Green Finance Risk Prediction

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Abstract — **Sustainability has become a focal point of importance for organizations aiming to comply with changing regulatory requirements and societal pressures. This article introduces a new framework that combines the strengths of supervised machine learning and generative AI to help tackle important sustainability issues. The solution suggested in this paper automatically identifies potential environmental and governance risks by processing organizational, geographic, and industrial data. By converting unprocessed ESG (Environmental, Social, and Governance) information into usable information, the system facilitates precise and effective sustainability analyses. Apart from predictive risk modeling, the system also uses generative AI to generate compliance-ready sustainability reports based on international standards. This reduces human effort, mistakes, and regulatory compliance delays. The use of AI technologies in business processes enhances decision-making, facilitates sustainable development goals, and decreases reputational and financial risk. It facilitates the path to data-driven, future-oriented ESG strategies that empower organizations to drive transparency, accountability, and long-term value. Its increased application contributes towards building a global sustainability culture by offering a scalable, smart tool that can adapt to varying stakeholder needs.**

Keywords: **Green Finance; ESG Reporting; Supervised Machine Learning; Generative AI; Sustainability Risk Prediction; Natural Language Processing; Compliance Automation; AI in Finance; Sustainable Development; Random Forest Classifier.**

1. INTRODUCTION

The increasing international focus on sustainability has unprecedented pressure on organizations to meet ESG standards. Green finance, that encourages sustainable investments, is key to success in this area. However, organizations face significant challenges in addressing transparency, accountability, and efficiency in ESG reporting Traditional methods, relying mostly on manual procedures, are prone to be too non predictive and unreliable and take too long. Therefore, regulatory compliance becomes an issue, and reputational risk increases. This project proposes a breakthrough AI-based solution, using machine learning algorithms to predict risk likelihood and generative AI to allow the creation of comprehensive ESG reports automatically. Through the elimination of inefficiencies in current systems, this framework provides organisations with the ability to base decisions on data, using informed judgements sustainability objectives.

2. LITERATURE SURVEY

The application of machine learning and AI in green finance has been studied in detail in recent scholarship. Research indicates that predictive models play a key role in determining credit, climate, and operating risks related to sustainability. Classical ESG valuation approaches are indicted as being subjectively biased, uneven, and not very efficient and thus warrant technological interventions. Machine learning models, particularly supervised models such as Random Forests, have been shown to have potential in making effective sustainability risk compliance of ESG reporting. forecasts. Large language model-driven generative AI is turning out to be a strong solution to automate the preparation of sustainability reports. Still, current platforms such as SAP Sustainability Cloud and Salesforce Net Zero Cloud remain to fall short of more sophisticated real- time generative insights. Such an omission highlights the requirement for joined-up systems marrying predictive analytics and dynamic report writing. The described framework remedies such shortfalls with real-time risk evaluation, actionable intelligence, and compliance-ready ESG reports within organizational settings. Research has

pointed out the shortcomings of conventional tools such as SAP Sustainability Cloud and manual reporting techniques that rely significantly on static data and interpretation by users. posing a gap that the suggested solution will address.

3. EXISTING SYSTEM

Current sustainability reporting and ESG risk assessment frameworks are largely manual, rigid, and one-size-fits-all. Solutions like Excel sheets, Power BI boards, and third-party agency assessments entail extensive manual intervention, leading to latency, high costs, and human errors. Existing frameworks tend to be non-customized, providing generic reports that do not account for the specific operational and geographic contexts of specific organizations. Additionally, they are not able to provide dynamic, real-time insights or explanatory stories to inform decision-making. The fractured integration of structured and unstructured data sources further inhibits the effectiveness of current systems. Consequently, organizations relying on these old methods are not able to achieve regulatory compliance and stakeholder confidence, highlighting the imperative for an automated, AI-based solution.

