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Generative AI Adoption and Sustainable Development

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ABSTRACT: While Generative AI (GenAI) is a critical enabler for achieving key United Nations Sustainable Development Goals (SDGs) in the construction industry, organizations remain hesitant to implement it due to limited awareness of key barriers and the absence of clear adoption strategies. This study aims to (1) identify key barriers and propose strategies for GenAI adoption in the construction industry, and (2) examine how the significance of barriers and the effectiveness of strategies vary across organizations of different types and sizes. Through a systematic literature review and pilot interviews, this study identified 23 barriers and 17 strategies, which were then evaluated using statistical analysis and post-survey interviews. The findings reveal that “Unclear Legal Liability,” “Lack of Explainability,” and “Lack of Accuracy/Precision” are the most significant barriers, while there is an industry-wide preference for a passive “wait-and-see” stance, prioritizing external, government-led initiatives over driving internal change for GenAI adoption. The study further uncovers notable differences in barrier significance and strategy effectiveness across organizational contexts. This study provides a structured classification of barriers and strategies, along with comparative insights across organizational types and sizes. Practically, it supports construction organizations in adopting GenAI responsibly and advancing progress toward SDG commitments.

This study proposes an empirical framework for examining the relationship between Generative AI adoption and sustainable development. The study investigates whether GenAI adoption contributes to organizational innovation, productivity and sustainability performance and examines the roles of AI literacy and responsible AI use in this relationship. A quantitative research design can be employed using a structured questionnaire administered to employees, managers, academic professionals or organizational decision-makers. Structural Equation Modeling (SEM) can be used to examine the proposed relationships between GenAI adoption, AI literacy, responsible use, innovation and sustainability outcomes. The proposed study contributes to the emerging literature by treating sustainability as a multidimensional outcome involving economic, social and environmental dimensions rather than focusing exclusively on technological adoption. The findings may provide practical guidance for organizations and policymakers seeking to adopt GenAI while maximizing sustainable benefits and minimizing ethical and environmental risks.

KEYWORDS: Generative Artificial Intelligence; AI Adoption; Sustainable Development; AI Literacy; Responsible AI; Innovation; Sustainability Performance; Digital Transformation; Sustainable Development Goals.

I. INTRODUCTION

Generative Artificial Intelligence has rapidly evolved from an emerging technological innovation into a widely accessible tool capable of generating text, images, software code, analytical outputs and other forms of digital content. Its increasing adoption is changing how organizations perform knowledge-intensive activities, communicate information, develop products and services and make decisions.

The significance of GenAI extends beyond productivity and technological innovation. Artificial intelligence is increasingly discussed in relation to the United Nations Sustainable Development Goals (SDGs), with potential applications in areas including smart agriculture, energy systems, production, water management, healthcare and urban planning. UNCTAD's 2025 Technology and Innovation Report emphasizes that AI can accelerate progress toward the

SDGs when accompanied by appropriate policies, infrastructure and skills, while inadequate governance and unequal access may increase existing inequalities.

This paper presents a detailed taxonomy of the current landscape of GenAI research, obtained from Latent Dirichlet Allocation (LDA)-based topic modeling applied to a corpus of 2162 Scopus-indexed publications. The taxonomy categorizes GenAI research into eleven thematic domains: Process Automation, Creative Arts, Healthcare Applications, Educational Technology, Business Optimization, Cybersecurity, Content Creation, Data Science, and Ethics and Bias. Each domain corresponds to one or more pertinent United Nations Sustainable Development Goals (SDGs), underscoring GenAI's potential contributions to global development objectives. For instance, GenAI applications in healthcare immediately contribute to SDG 3 (Good Health and Well-Being), whilst advancements in educational technology correspond with SDG 4 (Quality Education). The incorporation of subjects like cybersecurity and ethical AI highlights the interdisciplinary character and societal implications of GenAI research. This taxonomy integrates fragmented research initiatives into organized categories and functions as a strategic framework for future research, policymaking, and the responsible implementation of technology to promote sustainable and equitable innovation.

II. RELATED WORK

Generative AI represents a relatively new stage in the development of AI because it can create new content, generate ideas, assist knowledge-intensive tasks and interact with users through natural language. Compared with traditional predictive or optimization-oriented AI, GenAI can directly influence how individuals and organizations perform creative, analytical and knowledge-based activities.

