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PROJECT MANAGEMENT IN THE BIOECONOMY AND CIRCULAR ECONOMY

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Abstract: Integrating project management into bioeconomy and circular economy improves efficiency, sustainability, and resource optimization. Structured planning enables projects to meet goals on time and within budget while reducing waste and environmental impact. Effective coordination supports interdisciplinary collaboration and clear goal achievement. Regulatory differences across regions remain a key challenge. The paper analyses benefits, limitations, and recommendations, illustrated with a practical example.

Keywords: Project management, Bioeconomy, Circular economy, Efficiency, Environment

INTRODUCTION

Bioeconomy is an innovative approach that uses renewable biological resources such as biomass, bio-waste, plants, and microorganisms to create economic and ecological values. According to the Global Bioeconomy Summit (2018), bioeconomy includes “the production, use, and conservation of biological resources, including related knowledge, science, technology, and innovation, to provide products, processes, and services across all economic sectors aimed at a sustainable economy” (Boliko, 2019). Similarly, the National Academies of Sciences emphasize that bioeconomy “enables the conversion of renewable biological resources into food, bio-based products, and energy, reducing dependence on fossil resources and supporting sustainable development” according to National Academies of Sciences, Engineering, and Medicine. (NASEM, 2020).

This approach also supports the circular economy, where resources are maximally used, recycled, and returned to production cycles, minimizing waste and protecting the environment (Popović et al., 2022). In this context, project management plays a key role, as it allows for systematic planning, organizing, and implementing projects in an efficient and effective way. Well-managed projects not only increase productivity and economic viability but also contribute to sustainable use of biological resources, reduce waste, and optimize processes. The aim of this study is to show how the application of project management principles can significantly improve the efficient and sustainable use of biological resources and support the development of innovative and environmentally friendly solutions within the bioeconomy.

The bioeconomy focuses on the sustainable valorization of biological resources, whereas the circular economy provides the operational framework for closing material and resource loops. Integrating both approaches enables the development of a circular bioeconomy that supports green growth, innovation and environmental protection (Figure 1).

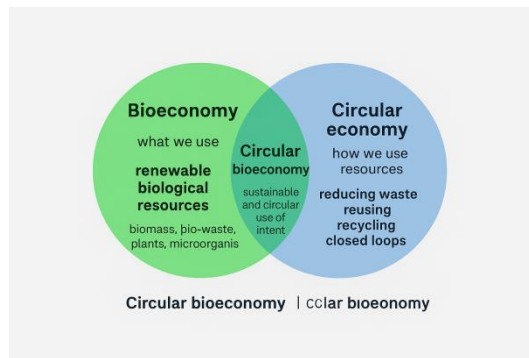


Figure 1. Bioeconomy and Circular economy
Source: Authors illustration

Bioeconomy is a broad concept based on the sustainable use of renewable biological resources, while circular economy represents a resource-efficiency model applicable across all sectors. Their intersection forms the circular bioeconomy, which promotes closed-loop use of biological resources with minimal environmental impact.

Literature Review

Concept of Bioeconomy

Bioeconomy is seen as an analytical concept, a dynamic sector of the modern economy using biological resources for food, medicine, industrial products, and energy, and a strategic tool for planning, research, and sustainable development. The study highlights the importance of technological advances, rational resource management, and integration with sustainable development to promote economic, regional, and sectoral growth (Adamowicz, 2017).

Bioeconomy inherently supports a circular economy by using renewable biomass in cyclical processes that minimize waste, recycle carbon, and aim to reduce the need for new resource inputs, thereby promoting sustainability and mitigating climate change. (Yadav et al., 2021).

Transitioning to a sustainable biocircular economy using renewable, bio-based materials while minimizing waste and following strategic principles can simultaneously address climate change, biodiversity loss, and social equity, but requires careful management to avoid “biowashing”. Considering the extreme effects of the climate crisis and the urgent need to achieve sustainable development goals, managers, companies, and entire industries must transition to a sustainable, biocircular economy, enabling all stakeholders and our planet to thrive in the future (Marshall et al., 2023).

Both the bioeconomy and circular economy, although promoted as tools for sustainability, currently pay insufficient attention to biodiversity and social equity (Stephenson and Damerell, 2022). The concepts are not clearly defined, their implementation is inconsistent, and monitoring of impacts is underdeveloped. To truly achieve sustainability, it is necessary to harmonize definitions, involve civil society, establish effective governance frameworks, foster innovation, and monitor impacts on nature and people. The focus should be on preserving species, ecosystems, and the well-being of local communities (Stephenson and Damerell, 2022).

Project Management in Sustainable Projects

Project management in sustainable projects involves organizing and guiding a project through its key phases planning, implementation, monitoring, and evaluation while integrating sustainability principles at every step. Sustainable project management expands traditional project approaches by considering environmental, social, and economic impacts throughout the project life cycle (Deland, 2009). The first phase, planning, is crucial because it defines project goals, identifies stakeholders, allocates resources, and incorporates sustainability criteria early on to reduce risks and negative impacts on people and the environment. As one study notes, “sustainable project planning assists in guiding the project team in execution, controlling and monitoring the project and can lead to identifying and minimizing project risks” (Chow et al., 2021).