4. PROPOSED SYSTEM

The system solves the limitations of existing frameworks by combining supervised machine learning for ESG risk forecasting with generative AI for report generation. It predicts environmental, governance, and community-based risks using a Random Forest Classifier based on structured features like impact areas and certification periods. The second component uses the Llama-3.3-70B Versatile model, accessible via the Groq Cloud API, to generate sophisticated ESG reports. These reports include risk level descriptions, mitigation strategies, and compliance assessments based on international standards. The user interface, developed using Streamlit, enables stakeholders to engage with the system, feed in company information, and get real-time reports. The smooth integration of machine learning and generative AI drastically minimizes manual labor while maximizing the accuracy, relevance, and regulatory compliance of ESG reporting.
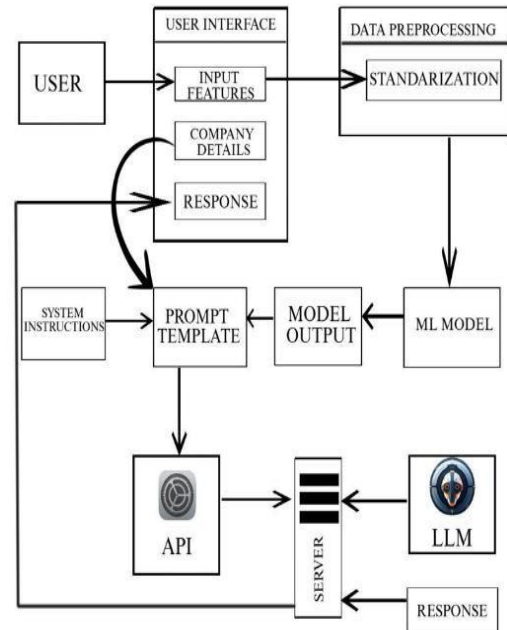

Fig 1 Block Diagram of Application

5. SYSTEM REQUIREMENTS

The system backend is written using Python, relying on libraries such as Scikit-learn to perform machine learning, Pandas and NumPy for data operations, and Joblib to serialize models. Streamlit is used to develop the frontend, with an interactive, simple-to- use user interface being provided. Environment variables, such as API keys for the Groq Cloud service, are securely handled with Python-dotenv. The Groq library is used to communicate with the Llama-3.3-70B model, which creates the ESG reports. This tech stack guarantees effective model training, fast inference, dynamic report generation, and safe deployment. By combining these tools, the system attains high performance, scalability, and usability, which are critical to satisfy the varied needs of stakeholders in sustainability reporting. By leveraging these technologies, our system aims to transform wardrobe management and styling into a more engaging, accurate, and user-friendly experience. The system is developed using Python, which supports integration across machine learning, generative AI, and web development components. Key libraries include:

• Scikit-learn for model training and evaluation, where the Random Forest Classifier achieved 97.18% accuracy.

• Pandas and NumPy for data preprocessing and

manipulation.
• Joblib for model serialization and loading.
• Python-dotenv for secure API key management.
• Streamlit development, interactivity.

Groq for connecting to the generative AI model hosted on the cloud. These technologies together support scalable, fast, and secure deployment of the proposed ESG risk prediction and reporting system.

