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CURIOST

Circular design and development of Sustainable products in 4 key sectors in Central Europe

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EVALUATION OF CURRENT BUSINESS MODELS

Deliverable 1.2.2.

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1. INTRODUCTION

Project CURIOST is funded by INTERREG Central Europe Programme and aims at enabling SME and small mid-caps to exploit their potential in innovative sustainable product development and profit from matching business cases in the 4 key sectors which are highly relevant in partner regions:

- Mechanics and mechatronics,
- Packaging,
- Plastic,
- Construction and building.

CURIOST project integrates two-fold approach which aims to develop a comprehensive strategy targeting its uptake by minimum 140 SME and small midcaps, followed by transformation of this strategy into an action plan developed and adopted by policymakers to serve local businesses. It´s main goal to initiate the change in all sectors of the partner regions in Central Europe which will result in creating universal solution of matching business cases, which will accelerate the green transition in the Central European economy.

Within the CURIOST project, each project partner should participate in activities that provide understanding of current situation in product development in four targeted sectors, including gaps and challenges analysis and capitalization of best practices and benchmark in sustainable product design in Central Europe. These activities will give deliverables of Activity 1.2, namely:

- D.1.2.1 Assessment of market status and readiness for sustainable products in the 4 sectors

  The partnership assesses and gains insight about the maturity level and readiness of the market regarding the design and development of sustainable products, in particular in the sectors relevant in the partner regions. The result flows into the development of the strategy in A1.3.

> **D.1.2.2 Evaluation of current business models**

  Already implemented circular business models will be evaluated (key success factors) and categorized according to their type. Further, its applicability as blueprint or reference for SME + small midcaps in the 4 sectors will be analyzed and summarized in fact sheets, to be shared among the companies.

2. AIM OF THE ANALYSIS

Various circular business models have been developed over the last decade. They integrate digital and hybrid (e.g. additive manufacturing) technologies, which foster their implementation. Such models are already applied to a different extent in the 4 sectors mechanics & mechatronics, plastics, packaging and construction & building, but mainly in large manufacturing businesses in Europe and beyond.

For a better understanding and a common starting point, the partners will assess the current market status in the partner regions and the readiness for sustainable product design and development in the 4 sectors. For that purpose, the activity leader UEBA will create a matrix of key performance indicators that reflect the market status of the 4 sectors. All partners collect the KPIs for the sectors relevant in their region, and UEBA will consolidate the results.

The outcome forms one of the corner stones for the development of the strategy for sustainable product development in SME + small midcaps, in activity A1.3.

Further, already realized circular business models for sustainable products will be collected and analyzed. The key success factors will be identified and the potential of transferability to SME + small midcaps, as well as the transferability between the 4 sectors will be assessed. Finally, the results will be consolidated and grouped in the following four categories that have developed over the last few years:

- Cycling (keeping materials in the cycle with reuse, refurbishment, recycling),
- Extending (longer product life through circular design, maintenance and repair),
- Intensifying (sharing products intensifies its use phase),
- Dematerialising (service and software solutions instead of hardware).

3. INTRODUCTION TO CIRCULAR BUSINESS MODELS

The basic principle of the circular economy is to use resources for as long as possible by minimizing the need for materials and energy, as well as the waste and emissions of a given economic system. Through reuse and recycling, recycling of products and raw materials, and resource-efficient product design (ecodesign), resource consumption and waste can be reduced at the same time. The concept of the circular economy focuses on the entire value chain or the entire life cycle of a product and includes the extraction of resources and raw materials, product design, the production of intermediates and products, and the use and subsequent recycling of materials.

The main objectives of the circular economy:

- Using resources for the longest possible time horizon.
- Saving primary materials.
- Minimise waste generation.
- Minimise greenhouse gas emissions.

Business models in the circular economy represent innovative approaches that go beyond traditional linear patterns of production and consumption. They aim to create value by minimizing waste and maximizing the use of resources, through the reuse, recycling and recovery of materials. In this chapter, we will focus on the principles, strategies and forms of circular models that enable companies to improve sustainability, efficiency and competitiveness in a dynamic economic environment.

3.1. Definitions

Circular disruption = represents the replacement of a successful linear business model with a circular economy approach.

Circular product = does not lose value at the end of its life; Through the measures, the transformation starts at a suitable point in the value chain, the so-called product splitting, in order to obtain material for the production of a new circular product.

Linear product = created by the classic linear production process "take, produce, use, dispose of".

Business model = in essence, it describes how a company does business, implements its business activities. Creating, maintaining, and sharing value by society is at the core of any business model.

Sustainable business model = has a positive impact on the environment, as it seeks to minimize/eliminate the negative impacts of business on the surrounding environment. Innovation consists either in the development of entirely new business models or

diversification into other business models, or in the acquisition of new business models or in the transformation from one business model to another.

Circular business model (abbreviated - circular model) = is aimed at enabling, closing, creating or extending cycles by preserving value with the longest possible use of resources, while respecting the need for the competitiveness of the company.

The business goal of a circular enterprise = maximizing the company's profit, or its market value, is not only achieved by minimizing costs and increasing sales, but also by expansion, to maximize the lifespan of products, minimize the use of primary resources and reduce waste.

Circular model strategies = creating, prolonging and closing cycles that improve the economic, social and environmental sustainability of the company, considering the satisfaction of needs (benefit), appropriate value chain architecture, appropriate revenue model.

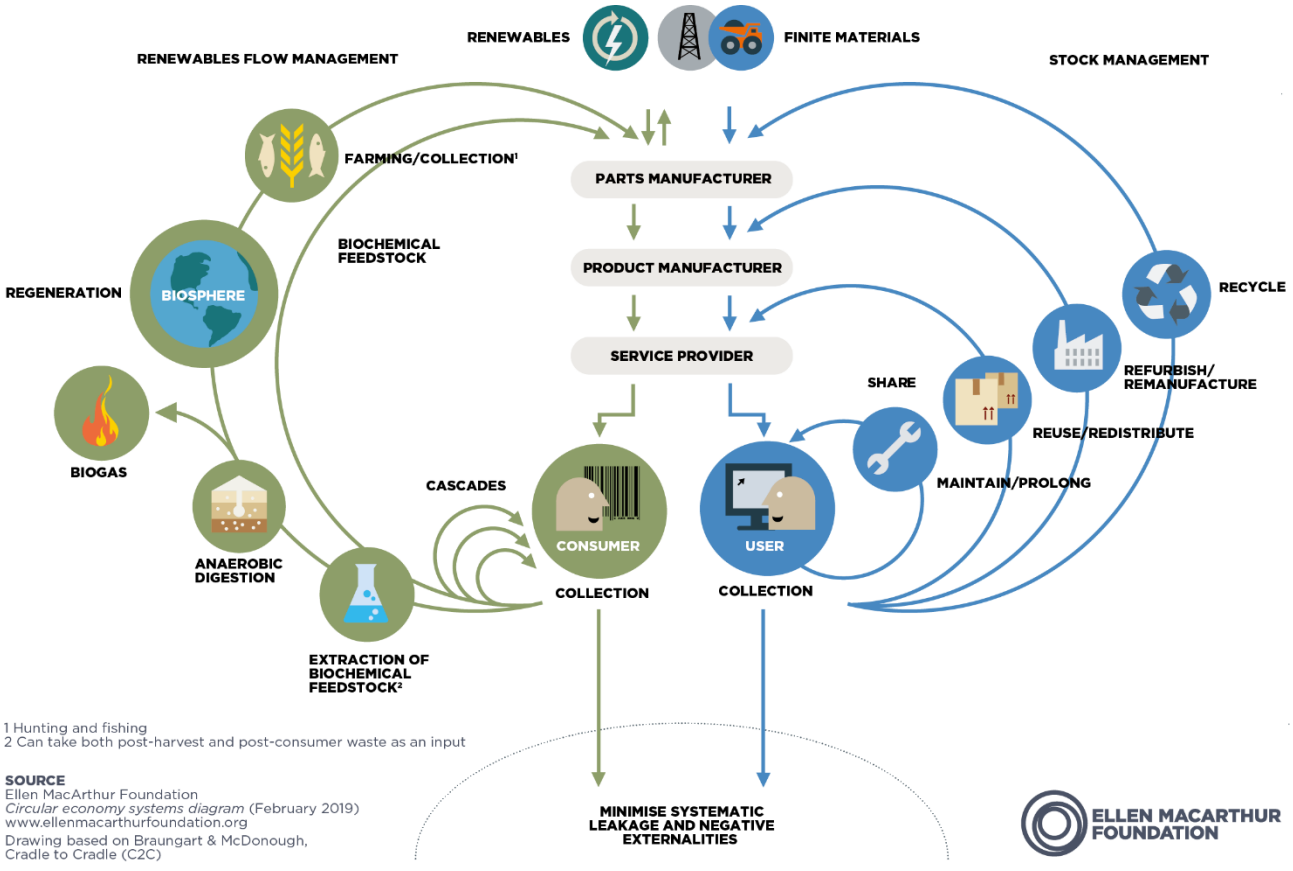


Figure 3.1 Circular economy butterfly diagram
Source: https://www.ellenmacarthurfoundation.org/circular-economy-diagram

3.2. Main strategies for implementing the circular economy in linear manufacturing

The transition to a circular economy requires the implementation of key strategies that support the change towards more sustainable business models and the management of available resources. A successful transition to a circular economy requires the following prerequisites:

- *Materials Technology Research* – especially for alternative and sustainable materials, this is key (development of biodegradable and renewable materials that are more environmentally friendly). This allows for a more efficient use of raw materials and a reduction in the ecological footprint.
- *Redesign of products and services* – so that they are more durable, repairable and recyclable. Businesses should invest in product designs that are modular and allow for easy repair or upgrade. This reduces waste and extends the life of products.
- *Promoting recycling* – ensuring a closed material cycle is the basis of the circular economy. Investment in efficient recycling technologies and infrastructure that enables the reuse of materials (for collection, sorting and treatment of waste) is key.
- *Fostering collaborative models and the sharing economy* - sharing resources can make a significant contribution to reducing consumption and minimizing waste. Models based on the sharing economy need to be developed and services must be provided instead of the sale of physical products.

