ISSN 2277-2685
IJESR/April-June. 2025/ Vol-15/Issue-2s/1412-1419
A S C L S Sruthi *et. al.*, / International Journal of Engineering & Science Research

Sustainascan: Smarter Shopping For A Sustainable Future

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Abstract

The rise in environmental concerns and consumer awareness has amplified the demand for sustainable shopping practices. However, identifying eco-friendly products based on their ingredients and environmental impact remains a challenge for everyday consumers. Traditional methods of assessing product sustainability require extensive research and lack real-time accessibility. The proposed work introduces *SustainaScan*, a web-based assistant that leverages Artificial Intelligence (AI) and Machine Learning (ML) techniques to automatically evaluate the sustainability of consumer goods. By utilizing image-based ingredient recognition and ECOSCORE computation, the system assesses carbon footprint, biodegradability, and toxicity levels to provide users with a clear sustainability rating. The platform also suggests environmentally preferable alternatives and redirects users to verified purchase sources. Various classification and scoring algorithms have been applied and tested for accuracy, precision, recall, and user impact. Despite the advancements, challenges persist in dataset completeness, OCR accuracy, and integrating real-time scanning capabilities. Future work aims to enhance model scalability and improve cross-platform deployment to broaden accessibility and effectiveness in promoting sustainable consumer behavior.

Index Terms—Sustainable Shopping, Artificial Intelligence (AI), Machine Learning (ML), ECOSCORE, Environmental Impact, Ingredient Recognition.

I INTRODUCTION

SustainaScan is an AI-driven eco-conscious shopping assistant developed to promote sustainable consumer habits by enhancing awareness of product-level environmental impact. In today's retail landscape, consumers often face challenges in identifying whether a product aligns with eco-friendly standards, especially in terms of carbon footprint, toxicity, and biodegradability. Conventional e-commerce platforms rarely provide transparency regarding these factors, making it difficult for users to make informed and responsible choices. SustainaScan addresses this challenge by enabling users to scan product images and receive an environmental assessment through a proprietary ECOSCORE.

The system extracts product ingredients using Optical Character Recognition (OCR), analyzes them through a backend powered by Python and

machine learning algorithms, and generates an ECOSCORE reflecting sustainability criteria. Users are also presented with greener alternative products, encouraging eco-friendly substitutions. Designed with Indian consumers in mind and focused on India-made products, the platform leverages React for its user-friendly frontend and MySQL for structured data storage. By simplifying access to sustainability insights, SustainaScan empowers users to adopt more responsible shopping practices. The system is particularly relevant for use in personal care, household, and lifestyle categories, and represents a scalable solution for promoting environmental awareness through technology.

Table 1. ECOSCORE grading used to classify products into sustainability tiers.

Score Range	Sustainability Class	Description
81 – 100	Excellent	Highly eco-friendly product with low carbon footprint, non-toxic, and biodegradable ingredients.
61 – 80	Good	Moderately sustainable product with minor environmental impact.
41 – 60	Average	Acceptable product with some environmental concerns, but within limits.
21 – 40	Poor	Product with significant negative impact due to toxic or non-biodegradable components.
0 – 20	Harmful	Highly unsustainable product with major environmental hazards.

The table 1 provides the ECOSCORE classification criteria, which is a grading system used to categorize products based on their environmental sustainability.

II LITERATURE SURVEY

Optical Character Recognition (OCR) is a critical technology for extracting textual information from product images, enabling automated analysis of ingredients and labels. Open-source tools like Tesseract have demonstrated effective performance in recognizing printed text in diverse languages and packaging styles, making them suitable for real-time product data extraction in shopping applications.

In the domain of environmental impact assessment, composite scoring systems such as ECOSCORE simplify complex sustainability indicators—including carbon footprint, toxicity, and biodegradability—into user-friendly metrics. Prior

studies have shown that combining these environmental factors into a single score aids consumers in quickly understanding the ecological implications of their purchases.

Machine learning approaches have been used to predict and aggregate sustainability scores based on ingredient data and associated environmental attributes. Python-based frameworks like TensorFlow allow the integration of datasets related to chemical toxicity, biodegradability, and carbon emissions, facilitating accurate scoring and ranking of consumer products.