Recent research has begun to examine GenAI specifically in relation to sustainable development. Sharma et al. analyzed 2,162 Scopus-indexed publications published between 2020 and 2025 using Natural Language Processing and topic modeling. Their findings identified major research themes involving automation, efficiency, innovation and sector-specific applications, while also highlighting concerns related to bias, privacy and social effects.

This emerging literature indicates that GenAI may contribute to sustainable development through several mechanisms. First, automation and productivity improvements can support economic sustainability. Second, GenAI-enabled knowledge creation and problem-solving can support innovation. Third, AI-assisted analysis may contribute to resource optimization and sustainability-oriented decision-making. However, these potential benefits should be evaluated against the social and environmental costs associated with GenAI.

III. METHODOLOGY

NLP stands for Natural Language Processing and is a subfield of Artificial Intelligence that deals with building systems designed to process natural language. It drives the creation of narratives, or their understanding, by allowing machines to interpret text or speech. NLP is thus an interface that brings together computational linguistics and elements of machine learning to translate natural language between people and machines.

Major areas of using NLP are opinion mining, translation, text generation and summarization, speech recognition, and conversational agents. Some implicated operations include tokens, stemming, lemmatization that reduces tokens to root form, named entity recognition that recognizes the occurrence of important entities, and syntactic parser that transforms text data to structured data. One of the most complicated methods of the NLP is topic modelling – the art of identifying abstract topics within a certain number of documents. The algorithms scrutinize the words in the documents and set out patterns or relationships in which similar words are grouped in topics. Common topic modelling techniques include:

- Latent Semantic Analysis (LSA): Singular value decomposition determines the relations between terms and documents in vector space models.
- Non-negative Matrix Factorization (NMF): A method that uses the properties of linear algebra to factorize and extract low-level representation from the document-term matrix with the discovery of latent topical structure .
- Latent Dirichlet Allocation (LDA): A generative model for unsupervised learning of texts that assumes each document is a composition of topics, which are distributions of words .

IV. EXPERIMENTAL RESULTS

Random assignment will ensure that individual differences between participants are distributed as evenly as possible across the two groups, thereby reducing selection bias and strengthening the internal validity of the experiment. Both groups will receive identical instructions, tasks, time limits, and evaluation criteria, with the availability of genai being the primary difference between the experimental and control conditions. The study will measure participants' performance using quantitative indicators related to decision quality, creativity, sustainability, and innovation. Decision quality will assess the extent to which participants identify relevant information, evaluate alternatives, and select appropriate solutions. Creativity will measure the originality and usefulness of the proposed solutions, while sustainability will evaluate the extent to which environmental, social, and economic considerations are incorporated into decision-making. Innovation will focus on the novelty and practical applicability of participants' proposed ideas. In addition, the study will examine the role of responsible GenAI use. Participants in the experimental group will be encouraged to use the AI tool critically and responsibly by verifying AI-generated information, considering potential biases, and applying their own judgment rather than relying entirely on AI-generated recommendations. This will allow the study to determine whether responsible GenAI adoption contributes to better sustainable decision-making and innovation outcomes. Data collected from both groups will be statistically analyzed to determine whether significant differences exist between participants with and without access to GenAI. Appropriate statistical tests will be used to compare group performance and assess the relationships between GenAI adoption, responsible use, sustainable decision-making, and innovation. The experimental design therefore provides a structured approach for evaluating whether GenAI access produces measurable improvements in participants' ability to develop creative, innovative, and sustainable solutions.

The study will also measure **task completion time** as an objective indicator of efficiency. the time required by participants to complete the sustainability task will be recorded and compared between the experimental and control groups. in addition, participants in the experimental group may be asked to provide information about their use of genai, including the frequency of interaction, types of prompts used and the extent to which ai-generated recommendations influenced their final decisions.

A. before the main experiment, a **pilot experiment** will be conducted with a small group of participants to assess the clarity, difficulty and reliability of the experimental task and evaluation rubric. the pilot study will also determine whether the allocated time is sufficient for participants to complete the task. necessary modifications will be made before conducting the final experiment.

