POLISH JOURNAL OF MANAGEMENT STUDIES
Štefko R., Chovancová J., Huttmanová E.,
Rovňák M., Fedorko R.

2024
Vol.29 No.1

# MANAGEMENT OF CIRCULAR ECONOMY PROCESSES IN THE PRODUCTION OF NOISE BARRIERS: PATHWAYS TO SUSTAINABILITY AND INNOVATION

**Štefko R., Chovancová J., Huttmanová E., Rovňák M., Fedorko R.***

**Abstract:** This study explores the management and application of circular economy principles to the production of noise barriers in order to reduce the environmental impacts and increase resource use efficiency. Using a comprehensive methodological framework that includes a literature review and a case study analysis within a noise barrier manufacturing company, the study uses the Circular Canvas tool to map and prioritise circular opportunities in the production process. The findings reveal significant potential for improving the sustainability of noise barrier production through the adoption of circular economy practices, such as sustainable material use, resource optimisation and eco-design principles. Applying these practices not only underlines the environmental benefits, but also adds value by providing a pathway to more sustainable process management.

**Key words:** Circular economy, Circular canvas, Resource efficiency, Waste management, Sustainability

DOI: 10.17512/pjms.2024.29.1.19

*Article history:*
*Received* February 10, 2024; *Revised* March 28, 2024*; Accepted* April 21, 2024

* **Róbert Štefko**, Professor, Department of Marketing and International Trade, Faculty of Management and Business, University of Prešov;
✉ email: robert.stefko@unipo.sk,
ORCID: 0000-0002-0650-7780
**Jana Chovancová**, Assistant Professor, Department of Management, Faculty of Management and Business, University of Prešov;
✉ corresponding author: jana.chovancova@unipo.sk,
ORCID: 0000-0002-6699-1244
**Emília Huttmanová**, Associate Professor, Department of Economics and Economy, Faculty of Management and Business, University of Prešov;
✉ email: emilia.huttmanova@unipo.sk,
ORCID: 0000-0003-4469-1248
**Martin Rovňák**, Associate Professor, Department of Finance, Accounting and Mathematical Methods, Faculty of Management and Business, University of Prešov;
✉ email: martin.rovnak@unipo.sk,
ORCID: 0000-0003-3969-6482
**Richard Fedorko**, Associate Professor, Department of Marketing and International Trade, Faculty of Management and Business, University of Prešov;
✉ email: richard.fedorko@unipo.sk,
ORCID: 0000-0003-3520-1921

## Introduction

The circular economy, an innovative model that emphasises the regeneration, reuse and restoration of resources, plays a central role in promoting global sustainability and efficient resource management. Unlike the traditional 'take, make, dispose' approach of the linear economy, the circular economy seeks to create a closed-loop system that minimises waste and environmental impact while maximising resource value. This framework is increasingly recognised as critical to addressing the pressing challenges of climate change, resource scarcity and environmental degradation. By promoting practices such as recycling, upcycling and the sustainable use of materials, the circular economy offers a pathway to more resilient and sustainable economic and environmental systems. Special actions for the circular economy are also undertaken by the construction sector, which consumes large amounts of materials.

In the context of these broader sustainability goals, the production of noise barriers provides a compelling case study for the application of circular economy principles. The increase in noise pollution has necessitated the development and deployment of noise barriers, which serve as critical infrastructure to mitigate its detrimental effects on human health and environmental quality (Rovňák et al., 2023; Hlushchenko et al. 2022). Noise pollution, a growing environmental concern in urban and industrial areas, requires the use of noise barriers as an effective mitigation strategy. Traditionally, the manufacturing and disposal processes associated with noise barriers have been characterised by significant environmental drawbacks, including the generation of significant waste materials such as PVC, textiles and metals. By rethinking the production of noise barriers through the lens of the circular economy, there is a unique opportunity to address these environmental challenges.

Within this global movement towards sustainability, the European Union (EU) has positioned itself at the forefront of advocating and implementing circular economy principles to address critical environmental issues (Huttmanová et al., 2023; Csete and Baranyi, 2023). The EU has been proactive in establishing a robust policy framework to promote sustainable production and consumption practices across a wide range of industries.

A milestone in this journey was the unveiling of the EU's new Circular Economy 2020 Action Plan (EC, 2020), which aims to restructure product lifecycle management by promoting 'closing the loop' of product ecosystems. The plan sets ambitious targets for minimising waste, increasing material recycling and promoting eco-design and innovation.

To take these initiatives further, the EU introduced the Circular Economy Package II in 2022 (EC, 2022), which outlines targeted strategies to promote circularity in its member states. This comprehensive package includes directives focused on efficient waste management, reducing the use of plastics, and promoting circular business models, reaffirming the EU's commitment to leading by example in the transition to a circular economy.

