HARMONIZING AI WITH PROJECT MANAGEMENT PHASES FOR SUSTAINABLE INITIATIVES

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Abstract: Sustainable project management and artificial intelligence (AI) are both interdisciplinary fields that have gained a lot of attention and interest worldwide. Their integration might provide a valuable synergy for organizations in many industries. The paper aims to analyze some of the possible aspects of connecting these two fields within the phases of sustainable project management. Each of the phases: programming, planning, execution and monitoring, and closing and evaluation, has its activities related to obtaining sustainable project results, and there is a space for the application of AI. The research was aimed at exploring the issue of integrating sustainability principles into project management phases to implement projects in line with the organizational strategy of sustainable development. It was important to identify and analyze the phases of sustainable project management to discuss the possibility of involving AI practices in these phases. It was concluded that every phase of sustainable project management provides an environment for involving AI to improve decision-making, implementation, and evaluation processes.

Keywords: Project management; Sustainability; Sustainable project management; AI

1. Introduction

Artificial intelligence (AI) is still a relatively new field in the project management domain. While traditional project management methodologies have been well established and explored, the integration of AI into project management practices is still in its early stages. This lack of historical precedence should not discourage researchers from exploring it more deeply.

Sustainable project management and AI are both interdisciplinary fields, using concepts and methodologies from various domains such as computer science, economics, environmental science, and engineering. The purpose of this research is to explore how AI can contribute to specific sustainable project management phases and indirectly enhance environmental, social, and economic outcomes.

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PAGE 109-118

AI algorithms are based on data for the purpose of training and decision-making. That is why obtaining high-quality data in the field of sustainable project management could be challenging for research. Sustainability metrics, such as carbon footprint or social impact, should be available and standardized across projects. This lack of accurate and reliable data can inhibit AI-driven analyses and decision-making in sustainable project management.

Moreover, introducing AI into sustainable project management raises various ethical and social implications. For example, there may be concerns about algorithmic differences, transparency, and accountability in decision-making processes that affect sustainable project outcomes. Therefore, exploring these implications requires a distinctive understanding of both AI ethics and sustainability principles. This research is intended to explore how to harmonize diverse disciplines, including AI, sustainability, and project management, to innovate insights when addressing certain sustainable project issues. One of the most comprehensive classifications of sustainability principles presented by Goedknegt and Silvius (2012) includes the principles that can relate when considering AI integration, such as value and ethics, holistic approach, long-term view, large-scale risk reduction, participation, accountability, transparency, and stakeholder interest.

2. Literature Review

Despite many challenges, there is growing recognition of the potential benefits of involving AI and digitalization in sustainable project management for the purpose of optimizing resource allocation, improving risk management, and enhancing decision-making processes to achieve long-term environmental, social, and economic goals. To emphasize the importance of connecting AI and digitalization on the one hand and sustainability on the other, Gupta et al. (2020) introduced the term "digitainability" by merging "digitalization" and "sustainability". This term refers to the very strong and important bond between the processes of digitalization and sustainable development.

As Daneshpour (2015) emphasizes, organizations and societies consider sustainability to be one of the most significant challenges. He states that sustainability is a key factor in project success and that project management in a sustainable manner is a key organizational skill. Moreover, by integrating sustainability and project management concepts, organizations might be supported in achieving competitive advantage (Chofreh et al., 2019). It is known that stakeholders react very well when an organization clearly states its concern for the well-being of society and the environment while also taking care of the financial interests of its stakeholders. Moreover, Xegwana et al. (2024) pointed out that an organization's survival depends on managing stakeholder interests in an effective manner.

With the aim of solving many challenges in a sustainable business environment, organizations today connect sustainability with AI as a significant opportunity. According to Obradović et al. (2021), the digital environment can empower activities when managing projects in a sustainable manner through the potential of new technologies and digital tools. By using the power of AI to optimize resources, mitigate environmental impacts, and promote sustainable practices in different industries, organizations make considerable progress towards achieving global sustainability goals. Considering that projects are a mechanism for ensuring the sustainable development of the organization

and society (Magano et al., 2021), the integration of the concepts of sustainable development and project management has attracted both science and practice and become a topic of great interest (Sabini et al., 2019; Schoper et al., 2015).

Advancements in AI technologies have opened new possibilities for improving various aspects of project management, such as risk management, resource optimization, analytics, task automation, and decision support systems. These benefits are of great importance in many industries. Researchers and practitioners have recognized the potential of AI to address sustainability challenges across various domains, including energy, transportation, agriculture, and urban planning. Nikmehr et al. (2021) emphasized how digitalization in construction could contribute to cost reductions, higher efficiency, and better returns on assets. This can be realized with dedicated efforts and the application of Industry 4.0 digitalization practices (Sajjad et al., 2023). This research provided empirical evidence of how Industry 4.0 digitalization practices can have a positive impact on sustainability, resource management, functionality, technology usage, design, and efficiency (Sajjad et al., 2023). Moreover, Chauhan et al. (2022) stated how some of Industry 4.0 technologies, such as AI, blockchain, big data, and cloud computing, can be significant for achieving sustainable and responsible consumption and production.

