Using Large Language Model to Generate ESG Report for Healthcare Organizations in Taiwan

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Abstract. This study developed an automated system leveraging the Llama 3.1 8B large language model, specifically designed for generating sustainability reports. The results indicate that, while the model performed well on the training data—demonstrating high accuracy and low loss—its generalization capabilities still require enhancement. This research not only demonstrates the feasibility of using large language models to automatically produce professional sustainability reports but also provides valuable methodological insights and a technical foundation for future studies in related fields.

Keywords: ESG, Healthcare, Large Language Models (LLM), SDGs.

1 Introduction

1.1 The Critical Position of Sustainability in the Modern Business Environment

In the 21st century, sustainable development has become a necessity for businesses. Over the past few decades, corporate focus and practice have shifted from marginal issues to mainstream strategies. Facing global environmental challenges such as climate change, resource depletion, and ecological degradation, businesses play a crucial role in achieving sustainability goals, particularly in managing carbon emissions. Many companies have developed carbon reduction strategies, reducing their carbon footprint by optimizing production processes and adopting renewable energy, which is central to achieving environmental sustainability.

In 2015, the United Nations established the "2030 Sustainable Development Goals (SDGs) [1]", a framework comprising 17 specific objectives aimed at addressing major global challenges, as illustrated in Fig. 1, providing a clear blueprint for global sustainable development. These goals target not only national governments but also encourage corporate participation, especially in the areas of technological innovation and promoting economic inclusivity [2, 3]. The SDGs framework guides govern-

ments, businesses, and civil society to collaborate towards achieving a vision for sustainable development.

Fig. 1. United Nations 17 Sustainable Development Goals (SDGs) [3].

The concept of ESG was first introduced in the United Nations' 2004 report "Who Cares Wins." ESG stands for Environmental, Social, and Governance, three critical aspects outlined in the report. It highlighted that the social responsibilities of business operators or investors are closely linked to corporate risk management and, over the long term, also affect financial performance [4]. Consequently, these three dimensions of sustainable development have gained widespread attention among global enterprises in recent years. ESG has become a crucial indicator for assessing a company's sustainability and social responsibility performance. Publishing ESG reports helps organizations comprehensively showcase their achievements and progress in these areas, underscoring their increasing importance.

1.2 Strategic Value of ESG Report

Environmental, Social, and Governance (ESG) reporting holds three key values for business development. First, ESG reports help investors assess a company's potential for long-term value creation by revealing quantitative indicators such as carbon emission management and renewable energy utilization, demonstrating the company's commitment to environmental sustainability. Additionally, well-developed human resource strategies and safety standards help reduce labor risks, which are crucial governance indicators that influence corporate image and competitiveness.

Secondly, Second, ESG reports serve as an important platform for communication between companies and stakeholders, enabling suppliers, community organizations, and employees to understand the company's sustainability goals and core values, fostering consensus and support from diverse stakeholders.

Lastly, the process of compiling ESG reports encourages companies to conduct self-examination and continuous improvement. Through data collection and cross-departmental collaboration, it strengthens management systems and decision-making quality, thereby enhancing the overall sustainability of the company.

In summary, ESG reporting not only demonstrates a company's commitment to social responsibility but also enhances corporate reputation, promotes positive internal governance and operational cycles, and creates long-term value for stakeholders.

2 Motivation

2.1 ESG Development and Current Situation in Taiwan

In Taiwan, sustainable development in corporate governance has been notably advanced by the Financial Supervisory Commission (FSC). Since 2015, the FSC has required certain listed companies to compile Corporate Social Responsibility (CSR) reports that cover diverse aspects such as the protection of vulnerable groups, food security, health and welfare, gender equality, and the green economy. In 2018, the FSC launched the "New Corporate Governance Roadmap (2018-2020)" to strengthen governance structure requirements. In 2020, the FSC issued the "Corporate Governance 3.0 Sustainable Development Roadmap," officially renaming the CSR report to "Sustainability Report/ESG Report," and incorporating ESG into the core scope of corporate governance. This included two core visions and five main axes of action, as shown in Fig. 2 [5]. The FSC also promotes the enhancement of sustainability report disclosure, broadens the scope of compilation and verification, and encourages the publication of reports in English to increase international visibility.