This research explores the potential of integrating circular economy principles into noise barrier production, with the aim of identifying sustainable and innovative solutions that reduce waste, improve resource efficiency and contribute to environmental protection. By analysing the material reuse and recycling within the noise barrier production process and application of circular design strategies, this study aligns with the EU's circular economy framework and broader sustainability objectives. Through this research, we aim to demonstrate how circular economy practices can be effectively implemented in specific industrial applications, contributing to the wider goal of transitioning to a more sustainable and environmentally conscious economy.

## Literature Review

The circular economy (CE) paradigm has emerged as a transformative approach to redefining sustainability in economic systems, emphasising the restorative and regenerative use of resources (Shevchenko et al., 2021). This literature review explores the foundations, applications and policy implications of CE, highlighting its potential to address environmental challenges, with a focus on its innovative application in the production of noise barriers.

The concept of CE, which is gaining traction among researchers and policy makers, is based on a shift from the traditional linear economic model of 'take, make, dispose' to one that is inherently sustainable and regenerative (Oliveira et al., 2021; Vence et al., 2019; Dzwigol et al., 2021; Shpak et al., 2021). This paradigm shift is thoroughly defined and conceptualised in the seminal work of Kirchherr (2017) and further elaborated by Montag, providing a comprehensive understanding of CE principles.

The British Standards Institution (BSI) introduced the first CE standard, BS 8001:2017, which defines CE as an economy designed to be restorative and regenerative, maintaining the highest utility and value of products, components and materials. The standard distinguishes between technical and biological cycles, emphasising the importance of maintaining value through 'restorative' reuse of resources and 'regenerative' practices that renew consumed resources (BSI, 2017).

The Ellen MacArthur Foundation (EMF) has been instrumental in operationalising CE concepts, particularly through the development of the butterfly diagram, which prioritises a hierarchy of circularity strategies from reuse to recycling (Bocken et al., 2017; EMF, 2013). This framework has had a significant impact on the understanding and implementation of CE practices, highlighting the cyclical flow of nutrients and synthetic materials to minimise loss and maximise value (Mestre and Cooper, 2017).

### *Circular economy in the EU context*

Within the European Union (EU), the Circular Economy (CE) paradigm is both a policy priority and a framework for innovation to promote a sustainable, low-carbon, resource-efficient and competitive economy. The EU's commitment to catalysing the CE transition is underlined by key policy initiatives, notably the Roadmap for a Resource Efficient Europe (EEA, 2011) and the New Action Plan for a Circular

Economy (EC, 2020). Domenech and Bahn-Walkowiak (2019) provide a critical review of these policies, acknowledging the EU's ambitious progress towards resource efficiency and CE. However, the analysis reveals a fragmented policy landscape characterised by a lack of binding targets and mandatory reporting, which, coupled with diverse national programmes, results in a lack of coordinated action across member states (Zumente and Lāce, 2020). This complicated policy framework, as articulated by Domenech, requires a more harmonised approach to effectively support CE initiatives across the EU.

In the midst of policy development, the path to CE is accompanied by a number of challenges. Kirchherr et al. (2017) focus the discourse on the barriers to CE adoption in the EU, highlighting cultural and market barriers as significant obstacles. In contrast to the perceived technological barriers, the study identifies a lack of consumer interest and a business culture aligned with CE principles as the main barriers, suggesting an urgent need for comprehensive government intervention to foster a culture conducive to CE principles.

Building on the understanding of these barriers, Hartley et al. (2020) explores experts' expectations for policies that could accelerate the CE transition beyond the scope of existing frameworks. Recommendations include robust standards and norms, circular procurement, tax incentives and support for eco-industrial parks, presenting a life-cycle perspective that is critical for a holistic transition towards CE. These findings underscore the need for innovative policies to overcome existing barriers and drive the CE agenda forward.

To further enrich this narrative, Hartley et al. (2023) present a comprehensive policy framework developed from an extensive literature review and expert consultations. This framework, with over 100 policy instruments categorised into nine groups, provides a structured approach to CE policy development, emphasising the importance of a life-cycle and holistic perspective. This innovative framework aims to guide both theoretical exploration and practical policy design, thus making a significant contribution to the CE discourse.

In the midst of these strategic discussions, Mazur-Wierzbicka (2021) draws attention to the disparities in CE uptake across the EU-28, identifying a 'two-speed Europe' phenomenon. Through a careful analysis using CE indicators proposed by the European Commission, the study distinguishes between leaders and laggards in CE adoption, revealing a geographical and developmental disparity that underscores the varying effectiveness of national CE strategies.

Collectively, the studies highlight the challenges of achieving a coordinated and effective transition to CE across the EU, and underline the need for nuanced strategies that take into account the diverse socio-economic and cultural landscapes of Member States.

***Industry-specific applications and challenges***

Despite the growing consensus on the importance of CE, its implementation remains diverse across industries and regions. Blomsma and Brennan (2017) suggest that CE should be viewed as an umbrella concept, encompassing a range of practices aimed

at enhancing circularity. This diversity is evident in the potential economic benefits of adopting circular business models, particularly within the European Union, where material resource savings could reach significant figures (EMF, 2013).

