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EVALUATING THE CREATIVITY LEVEL OF A MULTIMODAL AI SYSTEM FOR MANAGEMENT INNOVATION IN A TURBULENCE ENVIRONMENT

Abstract. *In an era characterized by rapid technological advancements and unpredictable socio-economic shifts, organizations face increasing pressure to innovate and adapt. This turbulence necessitates advanced management strategies powered by intelligent systems capable of creative problem-solving. This paper explores a novel approach to evaluating the creativity level of multimodal artificial intelligence (AI) systems designed to drive management innovation in turbulent environments. The study presents a comprehensive evaluation framework that assesses AI-driven creativity through four dimensions: originality, fluency, flexibility, and elaboration. Leveraging multimodal capabilities – including natural language processing, computer vision, and machine learning – the AI system generates, analyzes, and refines innovative solutions for complex managerial challenges. A weighted scoring system, combined with expert judgment and real-time feedback, ensures a holistic evaluation of the AI's creative output. The proposed framework was tested in various management contexts, including project planning, risk mitigation, and strategic decision-making under uncertainty. Results indicate that multimodal AI systems significantly enhance managerial creativity by identifying novel solutions, predicting potential outcomes, and adapting real-time strategies. Furthermore, the study highlights how AI-driven creativity fosters resilience, efficiency, and sustainable innovation in dynamic business environments. Evaluating the creativity level of a multimodal AI system like ChatGPT requires defining creativity in measurable terms and creating a framework to assess it quantitatively.*

Keywords: creativity; multimodal AI; management; innovation; turbulence environment

Introduction

The accelerating pace of technological disruption, economic volatility, and socio-political shifts have created an increasingly turbulent environment for organizations. Traditional management frameworks, designed for relatively stable conditions, often fall short in navigating the complexities and uncertainties of modern business landscapes. In response, organizations are turning to multimodal artificial intelligence (AI) systems to drive management innovation, enhance decision-making, and foster resilience. Multimodal AI systems integrate various data streams – such as text, images, audio, and structured data – to generate holistic insights and creative solutions. Unlike unimodal systems, multimodal AI can identify patterns across diverse inputs, enabling adaptive strategies and innovative problem-solving. However, while AI's analytical capabilities are well-documented, its creativity – a crucial factor for breakthrough innovations – remains underexplored and challenging to evaluate systematically. Creativity in management innovation involves more than generating novel ideas; it encompasses the ability to develop original, practical, and impactful solutions that address complex challenges. In turbulent environments, managers require not only efficiency but also ingenuity to reframe problems, explore unconventional approaches, and implement adaptive strategies. As AI systems increasingly support managerial decision-making, understanding and evaluating their creative potential becomes essential. This paper proposes a framework for evaluating the creativity level of multimodal AI systems in the context of management innovation. The framework assesses

AI-generated outputs across four key dimensions – originality, fluency, flexibility and elaboration.

The study applies this evaluation model to real-world management scenarios, demonstrating how AI-driven creativity enhances decision-making, risk mitigation, and strategic innovation. Findings reveal that multimodal AI can not only streamline operational processes but also act as a catalyst for transformative innovation, empowering managers to navigate turbulence with greater adaptability and foresight.

Literature review

The intersection of multimodal AI systems and management innovation in turbulent environments has emerged as a critical area of research. Creativity in AI – defined as the ability to generate novel, valuable, and contextually relevant solutions – is essential for addressing dynamic challenges such as market volatility, technological disruption, and regulatory shifts. This review synthesizes existing literature on – theoretical frameworks for AI creativity, metrics for evaluating creativity in multimodal AI systems and applications of creative AI in turbulent management contexts.

The utilization of Artificial Intelligence (AI) is springing up through all spheres of human activities due to the current global pandemic (COVID-19), which has limited human interactions in our societies and the corporate world. Undoubtedly, AI has innovatively transformed our ways of living and understanding of how mechanical systems work on problem-solving as or even beyond human beings. The core issues of this book include the following issues understanding the working mechanism of the human mind on problem-solving, and exploring what it means to be computationally creative and how it can be evaluated [1].

