ISSN-L 2664-9969; E-ISSN 2706-5448

UDC 005.8:004.89:004.02
DOI: 10.15587/2706-5448.2025.322052

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DEVELOPMENT OF INNOVATION PROJECTS BASED ON THE SYNERGY TRIZ PRINCIPLE AND AI TECHNOLOGY

The object of the research is a novel development methodology for innovation projects that leverages the power of the synergy principle of the Theory of Inventive Problem Solving (TRIZ). It integrates artificial intelligence (AI) technology.

The problem addressed in this research is the inefficiency and limitations of traditional methods for development innovation projects, which often fail to comprehensively evaluate their potential, risks, and alignment with future technological trends.

The research results in the synergistic application of TRIZ principles and AI technology for conducting comprehensive audits of innovation projects. By integrating the structured problem-solving framework of TRIZ with the analytical power of AI, a novel approach is proposed to enhance the evaluation and optimization of innovation initiatives. The paper explores how artificial intelligence algorithms can be used to analyze project data and identify potential obstacles and opportunities based on the principles of TEDx. As well as to create alternative solutions and predict possible outcomes, help identify synergies between different project elements and external factors. And to constantly monitor and adapt the innovation process based on real-time data and AI-driven insights.

The difference in the research is the integration of TRIZ principles into auditing innovative projects using AI systems. The presented case showed the effectiveness of the proposed conceptual, mathematical and process models of auditing innovative projects. The master's program in artificial intelligence implemented at the Kyiv National University of Construction and Architecture (Ukraine) was chosen as an example for the case study. The study demonstrates the potential of this audit-integrated approach to improve the success rate of innovation projects by providing more accurate assessments, identifying hidden opportunities, and facilitating proactive decision-making. This research contributes to more effective and successful innovation projects by providing a data-driven and intelligent approach to project development and improvement. Within the framework of the considered case, an assessment of the acceleration of analysis and decision-making processes was carried out using the example of the innovative development program for training masters in artificial intelligence. It was found that the analysis and decision-making processes are implemented 2.68 times faster without loss of decision quality.

Keywords: *innovation project development, TRIZ, artificial intelligence, project management, predictive analytics, decision making.*

Received: 12.11.2024
Received in revised form: 02.01.2025
Accepted: 20.01.2025
Published: 31.01.2025

How to cite
Bushuyev, S., Bushuyeva, N., Puziichuk, A., Bushuiev, D. (2025). Development of innovation projects based on the synergy TRIZ principle and AI technology. Technology Audit and Production Reserves, 1 (2 (81)), 34–42. https://doi.org/10.15587/2706-5448.2025.322052

1. Introduction

In today's rapidly evolving business landscape, successful innovation is crucial for organizational growth and competitiveness. However, effectively managing and auditing innovation projects remains a complex challenge. Traditional audit methods often lack the depth and foresight required to identify potential roadblocks, uncover hidden opportunities, and predict future outcomes. This paper proposes a novel approach to innovation project auditing by synergistically combining the power of TRIZ (Theory of Inventive Problem Solving) with the analytical capabilities of Artificial Intelligence (AI).

The research on auditing innovation projects based on the Synergy TRIZ Principle and AI technology is highly relevant and timely. It has the potential to significantly impact innovation management practices across various industries and contribute to developing more effective and successful innovation initiatives.

The Theory of Inventive Problem Solving (TRIZ), introduced in [1], offers a systematic approach to identifying and resolving contradictions within systems to drive innovation. The TRIZ principle emphasizes synergy flow optimization. Identifying inefficiencies and losses in energy transfers within systems; contradiction resolution. Addressing trade-offs to achieve innovative solutions and predicting technological evolution. Aligning projects with trends to enhance relevance and competitiveness.

Applications of TRIZ in innovation projects have been explored in engineering, product design, and process optimization [2, 3]. However, TRIZ is rarely integrated into auditing processes, where its potential to systematically analyze and optimize projects remains underexplored.

AI technologies, such as machine learning (ML), natural language processing (NLP), and data analytics, have shown promise in improving auditing processes.

Automating repetitive tasks. Reducing time spent on data collection and analysis [4].

Enhancing decision-making. Using predictive models to forecast risks and outcomes [5].

Innovation success of performers, substituting technology by management [6–8].

Limited frameworks exist that combine AI's analytical capabilities with structured problem-solving methodologies like TRIZ.

Existing applications are primarily confined to specific domains and lack generalizability for diverse innovation projects.

Let's look at the integration of TRIZ and AI.

