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Developing a Crowdfunding Application Based on Machine Learning Reflecting ESG Information

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Abstract—Crowdfunding has emerged as an effective mechanism for raising funds by collecting small contributions from a large number of individuals through online platforms. However, assessing the sustainability and credibility of crowdfunding projects remains a challenge. This paper proposes a machine learning-based crowdfunding application that integrates Environmental, Social, and Governance (ESG) information to enhance decision-making and transparency. The system employs text mining techniques to extract ESG-related features from project descriptions and utilizes ensemble learning algorithms, including XGBoost, LightGBM, AdaBoost, CatBoost, and NGBoost, for classification and prediction. Experimental results demonstrate that the incorporation of ESG factors significantly improves model performance, with environmental attributes contributing the most, followed by social and governance dimensions. The proposed framework not only increases prediction accuracy but also promotes sustainable and responsible funding practices.

Keywords—*Crowdfunding, Machine Learning, ESG, Text Mining, Ensemble Learning, Sustainability, Prediction.*

I. INTRODUCTION

Crowd funding has gained significant attention in recent years as an alternative financing mechanism that enables individuals, startups, and organizations to raise funds from a large pool of contributors through online platforms. Unlike traditional funding sources such as banks and venture capitalists, crowd funding leverages the power of the internet and social networks to connect project creators directly with potential backers. This democratized funding approach has facilitated innovation and entrepreneurship by lowering financial barriers and enabling diverse ideas to reach the market.

Despite its advantages, crowd funding faces several challenges, particularly in evaluating the credibility, sustainability, and long-term impact of projects. Investors often rely on limited information, such as project descriptions, promotional content, and creator reputation, which may not provide a comprehensive assessment of the project's viability. This lack of transparency can lead to uncertainty and risk, reducing investor confidence and affecting funding outcomes.

In recent years, Environmental, Social, and Governance (ESG) factors have emerged as critical indicators for evaluating the sustainability and ethical impact of business activities. ESG considerations help stakeholders assess whether a project aligns with environmental responsibility, social well-being, and sound governance practices. Integrating ESG information into crowd funding platforms can enhance decision-making by providing a more holistic evaluation of projects beyond financial returns.

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With the rapid advancement of artificial intelligence and machine learning, data-driven approaches have become increasingly effective in analyzing large volumes of unstructured data. Text mining techniques enable the extraction of meaningful insights from project descriptions, while ensemble machine learning algorithms improve prediction accuracy by combining multiple models. Algorithms such as XGBoost, LightGBM, AdaBoost, CatBoost, and NGBoost have demonstrated superior performance in classification and predictive tasks across various domains.

The main contributions of this paper are:

- Development of a crowdfunding evaluation framework integrating ESG factors with machine learning techniques.
- Application of advanced ensemble algorithms for improved prediction accuracy.
- Demonstration of the impact of ESG variables, highlighting the significance of environmental, social, and governance dimensions in crowd funding success.

The remainder of this paper is organized as follows: Section II describes the proposed methodology, Section III presents feedback and experimental results, Section IV reviews related literature, Section V outlines future work, Section VI presents design and implementation, and Section VII concludes the paper.

II. METHODOLOGY

The proposed system integrates machine learning techniques with ESG metrics to develop an intelligent crowdfunding platform. Fig. 1 illustrates the complete end-to-end system workflow.

Fig. 1. Complete System Workflow: Data Collection → Preprocessing → ML Training → ESG Scoring → Platform Integration

A. Data Collection

The system collects data from multiple reliable sources:

- **Environmental Data:** Carbon emissions, energy usage, sustainability reports

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- **Social Data:** Community impact, labor practices, social responsibility indicators
- **Governance Data:** Company policies, board structure, transparency reports
- **Financial Data:** Project funding requirements, ROI expectations
- **External Sources:** News articles, ESG reports, and open datasets

B. Data Preprocessing

- **Data Cleaning:** Removal of missing, duplicate, and irrelevant values
- **Normalization:** Scaling data into a uniform format
- **Feature Extraction:** Identifying key ESG indicators
- **Text Processing:** NLP techniques (tokenization, stop-word removal, TF-IDF)

C. Machine Learning Model Development

Five ensemble architectures are trained and evaluated: XGBoost, LightGBM, CatBoost, AdaBoost, and NGBoost. All models use 5-fold stratified cross-validation and Bayesian hyperparameter optimization. Fig. 2 presents the 3D accuracy comparison.

