VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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MINI PROJECT(BCS586)

SYNOPSIS

ON

“AI-Driven Sustainable Material Selection and Waste Optimization in Construction”

Submitted in the partial fulfilment for the award of degree

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Computer Science and Engineering

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AI-Driven Sustainable Material Selection and Waste Optimization in Construction

1. Introduction:

1.1 Background

The construction and design industries are among the largest consumers of raw materials globally, accounting for nearly 50% of resource use and generating significant waste. Traditional material selection prioritizes cost and performance but often overlooks sustainability factors, leading to excessive waste and high embodied carbon.

1.2 Current Industry Challenges

Conventional methods lack the ability to balance multiple criteria: such as cost, performance, and sustainability simultaneously. As a result, project managers face inefficiencies in material selection, waste estimation, and lifecycle carbon assessment.

1.3 Technology Integration Opportunity

Recent advances in artificial intelligence and optimization algorithms provide opportunities to revolutionize how materials are chosen, how waste is minimized, and how projects are planned. By embedding these tools into a digital platform, construction professionals can make more data-driven, sustainable, and cost-efficient decisions.

2. Problem Statement:

Material selection and waste management in construction projects are hindered by a lack of intelligent decision-support tools. Current design software fails to:

• Integrate sustainability metrics (e.g., embodied carbon, recyclability).
• Provide predictive waste analysis.
• Balance multi-criteria trade-offs (sustainability, cost, performance).
• Forecast environmental and timeline impacts.

This results in higher costs, environmental harm, and inefficiencies in construction workflows.

3. Objectives:

1. AI-Powered Material Recommendation: Develop a multi-criteria decision analysis (MCDA) engine to rank materials by sustainability, cost, and performance.

2. Waste Optimization Algorithms: Implement cutting stock–based algorithms to minimize leftover materials and estimate cost savings.

3. Carbon Footprint Calculator: Estimate embodied carbon from material choices and construction processes.

4. Construction Timeline Forecasting: Provide predictive timelines based on project complexity, materials, and labor factors.

5. Circular Economy Integration: Encourage the use of recyclable and low-carbon materials in project decisions.

4. Proposed Methodology:

4.1 AI-Powered Recommendation Engine

Uses weighted scoring models to evaluate materials across sustainability (40%), cost (30%), and performance (30%). Ranks and suggests the top-performing materials for each project type.

4.2 Waste Optimization

Employs First-Fit Decreasing cutting stock algorithm to minimize waste. Calculates potential savings in INR and generates optimized cutting plans.

4.3 Carbon Footprint Calculator

Computes embodied carbon for selected materials. Breaks down contributions by flooring, concrete, tiles, doors, and windows. Adds construction-phase emissions (~15%).

4.4 Timeline Forecasting

Estimates project duration (6–24 months) based on area, floors, and material complexity. Produces a phased schedule (foundation, structure, finishing).

4.5 Integrated Platform (FastAPI + React)

Backend (FastAPI): Hosts APIs for recommendations, optimization, carbon calculation, and timeline forecasting.

Frontend (React): Provides a user-friendly interface for material selection, analytics dashboards, and project tracking.

5. Expected Outcomes:

- Reduction in material waste via algorithmic optimization.
- Transparent visibility of embodied carbon and sustainability scores.
- Balanced decision-making using multi-criteria evaluation.
- Predictive insights into project timelines and costs.
- A digital tool promoting circular economy principles in construction.

References:

1. Zhang, X. and Liu, Y. – AI-Enhanced Material Selection Framework for Sustainable Construction, Journal of Cleaner Production, Elsevier, 2023.
2. Lee, H. and Patel, N. – Intelligent Material Selection Using Multi-Criteria Decision Analysis in Sustainable Architecture, Building and Environment, Elsevier, 2023.
3. Thompson, R. and Chen, L. – AI-Driven Material Optimization for Green Building Construction, Sustainable Cities and Society, Elsevier, 2023.