Strategy 1 Closing cycles

The aim of this strategy is to bridge the gap between the end of a product's life cycle and the material input factor for its production. Products are usually disposed of at the end of their life cycle due to their unsuitability for reuse/reuse. However, there are still valuable material resources in such waste. If they are reintroduced into the value chain, the cycle is closed, and waste is minimized.

Examples: recycled plastic packaging (made from recycled plastic); paper made from recycled fibres; recycled metal components; glass jars; recycled textile.

Strategy 2 "Enabling cycles"

The starting point is that the recycling target is already considered in the planning, development or design of products. Measures to enable cycles include the use of harmless inputs or the application of ecodesign. This means that it is a set of measures, systems

and approaches that help to optimise and streamline the use of raw materials to reduce waste and maximise the recovery of these resources.

Examples: Product lifecycle tracking software; rental of electrical equipment (sharing platform).

Strategy 3 Create new cycles

The point is that circularity opportunities that do not yet exist can arise mainly through material or production substitution. For example, a new product can be created as waste from linear production.

Examples: Biodegradable packaging; bioplastics, compostable kitchen utensils.

Strategy 4 Slowing down / lengthening cycles (slowing)

This strategy focuses mainly on maintaining the longest possible shelf life. If the old product is no longer used, it can be transferred to another customer instead of disposing of it (sharing principle). At its core, it's about sharing products with other users that you're not using at 100 percent capacity, which in turn reduces the demand for new products. The reparability of the product is also part of the strategy, which makes it possible to extend its service life.

Examples: Appliance repair services; furniture restoration; electrical reuse program; furniture based on modular design.

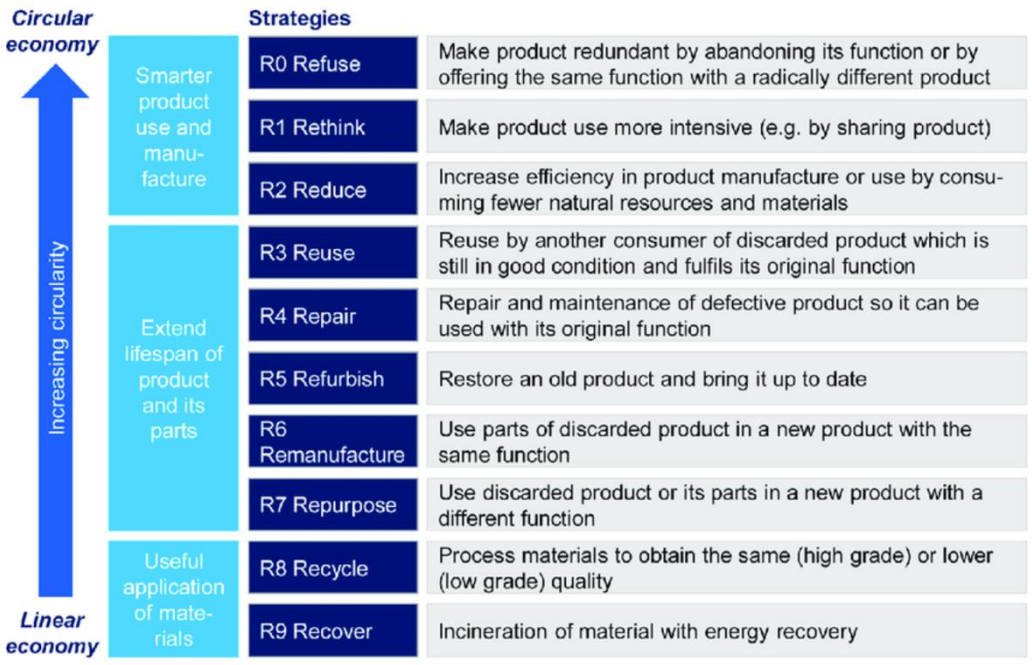


Figure 3.2 9R- Framework – from linear to circular economy
Source: https://www.topanga.io/post/how-the-9r-framework-can-change-our-economy

3.3. Basic phenomena of circular business models

A. Circular supply models

These business models include the replacement of traditional production inputs with bio-based, renewable or recovered materials. By making strategic sourcing decisions early in product development, businesses can reduce environmental pressures in supply chains while ensuring that the materials contained in their products do not become waste. It is a form of resource recovery model where material recovery is monitored at an early stage of a product's life cycle. When the product fulfills its mission, it is disassembled into further usable components.

B. Resource recovery models

These business models involve the creation of secondary raw materials from waste. The process begins with the collection of waste materials generated by households, businesses, and industry; it continues with sorting, which involves separating specific waste into its basic materials; The third phase is secondary production, which involves the conversion of sorted waste material back into input raw materials. The resulting secondary raw materials, e.g. metals, plastics, paper, are then sold to manufacturing companies. Business models envisage closer cooperation with local governments (waste collection) and waste disposal companies.

These business models can have several variants:

- *Downcycling* (recovered materials are of lower quality and can only be used to a limited extent).
- *Upcycling* (the opposite of downcycling; the conversion of waste into secondary raw materials and subsequent use in more valuable products).
- *Industrial symbiosis* (includes the use of by-products of the production of one enterprise as production inputs of another enterprise).

C. Product life extension models

These business models involve extending the lifespan of products, which takes place in three steps: (i) manufacturers themselves can extend the lifespan of products; (ii) reuse and repair activities ensure that products actually reach their intended lifetime; (iii) remanufacturing extends the lifespan of products.

	Key characteristic	Business case
Classic long life	The expected life of a product is extended through changes in product design	Manufacturers can charge a premium for higher quality, more durable products
Direct reuse	Involves the redistribution and reuse of products that would have otherwise been discarded before reaching their expected end of life	Firms that facilitate transactions of second-hand goods (whether online platforms or physical shops) can charge a percentage of the selling price
Maintenance and repair	By fixing or replacing defective components, maintenance and repair allows degraded products to reach their full expected life.	For original equipment manufacturers, extending product care beyond the point of sale may help to promote customer loyalty. In addition, repairing existing products can be a profitable activity for third party repair firms.
Refurbishment and remanufacturing	Gives products a "new life" by restoring them to their original working condition	Refurbished or remanufactured products are sold at a lower price than new ones, but may generate higher profit margins due to material cost savings

Figure 3.3 Overview of product life extension models
Source: OECD (2019, p. 29)

D. Sharing models

These business models involve increasing the use of under-exploited products, either through rental or sharing. In recent years, with the emergence of various online platforms (reduction of transaction costs), the use of this activity has intensified. With the advent of Generation Alpha, which does not pride itself on owning things, the demands on the sharing economy will increase. However, it should be noted that not every form of sharing meets the prerequisites of circularity (e.g. Uber/Bolt).

E. Product-service systems models

These business models combine a physical product and a service and can exist in the following variations:

- *Product-oriented product service system models* (the manufacturing business continues its core business but includes additional after-sales service in the value of the product – e.g. a maintenance and repair contract; warranty extension or product repurchase agreement).
- *User-oriented product service system models* (the customer pays for short-term use of the product (rental) without the possibility of acquiring ownership of the product – e.g. car rental, film rental).
- *Result-oriented product service system models* (providing a service instead of a product, e.g. maintaining a certain temperature level in a building instead of selling a heating device).

3.4. Circular business models in the European Union

Circular business models are implemented in many sectors in the European Union, with different intensities and content focuses. The following overview provides some examples of good practice (Table 3.1).

Table 3.1 Examples of circular business models

N.	Company	Activity
1.	IKEA	It has implemented a model of renting furniture and recycling used products to extend the life cycle of its products.
2.	Philips	It offers "light as a service", where customers pay for lighting and the company provides maintenance and recycling.
3.	Vigga	It rents children's clothes, maximizing the use of clothes and minimizing waste.
4.	Fairphone	It manufactures modifiable smartphones with an emphasis on ethical sourcing and repairs, thus extending the life of devices.
5.	Umicore	A Belgian company specializing in the recycling of precious metals, used for example in batteries.
6.	Rype Office	He renovates office furniture, which helps to reduce the consumption of raw materials.
7.	Loop Industries	A French company recycling waste plastics into new PET products of high quality.
8.	MUD Jeans	It offers a model of renting jeans that are returned after use and recycled into new products.
9.	Renault	In the automotive industry, it refurbishes used parts and vehicles, extending their service life and reducing waste.
10.	H&M	It implements the collection and recycling of clothes as part of the Garment Collecting Initiative program.
11.	Patagonia	It runs the Worn Wear program, which supports the repair and sale of used clothes.
12.	EnviroServ	It specializes in the collection and processing of waste, including hazardous materials, for reuse.
13.	Algramo	It offers packaging-free merchandising where customers use refillable containers.
14.	Ecovative Design	It produces eco-friendly mycelium packaging that replaces plastic alternatives and is completely compostable.
15.	Zipcar	They allow vehicles to be shared, reducing the need for vehicle ownership.
16.	Repair Café	Places where people can repair their appliances with the help of professionals, reducing waste.
17.	Circular Fashion	It offers shared clothing collections and promotes a circular approach to fashion.
18.	Remade in France	A network that refurbishes electronics and home appliances for resale.
19.	Tetracycle	It helps businesses and individuals recycle materials that are difficult to process in conventional ways.
20.	Rent the Runway	A model that allows you to rent luxury clothes for a short period.

These business models show diverse approaches to implementing circular principles that help not only to reduce waste and resource consumption, but also to improve the environmental performance of European businesses.