3. Research Methodology

The research was prepared to examine the process of connecting sustainability principles with project management phases to implement projects along with the organizational strategy of sustainable development. It was crucial to identify and analyze the phases of sustainable project management in order to discuss the possibility of involving AI practices in these phases. At the beginning, the questionnaire was designed and tested before being sent to the respondents. In the process of confirming its validity and reliability, preliminary testing of the questionnaire was performed. Experienced project managers were engaged and provided their valuable insights to the questionnaire. Their answers and recommendations were analyzed in detail so that the final questionnaire could be defined. The research sample included experienced project managers and professionals from different industries.

4. Research Results and Discussion

In total, 207 answers were collected, where 60% of the respondents were male and 40% were female. The next characteristics of the sample stated that 53% of projects included in the research were implemented in organizations that operate in the private sector, while 40% of them operate in the public sector and 7% in the civil sector. It was important that all sectors were included, as well as various industries. According to the results, organizations in the sample mainly operate in the IT industry (38 in total), which is followed by education (24 in total), energy (16 in total), and others. The next important characteristic of the sample was related to the professional experience of the respondents. According to the results, most of them have worked on more than ten projects (66%), followed by respondents who have worked on 3–10 projects (30%), while only 4% of project professionals have worked on less than three projects. Besides that, they were mostly engaged in the position of project manager (71%), while 20% of the respondents participated in projects as project team members. In accordance with the sample characteristics, it was concluded that this research included individuals with relevant experience in the project management field (Toljaga-Nikolić, 2022).

Next, it was important to analyze the phases of sustainable project management (Toljaga-Nikolić, 2022). In those phases, sustainability principles could be integrated by applying practices, tools, and techniques from the position of a project manager who is competent to manage projects in a sustainable manner. It was concluded that the following phases support sustainability integration: programming, planning, execution and monitoring, closing and evaluation. After that, it was analyzed to what extent those phases provide a space for using AI to enhance sustainable project results (Table 1).

Table 1. Possibilities of using AI within the sustainable project management phases

	Programming	**Planning**	**Execution and monitoring**	**Closing and evaluation**
Sustainable project management phases and AI integration	- feasibility assessment of sustainability initiatives - to identify and analyse key project stakeholders - assessment of environmental and social impacts - to set the project strategic direction - to automate documentation	- optimization of resource allocation - to develop sustainable project design - risk analysis - to enhance decision-making processes	- real-time monitoring - optimization of resource utilization - predictive maintaining - risk identification - compliance with sustainability objectives	- to evaluate project performance - identification of lessons learned - knowledge transfer for future projects

- *First phase of sustainable project management: Programming*

Activities in the programming phase are particularly important when managing projects in a sustainable manner, especially due to their long-term focus (Toljaga-Nikolić, 2023). This phase of sustainable project management encompasses many analyses related to the issues and trends in different industries and sectors. This dynamic environment requires the establishment of long-term priorities and goals, exploring the available energy sources, identifying stakeholders that are willing to establish long-term partnerships, etc. When performing the programming phase, program goals should be aligned with strategic goals, which will provide a framework for future project efforts. Moreover, the project results impact on the social, environmental, and economic dimensions of sustainability should be identified and aligned, as well as accepted by the project stakeholders.

In the programming phase of sustainable project management, AI can play a significant role in assessing the feasibility of sustainability initiatives, identifying key project stakeholders, assessing environmental and social impacts, setting the strategic direction for the project, and provide automated documentation.

AI can assess the technical, economic, and operational feasibility of sustainable projects by analyzing relevant data and identifying potential challenges and constraints. Machine learning algorithms can simulate different project scenarios, predict resource requirements, and evaluate the cost-effectiveness of sustainability initiatives, helping stakeholders make informed decisions about project feasibility.

Also, AI can analyze stakeholder data, communication channels, and engagement patterns to identify key project stakeholders and develop tailored engagement strategies. By analyzing social network connections, organizational affiliations, and past interactions, AI algorithms can help project managers build relationships, gather feedback, and foster collaboration among stakeholders in sustainable project initiatives.

When helps in assessing environmental impact, AI can analyze environmental data, such as air quality measurements, biodiversity records, and satellite imagery, to assess the potential environmental impact of proposed projects. By simulating different scenarios and conducting predictive modeling, AI algorithms can help project managers evaluate the environmental risks and opportunities associated with sustainable initiatives.