Recommendation systems that suggest greener alternatives rely on similarity measures between product features and sustainability scores. By guiding users toward eco-friendly options, these systems help promote sustainable consumer behavior, which is especially relevant in regions with increasing environmental awareness.

SustainaScan leverages these advances by integrating OCR for ingredient extraction, AI-driven environmental scoring, and alternative product recommendations, creating an end-to-end solution tailored for Indian-made products. This focused approach addresses the lack of transparent sustainability information on typical e-commerce platforms and supports responsible shopping decisions.

III METHODOLOGY

The proposed architecture in Figure. 1 illustrates the complete workflow of SustainaScan, an AI-driven system for promoting sustainable shopping by analyzing product ingredients and suggesting eco-friendly alternatives.

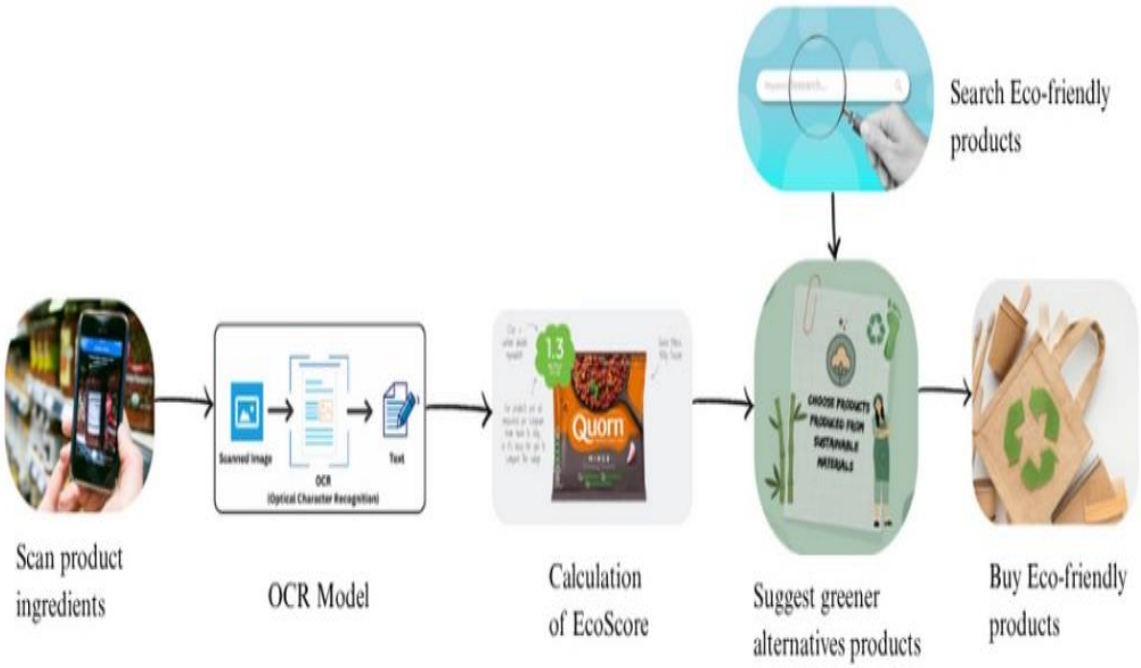

Figure 1. General Workflow of AI-Powered Sustainable Product Evaluation and Recommendation

The architecture of SustainaScan consists of six interconnected components that collectively enable the detection of environmentally harmful products and promote greener alternatives through a user-friendly workflow.

A. *Scan Product Ingredients*

Users initiate the process by scanning the ingredients label on a product using their

smartphone camera. The image serves as the primary input for downstream analysis.

B. *OCR Model*

The captured image is processed by the OCR (Optical Character Recognition) module, powered by the Tesseract OCR engine, which extracts textual data—primarily ingredients—from the product label.

C. *Calculation of EcoScore*

The extracted ingredients are analyzed against a predefined environmental database. Each component is evaluated based on three key sustainability criteria:

- Carbon Footprint
- Toxicity
- Biodegradability

These values are aggregated into a single numeric value called the EcoScore, which reflects the product's overall environmental impact.