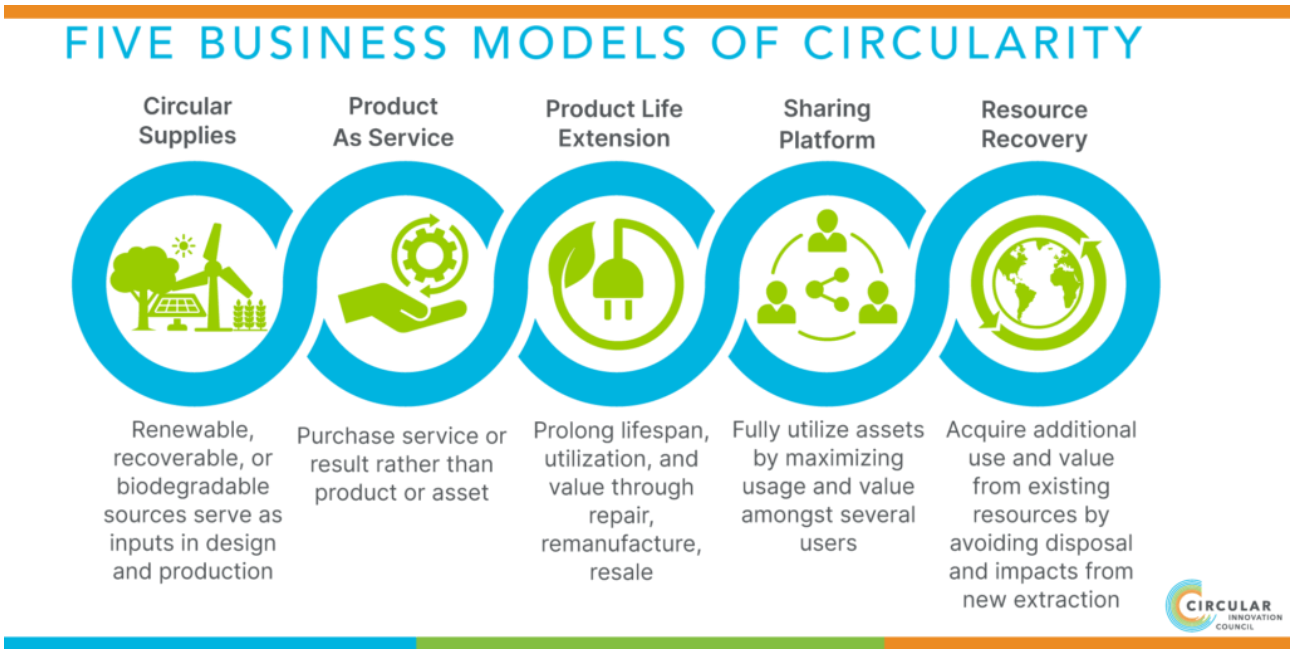


Figure 3.4 Circular business models
Source: https://circularinnovation.ca/circular-business-models-circular-supplies/

The OECD (2019), in the report "Business Models for the Circular Economy", analyzed business models for the circular economy. *The report focusses on the current scale and possible environmental impacts of five business models that could support the transition to a more resource efficient and circular economy.*

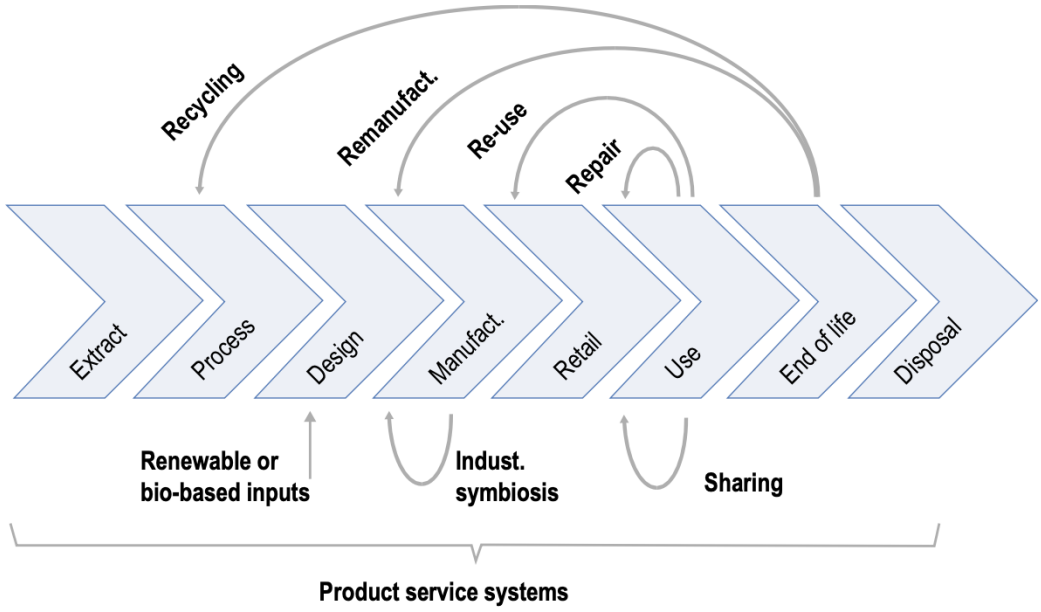


Figure 3.5 The impact of circular business models on the linear economy
Source: OECD (2019, p. 26)

Table 3.2 Circular business models from OECD-report

	Circular supply	Resource recovery	Product life extension	Sharing	Product service system
Key characteristic	Replace traditional material inputs with renewable, bio-based, recovered ones	Produce secondary raw materials from waste	Extend product lives	Increase utilisation of existing products and assets	Provision of services rather than products. Product ownership remains with supplier
Resource efficiency driver	Close material loops	Close material loops	Slow material loops	Narrow resource flows	Narrow resource flows
Business model sub-types	Cradle to cradle	Industrial symbiosis	Classic long life	Co-ownership	Product-oriented
		Recycling	Direct reuse	Co-access	User-oriented
		Upcycling	Repair		Result-oriented
		Downcycling	Refurbishment		
			Remanufacture		
Main sectors currently applied in	Diverse consumer product sectors	Metals	Automotive	Short term lodging	Transport
		Paper and pulp	Heavy machinery	Transport	Chemicals
		Plastics	Electronics	Machinery	Energy
				Consumer products	

Source: OECD (2019, p. 25)

Note: While the distinction between each type of business model is clear in theory, it may be less so in practice. In some cases, firms adopt combinations of business models rather than one in isolation.

4. ANALYSIS OF CURRENT CIRCULAR BUSINESS MODELS

This chapter deals with circular business models in four key sectors of the project - Mechanics and mechatronics, Packaging, Plastic, Construction and building. The intention is to bring the use of these models closer, identify key success factors and link them to the practice of small and medium-sized enterprises. Within the information possibilities (availability of appropriate data), applications for the countries of project partners are in progress. At the same time, we refer to the analyses carried out in this regard within the framework of the project work packages (WP1 and WP3).

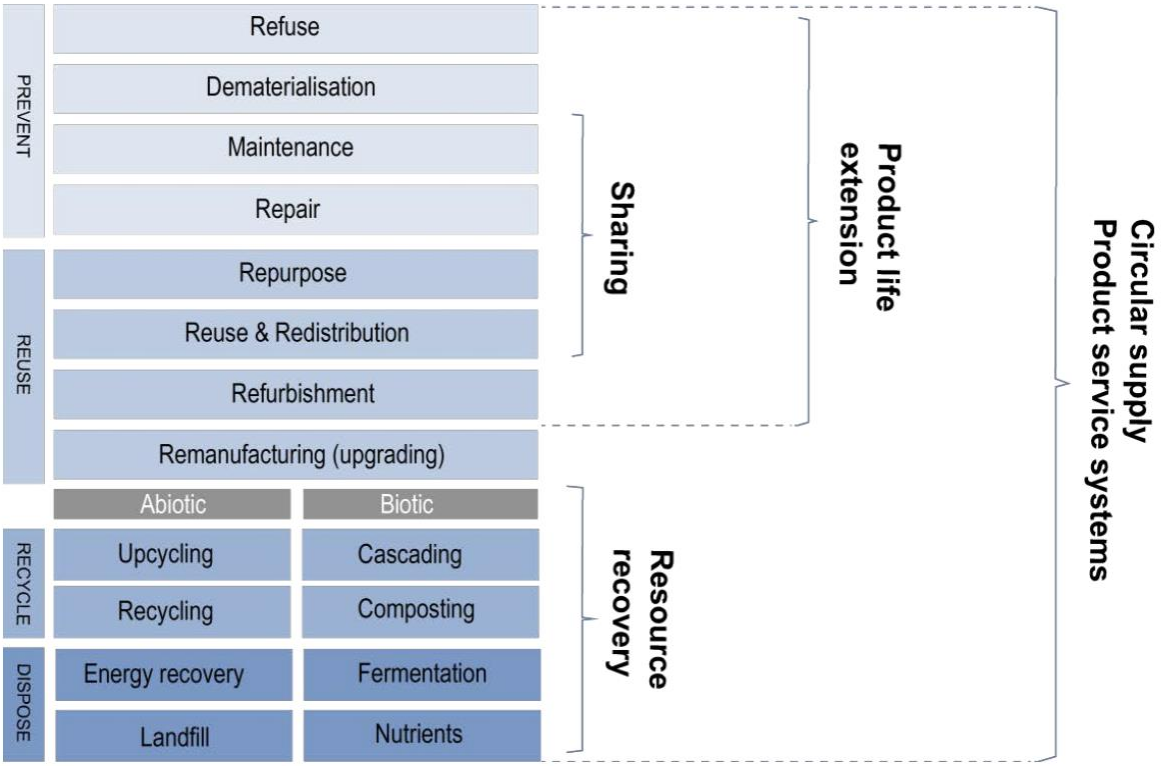


Figure 4.1 The circularity ladder concept
Source: OECD (2019, p. 64)

4.1. Key success factors for circular business models

The selection of key success factors of the relevant circular business model results in the state of knowledge of the issues and analytical materials that are presented in OECD reports and recommendations for public authority. This was based on the requirements defined by the legislative framework of the European Union, ESG standards and the results of comparative studies.