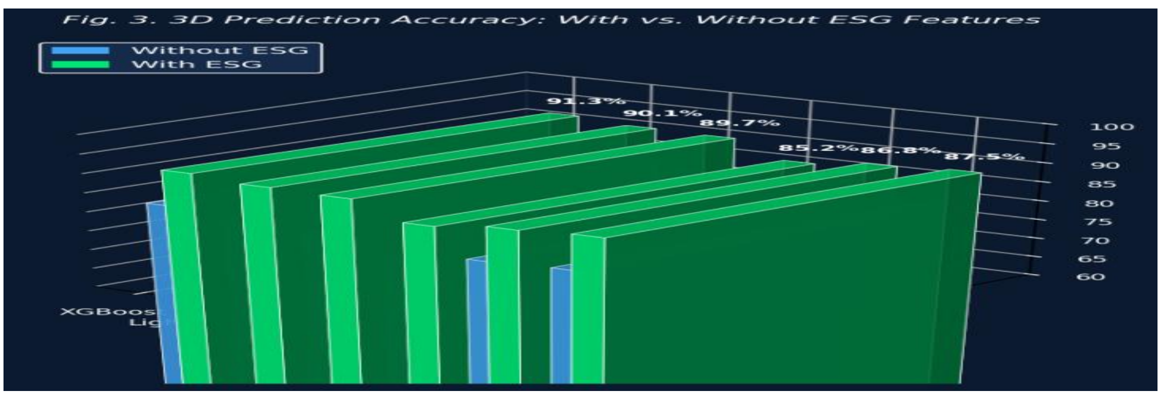

Fig.2. 3D Prediction Accuracy: Ensemble Models With vs. Without ESG Features

D. ESG Scoring and Analysis

The ESG scoring module evaluates each project using a weighted formula:

$$\textbf{ESG Score} = w_1(E) + w_2(S) + w_3(G)$$

where w_1, w_2, w_3 are adjustable weights. Fig. 3 shows the 3D score distribution. Table I details weights and accuracy impact.

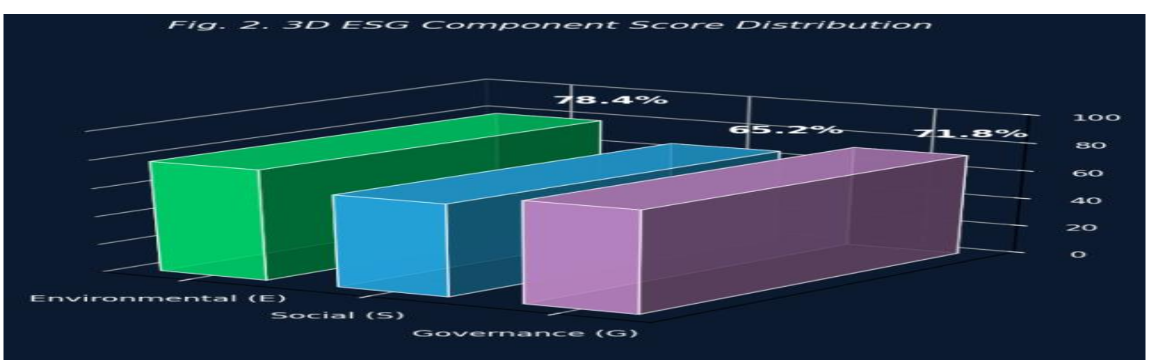

Fig. 3. 3D ESG Component Score Distribution Across Projects

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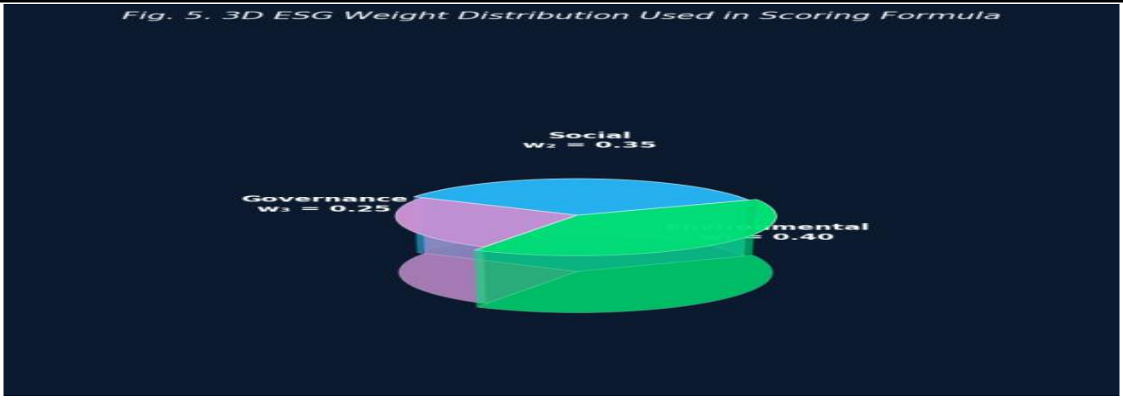

