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# TECHNOLOGICAL INNOVATIONS IN TOURISM BASED ON CIRCULAR ECONOMY

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***Abstract***

*The circular economy represents an innovative approach to economic development that promotes the sustainable use of resources through recycling, reuse, and waste reduction. In the context of tourism, the application of circular economy principles is becoming increasingly significant, especially with the support of technological innovations that enable more efficient and sustainable practices. This paper explores technological innovations in tourism that are based on the principles of the circular economy, including smart resource management systems, digital tools for optimizing energy efficiency, applications for recycling and waste management, as well as platforms for educating tourists about sustainability. Concrete examples of successful implementations of these technologies in various tourist destinations and sectors, such as hotels, restaurants, and travel agencies, are analyzed. Through quantitative and qualitative research methods, the paper provides insights into the economic, ecological, and social benefits brought by these innovations. Special emphasis is placed on evaluating their efficiency and potential for wider application with the aim of achieving sustainable tourism development. The conclusions of the paper highlight the importance of technological innovations as a key factor in the transition to a circular economy in tourism and propose strategies for improving and expanding these practices on a global level.*

***Key words:*** *sustainable tourism, circular economy, technological innovation, resource management, energetic efficiency*

## 1. Introduction

In recent decades, tourism has become one of the fastest-growing global industries, contributing to economic development and job creation worldwide.

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However, the expanding tourism sector also carries a significant ecological footprint, including increased resource consumption, waste generation, and harmful gas emissions. The traditional linear economic model, based on the "take-make-dispose" approach, is increasingly becoming unsustainable in the context of contemporary ecological challenges. In response to these challenges, the concept of a circular economy is gaining importance as a sustainable alternative focused on resource optimization through recycling, reuse, and waste reduction (Kirchherr, Reike, & Hekkert, 2017).

The circular economy in tourism is not only a strategy for reducing the negative impact on the environment, but also a potential source of competitive advantage for destinations and businesses that implement innovative approaches. In this context, technological innovations play a crucial role in enabling more efficient application of circular principles. Innovations such as smart resource management systems, digital platforms for tourist education, mobile applications for optimizing energy efficiency, and tools for recycling and waste management are just some of the ways technology can contribute to sustainable tourism development.

Technological innovations refer to the introduction of new or significantly improved technologies that enable more efficient resource management, process optimization, and a reduction of negative environmental impacts. In the context of the circular economy, they play a crucial role in transitioning from a linear to a sustainable economic model, where resources remain in use for as long as possible.

This paper aims to explore technological innovations in tourism based on circular economy principles, analyzing their effectiveness and potential application in various sectors of the tourism industry. Using quantitative and qualitative research methods, the paper will provide insights into how the application of these technologies can contribute to economic, ecological, and social benefits, and propose strategies for enhancing and expanding best practices to achieve sustainable tourism on a global level.

## 2. Literature Review

The concept of a circular economy is increasingly attracting attention in academic and business circles due to its potential to reduce negative environmental impacts and stimulate sustainable economic growth (Geissdoerfer et al., 2017). In tourism, the application of circular principles is particularly significant, given that this sector substantially contributes to resource consumption and waste generation (Goessling & Peeters, 2015).

Technological innovations play a key role in enabling the effective application of circular economy principles. According to research, smart resource management systems and digital platforms for optimizing energy efficiency are among the main technologies contributing to reducing the negative ecological footprint (Bocken et al., 2016). The use of digital tools and applications for recycling and waste management allows for better resource control, while educating tourists through modern platforms can promote more responsible behavior (Dedehayir, Ortt, & Seppaenen, 2017).

Applying technological innovations based on the circular economy in tourism can bring multiple benefits. For instance, smart resource management systems in

hotels can reduce energy and water consumption, thereby lowering operational costs and increasing business sustainability (Hojnik & Ruzzier, 2016). Additionally, the introduction of electric vehicle charging stations contributes to sustainable tourism development and encourages the use of low-emission vehicles (Zeng et al., 2020). The implementation of ISO 14000 standards in the tourism industry has proven to be an effective way to reduce the negative environmental impact, as it enables businesses to adopt environmentally friendly practices (Melnyk, Sroufe, & Calantone, 2003).