4.1.1 Key success factors for circular supply model

Key success factor	Name of the factor	Factor characteristics
1	Design for Circularity	Products must be designed with longevity, repairability, and recyclability in mind. Modular and easy-to-disassemble designs facilitate maintenance, reuse, and end-of-life recycling.
2	Sustainable Sourcing	Integrating renewable or recycled raw materials into the supply chain to reduce reliance on virgin resources and ensure a steady flow of sustainable inputs.
3	Efficient Reverse Logistics	Developing a well-coordinated system to collect, transport, and process returned products or waste for reintegration into production.
4	Innovation in Recycling and Reprocessing	Adopting new technologies for improved material recovery, reducing energy use, and minimizing waste.
5	Economic Viability	Balancing profitability with sustainability by creating value through cost savings in material reuse, potential tax benefits, and premium pricing for eco-friendly products.
6	Advanced Technology Integration	Leveraging digital tools such as blockchain, IoT, and data analytics to track materials and monitor product life cycles, ensuring transparency and optimized resource use.
7	Effective Partnerships	Collaboration with suppliers, partners, and third-party service providers to create a robust reverse logistics system for product take-back and recycling.
8	Stakeholder Buy-in	Engaging stakeholders at all levels—executives, employees, and customers—through awareness programs and incentives to support circular initiatives.
9	Consumer Engagement and Education	Encouraging consumer participation through buy-back programs, repair services, and clear information about the benefits of recycling and reusing products.
10	Compliance with Regulations	Aligning with regional and international laws that support sustainability and circular practices, such as the EU's Circular Economy Action Plan.

4.1.2 Key success factors for resource recovery model

Key success factor	Name of the factor	Factor characteristics
1	Sustainable Design Principles	Products should be designed with recovery in mind, incorporating materials that are easy to recycle and reuse, and minimizing hazardous components that complicate the recovery process.
2	Scalable and Flexible Operations	Establishing recovery operations that can scale according to demand and adapt to new types of waste materials as industries and technologies evolve.
3	Efficient Waste Collection and Sorting	Establishing systems that ensure waste is effectively collected, separated, and prepared for processing. Advanced sorting technologies such as AI-powered automation can enhance accuracy and speed.
4	Innovative Recycling Technologies	Implementing cutting-edge recycling and material recovery technologies to convert waste into usable raw materials efficiently. This includes chemical recycling, biorefining, and upcycling processes that increase the quality and versatility of recovered resources.
5	Technological Integration for Monitoring	Using IoT and blockchain for tracking materials throughout their lifecycle ensures transparency, accountability, and optimization in the recovery and reuse process
6	Economic Feasibility and Value Creation	Developing business models that make resource recovery profitable, such as turning waste into secondary raw materials that can be sold at a competitive price or reused internally to lower production costs.
7	Closed-Loop Supply Chain Management	Creating a seamless system where recovered resources are reintegrated into the production process, minimizing the need for virgin materials. This requires a well-coordinated network involving manufacturers, waste management companies, and logistics providers.
8	Partnerships and Collaboration	Fostering partnerships across industries to share technology, best practices, and logistics solutions. Collaborative efforts can also lead to shared recovery facilities and expanded market opportunities.
9	Consumer and Stakeholder Engagement	Educating consumers about the importance of recycling and sustainable practices to encourage their active participation. Stakeholders, including employees and investors, should be aligned with circular objectives.
10	Regulatory Compliance and Support	Ensuring adherence to environmental regulations and leveraging government incentives for circular practices. Policies that mandate recycling and support sustainable practices play a critical role in the success of resource recovery models.

4.1.3 Key success factors for product life extension model

Key success factor	Name of the factor	Factor characteristics
1	Product Durability and Quality	Design products with high-quality materials and robust engineering to ensure they can withstand prolonged use, repeated maintenance, and potential refurbishments.
2	Modular Design	Use modular components that are easy to replace or upgrade, allowing for simpler repairs and technological updates that extend the product's functional lifespan.
3	Sustainability in Operations	Integrate sustainable practices within the entire supply chain to align with broader environmental goals and build brand trust.
4	Efficient Maintenance and Repair Services	Establish accessible and cost-effective maintenance and repair infrastructure to keep products operational longer. This can include partnerships with service providers or in-house repair programs.
5	Feedback Loops	Establish systems to gather user feedback on product longevity and performance to refine future design and lifecycle strategies.
6	Reverse Logistics	Develop robust take-back schemes and reverse logistics to collect used products for refurbishment, remanufacturing, or parts harvesting.
7	Innovative Financial Models	Implement models such as leasing, renting, or product-as-a-service, which inherently encourage longer product life cycles as businesses retain ownership and responsibility for product performance.
8	Partnerships and Collaboration	Collaborate with other companies, industry groups, and stakeholders to improve product design standards and extend the reach of lifecycle extension practices.
9	Consumer Engagement and Education	Foster consumer awareness about the benefits of product maintenance, repair, and upgrades. Provide clear instructions, workshops, or incentives that encourage users to maintain or refurbish products.
10	Supportive Policies and Incentives	Leverage government policies, grants, and incentives that promote circular practices to enhance the financial viability of product life extension initiatives.

4.1.4 Key success factors for sharing model

Key success factor	Name of the factor	Factor characteristics
1	Sustainability and Circular Design	Emphasizing products or services that are designed for multiple users or repeated use, with durable materials and maintenance plans that enhance product lifespan and reduce waste.
2	Scalable and Flexible Infrastructure	The sharing model should be scalable to meet demand fluctuations and adapt to different locations and market conditions. This includes cloud-based platforms that can be easily expanded or modified.
3	User-Centric Design	Ensuring the sharing platform is intuitive, user-friendly, and facilitates easy access to shared assets or services. This includes a smooth onboarding process and clear navigation to encourage widespread participation.
4	Trust and Security Measures	Implementing systems that build trust among users, such as reliable identity verification, strong user reviews, and secure payment gateways. Guaranteeing the safety and quality of shared items or services is crucial for user confidence.
5	Continuous Feedback and Improvement	Collecting and acting on user feedback helps refine the model and adapt to changing preferences and technological advancements, ensuring a dynamic and responsive service.
6	Economic Viability and Cost Management	Ensuring the sharing model provides financial benefits, both for the company and users. Proper pricing structures, incentives, and clear cost-sharing mechanisms contribute to profitability and user satisfaction.
7	Effective Asset Management	Having robust processes for the maintenance, tracking, and efficient turnover of shared goods or services ensures that items remain in good condition and available for use. This helps optimize usage and lifecycle extension.
8	Strategic Partnerships	Forming alliances with complementary businesses or local governments can help expand the reach and functionality of the sharing model. These partnerships may include joint promotions, shared logistics, or integrating with existing networks.
9	Community Engagement and Social Impact	Building a community around the shared platform, with a focus on positive social outcomes like reducing consumption and promoting sustainable habits. Engaged communities often become advocates, enhancing word-of-mouth promotion and platform loyalty.
10	Regulatory Compliance and Support	Aligning with local regulations related to the sharing economy, including taxation, liability, and safety standards. This is vital for long-term operation and fostering a reputation as a responsible enterprise.

4.1.5 Key success factors for product-service systems model

Key success factor	Name of the factor	Factor characteristics
1	Sustainable Product Design, strong brand and trust	Ensuring that products within the PSS model are designed for durability, repairability, and modularity to support multiple use cycles. This design approach minimizes waste and maximizes resource efficiency. Building a reputation for reliability and quality service is vital. Trust in the company's ability to maintain, repair, and responsibly manage products encourages customer participation.
2	Scalability and Flexibility	Designing a model that can scale as demand grows and adapt to different markets or customer needs. This involves having flexible systems and operations that can evolve without compromising service quality.
3	Customer-Centric Approach	Developing of the model to address specific customer needs and provide clear benefits over traditional ownership. Clear communication of value, such as cost savings, convenience, and sustainability, is essential to drive adoption.
4	Continuous Improvement and Feedback Loops	Establishing mechanisms for gathering customer feedback and using it to improve services and product design. This iterative approach helps address challenges promptly and keeps the model aligned with market needs.
5	Efficient Service Infrastructure	Building a robust service network for maintenance, repair, and upgrades ensures products stay operational and maintain value over time. Effective logistics and after-sales service are critical to meet customer expectations and keep the system running smoothly.
6	Technology Integration	Leveraging IoT, data analytics, and digital platforms to monitor product usage, optimize service schedules, and personalize the user experience. This helps maintain product efficiency and creates added value for customers.
7	Innovative Financial Models	Offering flexible payment structures such as leasing, pay-per-use, or subscription services to appeal to different customer segments. Transparent pricing and clear terms increase customer trust and uptake.
8	Partnership, Education and Awareness	Engaging with suppliers, local businesses, and stakeholders to create a cohesive ecosystem that supports the PSS. Strong partnerships help streamline operations, share risks, and leverage expertise.

		Educating customers and employees on the benefits and practical aspects of using a PSS model can increase acceptance and proper utilization. Clear guidance on how to use and benefit from the service is essential for reducing barriers to entry.
9	Sustainability Metrics and Reporting	Implementing and communicating clear sustainability goals and achievements reinforces the commitment to circular principles and transparency. Regular reporting on impact can improve customer loyalty and attract environmentally conscious consumers.
10	Regulatory and Compliance Alignment	Ensuring that the business model complies with local and international regulations related to leasing, product safety, waste management, and environmental standards. Proactive engagement with policymakers can also help shape favorable regulations for circular practices.

4.2. Factsheets for SMEs in 4key sectors

This section formulates proposals for factsheets (examples) for the four key areas of the project.