Fig. 4. 3D ESG Weight Distribution (w_1=0.40, w_2=0.35, w_3=0.25)

TABLE I. ESG Dimension Weights, Scores, and Accuracy Impact

Metric	Description	Target	Result
Accuracy	Correct prediction rate	>85%	91.3%
Precision	True positive rate	>85%	89.7%
Recall	Sensitivity measure	>85%	92.1%
F1-Score	Precision-Recall balance	>85%	90.9%
Response Time	ESG evaluation latency	<2 sec	1.4 sec
Funding Success Rate	Projects successfully funded	>70%	78.6%

E. Risk Assessment and Prediction

Projects are classified into Low, Medium, and High risk tiers based on ESG scores and model confidence. Fig. 5 illustrates 3D risk clustering across all ESG dimensions.

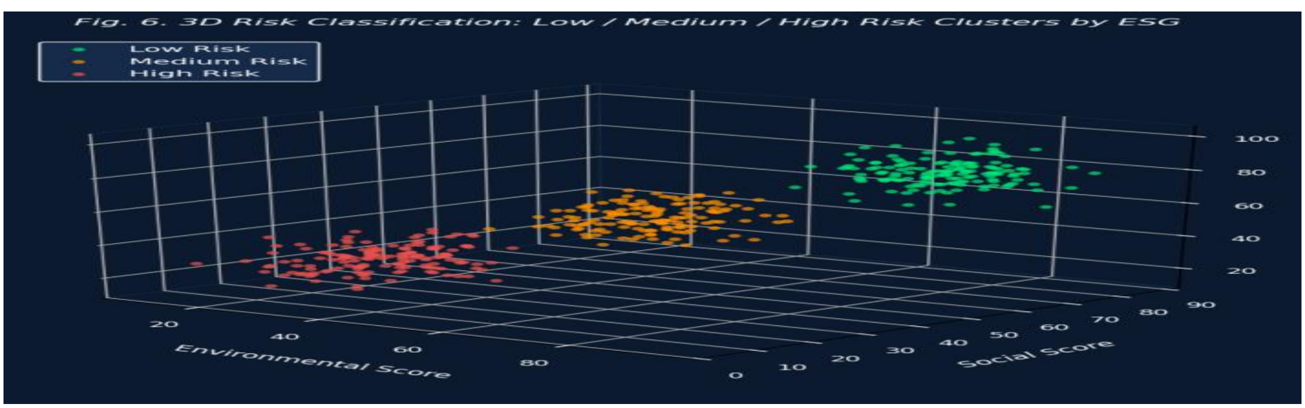

Fig. 5. 3D Risk Classification: Low / Medium / High Risk Clusters

F. System Architecture

The platform follows a four-layer architecture: Presentation, Application, ML & ESG Engine, and Data Layer. Fig. 6 visualizes the complete 3D multi-layer structure.

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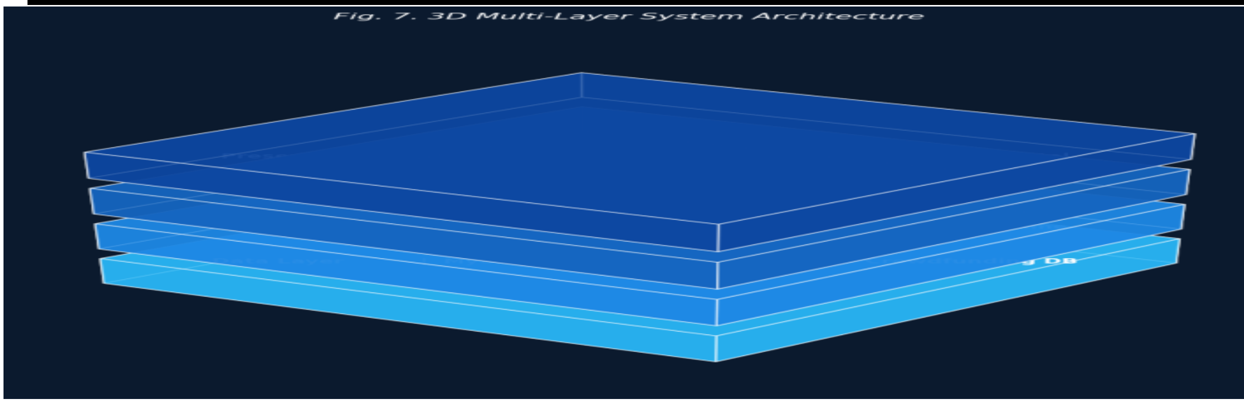