Few studies have explored the integration of TRIZ and AI. Recent advancements suggest that combining TRIZ's systematic approach with AI's computational power to automate the identification of contradictions suggests optimal solutions and enhances the scalability and adaptability of TRIZ methodologies for complex systems [9, 10].

However, these studies remain theoretical or are limited to prototype implementations. There is a need for comprehensive research to evaluate this integration in real-world scenarios, particularly in auditing innovation projects.

This review highlights the need for a novel approach that integrates the structured methodologies of synergy TRIZ with the computational efficiency of AI to transform the auditing process for innovation projects. This research aims to fill this gap by developing and testing such an integrated framework.

TRIZ, a systematic problem-solving methodology, provides a structured framework for identifying contradictions, analyzing existing solutions, and generating innovative concepts. AI, with its ability to process vast amounts of data, identify patterns, and make predictions, can significantly enhance the effectiveness of TRIZ-based audits.

By integrating TRIZ with AI, this research aims to develop a more comprehensive and insightful approach to innovation project auditing, ultimately improving the success rate of innovation initiatives and driving organizational growth. In an era of rapid technological advancement, innovation has become the cornerstone of competitive advantage for organizations across industries. However, the complexity and dynamic nature of modern innovation projects pose significant challenges to effective evaluation and management. Traditional auditing methods often fail to fully capture the multidimensional aspects of innovation, particularly in identifying systemic inefficiencies, contradictions, and opportunities for optimization. To address these limitations, this paper introduces an integrative framework for auditing innovation projects that combines the TRIZ (Theory of Inventive Problem Solving) principle with the capabilities of artificial intelligence (AI) technologies.

The TRIZ principle focuses on resolving contradictions and optimizing energy flows within a system to foster inventive solutions. Its systematic approach to problem analysis and solution generation has been widely recognized as a powerful tool for driving innovation. Meanwhile, AI technologies, including machine learning, data analytics, and natural language processing, have demonstrated their potential in automating complex tasks, uncovering hidden patterns, and enhancing decision-making processes. By combining these two paradigms, this paper proposes a method to systematically audit innovation projects, providing deeper insights into their potential, risks, and areas for improvement.

Thus, research addresses a critical need in the field of innovation management. Combining the power of TRIZ and AI, offers a promising approach to improving the efficiency, effectiveness, and impact of innovation projects.

The aim of this research is to develop a methodology that not only improves the audit of innovation projects but also contributes to advancing the intersection of problem-solving methodologies and intelligent technologies.

2. Materials and Methods

The object of the research is a novel development methodology for innovation projects. The proposed methodology leverages the power of the synergy principle of the Theory of Inventive Problem Solving (TRIZ) and integrates artificial intelligence (AI) technology.

Let's look at the Basis of the Study.

TRIZ Principles identifies patterns of inventive solutions and contradictions to improve problem-solving in innovation projects. Selected principles such as contradiction resolution, functionality optimization, and resource utilization were central to the study.

AI's capability in data processing, pattern recognition, natural language understanding, and predictive analysis was leveraged. AI tools included neural networks, decision support systems, and generative AI for conceptual ideation.

Synergy Combining TRIZ with AI was hypothesized to enhance creative problem-solving by automating routine tasks, generating inventive concepts, and evaluating potential solutions.

Methods used in Case study development and analysis of innovation projects in education. Selection Criteria of Projects with an explicit focus on addressing technical or systemic contradictions. The evaluation parameters are solution quality, time to innovate, and resource utilization.

Tools and Techniques are TRIZ Framework with application tools like Contradiction Matrix, Ideal Final Result (IFR), and 40 Inventive Principles. AI Models: Machine learning algorithms and generative AI for solution generation and validation and hybrid models – Custom-designed workflows combining TRIZ principles with AI inference. The Performance Metrics used Efficiency Gains, Creativity Index, and Cost-Benefit Analysis.

The study confirmed the potential of TRIZ and AI synergy in enhancing innovation project outcomes. The combination provides a structured yet creative framework for problem-solving, offering measurable benefits in efficiency and creativity. However, further research is needed to standardize workflows and address integration challenges.

This research explores how AI algorithms can be integrated into the innovation audit process as presented in Fig. 1.

Fig. 1. AI algorithms integrated into the innovation audit process

ISSN-L 2664-9969; E-ISSN 2706-5448

The integration of TRIZ and AI offers several advantages.

It enhances the identification and resolution of systemic contradictions that hinder innovation.

It leverages AI to analyze large volumes of data, enabling more accurate and efficient audits.