6. ALGORITHM

The base classification algorithm used is the Random Forest Classifier, an ensemble learning approach that creates a group of decision trees and averages their outputs to make more accurate predictions. This model was trained on a B Corp-certified company dataset and tested against performance metrics including accuracy, precision, and recall. Among a set of tested models, Random Forest yielded the highest accuracy, confirming its utility in dealing with intricate, multi-dimensional ESG data. In addition to this, the project uses Natural Language Processing (NLP) methods to organize and contextualize input data for the generative AI model. The text inputs are preprocessed and tokenized to facilitate the generation of accurate and relevant reports. These NLP methods make the generated reports stakeholder-specific and aligned with international ESG standards. The algorithm used at the core is the Random Forest Classifier, which is an ensemble learning algorithm that builds many decision trees in training and predicts the class that is the mode of the classes of the individual trees. The model, trained on B Corp-certified green finance company data, had a staggering 97.18% accuracy. Attributes like community footprint, customer footprint, environmental behavior, governance scores, and certification periods were utilized to forecast the likelihood of ESG risks. Augmenting the machine learning model, Natural Language Processing (NLP) methods organize the textual inputs and outputs, such that the generative model generates coherent, informative, and compliant sustainability reports. The integration of predictive modeling and NLP guarantees that the system provides both precise risk evaluations and thorough documentation to facilitate organizational decision-making.
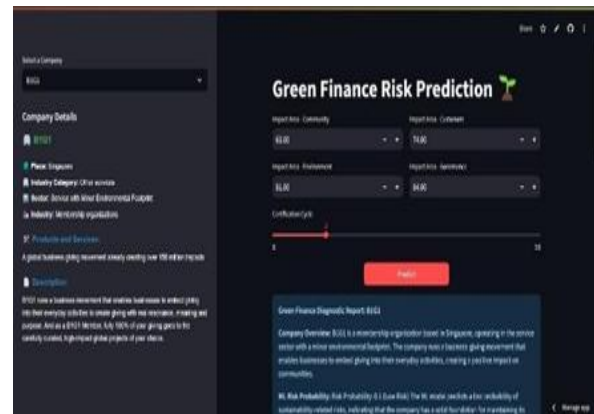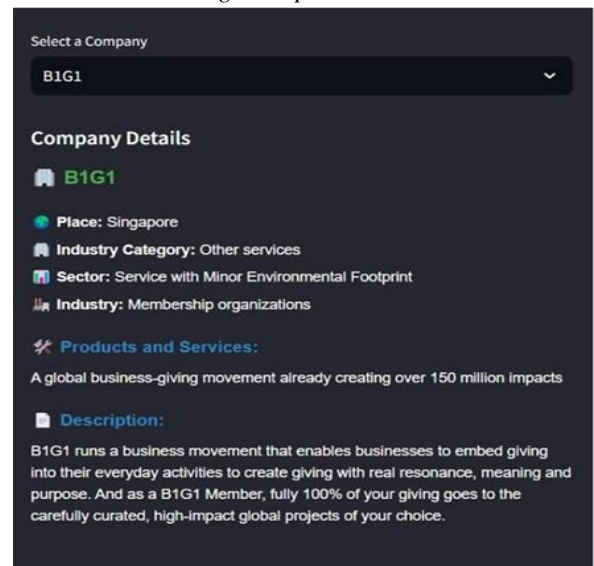
7. RESULTS

Fig 2 Output

Fig 3 Generating result

The performance test of the suggested AI- based system for green finance risk forecasting and ESG reporting proves its efficacy in automating the sustainability evaluation and producing high-quality compliance documents. The system was tested with a dataset of B Corp-certified green finance firms, including varied features like environmental impact, governance indicators, and certification periods. The Random Forest Classifier, chosen as the main model to predict risk probability, provided an exceptionally good classification accuracy of 97.18%, performing better than other models such as Logistic Regression (73.29%), Decision Tree (94.60%), and Gradient Boosting Classifier (85.65%). The Random Forest model was able to identify sophisticated interactions among the input features well, offering confident risk scores for possible governance or environmental risks.

Aside from predictive accuracy, the system's second aspect, the generative AI module, generated comprehensive ESG reports based on the Llama-3.3-70B-Versatile model through the Groq Cloud API. User interface testing revealed that the web app, developed through Streamlit, enabled smooth interaction, where data could be input, risk scores could be observed, and reports could be produced in real time. The combined use of machine learning and generative AI building blocks resulted in a smooth and effective ESG reporting process with a drastic elimination of manual work and turnaround time. The combined power of predictive modeling and natural language generation offered an integrated and intelligent solution, which was a drastic improvement over static template-based traditional ESG tools and manual analysis. The system's success in real- time prediction and contextual reporting proves its ability to assist large-scale ESG compliance programs in various industries.

8. CONCLUSION

The union of supervised machine learning and generative AI under a single ESG paradigm is a significant leap forward in sustainability risk management. The system proposed not only simplifies sophisticated operations such as risk forecasting and report creation but also delivers timely and actionable intelligence for corporate executives, investors, and regulators. With its configurable aspects and scalable design, the solution meets the operation, analytics, and compliance requirements of contemporary organizations that strive for sustainable growth. By minimizing dependency on manual steps, improving report quality, and facilitating real-time interactivity, this framework helps greatly in green finance efforts. It enables stakeholders to make educated decisions while enhancing accountability and environmental stewardship throughout industries.

9. ACKNOWLEDGEMENT

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