During the implementation phase, the project plan is put into action, and sustainability practices such as resource efficiency, waste reduction, and stakeholder engagement are actively applied. Effective implementation ensures that sustainability targets are met alongside traditional performance metrics like time and cost. The monitoring phase involves continuously tracking progress and sustainability indicators, such as environmental performance or social outcomes, to ensure the project remains aligned with its sustainability goals. Finally, the evaluation phase assesses the overall project results, including sustainability impacts, lessons learned, and opportunities for future improvement. By systematically integrating these phases, sustainable project management not only seeks successful project delivery, but also minimizes resource use and supports long-term sustainability outcomes (Deland, 2009).

Link Between Bioeconomy and Project Management: Insights from Studies and Best Practice Examples

The connection between bioeconomy and project management lies in the need to plan, organize, implement, monitor, and evaluate complex initiatives that advance sustainable and circular use of biological resources. Research on sustainable bioeconomy strategies highlights the importance of structured planning and stakeholder coordination to achieve environmental, social, and economic goals. For example, studies on smart and sustainable bioeconomy platforms emphasize that effective bioeconomy development involves planning and stakeholder management as a core phase of strategy implementation, which aligns with project management processes such as defining goals, coordinating stakeholders, and setting performance indicators (D’Amico et al., 2022).

Moreover, research exploring sustainable development frameworks in bioeconomy shows that monitoring and evaluation practices, which are key components of project management, can support tracking progress toward sustainability objectives and help integrate bioeconomy actions with global goals such as the Sustainable Development Goals (SDGs) (Calicioglu and Bogdanski, 2021). These frameworks suggest that applying systematic project management principles including goal setting risk assessment, and performance tracking enables bioeconomy initiatives to be more transparent and effective in achieving sustainable outcomes.

Practical examples also illustrate how project management is integral to implementing large bioeconomy initiatives. European Union bioeconomy programs such as those funded through Horizon 2020 and Horizon Europe rely on structured project cycles and management frameworks to deliver complex research and innovation results, including integrated biorefineries and biomass valorization projects, demonstrating how strategic project planning and governance drive tangible bioeconomic impacts (European Commission, 2020).

Overall, studies and practice examples indicate that project management provides the tools and frameworks needed for the successful implementation of bioeconomy strategies, helping to align technical innovation with sustainability principles, manage multi-stakeholder collaborations, and monitor progress toward long-term ecological and economic objectives.

Methodology

The methodology of this study combines several qualitative research approaches to examine the link between bioeconomy and project management. First, an analysis of expert literature and reports was conducted, reviewing scientific papers, policy documents, and industry publications to gather existing knowledge, identify trends, and understand both theoretical and practical frameworks in the bioeconomy sector. Next, successful projects were identified and analyzed through case studies to explore best practices and provide concrete examples of how project management principles are applied in real-world sustainable initiatives. Finally, a qualitative assessment was carried out to evaluate the effectiveness of project management in promoting sustainable resource utilization, focusing on how planning, implementation, monitoring, and evaluation phases contribute to environmental, economic, and social outcomes. By integrating these methods, the study offers a comprehensive understanding of the role of project management in supporting sustainable bioeconomy practices and highlights strategies that can enhance both efficiency and sustainability. The selection of the case study was based on its relevance, level of development, and capacity to practically demonstrate the principles of the circular bioeconomy under real industrial conditions. Eco-Recycling d.o.o. was chosen as a representative example of best practice due to its long-term operation and the application of a closed-loop recycling model that integrates waste management, material recovery, and value creation.

Case study - Best Practice Example of ECO-RECYCLING Tire Facility

Eco-Recycling d.o.o. from Novi Sad stands out as a comprehensive and well-established example of circular economy best practice in Serbia, operating as the country's first

dedicated tire recycling facility since 2009 and fully licensed for storage, treatment, disposal, and transport of non-hazardous waste in compliance with domestic regulations and EU environmental standards (ISO 9001:2015 and ISO 14001:2015). The recycling complex in Sirig covers approximately 54.500 m² and includes large storage and handling areas as well as state-of-the-art production halls equipped with advanced machinery capable of processing all types and sizes of tires, including large damper tires, with an annual capacity of around 36.000 tons of rubber waste, producing granulates of up to 99% purity without generating additional waste or harmful emissions. Eco-Recycling not only collects and purchases waste tires from both individuals and legal entities offering transport services when needed but also integrates the entire recycling process into new value chains: recycled rubber granulate is used in a wide range of applications such as road construction materials, sports and recreational surfaces, building and agricultural products, and household items, thereby significantly reducing reliance on virgin resources and mitigating the environmental impact of non-biodegradable waste. By investing in skilled personnel and cutting-edge technology, maintaining strong operational standards, and creating secondary materials with diverse industrial uses from traffic infrastructure and sports facilities to insulation and rubber components for everyday use Eco-Recycling effectively demonstrates how sustainable industrial practices can be scaled locally while contributing to Serbia's broader circular economy goals and environmental protection efforts (Eco Recycling, 2025).