The application of circular economy (CE) principles in different sectors demonstrates the wide range of challenges and opportunities unique to each industry, from agriculture and food production to construction and beyond. In this regard, one of the most developed sectors with advanced CE practices is municipal waste management (Ginevičius, 2022). In agriculture, the bioenergy production offers sustainable opportunities through CE practices (Barros et al., 2020). Furthermore, Castillo-Díaz et al. (2023) emphasise the importance of quantifying sustainability within the European agri-food sector using a homogeneous criterion. This study highlights the trade-offs between economic and social progress and environmental quality and suggests a policy shift towards local productive systems based on CE principles to achieve territorial balance and improve sustainability. The study by Ramirez et al., (2021) advocates for the adoption of a CE model in the livestock sector, emphasising the recovery of value from waste and low-value by-products through innovative technologies such as anaerobic digestion and microbial technologies.

The application of CE principles in the leather industry is reviewed by Moktadir et al. (2020), who identify financial support as a key barrier to CE adoption.

Similarly, in the built environment, sustainable urban development benefits from the integration of CE approaches, highlighting the potential for innovative concepts such as urban-rural symbiosis (Joensuu et al., 2020) and the potential of Information and Communication Technologies (ICT) as solutions to support CE-oriented decision making (Yu et al., 2022).

Further broadening the scope of CE applications, there are emerging studies in less traditional sectors such as the outdoor sporting goods industry (Fuchs and Hovemann, 2022) and the hairdressing industry (Hodgson et al., 2024). These opportunities are increasing due to the growing customers' awareness and readiness to responsible behaviour (Koval et al., 2023, Mishchuk et al., 2023; Zhidebekkyzy et al., 2022) and supporting the responsible business (Bilan et al., 2017).

The literature review reveals a significant gap in the application of Circular Economy (CE) principles to noise barrier production, highlighting an area that has remained untouched by existing research. This gap provides an opportunity for our study to explore sustainable and circular approaches specifically tailored to noise barrier production. By integrating CE concepts into this specific context, our research aims to make a pioneering contribution to the wider discourse on CE, in line with global sustainability goals and EU policy initiatives.

This research not only addresses a notable gap in the literature, but also sets the stage for promoting sustainability and circularity within environmental management practices. The findings of this study are expected to enrich the academic discourse on CE and provide valuable insights for industries seeking to integrate circular principles into their operations.

## Research Methodology

In our investigation of the adoption of Circular Economy (CE) principles within the noise barrier manufacturing sector, we use a case study methodology. This method is particularly advantageous for conducting detailed investigations of complex, context-specific phenomena, facilitating an in-depth understanding of particular cases in their real-life settings. Such an approach is critical for investigating complicated or novel issues, and allows for a nuanced understanding of the subject under study (Yin, 2009).

### *Research design*

The research is designed around a case study methodology, focusing on the application of CE principles in the noise barrier production process. This design allows for a focused exploration of a specific company involved in the production of noise barriers, providing an in-depth perspective on its operational practices and the potential for circularity. The application of the Circular Canvas tool within this framework aims to identify and assess opportunities for implementing CE strategies within the company's manufacturing operations.

### *Case selection*

The selection of an appropriate case involves identifying a manufacturing company that not only specialises in the production of noise barriers, but also demonstrates a commitment to sustainability and efficient resource management. The selection criteria ensure that the selected company is representative of the wider industry, thereby ensuring the generalisability and relevance of the study findings to the sector.

### *Data collection*

Data will be collected through a combination of primary and secondary methods:

- Interviews and consultations: Conducting semi-structured interviews with key organisational stakeholders will shed light on the company's current manufacturing processes, waste management strategies and the feasibility of integrating CE principles.
- Document analysis: Examination of organisational documents, sustainability reports and policy documents will provide insight into the company's environmental policies and practices.
- Observational studies: Direct observation within the manufacturing facility will provide a tangible understanding of operational processes, waste generation and resource use patterns.
- Secondary data review: An analysis of existing literature, industry reports and CE best practices will contextualise the primary data and inform the analytical framework.

### *Application of the Circular Canvas*

The application of the Circular Canvas tool will enable a systematic assessment of the company's potential for circularity. This analysis will cover various operational facets, such as product design, material sourcing, waste management and life cycle

assessment, to identify misalignments and opportunities to more effectively embed CE principles into the manufacturing lifecycle.

***Data analysis***

Using thematic analysis, the collected data will be scrutinised to identify prevalent practices, challenges and potential interventions for incorporating CE principles into noise barrier production. This phase will critically evaluate ways to improve circularity, focusing on waste reduction, resource efficiency and the integration of sustainable materials.

***Findings and recommendations***

The study will articulate the findings from the thematic analysis, outline the current circularity practices within the case study unit, and provide strategic directions for incorporating CE principles into noise barrier production. Recommendations will be developed to promote circularity and sustainability in the company's operational processes.