B. the collected data will be analyzed using **descriptive statistics and inferential statistical techniques**. mean and standard deviation will be calculated for the major dependent variables. an **independent-samples t-test** will be used to compare the experimental and control groups on innovation performance, sustainability performance, decision quality and task completion time. where the research includes more than two experimental conditions, **one-way or two-way anova** will be used as appropriate. effect sizes will also be reported to determine the practical significance of the observed differences.

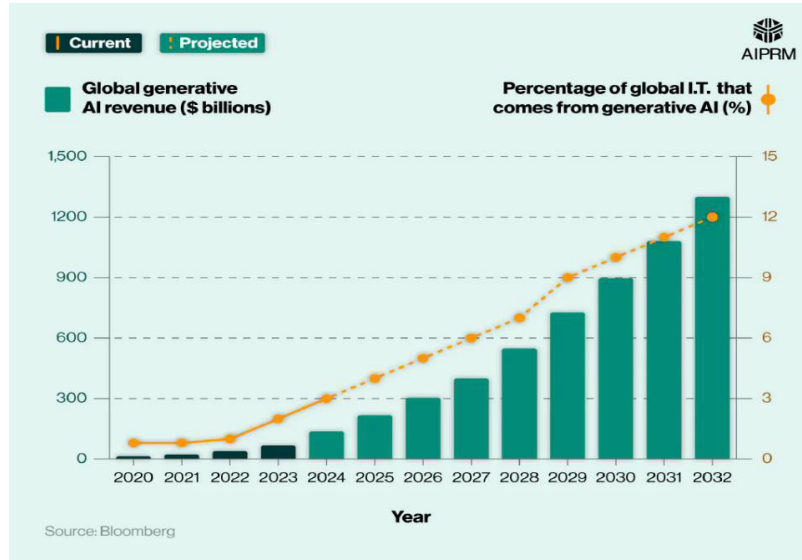


Figure 1: Generative AI is set to reshape the global IT industry, with revenue projected to surge past \$1.3 trillion by 2032 as its share of global IT spending reaches 12%.

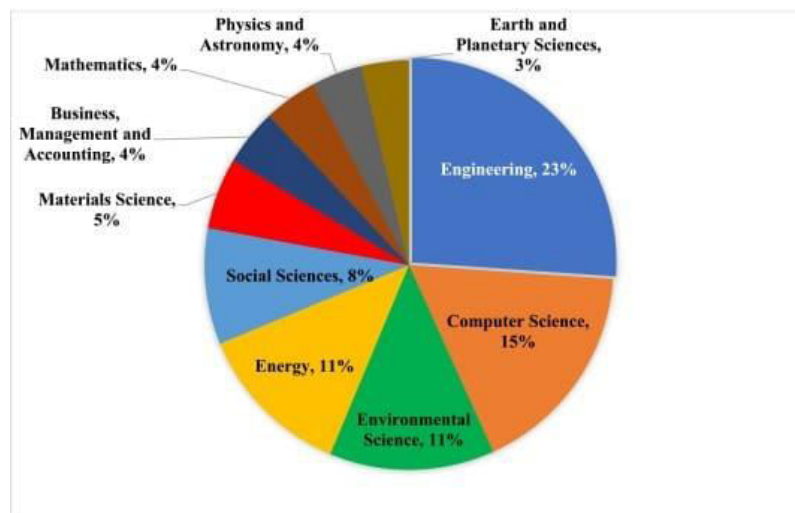


Figure 2: Research Areas: A Percentage-Wise Overview

V. CONCLUSION

Generative AI represents an important technological opportunity for advancing sustainable development, but its contribution cannot be assumed to be automatically positive. The technology has the potential to increase productivity, accelerate innovation, improve decision-making and support sustainability-oriented activities. At the same time, its environmental footprint, ethical risks and unequal accessibility create significant challenges. Therefore, sustainable GenAI adoption requires more than technological availability. It requires AI literacy, responsible governance, human oversight, organizational innovation and consideration of environmental impacts. The proposed study aims to provide empirical evidence regarding how these factors interact and whether responsible GenAI adoption can translate technological capabilities into measurable sustainability outcomes.

The central proposition of the study is: Generative AI does not automatically create sustainable development; sustainable development emerges when GenAI is adopted responsibly, supported by AI literacy and transformed into innovation and resource-efficient practices.

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