AI Tool for Enhancing the Process of Gap Analysis in ESIA and ESDD Studies

(A Comparative Study of Manual vs. AI Approaches for Gap Analysis in E&S Regulatory Compliance)

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1 INTRODUCTION

1.1 BACKGROUND

Environmental and Social Impact Assessments (ESIA) and Environmental and Social Due Diligence (ESDD) are key processes for identifying potential environmental and social risks and ensuring compliance with regulatory frameworks and international standards. A central step in both processes is the Environmental and Social (E&S) Gap Analysis, which evaluates discrepancies between local laws and international standards to evaluate the level of alignment or the gaps to be addressed.

Due to the variation in regulatory systems, stakeholders must compare national laws with international benchmarks such as the IFC Performance Standards (PS) and the IFC General Environmental, Health, and Safety (EHS) Guidelines. This task is traditionally achieved manually generating large comparison tables and involves collecting relevant national laws, identifying applicable international standards, comparing them, and defining corrective actions.

This manual process is often slow and complex, especially due to updates, language differences, and the volume of documentation. In this context, Generative AI (GenAI) and Large Language Models (LLMs) offer promising opportunities to automate parts of this work. AI can analyze regulatory content, extract requirements, and compare them quickly, saving significant time.

Although AI has been applied in legal and financial domains (Alhasan, 2025; Liang, 2024), its use for E&S gap analysis is still unexplored.

1.2 RESEARCH OBJECTIVE

This study explores the potential of AI tools to enhance the E&S Gap Analysis process by comparing a traditional expert-led manual approach with an AI-assisted methodology.

Specifically, the research objectives are to:

- ✓ Evaluate efficiency improvements in AI-driven gap analysis;
- ✓ Assess accuracy and consistency in AI-generated results compared to expert assessments;
- ✓ Identify challenges and limitations associated with integrating AI into this process.

A case study comparing Algerian environmental laws with IFC PS3 and the General EHS Guidelines is presented.

2 METHODOLOGY

2.1 PROCESS AND TOOL USED

Our approach was structured into two main phases: data preparation and gap analysis.

Data preparation is crucial when working with large language models (LLMs), due to their token limits and limited attention span. Long inputs can dilute context, potentially leading to incoherent outputs. To avoid this, we summarized and extracted key information from documents, ensuring the model focuses on relevant content and performs more effectively.

In this phase, we extracted key data from three sets of documents:

- ✓ IFC performance standards, which identify lenders E&S compliance requirements;
- ✓ IFC general EHS guidelines, for quantitative limits; and.
- ✓ Local laws, for articles detailing regulatory limits and their implementation.

The process began with document ingestion and text extraction, using advanced Optical Character Recognition (OCR). We then used Azure OpenAI services, employing both GPT-4o and GPT-4o-mini models depending on task complexity. GPT-4o handles structured tasks like comparing legal frameworks or analyzing images of tables, thanks to its multimodal capabilities. GPT-4o-mini is used for simpler tasks like summarizing or data conversion.

Before performing the comparison, we applied embedding, which converts text into numerical vectors to calculate similarity. This technique helps matching each requirement with the most relevant regulatory articles, reducing the volume of text processed and improving precision and performance. This also ensures better model focus and output quality.

The gap analysis phase aims at verifying alignment between local regulations and international standards. Each requirement is compared to the corresponding regulatory articles using GenAI. Thanks to the models' semantic understanding, we interpret legal language and context to assess compliance, highlight discrepancies, and identify missing elements - forming a robust compliance review.

We repeated the process with the IFC general EHS guidelines, comparing extracted tables and limit values with local regulations. This ensures benchmarks are met and any inconsistencies are flagged.

This holistic approach to gap-analysis not only enhanced our understanding of the legal landscape but also improved our ability to navigate the complexities of regulatory frameworks effectively. Ultimately, this rigorous process was instrumental in ensuring that all aspects of our operations aligned with both national and international expectations, thereby mitigating risks and promoting sustainable practices.

2.2 MANUAL VS AI GAP ANALYSIS

In evaluating the potential of Generative AI to enhance the gap analysis process, we focused on a specific case requiring application of the IFC Performance Standard 3 on Resource Efficiency and Pollution Prevention, and the IFC General EHS Guidelines about Environmental, Health, and Safety (EHS) to be compared with 8 Algerian local environmental laws. This test case was selected since RINA has performed the gap analysis already, using a classic manual approach.