Project

The project focuses on the management of rubber waste, specifically end-of-life car and truck tires, through recycling and conversion into high-quality rubber granulate. This aligns with circular bioeconomy principles by transforming waste into reusable materials.

Project Objectives

Waste reduction, circular use of resources, and economic sustainability. Reduce tire waste and prevent environmental pollution. Promote circular use of rubber resources. Ensure economic sustainability by producing valuable products for multiple industries (construction, sports surfaces, agricultural applications).

Project Approach

Resource planning, team organization, progress monitoring, and evaluation of results.

Results

Recycled materials, energy efficiency, economic contribution.

Lessons Learned and Recommendations

Key insights for improving future projects. Importance of investing in employee training to maintain operational efficiency and quality. Demonstrates how circular economy principles can be applied to industrial waste management. Encourages replication of similar projects in other waste sectors to promote sustainability.

Key Finding: Bioeconomy + Project Management = Sustainable, Innovative, and Effective Projects



Recommendations:

- Apply project management in all bioeconomy phases
- Foster interdisciplinary collaboration

Future Perspective:

- Expand research and development in bioeconomy
- Utilize digital tools & innovative approaches

Figure 2. Sustainable, innovative and effective projects
Source: Authors illustration

DISCUSSION

Integrating project management into bioeconomy initiatives offers clear advantages that can enhance the effectiveness and sustainability of these projects. One of the primary benefits is resource optimization, as project management ensures that human, financial, and material resources are allocated efficiently, reducing waste and maximizing outputs in systems that rely on renewable biological materials. Additionally, better coordination among interdisciplinary teams including scientists, engineers, policymakers, and industry stakeholders facilitates smoother collaboration, reduces redundancies, and ensures that objectives are clearly communicated and achieved. These factors collectively contribute to higher efficiency, allowing bioeconomy projects to meet their targets on time and within budget, while also minimizing environmental impacts and promoting sustainable outcomes.

However, the implementation of project management in bioeconomy contexts is not without challenges. Regulatory issues pose significant obstacles, as projects often operate across different regions with varying environmental, safety, and industrial standards, making compliance complex. Financing is another key challenge, since bioeconomy initiatives frequently require substantial initial investment in infrastructure, technology, and skilled personnel, and funding sources can be uncertain or fragmented. Finally, technological limitations can hinder progress, as advanced equipment and processes such as biomass processing, bioproduct development, and circular resource utilization are often necessary but costly or not widely available.

To overcome these challenges, several strategies can be applied. Innovation is essential, enabling the development of new biotechnologies and the optimization of existing processes to improve efficiency and reduce costs. Education and capacity building help equip stakeholders with the knowledge and skills needed to navigate complex regulatory environments, adopt best practices, and implement sustainable solutions effectively. Furthermore, digital resource management tools and project management software can enhance monitoring, facilitate real-time decision-making, and improve overall coordination among teams. By combining these strategies, bioeconomy projects can not

only address their operational and regulatory challenges but also maximize their social, economic, and environmental impact, ensuring long-term sustainability and success.

CONCLUSION

Project management involves organizing and leading a project through the key phases: planning, implementation, monitoring and evaluation. In order for projects to be sustainable, sustainability principles need to be integrated into that every step. Sustainable project management extends traditional project approaches by taking into account environmental, social and economic impacts throughout the project life cycle.

Project management in the bioeconomy and circular economy involves the use of planning, organizing, implementing, monitoring and evaluating complex initiatives that promote the sustainable and circular use of biological resources. Structured planning and coordination of stakeholders are particularly important in order to achieve environmental, social and economic goals. In this way, sustainable project management strives for successful project implementation, minimizes resource use and supports long-term sustainability outcomes.

EU programs funded through Horizon 2020 and Horizon Europe, for example, rely on structured project cycles and governance frameworks to deliver complex research and innovation outcomes, including integrated biorefineries and biomass valorization projects, demonstrating that strategic planning and project management drive tangible bioeconomy impacts. Practice shows that project management provides the tools and frameworks needed for the successful implementation of bioeconomy strategies, helps align technical innovation with sustainability principles, and manages multi-stakeholder collaboration and monitors progress towards long-term environmental and economic goals.

A key finding of our research is that the implementation of project management into bioeconomy and circular economy lead to sustainable, innovative and efficient projects. Based on all of the above, it can be recommended that project management be included in all phases of bioeconomy and circular economy initiatives. In future research, we can pay more attention to the opportunities for research and development in the bioeconomy and circular economy sector.

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