***Limitations and ethical considerations***

The study acknowledges potential limitations, such as the scalability of findings and challenges in accessing proprietary company data. Ethical considerations, including informed consent and data confidentiality, will be strictly adhered to, bringing the research in line with current ethical standards.

This methodology, combining a case study approach with the Circular Canvas tool, will provide insights into the integration of CE principles in noise barrier manufacturing and contribute to the wider discourse on sustainable industrial practices.

## Research Results

Through an in-depth analysis of the company's noise barrier production process, interviews with company representatives, observation of the technological process, analysis of internal documents and databases, and a comprehensive review of relevant literature, we aim to identify opportunities for effective implementation of Circular Economy (CE) principles. Our research uses a case study approach, focusing on a company involved in the manufacture of noise barriers, to gain in-depth insights into its current practices and potential pathways to circularity. We begin by mapping the material flow, including the quantities of input materials used in the production of noise barriers, as well as the amount of waste generated during the process.

The noise barrier manufacturing process involves a wide range of input materials, such as various technical fabrics, noise barrier layers, reflective elements, edgings, threads, brackets, rings and adhesive tapes. Working closely with production operators, managers and internal records, we carefully track the waste generated during the production and processing of materials:

1. Technical fabric: The base of any noise barrier, the PVC technical fabric consists of three layers: PVC film, glass fibre mesh and another PVC film. The combination of these layers enhances the properties of the technical fabric,

providing exceptional strength and elasticity, making it suitable for demanding conditions and ensuring durability over long periods. An average of 61,271 m2 of technical fabrics in various colours and sizes are processed each year.

2. Mesh: Similar to PVC technical fabrics, mesh technical fabrics are made from PVC material, but have a structure with numerous holes due to the fibreglass mesh. Used mainly in large banners and some noise barriers, mesh provides an essential function in trapping sound waves and dust particles, while also acting as a windbreak and withstanding harsh weather conditions. Approximately 12,703 m2 of mesh is processed each year.
3. Polyester coated fabric (PCF): Consisting of a textile surface layer (polyester) and a PVC layer, PCF is a versatile material used in a variety of industries. Its role in noise barriers is to prevent water penetration while allowing breathability. Approximately 63,721 m2 of PCF is used each year.
4. Recycled cotton: A fundamental component in the construction of the noise barrier, recycled cotton is sandwiched between the PVC and PCF layers, providing stability and shape to the barrier. Approximately 19,070 sheets of recycled cotton are used annually.
5. Reflective elements: Essential for visibility in low light conditions, reflective elements are sewn or welded onto the noise barrier. Approximately 32,646 linear metres of reflective elements are processed annually.
6. Edging: To enhance the appearance of the barrier, edging is sewn around the perimeter to conceal welds and maintain product integrity. An average of 121,947 linear metres of edging is processed annually.
7. Threads: Essential to sewing operations, thread is used to attach edgings, install brackets and buckles, and secure recycled cotton. Approximately 890,034 linear metres of thread in various colours and lengths are processed each year.
8. Brass rings: Brass rings are attached to the outer perimeter of the barrier to provide stability and serve as attachment points. An average of 283,658 brass rings are used each year.
9. Brackets and buckles: These elements facilitate the transport of noise barriers and are attached from the rear to maintain aesthetics. Approximately 19,070 brackets and buckles are processed each year.
10. Adhesive tapes: Double-sided adhesive tapes are used to hold the recycled cotton securely to the PVC membrane. Approximately 87,559 linear metres of tape are used annually.
11. UV printing ink: UV-resistant ink in various shades is used for industrial printing, with specific graphics tailored to individual customers. Approximately 360 litres of ink are processed annually.

Figure 1 illustrates the amount of recyclable waste generated during the noise barrier manufacturing process.