It is noted that the identification and selection of all source documents, both local laws and international standards, were carried out manually and were already available prior to the AI-assisted analysis. Therefore, the objective of this study was not to test the AI's ability to search or retrieve documents, but rather to assess its ability to analyze, compare, and synthesize content from known regulatory sources, data rooms or project folders.

First Step – data preparation: we uploaded all the input documentation in the tool and extracted the relevant information (Figure 1), specifically:

- ✓ IFC Performance Standard 3: we have thoroughly analyzed and extracted 14 distinct requirements pertaining to environmental safeguards and sustainability measures. These requirements, mainly qualitative information, encompass regulations on pollution control, emission standards, waste management, and resource conservation;

- ✓ IFC General EHS Guidelines: we have extracted 2 tables which contains quantitative data. Specifically, we extracted table “1.1.1 - WHO Ambient Air Quality Guidelines” which includes quantitative ambient air quality standards, and table “1.7.1 - Noise Level Guidelines” which includes quantitative noise level standards;
- ✓ Algerian Laws: Our research into Algerian legislative frameworks yielded 445 specific articles in 8 laws.

Using the international requirements as a benchmark, the concept of semantic embedding was used to associate each international requirement with the most relevant local legal provisions. This significantly reduced the volume of irrelevant text processed and improved the precision of the subsequent comparison. For each type of file, a specific prompt was used to extract the requested information. The system took the relevant input file and, by prompting a set of instructions and constraints like which type of information we desired, extracted the correct and relevant information, such as requirements, standards, and legislative articles.

Second Step – gap analysis phase: we outlined each requirement of the performance standards and tasked GenAI to conduct a comprehensive comparison with the most relevant legal articles, and to generate an excel table to display all the comparison results and the identified gaps between the international and the local requirements. In this prompt, the scope is to provide a focused and structured comparative analysis between international IFC standards and Algerian legal requirements within a chosen topic area. The prompt is designed to filter out irrelevant legal content, ensuring that only laws directly related to the specific IFC requirement are considered and it is organized in sections that highlight both alignments and gaps between the two regulatory frameworks, including both surface-level and deeper conceptual differences.

Third Step – comparison of the results: finally, we compared the AI-generated output with the manual gap analysis previously conducted by RINA to evaluate the completeness and reliability of the AI-based results, the consistency of interpretations, and the time and resource savings introduced by automation.

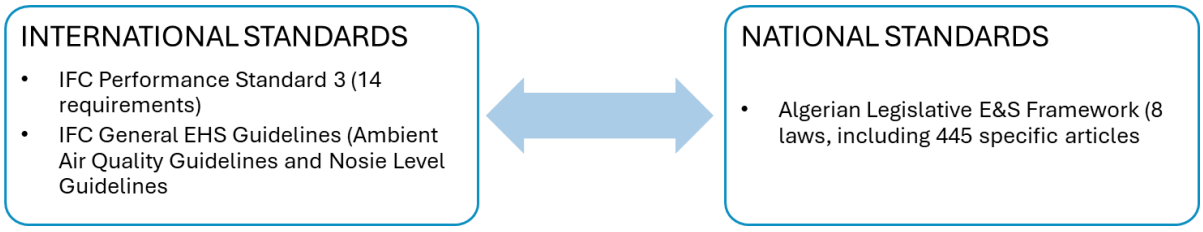

Figure 1: International and National Standards Cross-Comparison

3 CONCLUSION

3.1 RESULTS

Quantitative comparison (timing) between AI process and manual process

This study has demonstrated the significant potential of integrating Generative AI (GenAI) and Large Language Models (LLMs) into the Environmental and Social (E&S) Gap Analysis process within ESIA and ESDD studies. By comparing the traditional manual workflow to the AI-assisted approach developed by RINA, the efficiency gains in terms of time-saving are evident:

- ✓ Preparation and uploading of relevant regulatory documentation package in the Tool: 5 minutes;
- ✓ Extraction of PS3 requirements: 1 minute;
- ✓ Extraction of local regulatory texts: 15 minutes;
- ✓ Comparative analysis of PS3 vs. local legislation: 5 minutes;
- ✓ Comparative analysis of extracted General EHS Guidelines tables vs. local legislation: 3 minutes.

Performing the same analysis manually typically requires approximately 3 to 5 full working days, highlighting the substantial time-saving advantage of AI integration.