It aligns innovation projects with the trends of technological evolution, increasing their relevance and sustainability.

By addressing the critical need for a more robust and systematic audit methodology, this study aims to contribute to the growing field of innovation management and provide practical tools for organizations to better navigate the challenges of the modern innovation landscape.

Let's define Inadequate Identification of Systemic Contradictions.

Traditional auditing approaches (Table 1) lack systematic methodologies for uncovering and resolving contradictions inherent in complex innovation projects, which can hinder progress and innovation.

As innovation projects grow in scale and complexity, traditional audits struggle to keep pace, leading to inefficiencies and oversight of critical factors.

This research seeks to address these challenges by developing a robust, systematic, and scalable framework that integrates TRIZ principles with AI technologies, enabling a more comprehensive, accurate, and efficient audit process for innovation projects.

This research considers the process of auditing innovation projects through the integration of TRIZ principles and artificial intelligence (AI) technologies. Specifically, the study focuses on the following areas (Table 2).

Table 1

Traditional auditing approach to innovation projects

Issue	Description
Fragmented evaluation frameworks	Current methods often rely on qualitative assessments or isolated quantitative metrics, resulting in incomplete or biased evaluations of project feasibility and sustainability
Limited use of advanced technologies	The potential of artificial intelligence (AI) for automating and enhancing audit processes remains underutilized. Traditional audits rarely incorporate AI for data analysis, pattern recognition, or predictive modelling
Lack of alignment with innovation principles	Auditing frameworks do not sufficiently leverage established innovation methodologies, such as the TRIZ principle, to systematically evaluate and optimize project design
Scalability and efficiency challenges	As innovation projects grow in scale and complexity, traditional audits struggle to keep pace, leading to inefficiencies and oversight of critical factors

Table 2

Focus areas of auditing innovation projects

Focus Area	Description
Systematic problem-solving in innovation projects	The research examines how the TRIZ principle can be applied to identify and resolve contradictions, optimize energy flows, and drive creative solutions within innovation projects
Integration of AI in audit processes	AI technologies, such as machine learning, data analytics, and natural language processing, are explored as tools to enhance the efficiency, accuracy, and scalability of innovation project audits
Evaluation of project potential and sustainability	The research investigates how combining TRIZ and AI can help organizations evaluate the feasibility, risks, and alignment of projects with technological trends and market needs
Development of a hybrid audit framework	The objective includes the creation of a unified framework that leverages the strengths of TRIZ and AI to provide actionable insights and support decision-making in innovation management

To edit the English text, let's use Grammarly, which contains artificial intelligence technologies.

3. Results and Discussion

3.1. Conceptual model audit of innovation projects based on synergy TRIZ principle and AI technology

The conceptual model proposed in this research integrates the TRIZ principle and AI technologies into a unified framework for auditing innovation projects. The model consists of three core components: the audit process, the TRIZ principle, and AI-based automation and enhancement. These components interact systematically to address key challenges in innovation project evaluation (Fig. 2).

Let's discuss this model and the structure of elements:

1. *Core Components of the Model* (Table 3).
2. *Conceptual Flow of the Model.* The model follows a cyclic and iterative flow, ensuring continuous feedback and optimization (Fig. 3).
3. *Visual Representation of the Conceptual Model.* The conceptual model can be visualized as an interconnected framework, where TRIZ and AI technologies form two complementary pillars supporting the audit process.
4. *Benefits of the Model.* Comprehensive Auditing. Integrates structured TRIZ problem-solving with AI's data analysis capabilities to ensure a holistic evaluation.

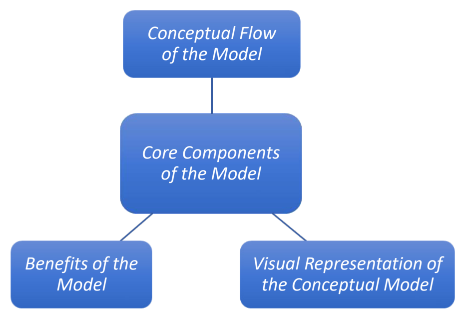

Fig. 2. Structure of conceptual model audit of innovation projects based on synergy TRIZ principle and AI technology