Besides this, AI can analyze social media data, community feedback, and stakeholder engagement metrics to assess the potential social impact of proposed projects. Natural language processing (NLP) algorithms can identify relevant social issues, concerns, and aspirations within the project's target communities, helping project managers develop strategies to address social needs and enhance community engagement.

Related to setting the strategic direction for the project, AI can assist in setting strategic goals and targets for sustainable projects based on data-driven insights and predictive analytics. By analyzing historical project data, industry benchmarks, and sustainability performance indicators, AI algorithms can help project managers identify areas for improvement, set ambitious yet achievable goals, and develop a roadmap for achieving long-term sustainability objectives.

AI can provide an extremely important support to sustainable project management with AI-powered tools that automate the documentation processes during the programming phase, saving time and reducing administrative burden. Natural language generation (NLG) algorithms can generate project charters, feasibility studies, and other documentation based on predefined templates and input data, ensuring consistency and accuracy in project documentation.

- *Second phase of sustainable project management: Planning*

The programming phase in sustainable project management is followed by the planning phase. The activities are aimed at the development of feasible project plans. In the planning phase, the project scope should be defined and structured in detail so that all the project work packages and tasks can be identified. These elements are incorporated into project plans that should be approved by project stakeholders before starting the next phase. By considering to what extent the project environment could be changeable, it is important to establish project plans that are flexible during project execution, if necessary. In the planning phase of sustainable project management, special attention should be paid to project risks and the development of risk mitigation strategies (Toljaga-Nikolić, 2023).

In the planning phase of sustainable project management, AI can play a significant role in optimizing resource allocation, developing sustainable project design, conducting risk analysis, and enhancing decision-making processes. Here are several ways AI can contribute to the planning phase in sustainable project management:

Related to the resource optimization, AI can analyze historical project data, resource availability, and sustainability metrics to optimize resource allocation in sustainable projects. Machine learning algorithms can identify resource constraints, prioritize resource allocation based on project priorities, and develop resource-efficient project plans that minimize waste and maximize sustainability outcomes.

Also, AI can facilitate sustainable design and innovation by generating alternative design solutions, evaluating their environmental impact, and optimizing design parameters for sustainability performance. Generative design algorithms can explore a wide range of design options, considering factors such as material selection, energy efficiency, and life cycle analysis, to identify the most sustainable design solutions.

Moreover, AI-powered risk assessment tools can identify potential risks and uncertainties associated with sustainable projects and develop strategies to mitigate them. Machine learning algorithms are equipped to analyze recent project information, stakeholder feedback, and external factors to predict project risks and recommend risk mitigation measures, ensuring the successful implementation of sustainable initiatives.

When preparing project plans in sustainable project management, AI can assist in scenario planning and decision-making by simulating different project scenarios, evaluating their potential impact on sustainability objectives, and recommending optimal courses of action. Decision support systems powered by AI algorithms can analyze complex data sets, assess trade-offs between competing objectives, and provide stakeholders with actionable insights to inform strategic planning and decision-making.

- *Third phase of sustainable project management: Execution and monitoring*

Inputs to the phase of execution and monitoring are approved project plans from the previous phase that are implemented here, while project performance is reported to key stakeholders (Toljaga-Nikolić, 2023). In cases of necessity, project plans should be adapted and harmonized to the new circumstances. Sustainability encompasses different dimensions, social, environmental, and economic, which can cause many situations that require minor or major revisions. As a measure of the project's success, a sustainable project result has to be accepted and approved by the key project stakeholders.

During the execution and monitoring phase in sustainable project management, AI can significantly contribute by facilitating real-time monitoring, optimizing resource utilization, predictive maintaining, identifying potential risks, and ensuring compliance with sustainability objectives.

Real-time monitoring and data analysis is of a great importance in sustainable project management. AI can continuously monitor project activities and environmental metrics in real-time, enabling early detection of deviations from sustainability targets. By analyzing sensor data, satellite imagery, and other sources of information, AI algorithms

can provide project managers with insights into energy consumption, waste generation, and environmental impact, allowing for timely interventions to address sustainability concerns.

Also, AI can optimize resource utilization during the execution phase by dynamically adjusting resource allocation based on project requirements and sustainability objectives. Machine learning algorithms can analyze project data, resource availability, and environmental factors to optimize energy use, minimize waste generation, and maximize resource efficiency, ensuring that project activities are conducted in a sustainable manner.

AI-powered predictive maintenance systems can anticipate equipment failures and maintenance needs based on sensor data and historical performance data. By analyzing equipment indicators and usage patterns, AI algorithms can recommend proactive maintenance actions to minimize downtime, reduce repair costs, and prolong the lifespan of assets, contributing to sustainable project outcomes.