4.2.1 Factsheet - Mechanics and mechatronics

Table 4.1 Factsheet: Circular Business Models for SMEs in Mechanics and Mechatronics

Introduction to circular economy: The circular economy is a sustainable approach that prioritizes resource efficiency, waste minimization, and environmental regeneration. For SMEs in the mechanics and mechatronics sector, adopting circular business models can enhance sustainability, reduce costs, and open new market opportunities.		
Key circular business models	**Explanation**	
Circular Supply Chains	*Definition*	Using recycled, bio-based, or sustainable materials in the production process.
	Implementation strategies	Partner with suppliers providing recycled metals and components, integrate 3D printing with recycled materials, and develop closed-loop supply systems.
	Benefits	Decreased dependency on raw materials and enhanced sustainability credentials.
Resource Recovery	*Definition*	Capturing and repurposing by-products and waste from manufacturing processes.
	Implementation strategies	Invest in waste collection systems, collaborate with recycling facilities, and leverage waste-to-energy solutions.
	Benefits	Revenue generation from waste, improved compliance with environmental regulations, and reduced disposal costs.
Product Life Extension	*Definition*	Extending the life of mechanical and mechatronic products through maintenance, repair, refurbishment, and remanufacturing.
	Implementation strategies	Establish dedicated service centers, develop user-friendly repair kits, and offer subscription-based maintenance services.
	Benefits	Increased customer loyalty, reduced production costs, and minimized resource extraction.
Sharing Platforms	*Definition*	Facilitating the shared use of machinery and equipment among multiple businesses.
	Implementation strategies	Create or join digital platforms for equipment sharing, establish rental hubs for specialized tools, and form cooperative networks.
	Benefits	Optimal use of resources, reduced operational costs, and broadened access to high-tech equipment.

Product-as-a-Service (PaaS)	*Definition*	Shifting from product ownership to providing products as services.
	Implementation strategies	Implement leasing models for high-value machinery, offer pay-per-use systems, and develop performance-based contracts.
	Benefits	Continuous revenue streams, strengthened customer relationships, and incentives for designing longer-lasting products.

Success Factors for SMEs:

- Innovative Partnerships: Collaborate with technology providers, recycling partners, and other SMEs.
- Digital Integration: Utilize IoT, AI, and predictive analytics for efficient maintenance and resource tracking.
- Customer Engagement: Educate clients on the benefits of circular practices and involve them in sustainable initiatives.
- Regulatory Alignment: Stay informed and compliant with environmental legislation and standards.
- Financial Planning: Secure funding through green grants and sustainable investment programs.

Challenges and Solutions:

- Initial Investment: The shift to circular models may require capital. SMEs can mitigate this through phased implementation and securing public and private funding.
- Technical Expertise: Developing circular capabilities requires training. Investing in employee education and partnering with academic institutions can provide necessary skills.
- Market Acceptance: Educating customers and emphasizing value propositions can foster trust and acceptance of circular practices.

Conclusion:

Adopting circular business models in mechanics and mechatronics not only enhances sustainability but positions SMEs competitively in a rapidly evolving market. By focusing on product life extension, sustainable supply chains, and innovative service offerings, these businesses can drive long-term value and resilience.

4.2.2 Factsheet - Plastic

Table 4.2 Factsheet: Circular Business Models for SMEs in Plastic

Introduction to circular economy: Circular economy principles emphasize resource efficiency, waste reduction, and product lifecycle optimization. SMEs in the plastics sector can leverage circular models to reduce environmental impact, enhance sustainability, and create economic opportunities.		
Key circular business models	**Explanation**	
Circular Supply Chains	*Definition*	Utilizes renewable, recyclable, or biodegradable materials in production.
	Benefits	Reduces dependency on virgin plastics, lowers carbon footprint, and aligns with sustainable sourcing policies.
	Example	Switching to bio-based plastics or recycled polymers.
Resource Recovery	*Definition*	Recovers valuable materials from post-consumer products for reuse in production.
	Benefits	Minimizes landfill waste, promotes closed-loop systems, and reduces raw material costs.
	Example	Collecting and processing used plastic bottles to create new packaging.
Product Life Extension	*Definition*	Extends the lifespan of plastic products through maintenance, repair, or refurbishment.
	Benefits	Reduces the demand for new production, enhances brand reputation for sustainability, and offers new service revenues.
	Example	Offering repair services for plastic components used in industrial applications.
Sharing Platforms	*Definition*	Facilitates shared access to plastic products, reducing the need for ownership and overproduction.
	Benefits	Maximizes product use, decreases resource consumption, and encourages collaborative consumption.
	Example	Platforms for shared use of plastic equipment or tools.
Product-as-a-Service (PaaS)	*Definition*	Shifts from selling products to offering them as a service. The producer retains ownership, ensuring optimal recycling and reuse.
	Benefits	Creates recurring revenue streams, incentivizes sustainable design, and closes material loops.
	Example	Leasing plastic storage containers or reusable packaging solutions.
Key Success Factors for Implementation: • Innovative Design: Invest in R&D for materials and products that facilitate recycling and reuse. • Collaboration: Partner with stakeholders across the value chain for shared goals in sustainability. • Regulatory Compliance: Adhere to environmental regulations and adopt standards like ISO 14001. • Consumer Engagement: Educate customers on the benefits of circular models to encourage participation. • Technology Integration: Use digital tools for tracking, collection, and efficient sorting of recyclable plastics.		

Challenges and Considerations:

- Initial investment costs and adapting existing production systems.
- Navigating policy changes and ensuring continuous material supply.
- Consumer perception and the shift from ownership to access-based models.

Conclusion:

Adopting circular business models can significantly enhance sustainability and competitiveness for SMEs in the plastics industry. By embracing these practices, SMEs can play a pivotal role in advancing a more sustainable and resource-efficient economy.

4.2.3 Factsheet - Packaging

Table 4.3 Factsheet: Circular Business Models for SMEs in Packaging

Introduction to circular economy: The packaging sector plays a crucial role in modern commerce but is often associated with environmental challenges due to waste generation and resource depletion. Adopting circular business models can help small and medium-sized enterprises (SMEs) in the packaging industry become more sustainable while driving economic growth.		
Key circular business models	**Explanation**	
Circular Supply Chains	*Description*	Focus on sourcing renewable, recyclable, or biodegradable materials to produce packaging.
	Benefits	Reduces dependency on finite resources and minimizes environmental impact.
	Implementation Tips	Partner with suppliers that provide sustainable materials and use life-cycle assessments to choose the most effective inputs.
Resource Recovery	*Description*	Design packaging that can be efficiently reclaimed and reprocessed after use.
	Benefits	Encourages recycling and reduces waste ending up in landfills.
	Implementation Tips	Collaborate with recycling firms to establish return schemes for used packaging materials.
Product Life Extension	*Description*	Create durable, reusable packaging that maintains its quality over multiple uses.
	Benefits	Lowers production costs and enhances customer loyalty.
	Implementation Tips	Invest in high-quality materials and design for easy cleaning and maintenance.
Sharing Platforms	*Description*	Offer shared access to packaging solutions, such as pallet pooling or reusable container services.
	Benefits	Reduces overall packaging needs and optimizes resource utilization.
	Implementation Tips	Establish partnerships with logistics companies to streamline shared packaging services.
Product-as-a-Service (PaaS)	*Description*	Provide packaging services rather than selling packaging as a one-time product.
	Benefits	Facilitates consistent recycling and reusability practices.
	Implementation Tips	Develop subscription-based models or leasing arrangements for packaging solutions.
Key Success Factors for Implementation:		

- Strong Partnerships: Collaborate with stakeholders across the value chain, from suppliers to customers, to ensure a seamless circular approach.
- Technology Integration: Leverage digital tools for tracking packaging use, facilitating returns, and monitoring life cycles.
- Consumer Engagement: Educate customers on the importance of participating in circular models and incentivize their involvement.
- Regulatory Compliance: Stay informed about packaging regulations and align business strategies with national and EU sustainability goals.
- Innovation and Flexibility: Regularly review and adapt business models to integrate emerging sustainable technologies and practices.

Challenges and Solutions:

- Challenge: High initial costs for adopting sustainable materials.
  - Solution: Seek government grants or sustainability-focused investment funds.
- Challenge: Consumer habits favor disposable packaging.
  - Solution: Run awareness campaigns highlighting the benefits of circular packaging.
- Challenge: Limited infrastructure for recycling certain materials.
  - Solution: Partner with innovative recycling startups or invest in proprietary recycling capabilities

Case Studies:

- Reusable Packaging Initiatives: Several SMEs in Europe have adopted circular models by introducing reusable containers, drastically cutting waste.
- Biodegradable Material Use: Companies shifting to compostable films for food packaging have gained a competitive advantage.
- Collaborative Networks: SMEs that joined recycling alliances improved their material recovery rates and strengthened their brand reputation.

Conclusion:

Transitioning to circular business models enables SMEs in the packaging industry to enhance sustainability, foster customer trust, and comply with evolving regulations. By embracing these strategies, companies can not only contribute to environmental conservation but also secure long-term profitability and resilience.

4.2.4 Factsheet - Construction and building

Table 4.4 Factsheet: Circular Business Models for SMEs in Construction and building

Introduction to circular economy: Circular business models in the construction industry promote sustainable practices by focusing on minimizing waste and maximizing resource efficiency throughout the lifecycle of materials and structures. These models align with global sustainability goals and support long-term business growth through innovation and operational resilience.	
Key circular business models	**Explanation**
Circular Supply Chains	Focuses on sourcing sustainable, recyclable, and renewable materials. SMEs can leverage partnerships with suppliers who prioritize sustainable extraction and recycling processes. Key benefits include reduced dependency on virgin materials and improved resilience to supply chain disruptions.
Resource Recovery	Involves reclaiming and repurposing construction waste. SMEs can integrate deconstruction practices to salvage valuable materials and components, reducing landfill contributions and lowering costs. This model also supports secondary revenue streams through the sale of reclaimed materials.
Product Life Extension	Encourages the design of buildings and components for durability, adaptability, and ease of maintenance. SMEs can offer services such as building retrofitting, modular construction, and maintenance programs that extend the usable life of assets.
Sharing Platforms	Promote the shared use of tools, machinery, and construction spaces. SMEs can develop or participate in platforms that facilitate equipment rental and sharing, leading to cost savings and reduced need for asset ownership.
Product-as-a-Service (PaaS)	Focuses on providing construction services (e.g., lighting, heating) rather than selling physical products. SMEs can transition from selling products to offering long-term service agreements, aligning profits with sustainable usage.
Benefits of Circular Models for SMEs: • Cost Efficiency: Reducing material waste and reusing resources can lower operational costs. • Market Differentiation: Adoption of sustainable practices enhances brand reputation and competitiveness. • Regulatory Compliance: Proactive circular strategies help meet evolving environmental regulations. • Customer Engagement: Demonstrates a commitment to sustainability, appealing to eco-conscious clients.	
Challenges for Implementation:	

- Initial Investment: Higher upfront costs for new technologies and training.
- Market Awareness: Limited understanding of circular benefits among clients and stakeholders.
- Collaboration Needs: Requires strong partnerships with suppliers and waste management firms.

