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AI-Based Environmental Code Checking Tool for Sustainability Best Management Practices of Infrastructure Construction Projects

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Introduction

Infrastructure projects such as roads, bridges, and buildings are essential to modern life—but they also generate substantial greenhouse gas emissions. To help reduce these impacts, project owners and agencies increasingly rely on sustainability frameworks such as Envision. However, verifying compliance with these standards remains largely manual and time-consuming. Sustainability managers must review extensive project documentation, making it difficult to apply sustainability practices consistently across projects. While recent advances in artificial intelligence (AI) and natural language processing (NLP) offer new ways to automate this work, their use in infrastructure sustainability assessments remains limited. This research developed an AI-based tool that can automatically review project documents and evaluate projects against Envision sustainability standards, making the process faster, more consistent, and easier to scale.

Study Methods

This research develops, implements, and evaluates an AI-based environmental compliance checking system aligned with the Envision sustainability rating framework. The goal is to automate lifecycle greenhouse gas (GHG) assessment, reduce human error in data extraction, and improve the transparency and reproducibility of Envision credit evaluations. To accomplish this, the research combines case study analysis, NLP, life-cycle assessment (LCA), and Envision rating system's scoring into a single automated workflow. This research adopts the LCA approach of Dequidt (2012) to quantify and compare emissions against baseline scenarios. Publicly available documentation was used to develop infrastructure-specific NLP training datasets. A case study using real-world bridge lifecycle GHG data tested extraction accuracy, unit normalization, and LCA computations. This project developed a custom spaCy-based NER model to extract three key pieces of information in groups from unstructured text, such as metadata, materials and activities, and quantities. Extracted values were standardized and transferred into an LCA module that applied emission factors from established databases to compute total, annualized, and intensity-based GHG metrics. These results were mapped to Envision Credit CR1.2 to determine performance tier alignment. The system takes documents as input, extracts relevant environmental data, calculates emissions, and automatically determines the project's Envision performance level.

A Streamlit application operationalized the workflow, supporting PDF upload, AI-driven extraction, user validation, automated emissions calculation, and visual reporting. Performance was evaluated against manually annotated benchmarks, measuring extraction accuracy and assessment speed. The results demonstrated high extraction fidelity and substantial reductions in assessment time, confirming suitability for scalable sustainability compliance verification.

Findings

The AI-based tool successfully automated a sustainability review process that traditionally requires hours of manual work. It can extract key information from project documents, calculate lifecycle greenhouse gas emissions, and evaluate projects against Envision sustainability credits—all within a single web application. The Envision-focused web application for the AI-based environmental compliance checking system successfully automates a

process traditionally requiring hours of manual work. The web application brings several sustainability assessment tasks into one place, using AI to review project documents, identify key project and material information, calculate lifecycle greenhouse gas emissions, and evaluate performance against Envision sustainability credits. Users can easily navigate Envision categories and see how a project performs across different sustainability measures.

An AI-based environmental compliance checking system automates lifecycle GHG assessments, reduces human error in data extraction, and improves the transparency and consistency of sustainability credit evaluations.

The system successfully analyzed the bridge project's environmental impact, identifying opportunities to reduce lifecycle emissions and earning an Envision rating of "Improved." It completed the analysis in under five seconds—compared with hours of manual review—while achieving more than 95% overall accuracy. Dynamic checklist updates further enhanced transparency, showing real-time credit status. Overall, the findings validate the feasibility and value of AI-enabled sustainability compliance automation for infrastructure projects, demonstrating that AI can accelerate sustainability assessments while maintaining high accuracy and consistency.

Policy/Practice Recommendations

The results support several policy and professional practice recommendations to modernize sustainability assessment in infrastructure delivery. Public agencies and infrastructure owners should consider integrating AI-assisted document analysis into formal review workflows, as automated GHG assessments reduce processing time and improve consistency. To maximize automation benefits, agencies should also standardize digital documentation requirements. Design teams are encouraged to use automated LCA tools during early project stages, enabling timely identification of carbon-intensive materials and more cost-effective mitigation strategies. The demonstrated accuracy of automated CR1.2 scoring suggests that AI-enabled pre-screening could streamline Envision verification and reduce evaluators' workload. Transparency can be further strengthened by adopting visual, auditable reporting outputs similar to those generated by the system. As AI becomes integral to sustainability evaluation, engineering and construction professionals should receive training to ensure proper interpretation and oversight of automated compliance tools. These technologies can help project teams spend less time reviewing paperwork and more time identifying meaningful opportunities to improve project performance and reduce environmental impacts.

About the Authors

Dr. Joseph J. Kim, PE, Professor and Chair of Civil Engineering and Construction Engineering Management at California State University, Long Beach (CSULB), served as Principal Investigator, overseeing all project activities, supervising the graduate Research Assistant, and leading the development and completion of the MTI report. Pooja D. Chavan, a recent computer science graduate from CSULB, contributed to this project by assisting in the development of the AI model and supporting data analysis efforts.

To Learn More

For more details about the study, download the full report at https://transweb.sjsu.edu/research/2524

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