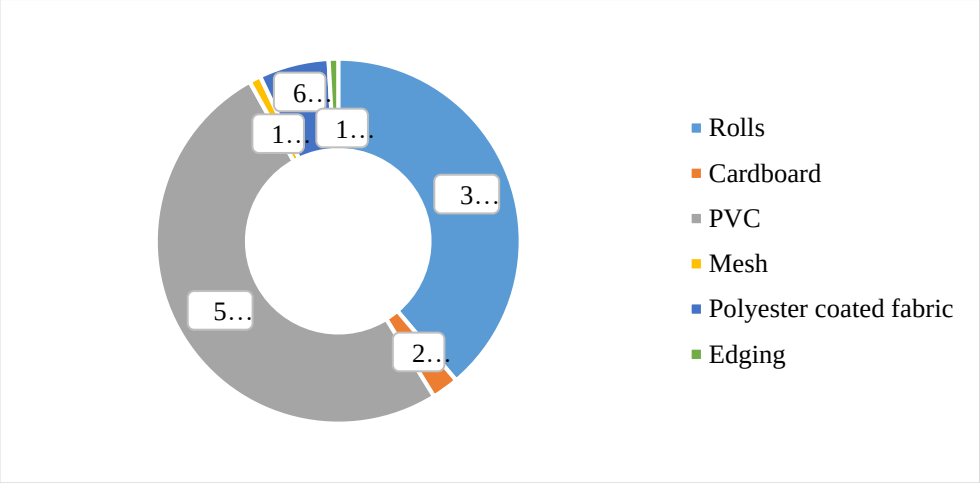


**Figure 1: Quantity of recoverable waste [%]**
**Source:** Own elaboration

The detailed analysis of input materials and waste production provides critical insights into the organisation's existing state of circularity, providing a fundamental basis for identifying improvements in circular implementation within the noise barrier manufacturing process.
The study then used the Circular Canvas, a sophisticated and functional tool, to delineate and prioritise circular opportunities within the noise barrier manufacturing workflow.
The Circular Canvas model is a comprehensive tool designed to facilitate a deep understanding of how an organisation creates and delivers value, with the ultimate aim of identifying actionable levers to transition to more sustainable and circular practices. It serves as a versatile framework for analysing and redesigning various aspects of an organisation, including its business model, products or services, customer types, partnerships, assets, flows and events, through the lens of circular economy principles.
This model encourages the application of systems thinking, allowing stakeholders to holistically assess the interrelationships and impacts of their operational decisions.
The objectives of the Circular Canvas model are as follows:

- Understanding value creation: The model helps to analyse how an organisation creates value, provides insights into the mechanics of value creation and uncovers opportunities for action.
- Identifying impact: Enables users to identify and anticipate the impact of a business model, product or activity, including both immediate and long-term effects.
- Circular Design: The framework supports the design of new products, services and activities that adhere to circular economy principles, promoting sustainability and resource efficiency.

The Circular Canvas is a tool for describing a wide range of organisational components, including business models, products or services, customer demographics, partnerships, equipment, operations and events. This flexibility makes it an invaluable asset for organisations seeking to apply systems thinking to their projects, ensuring a comprehensive assessment of their practices and impacts.

At its core, the Circular Canvas is structured around central boxes, delineated by solid lines, which represent the strategic choices the organisation has made. These decisions span the entirety of the organisation's operations and are essential to a thorough understanding of its activities. It is essential that all these boxes are filled in, except where the organisation does not use natural resources.

The model emphasises the dual impact of design decisions on both the economy and the ecosystem. Economic impacts, including costs and revenues, are detailed in the yellow rows below the central boxes, highlighting the financial dimensions of the organisation's decisions. Ecosystem impacts, which can be both beneficial and detrimental, are listed in the light blue rows above the central boxes, highlighting the environmental aspects of operational decisions. While not all boxes marked with dotted lines are mandatory to complete, they provide space for additional insight into the less direct impacts of organisational decisions.

By using the Circular Canvas, organisations can meticulously map their operations against circular economy principles, fostering a culture of sustainability and innovation. This tool not only supports the practical application of these principles, but also ensures that strategic decisions are made with a full understanding of their economic and environmental impact.

In collaboration with stakeholders from the analysed company, we constructed a Circular Canvas model tailored to the noise barrier manufacturing process, as shown in Figure 2. The aim of this collaborative process was to uncover and capitalise on circular economy opportunities within the company's operational methods, thereby generating environmentally beneficial outcomes and strengthening business sustainability.