Key Strategies for Success:

- Educate and Train Staff: Enhance skills in deconstruction, sustainable design, and resource management.
- Develop Strong Partnerships: Work with suppliers and waste processors committed to sustainability.
- Adopt Modular Design: Facilitate easy upgrades and deconstruction.
- Utilize Digital Tools: Implement BIM (Building Information Modeling) to track resources and optimize material usage.
- Engage with Circular Initiatives: Join industry networks and alliances that promote circular practices.

Examples from the EU:

- Deconstructable Building Systems: Companies in the EU have developed structures that can be easily disassembled and reused.
- Recycling Partnerships: SMEs collaborate with local recycling facilities to process construction waste into new products.
- Tool-Sharing Networks: Platforms that enable construction firms to share equipment and reduce redundant ownership.

Future Opportunities:

Adopting circular models positions SMEs to thrive in a low-carbon economy. Investing in sustainable practices ensures long-term resilience, aligns with policy trends, and supports environmental stewardship. By incorporating these business models, SMEs can contribute meaningfully to the circular economy and benefit from emerging market opportunities.

Conclusion:

Circular business models provide SMEs in construction with a pathway to sustainable growth, cost savings, and enhanced competitiveness. Through strategic implementation, these models enable businesses to meet regulatory standards, appeal to clients, and foster innovation.

4.3. Examples of good practice – circular business models in the project partner countries

The analysis of circular business models, elaborated in section 4, documents the high diversity of perception of theoretical solutions and their application in economic practice. Depending on the sector, the intensity of the use of circularity elements varies, which is partly due to the structure of business entities (small, medium and large enterprises), the degree of maturity of the business, the soft and hard skills that business management has.

Based on the results of analyses and expert interviews, which were carried out in the initial stage of the project, examples of good practice were processed, where the degree and intensity of use of selected elements of the circular economy are documented, while emphasis is also placed on considering the national specifics of the project consortium partners.

Country:	Austria	Austria
Name of company:	WFL Millturn GmbH	Engel
Sector:	Mechanics and mechatronics	Mechanics and mechatronics Plastics
Short description: What is the main activity of the company?	WFL Millturn GmbH produces multifunctional turning-drilling-milling machines. In 2016 WFL started this business model on customer demand. They remanufactured an old machine. Since then, WFL has been proactively buying back old WFL machines for several reasons: 1. Earning money with as-good-as-new machines (refurbishment or remanufacturing) 2. Relieving the service hotline from complaints from former 2nd or 3rd hand users of unprofessionally modified machines 3. Maintaining their good reputation on the market (less complaints) 4. Balancing their business: in booming years new machines are in high demand whereas in economically poor years the as-good-as-new machines are highly demanded. 5. Modularising and optimizing the product design based on learnings gained during refurbishment & remanufacturing.	Engel produces injection molding machines with a clamping force in the range of 280 kN to 55.000 kN. They established a new business field: upgrade or retrofit of injection molding machines, with • conversion for new injection molding applications • increased efficiency, reduced power consumption extended lifetime
Identify the elements that the company applies	1. Product life extension with Refurbishment & remanufacturing 2. Resource recovery with Recycling of replaced parts	1. Product life extension with Refurbishment/ & remanufacturing 2. Resource recovery with Recycling of replaced parts
Which circular business model does the company apply?	• Resource recovery model • Product life extension model	• Resource recovery model • Product life extension model

Country:	Austria	Austria
Name of company:	IAG SPECIAL MACHINERY	ARA Plastics
Sector:	Mechanics and mechatronics	Packaging Plastics
Short description: **What is the main activity of the company?**	IAG Special Machinery creates quality machines that last for a longer period with adequate support and service. Modern production system, extensive services and comprehensive after-sales support across the entire life cycle are offered. Experienced employees support machines with remote service, retrofitting and optimization tools for new machines and the one´s in operation for many years.	Offering a wide range of services for manufacturing to help the process of product design, making packaging circular and improving the recyclability for packaging with higher usage of recycled materials. Advantage for business and consumers to have all information and services in one place which makes it easier to keep up with many regulations.
Identify the elements that the company applies:	Reuse: Remanufacturing (upgrading) Prevent: Repair and Maintenance	Reuse: Repurpose, Reuse and redistribution Recycle: recycling
Which circular business model does the company apply?	• Circular supply model • Product life extension model – extending the life of mechanical and mechatronic products through maintenance, repair, refurbishment and remanufacturing. • Sharing model	• Circular supply model • Resource recovery model • Product life extension model • Sharing model • Product-service systems model

Country:	Austria	Austria
Name of company:	CORETH	BAUMIT
Sector:	Packaging Plastics	Construction and building
Short description: **What is the main activity of the company?**	CORETH offers a wide range of film products, stretch film, bags, adhesive tapes, packaging accessories, etc. All films are recyclable. The printing hall exists in the company premises, as well as own recycling center where films are recycled and returned to production. Use of raw materials and conservation of raw materials resources is used.	Company wants to offer beauty and sustainability in the areas of construction since the beginning. The company is striving to develop and produce sustainable products that meet highest quality standards. Circular economy, resource conservation, new technologies, reduced CO2 emissions.
Identify the elements that the company applies:	Prevent: dematerialization Reuse: repurpose, reuse and redistribution Recycling Upcycling Refurbishment	Reuse: repurpose, refurbishment, remanufacturing Upcycling Recycling Energy recovery
Which circular business model does the company apply?	• Circular supply model – using renewable, recyclable materials, reusing materials • Resource recovery model – owning recycling center in the company premises, using recycling materials • Product-service systems model – offering recycling possibilities for other	• Circular supply model • Resource recovery model • Product life extension model – Bauminator – special tool used for production of concrete ceilings with saving up to 50% of materials and Co2 emissions. • Sharing model

4.3.2 Croatia

Country:	Croatia	Croatia
Name of company:	Metal Dekor d.o.o.	EKO MEĐIMURJE d.d.
Sector:	Mechanics and mechatronics	Mechanics and mechatronics
Short description: **What is the main activity of the company?**	Metal Dekor d.o.o. specializes in manufacturing transformer boilers, steel structures, and welding services, focusing on sustainable development and exporting over 60% of its production to the European market.	EKO MEĐIMURJE d.d. specializes in manufacturing welded, machined, and painted metal products for various industries, including construction and food processing. They emphasize quality, innovation, and environmental responsibility.
Identify the elements that the company applies:	Dematerialisation, Maintenance, Repair, Landfill	Dematerialisation, Maintenance, Repair, Energy Recovery, Landfill
Which circular business model does the company apply?	• Circular supply model • Resource recovery model • Product Life Extension	• Circular supply model • Resource recovery model • Product Life Extension

Country:	Croatia	Croatia
Name of company:	Senko d.o.o.	PRIMABIRO d.o.o.
Sector:	Mechanics and mechatronics	Mechanics and mechatronics
Short description: **What is the main activity of the company?**	Senko d.o.o. specializes in manufacturing metal products for various industries, including cookers, stoves, fireplaces, and gas sensors. They focus on high-quality production and environmental responsibility.	PRIMABIRO d.o.o. specializes in fabricated metal products, focusing on structural metal manufacturing. They emphasize sustainability, renewable energy, and modern technologies, enhancing efficiency and quality.
Identify the elements that the company applies:	Dematerialisation, Maintenance, Repair, Energy Recovery, Landfill	Dematerialisation, Maintenance, Repair, Landfill
Which circular business model does the company apply?	• Circular supply model • Resource recovery model • Product Life Extension	• Circular supply model • Resource recovery model • Product Life Extension

Country:	Croatia	Croatia
Name of company:	Ferro-Preis d.o.o.	IZIT d.o.o.
Sector:	Mechanics and mechatronics	Mechanics and mechatronics
Short description: **What is the main activity of the company?**	Ferro-Preis d.o.o. producing high-quality cast iron products, machining parts, and industrial equipment. They focus on sustainability through efficient resource utilization, recycling, and leveraging advanced technologies.	IZIT d.o.o. specializes in 3D printing and additive manufacturing, offering services like rapid prototyping, reverse engineering, 3D scanning, and model development. They cater to various industries, including medicine, art, and engineering.
Identify the elements that the company applies:	Dematerialisation, Maintenance, Repair, Refurbishment, Upcycling, Recycling, Landfill	Dematerialisation, Maintenance, Repair, Upcycling, Recycling, Landfill
Which circular business model does the company apply?	• Circular supply model • Resource recovery model • Product Life Extension	• Circular supply model • Resource recovery model • Product Life Extension

Country:	Croatia	Croatia
Name of company:	MURAPLAST d.o.o.	QUADRO d.o.o.
Sector:	Plastics	Construction and building
Short description: **What is the main activity of the company?**	MURAPLAST d.o.o. produces polyethylene films, plastic bags, and flexible packaging. They focus on sustainability with recycled materials, renewable energy, emission reduction, and circular economy principles.	QUADRO d.o.o. specializing in high-quality product manufacturing, with a focus on modernizing machinery, using raw materials efficiently, and implementing circular economy principles.
Identify the elements that the company applies:	Dematerialisation, Maintenance, Repair, Reuse, Upcycling, Recycling, Energy Recovery, Landfill	Dematerialisation, Maintenance, Repair, Reuse, Reburbishment, Recycling, Landfill
Which circular business model does the company apply?	• Circular supply model • Resource recovery model • Product Life Extension	• Circular supply model • Resource recovery model • Product Life Extension