In 2023, Taiwan responded to global climate challenges by launching "Taiwan's 2050 Net-Zero Emission Path and Strategies" and passed the "Climate Change Response Act" to legally incorporate carbon neutrality goals. The Financial Supervisory Commission introduced the "Green Finance Action Plan 3.0," emphasizing the enhancement of the accuracy and transparency of ESG reporting. This plan covers environmental protection, social responsibility, and corporate governance, and increases focus on biodiversity and supply chain human rights.

Fig. 2. Corporate Governance 3.0 Sustainable Development Roadmap [5].

2.2 The Current Status of ESG Reporting in Taiwan Hospitals

In Taiwan's healthcare system, the promotion of Corporate Social Responsibility (CSR) and Environmental, Social, and Governance (ESG) reporting is notably lagging. Statistics show that among 422 medical institutions, only 3.1% publicly disclose relevant information, and 3.8% provide ESG reports. To promote ESG practices, Taiwan's Ministry of Health and Welfare developed strategies in November 2023 to incorporate ESG principles into the hospital evaluation mechanism, providing guidance on carbon emissions inventory and energy efficiency optimization, with the goal of achieving net-zero emissions. Additionally, the medical industry is a significant source of greenhouse gas emissions. The global healthcare system emits approximately 2 billion tons annually, accounting for 4.4% of global total emissions, while emissions from Taiwan's medical institutions account for 4.6% of the country's total, higher than the global average, as shown in Fig. 3 [6].

This phenomenon highlights the responsibility and challenges that medical institutions face in sustainable development and environmental protection, making the development of tools for automatically generating ESG sustainability reports particularly important. Through automation, medical institutions can more efficiently integrate and analyze data and information from various aspects, thereby enhancing the accuracy and timeliness of reports and demonstrating their achievements and efforts in environmental protection, social responsibility, and governance structure. The benefits of automatically generated reports include:

1. Increased Efficiency: Automation significantly reduces the time needed for manual data entry and report writing, enabling medical institutions to quickly respond to stakeholder demands.
2. Enhanced Accuracy: Reduces human errors, ensuring consistency in data analysis and quality of reports.
3. Optimized Resources: Frees up human resources from the tedious task of report production to focus on more strategic decision-making and action plans.
4. Transparency and Credibility: Automatically generated reports provide a standardized format and detailed records, increasing the transparency and trustworthiness of the reports.