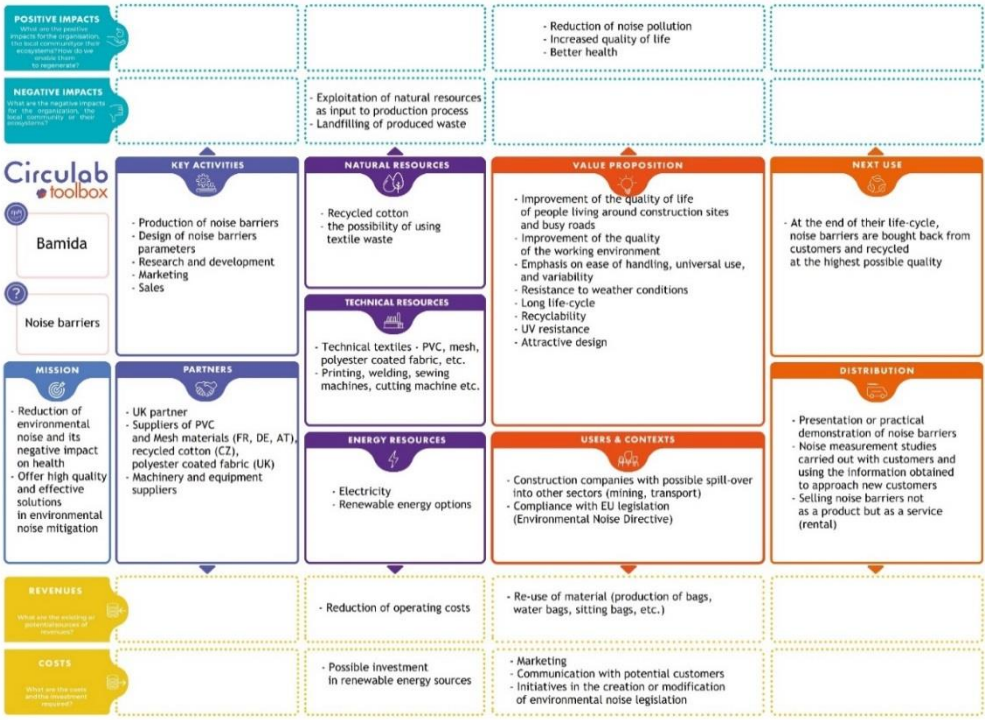


**Figure 2: Circular Canvas of Noise barriers production**
**Source:** Own elaboration based on Circulab template (Circulab, 2023)

By applying the Circular Canvas to the noise barrier manufacturing company, we systematically assessed its circularity potential, identified areas for improvement and prioritised actions to improve circularity practices. This methodological approach ensures a practical and actionable framework for advancing the company's sustainability and circularity goals in the noise barrier manufacturing process.

## Discussion

Our investigation into the incorporation of Circular Economy (CE) principles into the noise barrier manufacturing sector highlights a notable opportunity to fill an identifiable gap in existing academic work. Based on the practical application of CE methods in this particular field, our research outlines a pathway towards the establishment of sustainable and circular methods for noise barrier manufacturing that are alligned with European Union (EU) initiatives and contribute to the achievement of the Sustainable Development Goals (SDGs).
The analytical results highlight the presence of significant amounts of unused waste materials - such as paper rolls, cardboard and polyvinyl chloride (PVC) waste - and the potential for their upcycling into novel products, thereby increasing the efficiency of noise barrier production processes and reducing waste generation

(Kerdlap et al., 2019). The process of recycling paper rolls and cardboard involves their collection, followed by their breakdown into fibres, which are then upcycled into fresh cardboard products, reducing the need for virgin cardboard materials and the environmental impacts associated with their production.
PVC waste offers opportunities for recycling or up-cycling into alternative products. PVC recycling returns the material to its original form for the production of new PVC items. In addition, upcycling of PVC includes its transformation into various products, such as PVC accessories, furniture components or materials for non-structural construction purposes. Reprocessing or upcycling PVC waste extends the life of these materials and reduces the demand for new PVC production.
Given the potential limitations of addressing this challenge autonomously, there is an opportunity to seek collaborations with other sectors (Janssen and Stel, 2017) that could benefit from the by-products of noise barrier production. For example, industries that require cardboard packaging or PVC-based materials could derive significant benefit from the reuse or recycling of waste from noise barrier manufacturing. Establishing collaborative networks with such sectors enables the creation of a closed-loop system in which waste materials from noise barrier production are reused as valuable inputs for other industries, promoting a more sustainable and circular economic model.
Adopting CE principles in the production of noise barriers brings many benefits to the company:

- Sustainability leadership: Integrating circular practices can enhance the company's standing as a sustainability leader in its industry, strengthening its brand and appealing to environmentally conscious consumers.
- Resource efficiency: Circular strategies increase the efficiency of resource use, reducing material demand and waste production, which in turn promotes cost reduction and increases profitability.
- Environmental protection: Reducing the use of virgin materials and promoting recycling and reuse significantly reduces the company's environmental impact, contributing to global efforts to protect the environment, mitigate climate change and conserve natural resources.

## Conclusion

This case study illustrates that the adoption of Circular Economy (CE) principles in the context of noise barrier manufacturing creates opportunities for both sustainable and innovative practices. By prioritising the use of sustainable materials, alongside the reuse and recycling of materials, the company under study is poised to adopt a circular model. This shift not only enhances its economic performance, but also makes a significant contribution to environmental protection and noise reduction. Given the critical role of noise barriers in mitigating noise pollution, the effective integration of CE principles into their production underlines the potential for promoting a more sustainable future.

However, it is imperative to recognise certain limitations inherent in this study. The focus of the research on a single unit within a specific sector may limit the extrapolation of findings to different industries or different operational contexts. In addition, the transition to a CE model requires complex systemic changes involving a wide range of stakeholders, regulatory frameworks and market mechanisms. This research has primarily focused on production phase waste materials and their potential circular applications, and has not explored other facets of CE adoption, such as product lifecycle extension or sustainable supply chain.

Future academic work could broaden the scope of the research to include a more comprehensive assessment of the impact of CE principles in the production of noise barriers, particularly in terms of their long-term economic sustainability and environmental impact. A comparative study of different CE methodologies across different sectors could provide a holistic perspective on the intricacies and benefits of circularity. Furthermore, the development of specific guidelines or frameworks tailored to the noise barrier manufacturing industry could help companies to integrate circular practices, thereby optimising their benefits.