Country:	Croatia	Croatia
Name of company:	FI-MAN d.o.o.	KNAUF
Sector:	Construction and building	Construction and building
Short description: **What is the main activity of the company?**	FI-MAN d.o.o. specializing in residential and non-residential buildings, repairs, consulting services, focusing on sustainability through increased use of recycled materials and compliance with zero-emission building regulations.	KNAUF specializes in sustainable building materials, producing high-quality products with a focus on recycled content, energy efficiency, and active participation in the circular economy.
Identify the elements that the company applies:	Dematerialisation, Maintenance, Repair, Reuse, Reburbishment, Repurpose, Recycling, Upcycling, Landfill	Dematerialisation, Maintenance, Repair, Reuse, Upcycling, Recycling, Energy Recovery, Landfill
Which circular business model does the company apply?	• Circular supply model • Resource recovery model • Product Life Extension	• Circular supply model • Resource recovery model • Product Life Extension

Country:	Croatia	Croatia
Name of company:	Draco Pro	The University of Rijeka Faculty of Civil Engineering
Sector:	Construction and building	Construction and building
Short description: **What is the main activity of the company?**	Draco Pro specializes in producing high-quality waterproofing solutions and construction-related materials, innovating with waste materials to enhance sustainability and product performance.	The University of Rijeka Faculty of Civil Engineering conducts research on integrating recycled materials into asphalt mixtures, providing innovations to support circular economy practices in the construction sector.
Identify the elements that the company applies:	Prevent: Dematerialization (reducing raw material dependency). Recycle: Upcycling (transforming industrial waste into high-value construction products).	Prevent: Research aims to reduce reliance on virgin resources through recycled material use. Recycle: Develops methods for reusing waste materials, such as plastics and rubber, in construction.
Which circular business model does the company apply?	• Circular Supply Model: Incorporating recycled and sustainable materials into production processes. • Resource Recovery Model: Utilizing industrial waste as raw material. • Product Life Extension Model (Indirect): Innovating materials to improve product longevity.	• Circular Supply Model: By enabling the use of recycled materials in asphalt production. • Resource Recovery Model: Developing methodologies to repurpose waste materials into new construction inputs.

Country:	Croatia	Croatia
Name of company:	Lož Metalpres	Primax d.o.o.
Sector:	Plastics	Plastics
Short description: **What is the main activity of the company?**	Lož Metalpres produces plastic and metallic components, specializing in bathroom siphons, while recycling technological waste back into their production processes to enhance sustainability.	Primax d.o.o. specializes in producing biodegradable and compostable cemetery lanterns (Ecolant) and plastic films, with 90% of their production based on recycled materials.
Identify the elements that the company applies:	Recycle: Recycling and reusing production remnants such as plastics and metals. Recover: Efficiently handling byproducts and technological waste.	Prevent: Uses renewable and recycled materials to minimize the use of virgin plastics. Recycle: Recycles 100% of production waste and integrates recycled PVC in packaging. Dematerialize: Designs biodegradable and compostable products to replace traditional plastic items.
Which circular business model does the company apply?	• Resource Recovery Model: Recycling technological waste into raw materials for new production cycles. • Circular Supply Model: Reducing reliance on virgin materials by integrating recycled inputs into their processes.	• Circular Supply Model: Utilizes recycled and renewable materials in production. • Resource Recovery Model: Recycles production waste and uses it in manufacturing.

4.3.3 Germany

Country:	Germany	Germany
Name of company:	Zapf GmbH & Co KG	Lorenz GmbH & Co. KG
Sector:	Construction and building	Mechanics and mechatronics
Short description: **What is the main activity of the company?**	Sand-lime bricks consist of 3 natural raw materials: lime, sand and water. They are mined in local quarries with only very short transportation routes. Very little energy is required for production. All residual materials generated during production are crushed using crushing plants and fed directly back into the production process. This results in no production waste.	Lorenz GmbH & Co. KG produces high-quality water meters (95% of all parts come from Southern Germany) with full modularity and "Design for Remanufacturing" (optimum disassembly and reprocessing; the company takes back the smart meters to recondition them and return them to the production cycle).
Identify the elements that the company applies:	• Refurbishment • Abiotic recycling	• Refurbishment • Remanufacturing
Which circular business model does the company apply?	• Resource recovery model	• Product life extension model • Sharing model • Product-service systems model

Country:	Germany	Germany
Name of company:	REHAU	MAINCOR Rohrsysteme GmbH & Co. KG
Sector:	Plastics Construction and building	Plastics Construction and building
Short description: **What is the main activity of the company?**	REHAU develops and produces innovative window solutions that impress with their durability, energy efficiency and conservation of resources. The CiE principle: old windows are collected; their PVC components are processed into high-quality recycled granulate and incorporated into the resource-saving production of new window profiles.	MAINCOR Rohrsysteme GmbH & Co. KG developed and manufactures the first approved underfloor heating pipe on the market that contains regranulate. The CO2 footprint is a good quarter lower than that of pipes made from virgin material and still meets all technical requirements.

Identify the elements that the company applies:	• Dematerialization • Recycling	• Dematerialization • Recycling
Which circular business model does the company apply?	• Circular supply model • Resource recovery model	• Circular supply model • Resource recovery model

Country:	Germany
Name of company:	traceless materials GmbH
Sector:	Plastics
Short description: **What is the main activity of the company?**	traceless materials GmbH has developed a biodegradable alternative to conventional plastics which is fully compostable and based on natural bio-based raw materials that are by-products of the agricultural industry, such as residues from grain processing.
Identify the elements that the company applies:	• Dematerialization • Cascading
Which circular business model does the company apply?	• Circular supply model • Resource recovery model

4.3.4 Hungary

Country:	Hungary	Hungary
Name of company:	Magnus Aircraft	Termoplast Ltd.
Sector:	Plastics	Plastics
Short description: **What is the main activity of the company?**	Magnus Aircraft, based in Pécs, specializes in sustainable aviation solutions. Their flagship Fusion series integrates advanced materials, eco-friendly practices, and cutting-edge technologies, including Hungary's first all-electric aircraft.	Termoplast Ltd., based in Pécs, Hungary, specializes in producing secondary raw materials from recycled plastics. By utilizing innovative recycling technologies, they transform plastic waste into high-quality materials, supporting the circular economy and sustainability goals.
Identify the elements that the company applies:	• Substitution with sustainable materials (circular supply). • Maintenance and repair for extended product life cycle (product life extension). • Recycling and resource recovery in production processes.	• Recycling Process: Collecting and processing used plastics to produce secondary raw materials. • Reintegration of Recycled Materials: Supplying recycled materials to partner companies and businesses. • Material Sourcing: Identifying new sources of used plastic for recycling.
Which circular business model does the company apply?	• Circular supply chains • Resource recovery model	• Circular supply chains • Resource recovery model

Country:	Hungary	Hungary
Name of company:	Holcim Hungary Ltd.	IMG Építő Ltd.
Sector:	Construction and building	Construction and building
Short description: **What is the main activity of the company?**	Holcim Hungary Ltd. specializes in innovative cement production using alternative fuels and raw materials. The company emphases sustainability, community engagement, and environmental education programs to promote sustainable construction practices.	IMG Építő Ltd. specializes in sustainable construction practices for residential and industrial projects. They focus on selective waste collection, renewable energy usage, and sustainable material sourcing, including the production of plastic and aluminum doors and windows.
Identify the elements that the company applies:	• Resource recovery (reuse of waste materials as alternative fuels) • Recycling (integration of recycled materials into production) • Carbon footprint reduction	• Selective waste collection, • energy recovery • Recycling (materials processing) • Maintenance
Which circular business model does the company apply?	• Resource recovery model • Circular supply model	• Resource recovery model • Product life extension model • Circular supply model

4.3.5 Italy

Country:	Italy	Italy
Name of company:	RE-SPORT	ALKIVIO
Sector:	Plastics	Packaging
Short description: **What is the main activity of the company?**	RE-SPORT is a spin-off of the University of Bologna, that develops innovative recycling technologies for sport equipment recycling and everyday life goods made of plastic or composite materials. RE-SPORT develops all the recycling process steps of end-of-life multi-materials products, starting from the proof-of-concept up to the industrial plant design, considering the environmental and economic impact of the process.	Identify and develop new technologies to obtain a new material designed to be biodegradable, compostable, eco-sustainable and colourable from paper waste. Alkivio® technology, born in the Smart Materials laboratories of the Istituto Italiano di Tecnologia (IIT), transforms paper into AlkiPaper®, the first line of bio composites launched by Alkivio® onto the market. While these materials have the same characteristics as plastics, both in processing and use, they are formulated to be compostable at the end of their lifecycle.
Identify the elements that the company applies:	Circular supply chain - Switching to bio-based plastics or recycled polymers.	Circular Supply Chains and Resource Recovery
Which circular business model does the company apply?	• Circular supply model • Resource recovery model • Product life extension model • Sharing model • Product-service systems model	• Circular supply model • Resource recovery model • Product life extension model

Country:	Italy	Italy
Name of company:	ETRA	LAMEBO
Sector:	Plastics	Mechanics and mechatronics
Short description: **What is the main activity of the company?**	The European Tyre Recycling Association (ETRA) promotes sustainable tyre recycling by advancing the use of recycled tyre products, fostering circular design, and supporting innovative recycling technologies.	The BEFAIR project by Lamebo integrates IoT solutions to monitor energy consumption and measure the carbon footprint in real-time, enhancing sustainability and operational efficiency.
Identify the elements that the company applies:	Abiotic Recycle: Recycling	Abiotic Dispose: Energy Recovery
Which circular business model does the company apply?	Resource recovery model: ETRA focuses on recovering materials from end-of-life tyres through advanced recycling techniques and reintegrating them into new products, contributing to a circular economy.	Resource recovery model: The project focuses on optimizing resource use by monitoring and reducing energy and material consumption, aligning with sustainability goals in manufacturing.

