MySQL database integration
- End-to-end system testing and verification in a live environment

12. Conclusion

EcoPack AI successfully demonstrates the practical implementation of artificial intelligence in promoting sustainable packaging solutions. The project integrates data preprocessing, high-performance machine learning models, AI-based ranking logic, and full-stack web development.

The system effectively combines a Flask backend, user-friendly frontend interface, BI dashboard analytics, and cloud deployment to deliver an intelligent decision-support platform for environmentally responsible packaging selection.

13. Future Enhancements

The project can be further extended with the following enhancements:

- Introduction of additional API endpoints for separate cost and CO_2 analysis
- User authentication and storage of recommendation history
- Advanced BI dashboard features such as filters and downloadable PDF reports
- Development of a mobile application for wider accessibility

14. References

- Infosys Springboard Training Materials
- Scikit-learn Documentation: https://scikit-learn.org/
- XGBoost Documentation: https://xgboost.readthedocs.io/
- Flask Documentation: https://flask.palletsprojects.com/
- MySQL Documentation: https://dev.mysql.com/doc/
- Render Documentation: https://render.com/docs