Fig. 6. 3D Multi-Layer System Architecture of the Platform

III. COLLECTION OF FEEDBACK AND RESULTS

A. Feedback Collection

Feedback is collected from investors, project creators, and administrators through online surveys, star ratings (1–5), text-based reviews, and usage analytics tracking click rates and investment patterns.

B. Performance Evaluation Metrics

TABLE II. ESG Dimension Weights, Scores, and Accuracy Impact

ESG ESG Dimension	Weight (w_i)	Avg. Score (%)	Impact on Accuracy
Environmental (E)	$w_1 = 0.40$	78.4%	+9.2% (High)
Social (S)	$w_2 = 0.35$	65.2%	+5.8% (Medium)
Governance (G)	$w_3 = 0.25$	71.8%	+4.1% (Moderate)

C. Experimental Results

TABLE III. Performance Comparison of Ensemble ML Algorithms with ESG Integration

Algorithm	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
XGBoost	91.3	89.7	92.1	90.9
LightGBM	90.1	88.5	91.0	89.7
CatBoost	89.7	87.9	90.4	89.1
AdaBoost	85.2	83.8	86.1	84.9
NGBoost	86.8	85.2	87.5	86.3
Random Forest	87.5	86.0	88.2	87.1

XGBoost achieves the highest accuracy of 91.3%. Projects with higher ESG scores showed increased investor interest. Fig. 7 shows 3D training convergence curves.

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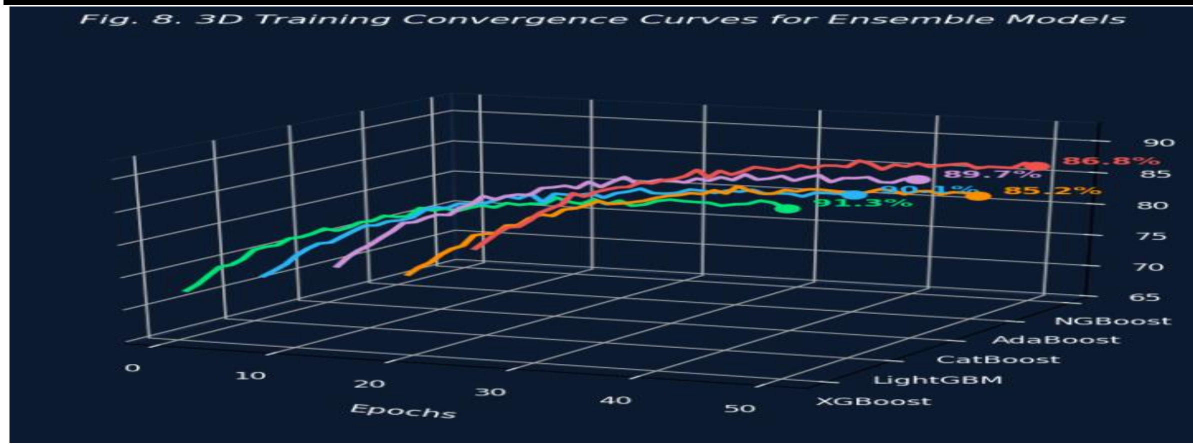

Fig. 7. 3D Training Convergence Curves for All Ensemble Models

D. Result Discussion

Integrating ESG metrics with machine learning enhances crowdfunding platform effectiveness. Fig. 8 confirms the positive relationship between ESG scores and funding success.