In conclusion, the application of CE principles in noise barrier manufacturing not only offers a viable way to improve business sustainability measures, but also aligns with the objectives of key global initiatives such as the EU's Circular Economy Action Plan and the UN's SDGs. By embracing circular practices, companies contribute to the achievement of the SDGs, particularly Goal 12 (responsible consumption and production) and Goal 13 (climate action), by promoting resource efficiency, reducing waste and reducing environmental degradation.

In addition, this research highlights the usefulness of the Circular Canvas as a powerful tool for identifying CE opportunities in an industrial setting. The Circular Canvas provided an in-depth examination of the company's manufacturing activities and identified critical points for integrating circular principles, thereby facilitating a strategic approach to sustainability and innovation in noise barrier manufacturing.

## Acknowledgements

This article is a part of the project BIN 02_2021_024 "Applied research for the improvement of acoustic properties of mobile noise barriers and ecological use of waste generated during their production" supported by Iceland, Liechtenstein and Norway in the amount of 1.197.226,- EUR through EEA Grants.

## References

Andriulaitytė I., Valentukeviciene M., (2020). Circular economy in buildings. *Construction of Optimized Energy Potential (CoOEP)*, 9(2), 23-29.

Barros, M. V., Salvador, R., de Francisco, A. C. and Piekarski, C. M., (2020). Mapping of research lines on circular economy practices in agriculture: From waste to energy. *Renewable and Sustainable Energy Reviews*, *131*, 109958.

Bilan, Y., Mishchuk, H. and Pylypchuk, R., (2017). Towards sustainable economic development via social entrepreneurship. *Journal of Security and Sustainability Issues*, *6*(4), 691-702.

Blomsma, F., Brennan, G., (2017). The Emergence of Circular Economy: A New Framing Around Prolonging Resource Productivity. *Journal of Industrial Ecology*, *21*(3), 603–614.

Castillo-Díaz, F. J., Belmonte-Ureña, L. J., López-Serrano, M. J. and Camacho-Ferre, F., (2023). Assessment of the sustainability of the European agri-food sector in the context of the circular economy. *Sustainable Production and Consumption*, *40*, 398–411.

Csete, M., Baranyi, T., (2023). Can smart city planning enhance the sustainable transition of the E.U. capitals? A project and strategy-based smart, sustainable performance analysis in the programming period 2014-2020. *Production Engineering Archives*, *29(4)*, 461-473.

Circulab., (2023). *Circular Canvas: A Tool to Design Circular Business Models. Business model template.* https://circulab.com/toolbox-circular-economy/circular-canvas-regenerative-business-models/

Domenech, T., Bahn-Walkowiak, B., (2019). Transition Towards a Resource Efficient Circular Economy in Europe: Policy Lessons From the EU and the Member States. *Ecological Economics*, *155*, 7–19.

Dzwigol, H., Trushkina, N. and Kwilinski, A., (2021). The Organizational and Economic Mechanism of Implementing the Concept of Green Logistics. *Virtual Economics*, *4*(2), 41–75.

EC., (2020). *Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the committee of the regions: A new Circular Economy Action Plan For a cleaner and more competitive Europe. COM(2020) 98 final COM/20*. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0098andfrom=EN

EEA., (2011). *Roadmap to a Resource Efficient Europe COM(2011) 571 — European Environment Agency*. https://www.eea.europa.eu/policy-documents/com-2011-571-roadmap-to

EMF., (2013). *Towards the circular economy Vol. 1: an economic and business rationale for an accelerated transition*. https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an

Fuchs, M., Hovemann, G., (2022). The Circular Economy Concept in the Outdoor Sporting Goods Industry: Challenges and Enablers of Current Practices among Brands and Retailers. *Sustainability*, *14*(13), 7771.

Ginevičius, R., (2022). The efficiency of municipal waste management systems in the environmental context in the countries of the European Union. *Journal of International Studies*, *15*(4), 63-79.

Hartley, K., Schülzchen, S., Bakker, C. A. and Kirchherr, J., (2023). A policy framework for the circular economy: Lessons from the EU. *Journal of Cleaner Production*, *412*, 137176.

Hartley, K., van Santen, R. and Kirchherr, J., (2020). Policies for transitioning towards a circular economy: Expectations from the European Union (EU). *Resources, Conservation and Recycling*, *155*, 104634.

Hodgson, S., Piscicelli, L., Frenken, K. and Williams, I., (2024). Circular economy beyond manufacturing: Exploring the challenges and opportunities for circularity in the hairdressing industry. *Sustainable Production and Consumption*, *46*, 512–521.

Huttmanová, E., Chovancová, J., Steiner, M. J. F., Ramharter, P. M. and Kočiščáková, K., (2023). Through Circularity Towards Sustainability: Assessing the Progress and Challenges of the Circular Economy in the EU and Slovakia. *European Journal of Sustainable Development*, *12*(4), 366–366.