AI can identify potential risks and uncertainties during the execution phase and recommend strategies to mitigate them. By analyzing project data, stakeholder feedback, and external factors, AI algorithms can predict project risks such as supply chain disruptions, regulatory changes, and environmental hazards, enabling project managers to take proactive measures to address them and minimize their impact on project outcomes.

Related to quality control and compliance monitoring, AI-powered systems can ensure product quality and compliance with sustainability standards by analyzing product specifications, manufacturing processes, and environmental regulations. Machine learning algorithms can identify deviations from quality standards, recommend corrective actions, and verify compliance with sustainability certifications, ensuring that project deliverables meet the required quality and sustainability criteria.

- *Fourth phase of sustainable project management: Closing and evaluation phase*

In the closing and evaluation phase of sustainable project management, the project result should be approved and accepted by the key stakeholders so that the administrative project closure can be conducted. This phase also includes lessons learned and project evaluation. Moreover, project managers should evaluate the impact of project results on sustainability dimensions as well as the future impacts on society and the environment (Toljaga-Nikolić, 2023).

During the closing and evaluation phase in sustainable project management, AI can play a role in evaluating project performance, identifying lessons learned, and facilitating knowledge transfer for future projects.
When it is about project performance evaluation, AI can analyze project data, environmental metrics, and sustainability indicators to evaluate project performance and assess its impact on environmental, social, and economic outcomes. By applying machine learning algorithms to project data, AI can identify key performance indicators (KPIs), measure progress towards sustainability goals, and provide insights into the overall effectiveness of the project in achieving its objectives.

AI can analyze project documentation, stakeholder feedback, and historical project data to identify lessons learned and best practices for sustainable project management. Natural language processing (NLP) algorithms can extract insights from project reports, meeting minutes, and post-project surveys, helping project managers identify areas for improvement and apply lessons learned to future projects.

To emphasize the importance of closing reports and documentation, AI-powered tools can automate the reporting and documentation process during this phase. Project closure reports, and evaluation summaries, can be generated by Natural language generation (NLG) algorithms, ensuring consistency and accuracy in project documentation.

5. Conclusion

In conclusion, harmonizing AI with sustainable project management phases provides strong support for addressing complex environmental, social, and economic challenges. In this paper, it is analyzed how using AI can contribute to different phases of sustainable project management, from the programming phase, planning, execution and monitoring to closing and evaluation. AI integration into the programming phase of sustainable project management can enhance project strategic direction setting, environmental and social impacts assessment, and feasibility of sustainability initiative assessment, laying a solid foundation for the successful implementation of sustainability projects and the achievement of long-term environmental, social, and economic goals. Moreover, when integrating AI into the planning phase, it can enhance decision-making processes, optimize resource allocation, mitigate risks, and foster collaboration among stakeholders, leading to the successful implementation of sustainable projects. The next phase of sustainable project management is the execution and monitoring phase, where AI can enhance real-time monitoring, optimize resource utilization, mitigate risks, and ensure compliance with sustainability objectives. Finally, the closing and evaluation phase of sustainable project management provide the environment for involving AI to perform project evaluation, facilitate knowledge transfer to future projects, and ensure that lessons learned are available for future sustainability initiatives to drive positive change over the long term. Overall, by applying the power of AI technologies to sustainable project management, organizations can overcome challenges, drive innovation, and create long-term positive impacts for societies and the environment. That is the road to building a more resilient, equitable, and sustainable world for generations to come.

When considering the impact that these two fields together might have on the future development of theories, it is important to understand several aspects. First, combinations of different concepts often lead to innovation and advancement in understanding. When merging ideas from different disciplines or fields, such as AI and sustainable project management, researchers can uncover new insights and perspectives that may not have been presented within a single theory or framework. Second, many complex phenomena cannot be fully understood through the lens of a single theory. Combining theories allows researchers to develop a more holistic understanding by considering multiple factors and perspectives simultaneously, where AI and sustainable project management provide unexplored possibilities. Moreover, some issues are too complex to be solved using only one theory. By combining theories, it is possible to provide more comprehensive approaches to problem-solving by leveraging the strengths of each theory involved. Finally, connecting AI and sustainable project management requires the collaboration of

researchers across different disciplines, which fosters interdisciplinarity and leads to the development of new research methods and approaches.

The integration of AI and sustainable project management is a promising area of research. This research has some limitations related to the structure of the research sample. In this research, the majority of respondents are from the IT industry, therefore, future research will focus on other industries. Also, future research could be more competency-oriented and include an examination of which project managers`s competencies contribute the most to the successful implementation of AI in sustainable project management. Since the use of AI in sustainable project management raises ethical considerations regarding privacy, autonomy, and accountability, future research needs to address these ethical challenges to ensure responsible AI integration.

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