Table 3

Core components of the conceptual model audit of innovation projects

Component	Description
Audit process framework	The audit process forms the foundation of the model, structured into four key stages
	Input Analysis. Collecting data and defining project objectives, scope, and constraints
	System Evaluation. Identifying contradictions, inefficiencies, and potential risks using TRIZ principles
	Solution Assessment. Evaluating proposed solutions for feasibility, alignment with trends, and energy flow optimization
	Output Recommendations. Providing actionable insights and prioritized recommendations for project improvement
TRIZ principles	TRIZ methodologies are embedded at each stage of the audit process to provide a systematic approach to problem-solving and optimization
	Contradiction Analysis. Identifying and resolving trade-offs in project design and implementation
	Flow Optimization. Analyzing the project's energy inputs, outputs, and losses to identify inefficiencies
	Technological Trend Analysis. Leveraging TRIZ patterns of evolution to align projects with future trends and innovations
AI integration	AI technologies enhance the audit process by automating data analysis, pattern recognition, and decision-making
	Machine Learning (ML). Identifying patterns in project data to predict risks and outcomes
	Natural Language Processing (NLP). Analyzing unstructured text, such as project documents and feedback, to extract insights
	Data Visualization Tools. Presenting audit results in intuitive formats for better decision-making
	Generative AI. Assisting in solution ideation by generating creative and technically feasible suggestions

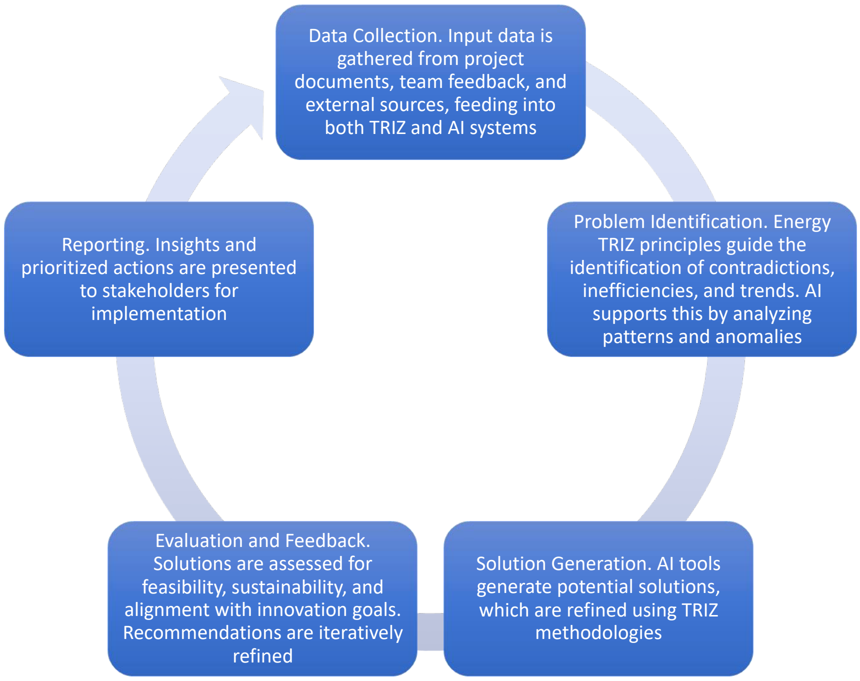

Fig. 3. The model follows a cyclic and iterative flow

Efficiency and Scalability. Automates repetitive tasks and processes large datasets, making it suitable for complex and large-scale projects.

Future-Oriented Insights. Aligns projects with technological trends and market demands using TRIZ patterns of evolution.

Actionable Recommendations. Provides clear, prioritized insights to guide decision-making.

The proposed conceptual model bridges the gap between traditional auditing methods and modern technological capabilities, offering a robust, scalable, and systematic framework for evaluating innovation projects.

3.2. Case study of application TRIZ principle in an AI environment

Evaluate TRIZ principles based on their relevance and impact on innovation project audits. The case study team included 10 teachers from the Project Management Department of Kyiv National University of Constriction and Architecture. Of these, 6 were doctors of science and professors.

Case study team Use these criteria to narrow down the choices:

1. *Applicability.* How well does the principle address common challenges in innovation projects (e. g., contradictions, inefficiencies)?
2. *Scalability.* Can the principle be applied to projects of varying complexity and scope?
3. *Alignment.* Does the principle align with audit objectives like feasibility, efficiency, and adaptability?
4. *Practicality.* How easily can the principle be integrated with AI-driven tools?
5. *Impact.* What is the potential contribution of the principle to project success?

Selected principles are presented in Table 4.

In the context of innovation projects, contradiction analysis identifies and resolves conflicts or trade-offs that arise between project goals and constraints. By leveraging TRIZ principles, let's aim to resolve these contradictions to improve project outcomes (Tables 5, 6).