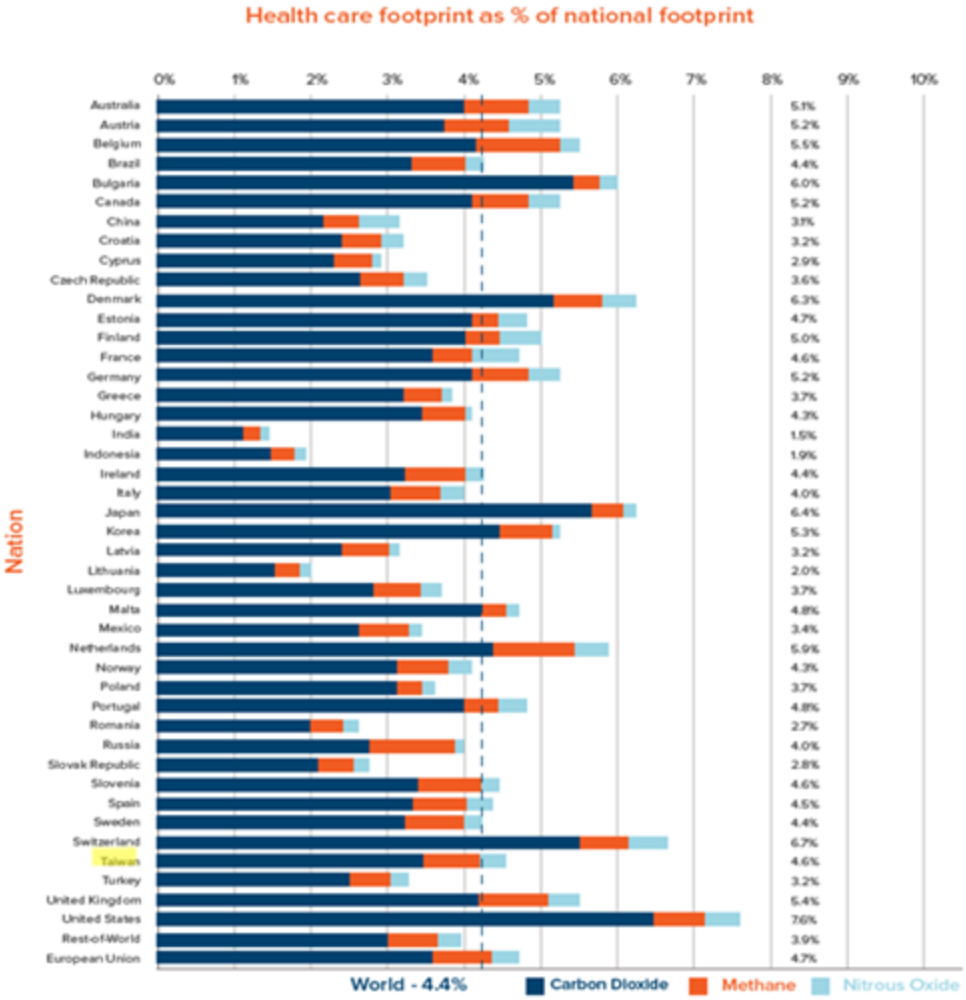

Fig. 3. Health care footprint as a percentage of national emissions for all nations and regions covered in this study [6].

By utilizing automation tools like Large Language Models (LLMs) to integrate data and generate high-quality sustainability reports, medical institutions can not only manage their sustainability performance more effectively but also enhance information transparency and demonstrate their commitment to society and the environment. This professional report writing not only improves efficiency and reduces costs but also enhances the market competitiveness and brand value of hospitals. Transparency and quality assurance further strengthen stakeholder trust, driving the healthcare industry towards a more environmentally friendly and responsible direction.

3 Research Method

Hospitals, as core institutions in maintaining public health, play an equally important role in environmental protection, social responsibility, and corporate governance. Therefore, providing tools specifically for writing ESG reports can significantly enhance these institutions' performance and transparency in the aforementioned areas.
This study aims to enhance Large Language Models (LLMs) through Supervised Fine-Tuning and Retrieval Augmented Generation (RAG) techniques, specifically for generating ESG reports in the healthcare sector. This approach not only ensures the accuracy of the reports but also meets the specific needs of the medical industry, enabling hospitals to more effectively and accurately demonstrate their efforts and achievements in environmental, social, and governance aspects, thereby enhancing their overall sustainability. Through this tool, medical institutions can better address current and future challenges while increasing transparency and trust with external stakeholders.

3.1 Research Design

Model optimization includes two main strategies: Supervised Fine-Tuning and Retrieval Augmented Generation. In Supervised Fine-Tuning, the Large Language Model (LLM) is trained on a specific ESG report dataset, aimed at enhancing its ability to accurately understand and generate content related to ESG. This process requires the use of a large amount of existing ESG reports as training data. Retrieval Augmented Generation (RAG) is a technique that combines traditional generative models with retrieval models, allowing the LLM to reference external data, such as relevant literature or information from databases, while generating text. This enhances the accuracy and richness of the generated content. Together, these strategies significantly improve the model's performance in handling ESG-related content.