Esposito et al. (2024) explore the use of social media for promoting the circular economy in the tourism sector, particularly in the post-pandemic context. The results show a high level of engagement on platforms such as Twitter, but emphasize the need for a more interactive approach to raise awareness about circular practices among users. This approach can play a crucial role in activating all stakeholders in the supply chain toward transitioning to a circular business model.

Some research suggests that innovations in tourism often rely on collaboration with suppliers and research institutions, which facilitates faster adoption of new technologies and environmentally sustainable practices (Shi et al., 2018). In the context of the Republic of Serbia, the application of circular principles is still in the developmental stage, but there are examples of good practices, especially in eco and ethno villages that use renewable energy sources and resource-saving technologies (Popovic et al., 2022).

A bibliometric analysis indicates a recent increase in publications exploring the link between circular practices and sustainability in tourism, highlighting the growing interest in this field. Kabil et al. (2023) analyze the scientific output related to the circular economy in tourism and identify key research areas such as waste management, resource optimization, and innovative business strategies.

Recent studies (Kabil et al., 2023; Esposito et al., 2024) confirm that the implementation of circular principles in tourism depends on the adoption of innovative technologies and that collaboration with research institutions is key to the success of these initiatives. Compared to earlier works, such as Bocken et al. (2016), more recent studies also emphasize the impact of global events, such as the COVID-19 pandemic, on accelerating the shift toward sustainable practices.

The conclusion of most studies is that technological innovations are one of the most important drivers in the transition toward sustainable tourism based on circular economy principles. Developing appropriate strategies for their broader application can contribute to the long-term economic, ecological, and social development of the tourism sector.

## 3. Research Methodology

This research focuses on the application of technological innovations based on circular economy principles in the tourism sector. The study was conducted through a survey questionnaire designed to assess the practices and attitudes of various stakeholders in the tourism industry regarding sustainable business and the circular economy. The survey included hotels, eco and ethno villages, as well as households implementing environmentally sustainable practices.

Respondents were selected based on criteria including the size of the establishment, type of services (hotel facilities, eco-villages), and geographical location. The study is dominated by regions with more developed tourist infrastructure, which may limit the generalization of findings to all tourism entities in the country.

### 3.1 Sampling and Distribution of the Questionnaire

The survey questionnaire was sent via email to over 80 addresses, with a total of 62 responses received, representing a response rate of 77.5%. The research was conducted from July 20 to August 25, 2024. The sample included subjects from various regions of Serbia, with the majority being from Sumadija and Western Serbia (53%), followed by Belgrade (28%), and Southern and Eastern Serbia (19%).

### 3.2 Research Instrument

The questionnaire contained 19 questions, divided into several thematic sections. The first group of questions addressed basic information about the application of circular economy principles, while the subsequent questions covered specific practices such as the use of renewable energy sources, automatic shut-off devices, electric vehicle charging stations, smart resource management systems, and the use of ecological products. Additionally, attitudes toward the use of ISO 14001 standards, wastewater management, and waste sorting were examined.

### 3.3 Data Analysis Methods

In this research, both quantitative and qualitative research methods were applied to provide a comprehensive insight into the application of circular practices in the tourism sector. **Quantitative analysis** was conducted through a factor analysis of the survey results in Table 1, using indicators such as the percentage of respondents, the significance rating of factors, the impact on ecological performance, and the average implementation rating. These indicators allowed for the quantification of the application of circular principles and the ranking of various sustainability factors. Additionally, Graph 1 presents the results on the implementation of circular practices in tourism.

At the same time, **qualitative analysis** was conducted, which included a deeper interpretation of the survey results. This analysis focused on identifying patterns, contextualizing findings in relation to existing literature, and considering the specific challenges and benefits of implementing sustainable practices in tourism. The combination of quantitative and qualitative methods enabled a deeper understanding of the situation and provided recommendations for the further development of the circular economy in the tourism industry.