D. *Suggest Greener Alternatives*

Products with poor EcoScores trigger the recommendation engine, which searches for and suggests alternative products with better EcoScores in the same category. These suggestions prioritize sustainability and are filtered based on similar usage or product type.

E. *Search Eco-Friendly Products*

Users can also use the search interface to browse products with high EcoScores directly, facilitating conscious choices without requiring image input.

F. *Buy Eco-Friendly Products*

Once the user selects a product, they can proceed to buy it either through external partner platforms or a built-in order summary feature, depending on implementation. The aim is to encourage responsible consumption by providing clear sustainability metrics at the decision point.

This streamlined methodology promotes awareness and accessibility for eco-conscious shopping, offering real-time insights through automation and AI.

IV. IMPLEMENTATION

A. Technologies Used

The SustainaScan platform leverages a modern web development stack to provide an intuitive and efficient eco-friendly shopping experience. The frontend is developed using HTML, CSS, and JavaScript, offering users a responsive interface to browse and interact with products. React.js is employed for component-based UI development. The backend is powered by Python, which handles ingredient extraction, ECOSCORE calculation, and alternative product recommendations. MySQL serves as the primary database, storing product details, environmental metrics, and user data. The image scanning feature uses Optical Character Recognition (OCR) through the Tesseract library to extract ingredients from uploaded product images. These ingredients are then processed using a custom algorithm that evaluates the carbon footprint, toxicity, and biodegradability of each component. Additionally, product translations and alternative suggestions are facilitated through a pre-defined mapping of eco-friendly options. The platform can redirect users to external sellers for product purchases, ensuring a seamless shopping experience without handling inventory directly.

B. Algorithms

The SustainaScan system relies on three core algorithmic processes: image-to-text conversion, ECOSCORE computation, and alternative recommendation generation.

The first algorithm uses Optical Character Recognition (OCR) to extract ingredient text from product label images. Preprocessing techniques such as grayscale conversion, binarization, and noise filtering enhance the accuracy of the OCR process. The Tesseract engine is then used to convert the visual content into structured text.

The second algorithm focuses on calculating the ECOSCORE for each product. This score is based on three environmental impact factors: carbon footprint (CF), toxicity (T), and biodegradability (B). The process is as follows:

- To compute total carbon footprint as:

$$\text{Total Product Carbon Footprint (Cf)} = \sum_{i=1}^{n}(Weight(i)\ X\ CEF(i))$$

Where:

Weight(i) = amount of ingredient *i* used

CEF(i) = carbon emission factor of that ingredient

- To compute total toxicity as:

$$\text{Total Product Toxicity (T)} = (\sum(Quantity\ used\ X\ toxicity\ factor)\ X\ 10)$$

- To compute total biodegradability as:

$$\text{Total Product Biodegradability (B)} = \sum(Quantity\ used\ X\ biodegradability\ factor)$$

- To calculate the final eco score:

$$\text{EcoScore} = Wc \cdot Cf + Wt \cdot T + Wb \cdot B$$

Where:

Cf = Total Product Carbon Footprint Score (0–100)

T = Total Product Toxicity Score (0–100)

B = Total Product Biodegradability Score (0–100)

Wc, Wt, Wb Weights for carbon footprint, toxicity, and biodegradability respectively.

This formula ensures that higher carbon footprint and toxicity reduce the score, while higher biodegradability improves it. A higher ECOSCORE indicates a more environmentally friendly product.

The third algorithm involves suggesting alternative products. The system filters the database for products in the same category with lower ECOSCOREs. Keyword matching and category-based filtering help identify and recommend more sustainable substitutes, enhancing eco-conscious consumer decisions.