3.2 Research Processes

Literature Review and Preliminary Preparation: Investigate existing ESG report formats and contents and collect ESG reports for training and validation. Fig. 4 is the research structure diagram, and Fig. 5 is the research process diagram.

1. Model Design and Development: Train the model using supervised fine-tuning and integrate Retrieval Augmented Generation (RAG) technology, designing data extraction and processing mechanisms.
2. Model Training Phase: Train the model on the specified ESG dataset and adjust parameters to optimize performance.
3. Model Evaluation: Use BLEU (Bilingual Evaluation Understudy) and ROUGE (Recall-Oriented Understudy for Gisting Evaluation) as primary evaluation metrics to more accurately measure the linguistic quality and content similarity between the generated ESG reports and manually written reports.
4. Iterative Optimization: Iteratively improve the model based on feedback, expanding the model's application range, such as adapting to ESG report generation for different regions or industries.
5. Results Analysis: Analyze the model's performance, including quality assessment of the generated reports.

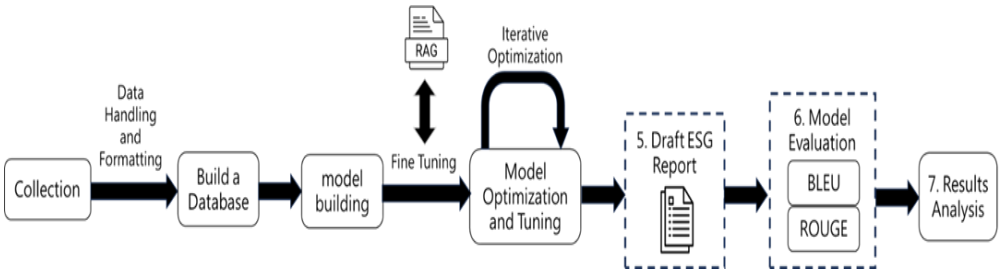

Fig. 4. Research structure diagram.

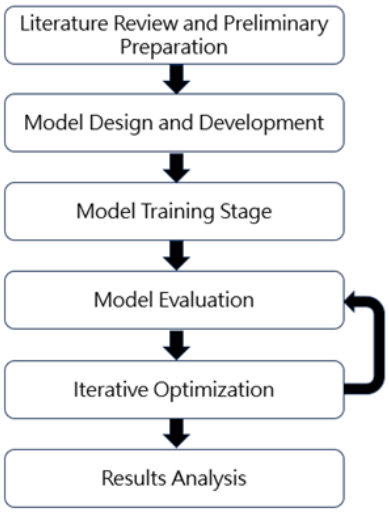

Fig. 5. Research process diagram.

3.3 Instruction Data Set Construction

Regarding the construction of the dataset for ESG-related directives, the main sources are:

1. *Corporate Annual Reports and ESG Reports.*

Currently, on the website of the Taiwan Stock Exchange's Corporate Governance Center, there are ESG reports publicly available from 724 listed companies and 348 OTC companies, totaling 1,072 companies [7]. Extracting the text information from these 1,072 companies' ESG reports to serve as inputs for the model, continuous fine-tuning training is conducted to enable the model to grasp domain knowledge in ESG, become familiar with various ESG topics, and understand the practices adopted by enterprises on these issues.

2. ESG Reporting Standards

Currently, the main ESG reporting standards in Taiwan include the GRI (Global Reporting Initiative) standards [8], the SASB (Sustainability Accounting Standards Board) standards [9], and the TCFD (Task Force on Climate-related Financial Disclosures) standards [10].

The GRI standards detail the economic, environmental, and social impacts of organizations; the SASB standards set financially significant ESG metrics for different industries; the TCFD standards focus on the risks and opportunities businesses face due to climate change. To effectively guide the model in conducting ESG corporate assessments, it is necessary to extract, summarize, and organize the main content of these three standards into a structured directive dataset, enabling the model to better understand and analyze ESG information.