The development of technology related to Artificial Intelligence is growing rapidly, and one of its implications is the teaching of mathematics in the classroom. Therefore, it is necessary to research the perspective of mathematics teachers in addressing the development of artificial intelligence (AI) used in mathematics learning. This study examines the role of AI technology in facilitating pedagogical reform in mathematics education from the perspective of teachers [2].

Mobile technologies have become increasingly important in the field of education, providing innovative ways to engage students and enrich their learning experiences. ChatGPT is an innovative tool that can be used in English for Specific Purposes (ESP) classes to engage students, enhance their knowledge and skills, and add variety and interest to the traditional process of learning engineering English, whether accessed through computers or mobile devices [3].

The application of 5G communication technology will help our lives in many ways because the biggest advantage of 5G technology is the ubiquitous wireless connectivity, coupled with the standardization of IP as a data protocol, the availability of low-cost and powerful computing resources in the cloud, and the increased speed of transmitted data, all of which help shape the vision of 5G. Many application scenarios can use lower-cost 5G networks. Based on advances in various communication technologies, several new application scenarios, including robotics and human-robot interaction, are beginning to emerge [4].

The ability to process multiple types of data from a given subject enhances a system's contextual understanding, leading to more accurate inferences and decisions. However, as previously mentioned, integrating diverse modalities presents significant challenges, and adding more data does not always guarantee improved judgment or accuracy. In some cases, multimodal AI may generate conflicting interpretations, increasing ambiguity and ultimately reducing model reliability [5].

Multimodal AI systems are designed to enable co-learning, meaning they must simultaneously learn from different modalities or tasks. However, this process is complex, as learning from one modality can negatively impact performance in others. Such interference can amplify ambiguity and reduce accuracy, potentially leading to unintended consequences for individuals [6].

Moreover, multimodality often requires processing larger volumes of data. For instance, training multimodal AI models depends on annotated datasets that establish correspondences between different data types. This significantly increases data processing demands, sometimes involving personal information, raising concerns about whether such extensive data use is always justified [7].

Another critical consideration in processing multimodal data is its potential impact on individuals, especially when certain modalities – such as neurodata – are highly intrusive. This raises ethical and legal concerns, as it could result in the unlawful processing of personal data [8].

A particularly sensitive application of multimodal AI is Multimodal Emotion Recognition (MER), which interprets human emotions by analyzing signals such as text, speech, and facial expressions (e.g., Google Gemini). The risks associated with misinterpreting emotions and manipulating user behaviour pose significant ethical concerns. Misjudgments in emotional analysis could lead to unfair treatment, flawed decision-making, and even restrictions on human rights, especially if AI systems adapt user interactions in ways that are not transparent to them [9].

Evaluating Creativity in Multimodal AI implemented by the metrics for AI creativity presented on table 1.

Table 1 – ***Evaluating Creativity in Multimodal AI implemented by the metrics for AI creativity***

Dimension	Metrics	Tools/Approaches
Novelty	– Uniqueness of outputs; – Divergence from training data.	Statistical divergence (KL divergence), human-AI benchmarking.
Usefulness	– Relevance to problem context; – Feasibility.	Expert evaluation, SWOT analysis.
Surprise	– Unexpectedness of solutions.	Entropy measures, user feedback.
Multimodal Cohesion	– Consistency across modalities (e.g., text-image alignment).	Cross-modal attention models, semantic similarity scores.

Evaluating the creativity of multimodal AI systems in turbulent environments requires a hybrid approach: blending computational metrics, human judgment, and adaptability frameworks. Future research should focus on context-aware evaluation, ethical safeguards, and integrating AI creativity into agile management practices. As turbulence becomes the norm, AI's role shifts from automating tasks to orchestrating innovation.

Model Components for Creativity Evaluation

The creativity of a multimodal AI system can be evaluated based on originality, relevance, diversity, and adaptability in its outputs. Each of these dimensions can be quantified as follows:

1. Originality

Measures how unique or novel the AI's responses are compared to a reference dataset.

$$O = 1 - \frac{Ns}{Nt},$$

where *Ns* – Number of outputs similar to existing entries in a reference database (e.g., training data); *Nt* – Total number of outputs evaluated.

2. Relevance

Evaluates how well the outputs align with the context or prompt provided.

$$R = \frac{\sum_{i=1}^{n} Rel(i)}{n},$$

where *Rel(i)* – Human-rated or AI-assessed score (e.g., on a scale of 0 to 1) for each output's relevance; *n* – Number of outputs evaluated.