Qualitative comparison between AI output and human assessment

From a qualitative perspective, the AI tool demonstrates strong capabilities in processing complex regulatory content and providing structured outputs. However, its performance is highly dependent on the quality and level of detail of the input. The more detailed and well-prepared the input - both in terms of document structure and clarity of information - the more accurate and insightful the AI-generated analysis.

In particular, the AI performs well when analyzing quantitative and well-structured standards, such as the IFC EHS Guidelines. For instance, it accurately identifies emission limits and regulatory thresholds, highlighting clear gaps in national legislation. In contrast, for more general and qualitative standards, such as IFC Performance Standard 3 (PS3), the AI tends to mirror the standard's broad language and, as a result, generates more generic conclusions.

This behavior is further amplified by the AI's conservative approach when providing compliance judgments. While the tool excels at summarizing requirements and aligning content, it often avoids definitive conclusions, especially in areas lacking precise or measurable criteria. Therefore, the AI's final outputs, although structurally consistent and traceable, still lack the decisiveness and contextual nuance typical of experienced human professionals.

In conclusion, AI cannot yet fully replace expert judgment, especially in the final interpretive phase of regulatory gap analysis. However, it remains a highly valuable support tool, particularly in the initial analytical stages, where it significantly reduces manual workload and accelerates the processing of large and multilingual document sets.

Avoidance, reduction, recovery and reuse of hazardous and non-hazardous waste	
Identified Gap from GenAI Tool	**Identified Gap from Manual Aprroach**
The comparison indicates a partial alignment between the IFC requirements and Algerian laws on waste management, particularly in the areas of waste prevention, environmental protection, and public awareness as outlined in Algerian Law 01-19, Articles 2 and 11. However, discrepancies arise due to the lack of measurable standards and the limited scope of waste management practices, as noted in Article 4, which excludes certain waste types. Additionally, while Article 19 prohibits the transfer of hazardous waste to unauthorized facilities, it fails to provide comprehensive guidelines for its treatment, potentially conflicting with the IFC's stringent standards. To enhance compliance with IFC standards, Algerian regulations should incorporate specific measurable technical parameters and detailed guidelines for hazardous waste management. Addressing these gaps will facilitate a more robust alignment with international standards, thereby promoting sustainability and environmental health.	Because of the risks to the environment and the ever-increasing costs and liabilities associated with the management and/or disposal of waste material, PS3 requires clients to investigate options for waste avoidance, waste recovery and/or waste disposal during the design and operational stages of the project. Local legislation embeds the principles of waste minimization at the source, waste reuse and recovery, and environemntally sound treatment of waste and no major gaps in terms of local requirements. The level of effort to address this requirement depends on the risks associated with the waste materials generated by the project.

Figure 2: Comparison of the identified gap outcome between GenAI Tool (left) and Human Assessment (right) – example for waste management waste (paragraph 12 of IFC PS 3)

3.2 LIMITATIONS AND POSSIBLE NEXT STEPS

The GenAI approach demonstrated strong performance in extracting and comparing regulatory texts, even across different languages and formats. Despite its efficiency and accuracy in the analysis, however, the AI tends to adopt a conservative approach when making final compliance judgments. While it is capable of accurately interpreting and summarizing regulatory content, its conclusions are generally more cautious and less decisive than those provided by human experts.

Therefore, while AI serves as a powerful support tool, it cannot yet fully replace expert judgment, particularly in the final evaluation and contextual interpretation of regulatory gaps. Possible solutions to enhance quality and ensure more precise and accurate judgments could involve the adoption of innovative models and approaches, such as reasoning LLM models and AI agents. These advanced systems possess the ability to comprehend complex data structures and execute sophisticated reasoning procedures, enabling them to analyze information more effectively and produce a more accurate judgment. Moreover, the implementation of AI in this domain still requires a supervised, step-by-step setup. The process is not yet fully automated or seamless, and it necessitates close monitoring and iterative adjustments to ensure optimal results. Nevertheless, when properly configured and integrated, AI offers substantial support throughout the E&S Gap Analysis.

As a possible next step, future developments could explore extending the AI's role beyond content comparison to include the automated identification and retrieval of applicable national and international regulations and standards. This would allow AI tools to assist in the entire workflow - from locating relevant documents in data rooms, to analyzing and comparing them - further enhancing scalability and reducing preparation time for compliance assessments.

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