Table 4

Selected TRIZ principles based on their relevance and impact on innovation project audits

TRIZ Principle	Description	Relevance (1–5)	Impact (1–5)	Priority
Segmentation	Divide a system/process into smaller parts for better analysis and customization	5	5	1
Local quality	Tailor components/processes to optimize performance for specific needs	4	5	2
The other way around	Reverse roles of processes/resources to find innovative solutions	4	4	3
Universality	Use multifunctional tools to streamline resources and reduce redundancy	3	5	4
Dynamics	Enable flexibility to adapt to changing conditions during execution	5	3	5
Prior action	Prepare resources/solutions in advance to mitigate risks	3	4	6

Table 5

Contradiction TRIZ principle by category

Category	Contradiction
Technological	Enhancing system complexity (to improve functionality) vs. maintaining simplicity (for usability)
Resource allocation	Allocating resources efficiently vs. ensuring all critical components are fully supported
Time management	Reducing time for development vs. ensuring high-quality testing and validation
Market readiness	Rapid deployment to meet market demands vs. ensuring robustness and reliability
Stakeholder alignment	Balancing diverse stakeholder requirements vs. maintaining a unified project direction

Table 6

Conflict resolution in application TRIZ principles for innovation projects audit

Category	Conflict	TRIZ principles applied	Expected outcome
Technological	Complexity vs. Simplicity	Segmentation, local quality, dynamics	The balance between functionality and usability
Resource allocation	Efficiency vs. Full Support	Universality, prior action, nested doll	Optimize resource usage while ensuring critical needs are met
Time management	Fast Development vs. Quality Assurance	Prior action, The other way around, parallelism	Accelerate timelines without compromising quality
Market readiness	Rapid Deployment vs. Robustness	Segmentation, dynamics, feedback	Deliver functional versions quickly and improve iteratively
Stakeholder alignment	Diverse requirements vs. Unified direction	Local quality, trimming, copying	Align stakeholder priorities while maintaining project coherence

Successful implementation of innovation projects supported with the next steps:

Integrate TRIZ Principles into AI Systems. Use AI tools to model potential solutions and simulate the resolution of contradictions dynamically.

Monitor Outcomes. Regularly assess the impact of resolved contradictions on project KPIs and adjust strategies accordingly.

Iterative Feedback. Continuously gather feedback to refine the application of TRIZ principles.

3.3. Sample of audit innovation project checklist

Let's present the Audit Checklist for Innovation Master Program Implementation (Tables 7–13).

Project Name. Implementation of a Master's Program in Artificial Intelligence and Cognitive Technology.

Institution. Kyiv National University of Construction and Architecture.

This checklist (Tables 7–13) is designed to ensure thorough preparation, compliance, and alignment with both academic and industry standards for a successful program implementation.

Table 7

Program design and development

Criteria	Status (Yes, No, In Progress)	Comments/actions needed
Defined program goals and learning outcomes aligned with AI and cognitive technology trends	Yes	Ensure alignment with industry demands and emerging trends in AI (e. g., explainable AI, AI ethics). Regularly review and update to reflect advancements in the field
Curriculum structure developed, including core, elective, and research-based courses	In Progress	Finalize the curriculum structure, ensuring a balance of theoretical foundations, practical skills, and research opportunities. Consider offering elective tracks specializing in different AI applications (e. g., computer vision, natural language processing, robotics)
Inclusion of TRIZ principles and innovative problem-solving methodologies in the curriculum	In Progress	Develop specific courses or modules that integrate TRIZ principles with AI methodologies. Explore the use of design thinking, agile methodologies, and other innovative approaches to problem-solving
Courses aligned with international academic standards (e. g., IEEE, ACM)	In Progress	Review existing courses and align them with relevant IEEE and ACM standards. Consider inviting guest lectures from industry professionals
Integration of practical AI tools and frameworks	In Progress	Ensure that the curriculum includes hands-on experience with relevant AI tools and frameworks through laboratory exercises, projects, and capstone projects
Inclusion of interdisciplinary elements (e. g., construction applications of AI)	Yes	Emphasize the application of AI in real-world contexts, such as construction, healthcare, and finance. Encourage interdisciplinary projects that involve collaboration with other departments or external organizations