V RESULTS

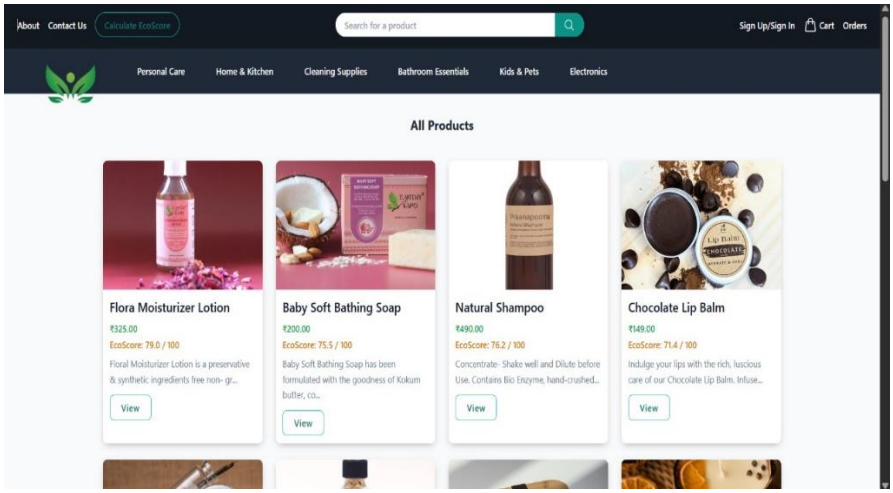

Figure 2. Home Page Displaying Eco-Conscious Products with EcoScore Insights

The result in Figure 2 showcases the home page of the eco-friendly shopping assistant, offering a seamless browsing experience for sustainable consumer products. The platform prominently displays a curated list of items along with their EcoScore—a quantified measure of environmental sustainability out of 100. Products such as the Flora Moisturizer Lotion (EcoScore: 79.0/100) and Natural Shampoo (EcoScore: 76.2/100) are featured for their favorable environmental attributes, including low toxicity and high biodegradability. This real-time EcoScore visibility helps users identify and compare eco-friendly alternatives at a glance, empowering them to make greener purchasing decisions. The user-centric design also includes category navigation, search functionality, and access to features like "Calculate EcoScore," ensuring a comprehensive and informative shopping journey.

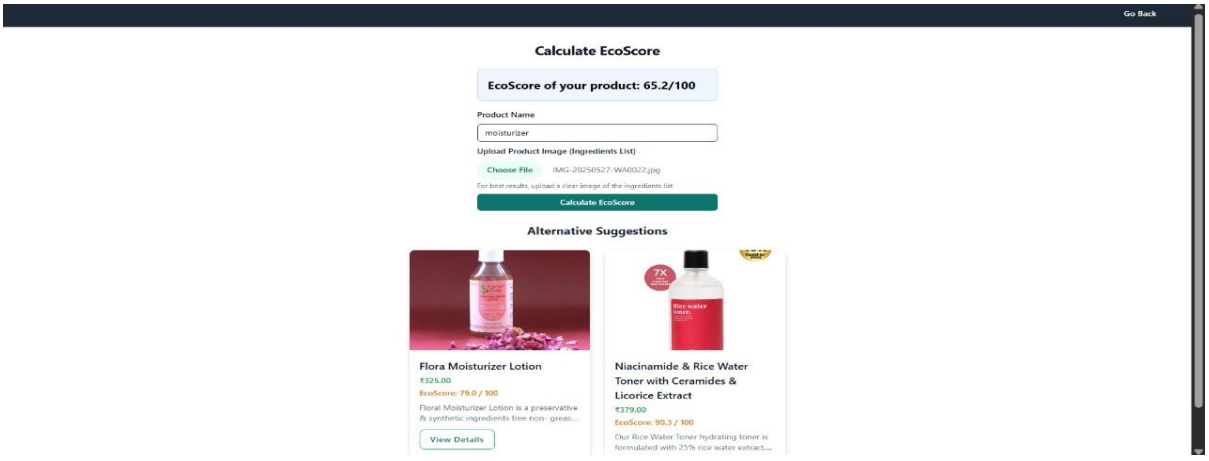

Figure 3. EcoScore Calculation and Sustainable Product Alternatives

The result in Figure.3 depicts Eco-Friendly Insight, the calculated EcoScore of 65.2/100 for the uploaded *moisturizer* indicates a moderate level of sustainability. Alternative products such as Flora Moisturizer Lotion and Niacinamide & Rice Water Toner offer higher EcoScores of 79.0/100 and 90.3/100 respectively, signifying better environmental performance. These products

demonstrate improved biodegradability, reduced carbon footprint, and safer ingredient profiles—emphasizing how thoughtful ingredient choices contribute to a more eco-conscious lifestyle.