3. ESG News, Articles, and Relevant Papers

News reports provide updates on the latest ESG dynamics and market reactions; professional articles delve into industry perspectives and practical insights; academic papers offer theoretical foundations and empirical research, ensuring scientific rigor. These three elements complement each other, forming a knowledge system that is timely, applicable, and scholarly. By integrating these diverse sources of information, it is possible to comprehensively grasp the full scope and evolving trends of ESG issues, identify specific practices across different industries and regions, and promote knowledge integration. This serves as an in-depth reference for policymakers, corporate managers, and researchers, advancing the construction and application of sustainable development knowledge.

The collected data will be converted into semi-structured JSON format for storage, facilitating subsequent model training.

3.4 Research Environment

This study uses Python as the primary programming language, paired with PyTorch, for fine-tuning and testing the model.
1. Model Selection

This research has chosen Meta's developed and open-source licensed Llama model as the foundational infrastructure for automating ESG reporting. It can integrate with Hugging Face and allows for user fine-tuning and customization, enabling researchers to quickly access technical resources and support during the development process. It offers multiple advantages in text generation applications. Compared to other larger-scale LLMs, the Llama 3.1 8B model requires less hardware and consumes fewer computational resources, making it more suitable for research environments with limited resources. Despite its relatively smaller size, it still maintains a good level of accuracy, making it suitable for fine-tuning specific scenarios.

2. Development and Runtime Environment

This study utilizes Google Colab (Google Colaboratory) as the development and testing environment, providing GPU and TPU resources to support the operation and debugging of deep learning models. It selects a high-performance runtime environment equipped with NVIDIA A100 GPUs and NVIDIA T4 GPUs to ensure the computational demands of large models can be met. Google Colab Pro+ offers approximately 52 GB of RAM and about 150 GB of temporary storage space, which is suitable for the operation of medium and small-scale models.

4 Results

In this study, the Llama 3.1 8B model is used to train a system capable of automatically generating sustainability reports. Fig. 6 shows that during 100 training steps, the mean token accuracy for the training set is relatively high, ranging between 0.64 and 0.66, while the accuracy for the test set ranges between 0.61 and 0.62, suggesting that the model's generalization ability on test data needs improvement. Fig. 7 loss curve indicates that the loss decreases progressively with training, but the loss on the test set remains consistently higher than that on the training set, which may indicate a problem of overfitting. Lastly, the analysis of the gradient norm reflects that the model's parameter updates are more stable on the training set, while showing greater fluctuations on the test set, indicating that adapting to new data requires more significant parameter adjustments, as shown in Fig. 8.