3. Diversity

Measures the variety in the generated outputs across a set of prompts. This can be calculated using entropy or distance measures.

$$D = -\sum_{i=1}^{k} p_i \, log(p_i),$$

where p_i – Probability distribution of output types or categories; *k* – Number of unique output types.

Alternatively, diversity can be measured using cosine similarity or pairwise distances between outputs in a feature space:

$$\mathrm{D} = 1 - \frac{\sum_{ij} \mathrm{Sim(i,j)}}{n(n-1)}.$$

4. Adaptability

Measures the AI's ability to modify its responses based on changes in context or constraints.

$$\mathrm{A} = \frac{\sum_{i=1}^{m} \mathrm{Adapt}(i)}{m},$$

where *Adapt(i)* – Score reflecting how well the system adapts to a shifted or modified prompt (rated 0-1); *m* – Number of adaptive tests conducted.

Overall Creativity Score

To combine these dimensions into a single creativity score, a weighted formula can be used:

$$C = w_O \cdot O + w_R \cdot R + w_D \cdot D + w_A \cdot A,$$

where w_O, w_R, w_D, w_A: Weights assigned to each dimension based on their relative importance.

The weights should sum to 1 ($w_O + w_R + w_D + w_A = 1$).

Evaluation Process

1. Dataset Creation: Define a set of prompts covering various topics, scenarios, and creativity challenges (e.g., storytelling, problem-solving, artistic generation).

2. Output Generation: Use the AI system to generate responses for each prompt.

3. Dimension Scoring:

– Measure originality by comparing outputs against a database of existing responses.

– Evaluate relevance and adaptability using human raters or AI-assisted scoring systems.

– Calculate diversity using entropy or similarity metrics.

4. Compute C: Use the formula to calculate the overall creativity score.

Example Calculation

Suppose the following scores are obtained for a multimodal AI system $O=0.85$ (85% of outputs are unique); $R=0.90$ (high relevance to prompts); $D=0.80$ (outputs are diverse); $A=0.75$ (good adaptability to changing prompts); Using weights $w_O=0.3$, $w_R=0.3$, $w_D=0.2$, $w_A=0.2$, the overall creativity score is $C = (0.3 \cdot 0.85) + (0.3 \cdot 0.90) + (0.2 \cdot 0.80) + (0.2 \cdot 0.75) = 0.855$.

Framework for Evaluation Evaluating the creativity level of a multimodal AI system for management innovation

Evaluating the creativity level of a multimodal AI system, especially in the context of management innovation within a turbulent environment, presents a complex challenge. It requires frameworks that can assess not just the output, but also the process by which the AI arrives at its solutions. The model 4P of Creativity is presented in Fig. 1.

The framework Evaluation tools and techniques are presented on the table 2.

Implementation of Framework for Evaluation Evaluating the creativity level of a multimodal AI system for management innovation is presented in Fig. 2.