Table 8

Faculty and resource allocation

Criteria	Status	Comments/actions needed
Qualified faculty with expertise in AI and cognitive technology recruited or assigned	In Progress	Actively recruit faculty members with strong research and teaching backgrounds in AI, machine learning, deep learning, cognitive science, and relevant AI applications. *Consider hiring adjunct faculty or establishing collaborations with researchers from other institutions to broaden expertise
Training programs or workshops for faculty to stay updated on AI advancements	In Progress	Organize workshops and seminars on emerging AI technologies, such as deep learning, natural language processing, computer vision, and reinforcement learning. Encourage faculty participation in conferences and workshops to stay abreast of the latest research and developments. Provide opportunities for faculty to pursue professional development through short courses and certifications
Adequate facilities, including computer labs and AI research centers, are available	In Progress	Assess current facilities and identify any gaps in computing power, specialized equipment, and research infrastructure. Develop a plan to upgrade existing facilities or acquire new equipment as needed. Consider creating dedicated AI research labs with access to high-performance computing resources
Access to software licenses, datasets, and cloud computing resources	In Progress	Negotiate licenses for essential software tools and frameworks. Explore options for accessing high-quality datasets relevant to AI research and applications. Investigate the feasibility of obtaining access to cloud computing resources for research and teaching purposes
Collaboration with industry experts for guest lectures or workshops	In Progress	Establish relationships with industry professionals and organizations working in AI. Invite industry experts to deliver guest lectures and participate in workshops and seminars. Organize industry visits and internships for students to gain practical experience

Table 9

Compliance and accreditation

Criteria	Status	Comments/actions needed
Alignment with Ukrainian higher education standards and accreditation requirements	In Progress	Conduct a thorough review of all relevant Ukrainian higher education standards and accreditation requirements. Ensure that all program aspects, including curriculum, faculty qualifications, resources, and assessment methods, comply with these standards. Regularly review and update the program to maintain compliance with evolving standards
Compliance with ethical guidelines for AI research and development	In Progress	Develop a clear set of ethical guidelines for AI research and development within the program. Integrate ethical considerations into all aspects of the curriculum, including discussions on bias, fairness, privacy, and the societal impact of AI. Provide students with opportunities to learn about and discuss the ethical implications of AI technologies
Incorporation of diversity and inclusion principles in program design	In Progress	Ensure that the program is accessible to all students, regardless of their background or socioeconomic status. Recruit a diverse faculty with a range of backgrounds and perspectives. Create a welcoming and inclusive learning environment for all students. Encourage the development of AI solutions that address societal challenges and promote equity and inclusion

Table 10

Student engagement and support

Criteria	Status	Comments/actions needed
Admission criteria are clearly defined and publicly communicated	In Progress	Develop clear and transparent admission criteria based on academic background, relevant skills (e. g., programming, mathematics), and relevant experience (e. g., personal projects, relevant coursework). Publicly communicate admission requirements on the program website and other relevant platforms. Ensure that the admission process is fair, equitable, and transparent
Scholarships and financial aid programs were established	In Progress	Explore options for establishing scholarships for high-achieving students and students from underrepresented backgrounds. Investigate potential sources of funding for scholarships, such as corporate sponsorships, alumni donations, and government grants. Communicate scholarship opportunities clearly to prospective students
Availability of mentoring and career counselling services for students	In Progress	Establish a mentorship program that connects students with industry professionals and successful alumni. Provide access to career counselling services, including resume and cover letter writing, interview preparation, and job search strategies. Organize workshops and seminars on career development and job search techniques
Partnerships with local and international tech companies for internships and placements	In Progress	Build strong relationships with local and international tech companies in AI and related fields. Negotiate internships and placement opportunities for students. Organize industry visits and networking events to connect students with potential employers

Table 11

AI integration in administration and evaluation

Criteria	Status	Comments/actions needed
AI-driven tools for administrative processes, including student enrollment and monitoring	In Progress	Explore and implement AI-powered tools for tasks such as student enrollment, scheduling, and academic advising. Investigate the use of chatbots for answering student inquiries and providing support. Implement AI-powered tools for plagiarism detection and academic integrity monitoring
Use of AI for program evaluation, feedback collection, and improvement	In Progress	Implement AI-powered tools for analyzing student performance data, identifying areas for improvement in the curriculum, and predicting student success. Utilize AI-powered tools for collecting and analyzing student feedback through surveys and other channels. Develop dashboards to visualize key performance indicators and track program progress
Data security and privacy policies in place for AI tools and student data	In Progress	Develop and implement robust data security and privacy policies to protect student data. Ensure compliance with relevant data protection regulations Regularly review and update data security measures to address emerging threats and vulnerabilities