Hlushchenko, R., Tkachenko, T., Mileikovskyi, V., Kravets, V. and Tkachenko, O., (2022). "Green structures" for effective rainwater management on roads. *Production Engineering Archives*, *28(4)*, 295-299.

Janssen, K. L., Stel, F., (2017). Orchestrating partnerships in a circular economy – a working method for SMEs. *Manchester: The International Society for Professional Innovation Management (ISPIM).* https://www.proquest.com/conference-papers-proceedings/orchestrating-partnerships-circular-economy/docview/2183490507/se-2

Kerdlap, P., Low, J. S. C. and Ramakrishna, S., (2019). Zero waste manufacturing: A framework and review of technology, research, and implementation barriers for enabling a circular economy transition in Singapore. *Resources, Conservation and Recycling*, *151*, 104438.

Kirchherr, J., Reike, D. and Hekkert, M., (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221–232.

Koval, V.V., Havrychenko, D., Filipishyna, L., Udovychenko, I., Prystupa, L. and Mikhno, I., (2023). Behavioral economic model of environmental conservation in human resource management. *Intellectual Economics*, *17*(2), 435–456.

Mazur-Wierzbicka, E., (2021). Circular economy: advancement of European Union countries. *Environmental Sciences Europe*, *33*(1), 1–15.

Mishchuk, H., Czarkowski, J. J., Neverkovets, A. and Lukács, E., (2023). Ensuring Sustainable Development in Light of Pandemic "New Normal" Influence. *Sustainability*, *15*(18), 13979.

Ramirez, J., McCabe, B., Jensen, P. D., Speight, R., Harrison, M., Van Den Berg, L. and O'Hara, I., (2021). Wastes to profit: a circular economy approach to value-addition in livestock industries. *Animal Production Science*, *61*(6), 541–550.

Rovňák, M., Minďaš, M., Chovancová, J., Huttmanová, E., Štefko, R., Fedorko, R., Jenčová, J., Ali-Taha, V. and Kotulič, R., (2023). Managing Environmental Noise with Mobile Noise Barriers - a Case Study of a Dolomite Quarry in Slovakia. *TEM Journal*, *12*(3).

Shevchenko, T., Kronenberg, J., Danko, Y. and Chovancová, J., (2021). Exploring the circularity potential regarding the multiple use of residual material. *Clean Technologies and Environmental Policy*, *23*(7), 2025–2036.

Shpak, N., Melnyk, O., Horbal, N., Ruda, M. and Sroka, W., (2021). Assessing the implementation of the circular economy in the EU countries. *Forum Scientiae Oeconomia*, *9*(1), 25–39.

Yin, R. K., (2009). Case study research: Design and methods (4th Ed.). In *Thousand Oaks, CA: Sage.* Nipissing University Library.

Yu, Y., Yazan, D. M., Junjan, V. and Iacob, M. E., (2022). Circular economy in the construction industry: A review of decision support tools based on Information and Communication Technologies. *Journal of Cleaner Production*, *349*, 131335.

Zhidebekkyzy, A., Moldabekova, A., Amangeldiyeva, B. and Streimikis, J., (2022). Assessment of factors influencing pro-circular behavior of a population. *Economics and Sociology*, *15*(3), 202-215.

Zumente, I., Lāce, N. (2020). Does Diversity Drive Non-Financial Reporting: Evidence from the Baltic States. *Intellectual Economics*, *14*(1), 50–66.

# ZARZĄDZANIE PROCESAMI GOSPODARKI O OBIEGU ZAMKNIĘTYM W PRODUKCJI EKRANÓW DŹWIĘKOCHŁONNYCH: ŚCIEŻKI DO ZRÓWNOWAŻONEGO ROZWOJU I INNOWACJI

**Streszczenie:** Niniejsze badanie bada zarządzanie i zastosowanie zasad gospodarki o obiegu zamkniętym do produkcji ekranów dźwiękoszczelnych w celu zmniejszenia wpływu na środowisko i zwiększenia efektywności wykorzystania zasobów. Wykorzystując kompleksową metodologiczną strukturę, która obejmuje przegląd literatury oraz analizę studiów przypadków w firmie produkującej ekrany dźwiękoszczelne badanie wykorzystuje narzędzie Circular Canvas do zmapowania i priorytetyzacji okazji związanych z gospodarką o obiegu zamkniętym w procesie produkcji. Wyniki ujawniają znaczący potencjał poprawy zrównoważonego rozwoju produkcji rekranów dźwiękoszczelnych poprzez przyjęcie praktyk gospodarki o obiegu zamkniętym, takich jak zrównoważone wykorzystanie materiałów, optymalizacja zasobów i zasady ekoprojektowania. Zastosowanie tych praktyk nie tylko podkreśla korzyści środowiskowe, ale także dodaje wartość, zapewniając ścieżkę do bardziej zrównoważonego zarządzania procesami.

**Słowa kluczowe:** Gospodarka o obiegu zamkniętym, Circular Canvas, Efektywność zasobów, Zarządzanie odpadami, Zrównoważony rozwój