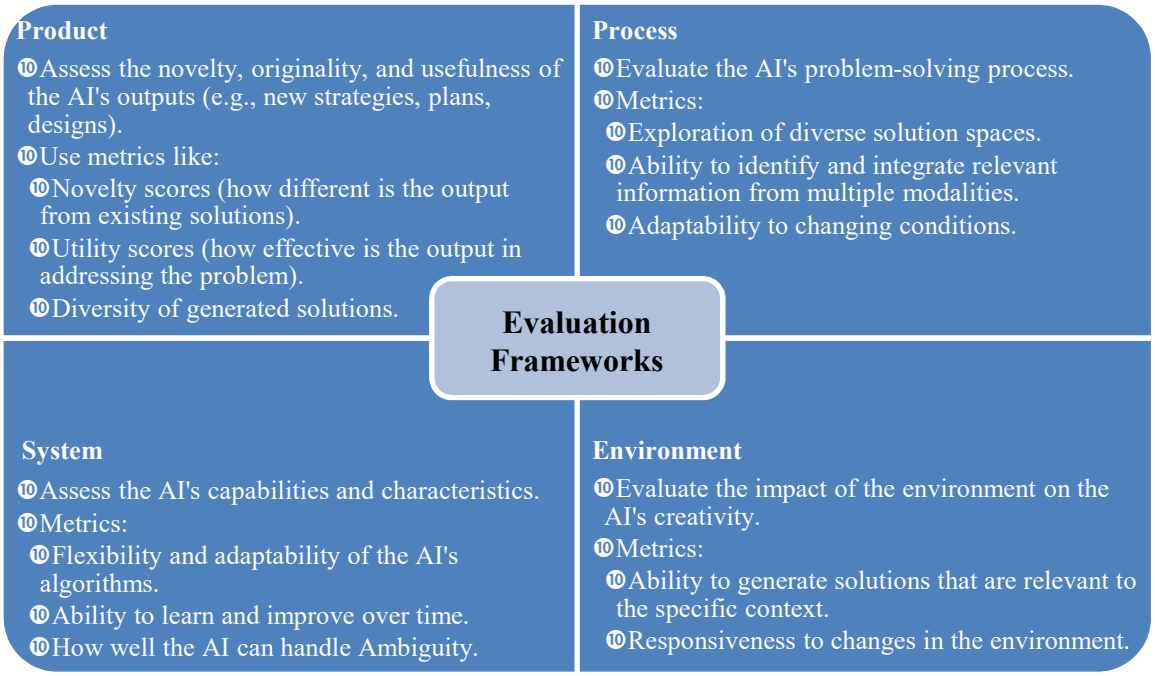

Figure 1 – The model of Creativity

Table 2 – Evaluation tools and techniques

Evaluation Method	Description	Examples/Metrics
Turing-Inspired Tests for Creativity	Develop scenarios where human experts evaluate AI outputs and compare them to human-generated solutions. Assess if AI outputs are indistinguishable from human creativity.	– Presenting AI's strategic plans to management experts. – Evaluating AI's design solutions in user testing. – Measuring the level of human expert's ability to distinguish between AI and human outputs.
Computational Creativity Evaluation	Utilize metrics from computational creativity research to assess AI creativity.	– Novelty: How statistically improbable are the AI's outputs? – Value: How useful or effective are the AI's outputs? – Surprise: Does the AI generate unexpected but valuable solutions?
Metrics Specific to Multimodal AI	Evaluate the AI's ability to integrate and understand information across multiple modalities.	– Cross-modal coherence: How well does the AI integrate information from different modalities (text, images, audio, etc.)? – Multimodal novelty: Does the AI generate novel combinations of information across modalities? – Contextual understanding: How well does the AI understand the context of the problem, considering all relevant modalities?

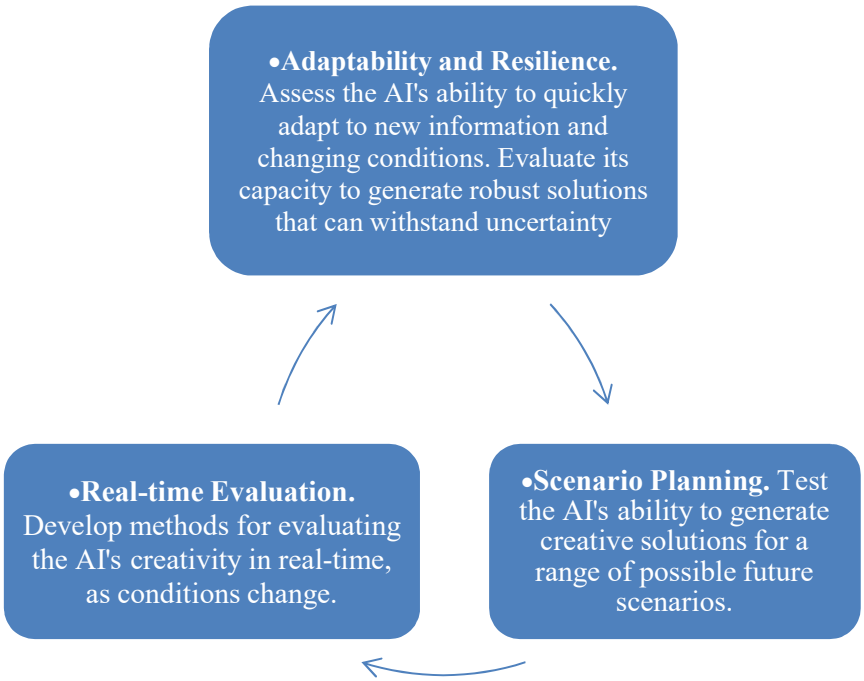

Figure 1 – Implementation Framework for Turbulent Environments

By combining these frameworks and tailoring them to the specific context of management innovation, it's possible to develop robust methods for evaluating the creativity level of multimodal AI systems.