Table 12

Industry and research collaboration

Criteria	Status	Comments/actions needed
MOUs signed with AI research organizations and industry leaders	In Progress	Identify and establish partnerships with leading AI research institutions, technology companies, and industry organizations. Negotiate and sign Memoranda of Understanding (MOUs) outlining areas of collaboration, resource sharing, and student exchange programs
Collaborative research projects initiated with construction and cognitive technology industries	In Progress	Identify and pursue collaborative research projects with industry partners, focusing on real-world challenges and opportunities in AI and construction. Facilitate student involvement in these research projects to provide hands-on experience and build valuable industry connections
Organization of AI-focused conferences, seminars, and hackathons	In Progress	Organize and host conferences, seminars, and workshops on cutting-edge AI topics and their applications in the construction industry. Invite industry experts and academic researchers to present their work and share their insights. Organize hackathons to encourage student innovation and creativity in applying AI to real-world challenges

Table 13

Monitoring and continuous improvement

Criteria	Status	Comments/actions needed
Establishment of a feedback mechanism for students and stakeholders	In Progress	Implement a system for collecting feedback from students through surveys, focus groups, and individual interviews. Establish a mechanism for gathering feedback from alumni, employers, and industry experts. Regularly review and analyze feedback to identify areas for improvement
Regular audits of the program to identify and address gaps	In Progress	Conduct regular program reviews and audits to assess the effectiveness of the curriculum, teaching methods, and student learning outcomes. Analyze student performance data, graduation rates, and employment outcomes to identify areas for improvement. Involve faculty, students, alumni, and industry representatives in the audit process
Updates to the curriculum based on technological trends and market needs	In Progress	Regularly review and update the curriculum to reflect the latest advancements in AI and cognitive technology. Incorporate new technologies, tools, and methodologies into the curriculum as they emerge. Stay abreast of industry trends and ensure that the program prepares students for the evolving job market

3.4. Mathematical model for audit of innovation projects based on TRIZ principle and AI technology

Let's define a mathematical model for the audit of innovation projects.

1. *Objective Function* (F). The main goal is to maximize the probability of project success (P_{suc}) by optimizing the key variables:

$$F=\max\left(P_{suc}\right)=f\left(T_f,R_e,M_r,I_c\right), \quad (1)$$

where T_f – technological feasibility; R_e – resource allocation efficiency; M_r – market readiness; I_c – innovation compatibility with organizational goals.

2. *Variables and Parameters*:

– Technological feasibility (T_f):

$$T_f=\frac{\sum_{i-1}^{n}S_i\cdot W_i}{n}, \quad (2)$$

where S_i – success of the i^{th} prototype iteration; W_i – weightage is assigned based on complexity; n – number of iterations.

– Resource allocation efficiency (R_e):

$$R_e=\frac{R_{used}}{R_{alloc}}, \quad (3)$$

where R_{used} – resources utilized during the project; R_{alloc} – total resources allocated.

– Market readiness (M_r):

$$M_r=\frac{D_{addr}}{D_{total}}, \quad (4)$$

where D_{addr} – customer demands addressed by the innovation; D_{Total} – total potential customer demands.

– Innovation compatibility (I_c):

$$I_c=\text{alignment of innovation features with strategic goals (0 to 1 scale)}. \quad (5)$$

3. *Constraints*. Define constraints for feasibility, resource efficiency, and market readiness:

– minimum technological feasibility threshold:

$$C_1{:}\ T_f\geq T_{\min}; \quad (6)$$

– resource efficiency must not exceed the allocated:

$$C_2{:}\ R_e\leq 1; \quad (7)$$

– minimum market readiness threshold:

$$C_3{:}\ M_r\geq M_{threshold}; \quad (8)$$

– minimum innovation compatibility threshold:

$$C_4{:}\ I_c\geq I_{\min}. \quad (9)$$

4. *Synergy Principle* (S). TRIZ principles emphasize the positive interplay of variables.

The synergy factor (SSS) models the interactions between key variables:

$$S=T_f\cdot R_e\cdot M_r\cdot I_c. \quad (10)$$

This accounts for the combined impact of technological, resource, market, and strategic factors.

5. *AI-Driven Optimization*. AI tools enhance the model by:

– *Predictive analytics*: Estimate future outcomes based on historical and real-time data.

– *Optimization algorithms*: Use machine learning to refine resource allocation and timeline planning.

– *Scenario simulations*: Test multiple what-if scenarios to evaluate constraints and dependencies.

The optimization problem can be solved as:

$$\max F \textit{subject to constraints}\ (C_1,C_2,C_3,C_4). \quad (11)$$

6. *Feedback and Iterative Improvement*.