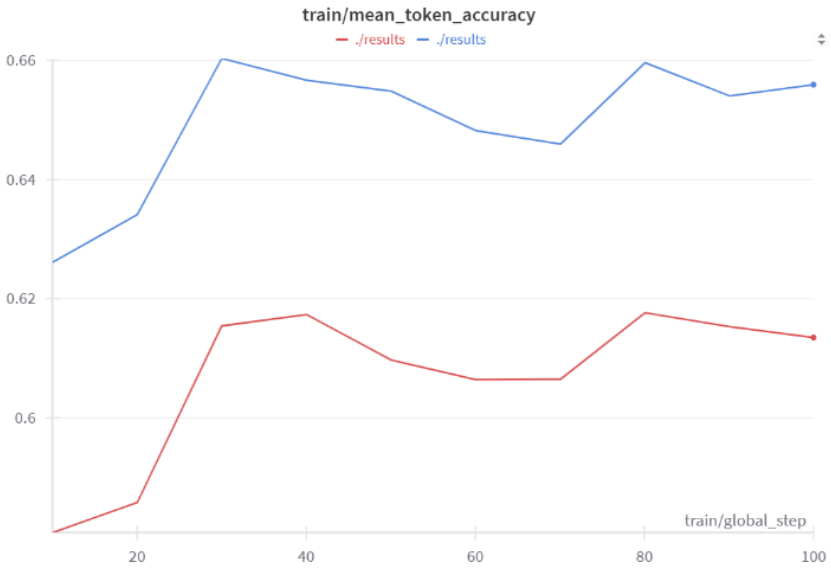

Fig. 6. Mean Token Accuracy. The horizontal axis represents the training steps, and the vertical axis represents the mean token accuracy. The blue line indicates the accuracy for the training set, while the red line represents the accuracy for the test set.

Fig. 7. Loss Curve. The horizontal axis represents the training steps, and the vertical axis represents the loss value. The red line is the loss curve for the test set, and the blue line is the loss curve for the training set.

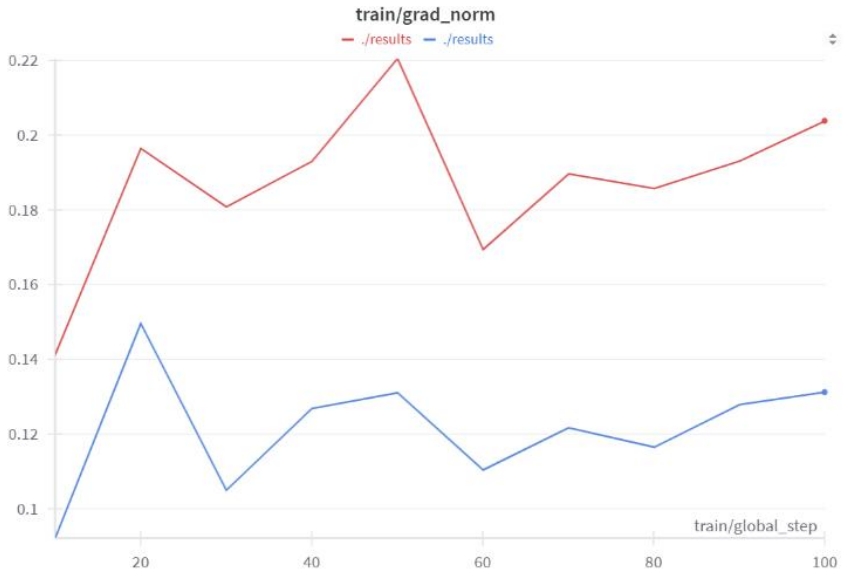

Fig. 8. Training Curve for Gradient Norm. The horizontal axis represents the training steps, and the vertical axis represents the magnitude of the gradient norm. The red line indicates the gradient norm for the test set, and the blue line represents the gradient norm for the training set.

5 Conclusion

This study has developed a system capable of automatically generating sustainability reports using the Llama 3.1 8B model, demonstrating the potential of large language models in handling professional text generation. The results show that the model achieves high accuracy on the training data and can effectively learn and mimic the writing style and structure of sustainability reports. However, the model's performance on the test set indicates limitations in its generalization ability, particularly reflected in the analysis of loss values and gradient norms, suggesting issues with overfitting.

To improve the model's effectiveness in automatically generating sustainability reports, future research will need to explore strategies such as data augmentation, the introduction of more regularization techniques, or adjustments to the model architecture to better learn from and adapt to diverse data. Additionally, considering that sustainability reporting involves multifaceted professional knowledge, future work will also explore methods of integrating cross-disciplinary knowledge to enrich the model's knowledge base and enhance the professionalism and accuracy of its outputs. This research not only provides an empirical foundation for the application of automated text generation technologies but also paves the way for further exploration of AI applications in professional fields. It anticipates broader implementation in actual workflows in the future, promoting automation and standardization in the creation of sustainability reports by enterprises and institutions.

Acknowledgment

This research is partially supported by the National Science and Technology Council, Taiwan (NSTC 113-2637-H-227 -001).

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