Conclusion

This paper has explored the complex challenge of evaluating the creativity level of multimodal AI systems within the dynamic and unpredictable landscape of management innovation in turbulent environments. We established that traditional evaluation methods are insufficient for capturing the nuanced nature of AI creativity, particularly when dealing with diverse data modalities and rapidly changing contexts. By proposing a comprehensive framework based on creativity – Product, Process, System, and Environment – we have offered a structured approach to assess the AI's creative capabilities.

Our framework emphasizes the importance of evaluating not just the outputs of the AI, but also the underlying processes that lead to those outputs. This includes assessing the AI's ability to integrate information across modalities, adapt to changing conditions, and generate novel and valuable solutions. Furthermore, we highlighted the necessity of considering the AI's inherent characteristics and the impact of the environment on its creative performance.

The proposed frameworks, including Turing-inspired tests and computational creativity metrics, offer practical tools for assessing AI creativity in real-world management scenarios. By implementing these evaluation strategies, organizations can gain a deeper understanding of their AI systems' creative potential and make informed decisions regarding their deployment for management innovation.

However, the evaluation of AI creativity remains an evolving field. Future research should focus on refining these frameworks, developing standardized metrics, and conducting empirical studies to validate their effectiveness across diverse applications and turbulent environments. Moreover, addressing ethical considerations and ensuring the transparency of AI decision-making processes is crucial for fostering trust and maximizing the benefits of AI-driven management innovation. Ultimately, the ability to accurately assess and leverage AI creativity will be a key determinant of organizational success in an increasingly complex and uncertain world.

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ОЦІНКА РІВНЯ КРЕАТИВНОСТІ МУЛЬТИМОДАЛЬНОЇ СИСТЕМИ ШІ ДЛЯ УПРАВЛІННЯ ІННОВАЦІЯМИ В ТУРБУЛЕНТНОМУ СЕРЕДОВИЩІ

Анотація. *В епоху, яка характеризується швидким технологічним прогресом і непередбачуваними соціально-економічними зрушеннями, організації стикаються з дедалі більшим тиском щодо інновацій та адаптації. Ця турбулентність вимагає розвинутих стратегій управління на основі інтелектуальних систем, здатних творчо вирішувати проблеми. У цій статті досліджується новий підхід до оцінки рівня креативності мультимодальних систем штучного інтелекту (ШІ), розроблених для стимулювання інновацій управління в турбулентних середовищах. Дослідження представляє комплексну систему оцінювання, яка оцінює креативність, керовану штучним інтелектом, за чотирма параметрами: оригінальність, плавність, гнучкість і продуманість. Використовуючи мультимодальні можливості, включаючи обробку природної мови, комп'ютерне бачення та машинне навчання, система ШІ генерує, аналізує та вдосконалює інноваційні рішення для складних управлінських завдань. Зважена система підрахунку балів у поєднанні з експертною оцінкою та зворотним зв'язком у реальному часі забезпечує цілісну оцінку творчих результатів ШІ. Запропонована структура була протестована в різних контекстах управління, включаючи планування проекту, зниження ризиків і прийняття стратегічних рішень в умовах невизначеності. Результати показують, що мультимодальні системи штучного інтелекту значно підвищують креативність менеджерів шляхом виявлення нових рішень, прогнозування потенційних результатів та адаптації стратегій у реальному часі. Крім того, дослідження підкреслює, як креативність, керована ШІ, сприяє стійкості, ефективності та сталим інноваціям у динамічному бізнес-середовищі. Оцінка рівня креативності мультимодальної системи штучного інтелекту, як-от ChatGPT, вимагає визначення креативності в вимірюваних термінах і створення основи для її кількісної оцінки.*

Ключові слова: креативність; мультимодальний ШІ; менеджмент; інновації; турбулентність середовища

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