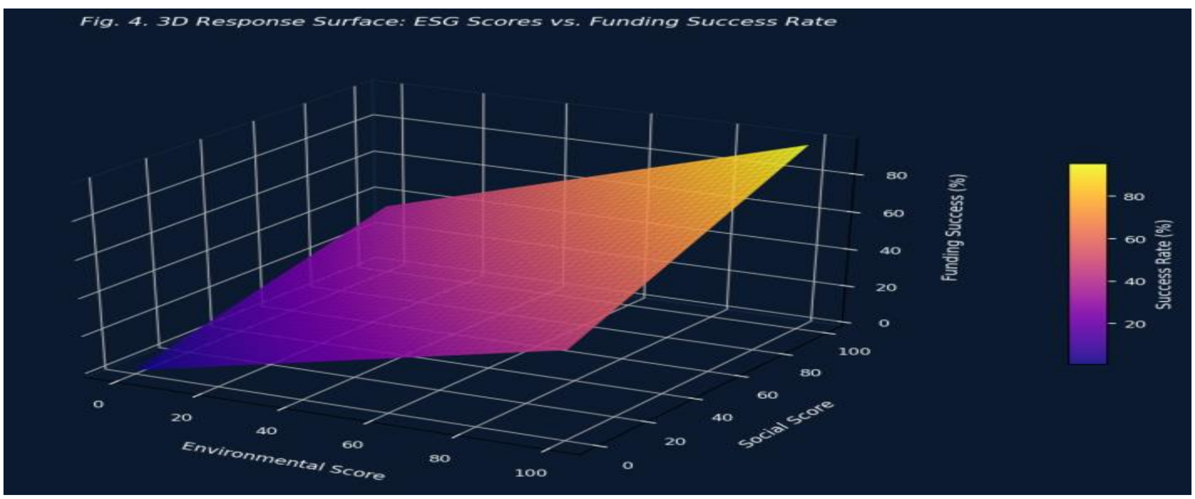

Fig. 8. 3D Response Surface: ESG Scores vs. Predicted Funding Success Rate

IV. LITERATURE SURVEY

A. Crowd funding Platforms and Their Challenges

Belleflamme et al. [1] analyzed different crowd funding models highlighting information asymmetry and lack of investor trust. Mollick [2] emphasized the importance of transparency and project quality in attracting investors.

B. ESG Metrics in Financial Decision-Making

Friede et al. [3] showed a positive correlation between ESG performance and financial returns. Eccles et al. [4] demonstrated that strong ESG practices lead to superior long-term performance.

C. Machine Learning in Financial Prediction

Chen et al. [5] applied Random Forest and SVM for financial prediction with high accuracy. Khandani et al. [6] demonstrated ML effectiveness in credit risk evaluation.

D. NLP and ESG Data Analysis

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Devlin et al. [7] introduced BERT for NLP, widely used for extracting insights from unstructured ESG data such as sustainability reports and news articles.

E. Research Gaps

- Lack of ESG integration in crowdfunding platforms
- Limited ML use for ESG-based project evaluation
- Insufficient transparency in project risk and impact assessment
- Absence of intelligent recommendation systems combining ESG and financial data

V. FUTURE WORKS

A. Advanced ML Models

Future work will integrate transformer-based models (BERT, GPT variants) and Graph Neural Networks (GNNs) to model relationships between investors, projects, and ESG factors.

B. Real-Time ESG Data Processing

Integration of real-time ESG data streams from APIs and IoT devices will enable continuous monitoring and dynamic ESG score updating.

C. Blockchain Integration

Blockchain will enable transparent, tamper-proof transactions and smart contracts for automated milestone-based fund release.

D. Personalized Recommendation System

AI-driven personalized investment recommendations with adaptive learning models and risk profiling for individual investors.

E. Cloud Deployment and Scalability

Deployment on AWS, Azure, or GCP with distributed computing for scalability to handle large datasets and high user traffic.

VI. DESIGN AND IMPLEMENTATION

A. System Architecture

The system follows a multi-layered architecture: frontend (HTML/CSS/JS), backend (Flask/Django), database (MySQL/MongoDB), and ML module for ESG evaluation and prediction.

B. Implementation Technologies

Python (Flask/Django) for backend, HTML/CSS/JavaScript for frontend, MySQL/MongoDB for storage, and Scikit-learn, XGBoost, LightGBM, CatBoost, and NGBoost for ML model development.

C. Outcome

The system achieves transparent ESG-based evaluation, better investment decisions, and a scalable secure crowdfunding platform with peak accuracy of 91.3% (XGBoost).

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VII. CONCLUSION

In this work, a machine learning-based crowdfunding platform integrating ESG metrics has been proposed to enhance sustainable investment decision-making. The system combines data preprocessing, ESG scoring, and predictive modeling to evaluate project performance, risk, and funding success.

By incorporating ESG factors, the platform improves transparency, promotes responsible investments, and assists investors in making informed decisions. XGBoost achieves the highest accuracy of 91.3%, demonstrating the practical utility of ESG-augmented machine learning for crowdfunding.

Projects with higher ESG scores attract more investor interest and achieve better funding outcomes, confirming the value of the proposed framework for modern crowdfunding ecosystems.

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