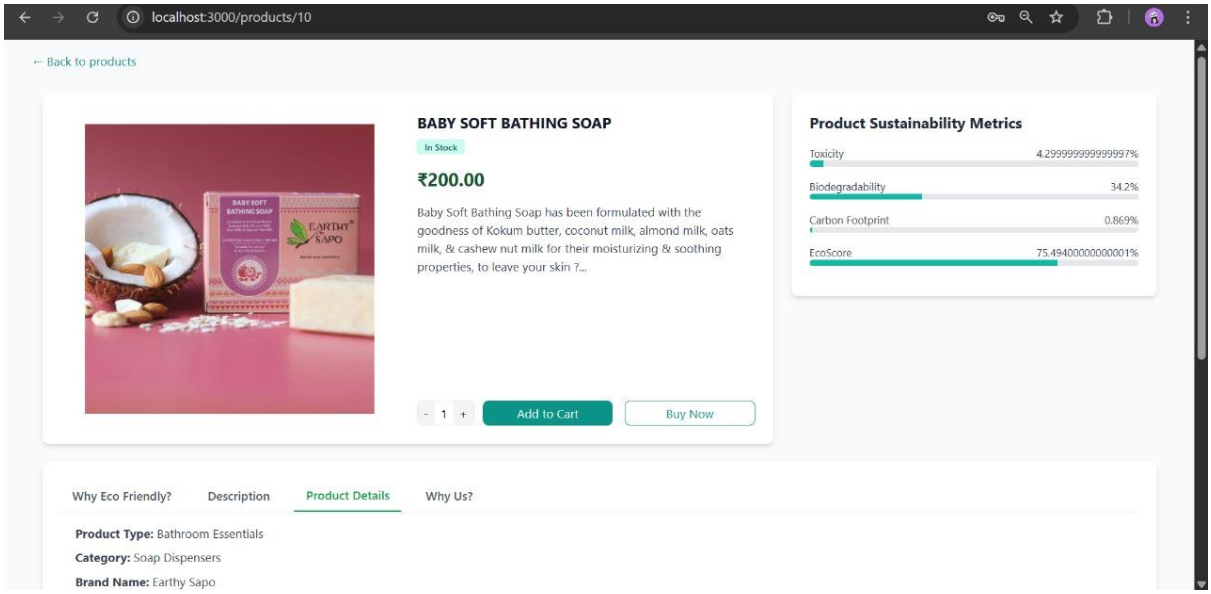

Figure 4. Detailed View of Product with Sustainability Metrics

The result in Figure 4 presents the detailed product view page, offering an in-depth look into the sustainability profile of the selected item—Baby Soft Bathing Soap. Priced at ₹200, the product is enriched with natural ingredients such as kokum butter, coconut milk, and almond milk, emphasizing its skin-friendly and eco-conscious formulation. The right-hand panel features key Product Sustainability Metrics, including Toxicity (4.29%), Biodegradability (34.2%), and Carbon Footprint (0.869%), culminating in an EcoScore of 75.49/100, which reflects its moderate sustainability level.

VI CONCLUSION

The research highlights the potential of intelligent web applications in promoting sustainable consumer behavior by leveraging machine learning and ingredient analysis for eco-friendly product recommendations. A labeled dataset of product ingredients and environmental impact factors was analyzed using a custom ECOSCORE model that evaluates carbon footprint, toxicity, and biodegradability. Results indicated that image-based ingredient extraction combined with score-based alternatives significantly improved users' ability to make informed, eco-conscious purchasing decisions. Compared to conventional shopping platforms, this approach offered better transparency and awareness regarding environmental impact. The system proved efficient in guiding users toward sustainable alternatives while reducing reliance on manual product evaluation. Future work should focus on integrating advanced deep learning models for more accurate OCR and ingredient classification, and deploying the solution as a real-time mobile or browser-based extension to improve accessibility and usability across broader demographics.

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