### 3.4 Research Results

The factor analysis of the survey results is presented in Table 1. In addition to the listed factors, the covered questions and survey results include columns with the following indicators:

- Percentage of respondents (%) – shows the percentage of respondents applying specific practices.
- Importance rating of factors (1-5) – quantitatively assesses the significance of each factor for sustainability.
- Impact on ecological performance (1-5) – evaluates how much a specific factor contributes to reducing negative ecological impact.
- Average implementation score (1-5) – displays the average level of implementation among respondents.

*Table 1: Factor analysis of survey results*

| | Factor | Covered questions | Survey results | Percentage of respondents (%) | Evaluation of the importance of factors (1-5) | Impact on environmental performance (1-5) | Assessment of implementation grades (1-5) |
|---|---|---|---|---|---|---|---|
| 1 | Resource management | Use of renewable energy sources, smart management systems | Most respondents use renewable energy sources and smart management systems | 56 | 4,5 | 4,3 | 4,0 |
| 2 | Environmental standards and certification | Application of ISO 14001, ecological products | The vast majority apply ISO 14001 and use ecological products | 92 | 4,8 | 4,7 | 4,6 |
| 3 | Infrastructure for sustainability | Charging stations for electric vehicles, waste water management | There is room for improvement, especially in the infrastructure for electric vehicles | 37 | 3,7 | 3,8 | 3,5 |
| 4 | Waste management | Waste selection, wastewater treatment, storage of hazardous materials | Well-developed waste management and wastewater treatment | 79 | 4,6 | 4,5 | 4,3 |
| 5 | Training and awareness of employees | Employee education, application of ecological principles | High awareness of environmental education and the application of ecological principles | 98 | 4,9 | 4,9 | 4,7 |

Figure 1 shows the quantitative analysis of circular economy factors in tourism. The figure includes the percentage of respondents applying specific practices, the importance rating of factors, the impact on ecological performance, and the average implementation score for each factor.

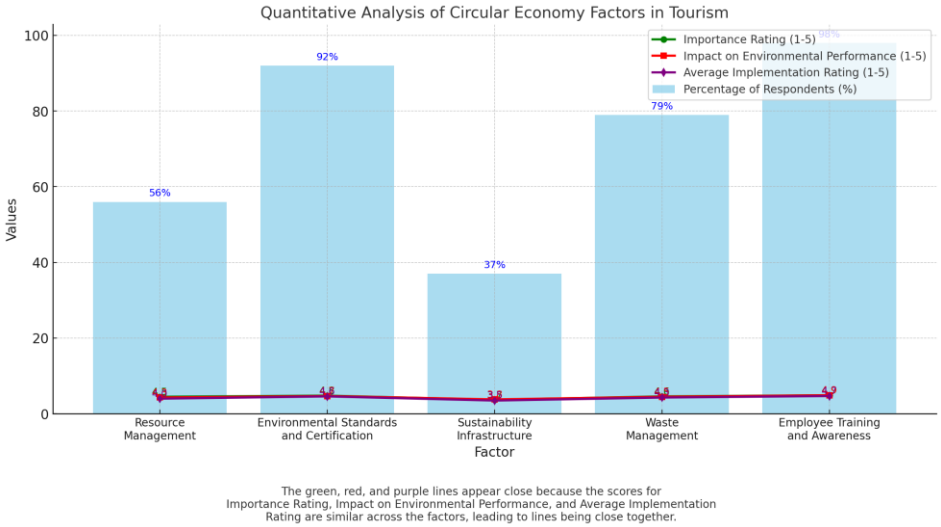


*Figure 1: Quantitative analysis of circular economy factors in tourism*

The survey results provide significant insight into the current state of circular economy implementation in the tourism industry in Serbia. The majority of respondents demonstrate awareness of the importance of environmentally sustainable practices, but there are significant differences in the level of implementation of certain circular principles.

**Resource Management and Use of Renewable Energy.** The use of renewable energy sources (56% of respondents) and smart resource management systems (53%) indicates a considerable level of awareness regarding the need for efficient resource management. However, this level of implementation may be linked to the availability of technology and financial resources for its implementation. The literature shows that the use of renewable energy sources depends on initial investments, which can be a barrier for smaller entities in the industry (Rodriguez et al., 2023). Introducing incentives or subsidies could increase interest in further implementation of these practices.