Integrate a dynamic feedback loop to adapt the model over time:

$$F(t+1)=F(t)+\Delta F(t). \quad (12)$$

This mathematical model integrates the synergy of TRIZ principles and AI capabilities to audit innovation projects effectively. It provides a structured framework to assess technological feasibility, resource efficiency, market readiness, and strategic alignment, ensuring projects adapt to dynamic and turbulent environments.

Table 14 format succinctly organizes the analysis, making it easy to identify key aspects of the framework's strategic position.

Practical significance of research is the methodology helps organizations allocate resources more efficiently, reducing costs and increasing profitability. By streamlining project management processes, this approach expedites the introduction of new products and services to the market. This methodology can help organizations become more resilient in the face of disruptions and uncertainties.

Table 14

SWOT analysis audit of innovation projects based on TRIZ principle and AI technology

Strengths	Weaknesses
A systematic framework combining TRIZ and AI for contradiction resolution and optimization	The complexity of integrating TRIZ principles with AI technology
High efficiency and scalability for handling large datasets	Dependence on high-quality, relevant input data
Provides both qualitative (creative) and quantitative (data-driven) insights	Subjectivity in applying TRIZ principles may lead to inconsistent results
Aligns projects with long-term technological and market trends	High initial costs for developing AI and TRIZ systems, including tools and training
Adaptable across various industries and project types	Resource-intensive setup for AI models and data pipelines
Opportunities	Threats
Advances in AI (e. g., NLP, machine learning) can enhance auditing processes further	AI systems are prone to biases and errors, risking incorrect audit outcomes
Adoption across diverse industries for innovation project management	Resistance to change in traditional organizations
Customizable frameworks tailored to specific industries or goals	Competing methodologies may provide similar capabilities
Enables organizations to differentiate in innovation and project auditing	Regulatory and ethical concerns around AI transparency and fairness
Supports alignment with global sustainability and energy efficiency goals	Economic uncertainty may limit investment in advanced systems

The limitations of the research are the accuracy and completeness of the data used to train the AI models will directly impact the reliability of the results, and understanding the decision-making process of AI models can be challenging, which may limit trust in the results.

Impact of war in Ukraine. Concern with economic instability can lead to reduced funding for research and development projects, war limits access to necessary resources, such as data, computing power, and skilled personnel and organizations prioritize immediate survival over long-term innovation.

Future research. The combination of AI with innovative frameworks, such as TRIZ principles, creates a robust ecosystem for managing complex projects. Continued advancements in AI technologies, such as machine learning and IoT, will further enhance the precision and applicability of technological audits. Organizations that embrace this integration will be better positioned to thrive in uncertain and dynamic environments.

By adopting AI-driven technological audits, businesses can achieve resilience, drive innovation, and maintain a competitive edge in the face of ongoing challenges.

4. Conclusions

Let's present Key Findings and Research Gaps.

Innovation Project Audits. Traditional methods lack a systematic approach to identifying and resolving contradictions and fail to leverage advanced technologies.

Synergy TRIZ. While effective for problem-solving, its application in audits remains underdeveloped.

AI Technologies. AI's potential to enhance audits and innovation management is clear, but frameworks combining AI with established methodologies like TRIZ are scarce.

Integration Opportunities. A unified framework combining Energy TRIZ principles and AI technologies has the potential to address the limitations of current auditing methods and improve innovation project evaluation.

The integration of Artificial Intelligence (AI) into the technological audit process brings transformative advantages, particularly in a turbulent environment where adaptability and precision are critical. By leveraging AI capabilities in data analysis, predictive analytics, and real-time monitoring, organizations can significantly enhance their ability to manage innovative projects effectively.

Enhanced Efficiency. AI automates labour-intensive tasks such as data aggregation and analysis, reducing time and resource requirements.

Proactive Risk Management. Predictive analytics enable early identification of potential risks and opportunities, supporting informed decision-making.

Agility in Response. Real-time monitoring ensures that deviations from project goals are addressed promptly, minimizing disruptions.

Strategic Insights. AI-powered tools provide deep insights into patterns and trends that may not be immediately evident through traditional methods.

While AI integration offers substantial benefits, challenges such as data quality, high implementation costs, and the need for skilled personnel must be addressed. Solutions include:

– Ensuring data integrity through validation mechanisms.
– Gradual adoption of AI tools to manage costs.
– Training teams to work effectively with AI technologies.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this study, including financial, personal, authorship or other, which could affect the study and its results presented in this article.

Financing

The study was performed without financial support.

Data availability

The manuscript has no associated data.

Use of artificial intelligence

The authors have used artificial intelligence technologies within acceptable limits to provide their own verified data, which is described in the research methodology section.

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