**Environmental Standards and Certification**. A high percentage of respondents (92%) applying the ISO 14001 standard indicates the prevalence of standardized practices in environmental management. This aligns with global trends in the tourism industry, where certification has become an important part of business strategy and a means of gaining competitive advantage (Esposito et al., 2024). However, certification alone does not guarantee complete implementation of all circular principles, highlighting the need for continuous improvement of standards and regular audits. Research findings show that the application of the ISO

14001 standard is most prevalent in environmentally oriented facilities. This practice also reveals regional specifics where the greatest challenges lie in infrastructural investments, especially for small establishments. Compared to similar studies, the results show similarities in the approach to sustainable tourism, but also differences in the level of support that facilities receive from local authorities.

**Sustainability Infrastructure.** The low representation of electric vehicle charging stations (37% of respondents) indicates challenges in implementing sustainable infrastructure. These results align with literature claims that investments in sustainable infrastructure in tourism are often insufficient due to high costs and a lack of support at the national or local level (Kabil et al., 2023). Improvements in this area could be achieved through public-private sector collaboration and directing funds from resources designated for the green transition.

**Waste and Resource Management**. Results indicate that waste management practices are well developed (79% segregate waste, 98% use treated wastewater). These data suggest a high awareness of the importance of waste reduction and recycling in the tourism industry.

**Employee Training and Awareness.** Nearly all respondents (98%) conduct training for employees on environmental principles, demonstrating that education is recognized as a key element for sustainable operations. The literature emphasizes that training and involving employees can significantly improve results in the implementation of circular practices, as it increases motivation and enables better innovation implementation (Esposito et al., 2024).

The survey results show that the tourism sector in Serbia is moving towards sustainable operations, but significant variations exist in the implementation of individual circular practices. The biggest barriers include a lack of investments in infrastructure and high implementation costs. Nonetheless, the existence of environmental standards and comprehensive employee training provides a solid foundation for the further development of sustainable practices. Linking with relevant sources in the literature and considering specific regional challenges enables a deeper understanding of the situation and offers guidance for enhancing the circular economy in tourism. This qualitative analysis highlights the importance of further improving environmental policies and supporting sustainable practices so that the tourism sector can effectively contribute to sustainable development.

## 4. Conclusions

The application of circular economy principles in the tourism industry is becoming increasingly significant as a response to ecological challenges and the need for sustainable development. Research conducted through quantitative and qualitative analysis shows that technological innovations play a key role in achieving sustainability goals, especially regarding efficient resource management, waste reduction, and optimization of energy efficiency. Technological solutions, such as smart resource management systems and renewable energy infrastructure,

enable the practical application of circular principles and promote sustainable growth.

The survey results indicate a high level of awareness among tourism entities regarding the importance of environmental standards, such as ISO 14001, and the implementation of sustainable practices, including technological innovations to increase energy efficiency and reduce negative environmental impacts. However, differences were observed in the level of implementation of specific circular practices, particularly concerning sustainability infrastructure, such as electric vehicle charging stations, where a lower level of application was recorded.

The quantitative analysis through factor analysis identified key factors contributing to the application of the circular economy, including resource management, standards and certification, infrastructure, waste management, and employee education. The qualitative analysis further highlighted the challenges faced by the tourism sector, such as high costs of implementing technological innovations and the need for additional infrastructural investments.

To accelerate the implementation of technological innovations in tourism based on the circular economy, it is recommended to introduce subsidies for investments in smart systems and renewable energy. Additional employee education through specialized training and greater collaboration with research centers can significantly enhance the efficiency of implementing sustainable practices.

Technological innovations based on circular economy principles represent a key driver of the transformation of tourism towards sustainable operations. Establishing more efficient strategies and incentive measures at the local and national levels can further accelerate the transition to sustainable tourism, reducing negative ecological consequences and enabling a better competitive position in the global market.

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