Country:	Italy
Name of company:	PRIMA INDUSTRIE
Sector:	Mechanics and mechatronics
Short description: **What is the main activity of the company?**	Prima Additive (part of Prima Industrie) specializes in metal additive manufacturing, providing innovative 3D printing solutions for industries such as aerospace, automotive, and medical. They focus on producing highly complex, lightweight, and durable parts with advanced materials like titanium and aluminum.
Identify the elements that the company applies:	Abiotic Recycle: Recycling
Which circular business model does the company apply?	Resource recovery model: through its powder bed fusion process, only the necessary material is used to create each part. The unused metal powder can be recycled and reused in subsequent production cycles, significantly reducing waste compared to traditional machining technologies, which generate substantial material scraps. This approach supports sustainable production by enabling the reuse of metal powders through a patented system, reducing both waste and energy consumption

4.3.6 Poland

Country:	Poland
Name of company:	Elemental Strategic Metals Sp. z o.o.
Sector:	Mechanics and Mechatronics
Short description: **What is the main activity of the company?**	Elemental Strategic Metals Sp. z o.o., https://elementalsm.pl/en/ core competency is the development and implementation of technologies for the processing, recovery and refining of strategic industrial metals and precious metals. The company's business is also the application of strategic and precious metals in new industries, in particular in the area of electromobility and cell production.
Identify the elements that the company applies:	Elemental Strategic Metals developed technologies for the safe, environmentally friendly and cost-effective transport, storage and recycling of Li-Ion batteries and used car catalysts. The new constructed plant was built to process used lithium-ion batteries from electric cars and automotive and industrial catalytic converters. The process produces raw materials that are used to produce precursors to battery materials (pCAM), new catalysts, and membranes for electrolyzers and fuel cells. By-products include plastics, copper, and aluminum. The aim of the project is to increase the recycling volume of Li-Ion batteries and catalysts and the recovery of metals of strategic importance for the European battery industry and electromobility, such as lithium, cobalt, nickel, platinum, palladium and rhodium.
Which circular business model does the company apply?	Resource recovery model

Country:	Poland
Name of company:	Cavitel Sp. z o.o.
Sector:	Plastics
Short description: **What is the main activity of the company?**	Cavitel Sp. z o.o., https://cavitel.pl/en The goal of the company is to protect seas and oceans by reducing the amount of plastic waste, especially fishing nets and other forms of plastic waste that end up in our waters. Cavitel specializes in the production of calcium carbonate filler based on LDPE (75% CaCO3). The company is currently implementing the CG7 project, which involves the production of GRANUL MAX BCF 7 pellets filled with calcium carbonate (CaCO3) in quantities exceeding 60%. Additionally, as part of the cooperation with OCEANIZE POLAND, they are engaged in the distribution of PP and PE Regrind produced from Norwegian fishing nets and ocean-recovered waste.

Identify the elements that the company applies:	The company takes pride in the ability to transform waste into something useful and sustainable, and they are always exploring new ways to improve processes and products. Best Practices: The eco-friendly calcium carbonate filler for film production CG 75K • Used for the extrusion, blow molding, and injection molding processes. • Specifically designed for the production of film, particularly when using recycled polyethylene from consumer waste. • Environmentally friendly due to its composition: calcium carbonate mineral and a polymer matrix that is 100% sourced from the recycling process. • It provides excellent dispersion, stabilizes the production process and reduces the frequency of replacing filter meshes. • It allows for more than three times greater dosing compared to other market products without losing the product's properties. • The lower content of calcium carbonate compared to other products on the market guarantees better mechanical parameters and reduces production costs.
Which circular business model does the company apply?	Resource recovery model

Country:	Poland
Name of company:	Plast-Box S.A.
Sector:	Packaging
Short description: **What is the main activity of the company?**	Plastbox is known for producing plastic packaging solutions with a strong emphasis on sustainability and recyclability. Plastbox environmentally friendly packaging is created according to the concept of a closed loop economy, which means that as a manufacturer they use materials derived from recycled resources. One of our solutions is eco packaging made from regranulate, which is made from recycled plastic. The regranulation process involves reprocessing plastic waste to produce high quality granules that can be used to make new packaging. This helps reduce the use of primary raw materials and the amount of plastic waste that ends up in landfills or the natural environment.
Identify the elements that the company applies:	A New Life for Old Materials At the heart of Plast Box's ecological strategy are PCR (Post-Consumer Recycled) and PIR (Post-Industry Recycled) materials.

	Packaging made from PCR material is created from waste generated by consumers. Their reuse not only reduces the amount of waste ending up in landfills but also decreases the demand for new raw materials and reduces greenhouse gas emissions. Meanwhile, PIR material comes from industrial waste - these are production residues that, instead of being wasted, find new applications. Using PIR is an example of effective internal resource management by the company, which translates into reducing the negative impact on the environment.
Which circular business model does the company apply?	Resource recovery model

Country:	Poland
Name of company:	Lindab Ltd.
Sector:	Construction and Building
Short description: **What is the main activity of the company?**	Lindab Ltd (www.lindab-polska.pl) – operating across all Poland, the company employes 420 people in all locations and has its main seat in Lower Silesia. At Lindab the technological innovation process aims directly at improving air conditions inside the buildings. In addition to ventilation systems, the offer includes roofing and gutter systems as well as heat pumps. It is an environmentally friendly company with a great emphasis on business responsibility. The strategy along with the measured results are published annually in public sustainability report/
Identify the elements that the company applies:	The company uses abiotic methods in resource recovery. (Upcycling and recycling). Lindab produces three kinds of waste: steel scrap, rubber and paper. In line with the company strategy, it is treated as a resource. All wastes are disposed to external firms, that use them for producing fully-fledged goods. A special monitoring system is implemented to check the percentage of using the recycled material in a new product. Each year company sets the numeric targets for savings achieved from generated post-production waste in relation to the real production scale. The company sells its products that are packed in ecological way in packages produced of waste. The packages are mainly paper and wood. The company cooperates only with suppliers who use waste in production. The company has a special category of product: Lindab Safe. The whole process of sale is transparent thanks to using efficient B2B platform, automation of processes and cooperation only with verified clients/suppliers in the supply chain. A good example is introducing an innovative packaging system “spiro pipes”. These are the spirboxes for transporting the pipes, which can travel to one client up to 16 times.
Which circular business model does the company apply?	Circular supply model: recoverable sources serve as inputs in design and production.

4.3.7 Slovakia

Country:	Slovakia	Slovakia
Name of company:	Cofin, a.s.	General Plastic, a.s.
Sector:	Packaging Plastics	Plastics
Short description: **What is the main activity of the company?**	Cofin, a.s. has been operating on the Slovak market since 1994, when it began to offer its clients its services in the field of prepress as a small progressive company. Over the course of twelve years, it has developed into one of the most progressive printing companies in the region. This was mainly due to the construction of a new printing house and its connection with the graphic center and CTP under one roof. In recent years, the company has rocketed the path of technology modernization to bring world-class services to clients at affordable prices.	General Plastic, a.s., is a leading producer of hot-washed PET flake and the only producer of food grade PET regranulate and PET preforms in Slovakia. The company recycles used PET bottles and use our recycled products in the production of PET preforms. The final product of PET bottle recycling is a hot washed and chemically cleaned PET flake. Depending on the colour, we offer for sale PET flakes that are transparent, pale blue, blue, green and a mix of colours.
Identify the elements that the company applies:	Recycling, Repair	Refuse, Recycling
Which circular business model does the company apply?	• Circular supply model • Resource recovery model	• Circular supply model • Resource recovery model

Country:	Slovakia	Slovakia
Name of company:	Kovorob, s.r.o.	LPH Vranov n/T, s.r.o.
Sector:	Mechanics and Mechatronics Plastics	Plastics
Short description: **What is the main activity of the company?**	The company is mainly focused on the production of injection molds for thermoplastics and molds for blowing bottles. The work team of our company consists of 26 employees. The company has your own design office consisting of designers and a technologist for	LPH has developed from a small business into an international enterprise with partners throughout Europe. Constant investments in new technology and software have brought to the forefront of our industry. First and foremost, they are committed to producing the highest quality products, which they see as the

	processing CNC programs. The main activities include plastic molding, design.	foundation for the long-term partnerships and satisfaction we provide our customers.
Identify the elements that the company applies:	Refuse, Recycling	Refuse, Recycling
Which circular business model does the company apply?	• Resource recovery model • Product life extension model	• Resource recovery model • Product life extension model

Country:	Slovakia	Slovakia
Name of company:	PERLON, s.r.o.	PRIFOL, s.r.o.
Sector:	Mechanics and Mechatronics Plastics	Packaging Plastics
Short description: **What is the main activity of the company?**	PERLON, s.r.o., is a family business with more than 30 years of experience. Our original focus was to print metal and plastic labels using screen printing technology. In cooperation with our clients, we have gradually expanded our product portfolio and production capabilities to today's state, where the company's core products are controls and structures made of flexible technical materials. The products often serve as an interface between machine and human. They are usually the first thing a user sees when interacting with a device, or even such an important identifying element for a device as an ID card for a person. Therefore, the emphasis on detail, accurate color reproduction and intuitive graphics has a great impact on the customer's first impression.	PRIFOL, s.r.o., provides services in the field of printing and production of foils and packaging materials. The company offers 8 color printing of PP Cast, OPP, PE foils, lamination and production of various types of custom packaging, bags and tapes. In recent years, in addition to operating in the food industry, the company has been reorienting itself in other industries, especially where there are requirements for plastic-based packaging material. Our packaging is used in the food, pasta, confectionery, drugstore and agricultural sectors.
Identify the elements that the company applies:	Recycling, Repair, Remanufacturing, Repurpose	Recycling, Repair, Remanufacturing, Repurpose
Which circular business model does the company apply?	• Resource recovery model • Product life extension model	• Resource recovery model • Product life extension model

Examples of good practice partially reveal reserves on the part of companies, but the effort to improve is undeniable and unquestionable. The results of the analyses in Activity 1 (WP1 and WP3) and the conclusions presented in the SWOT analysis provide valuable incentives for changes in the attitudes and behaviour of public authorities to create economic, environmental, social and financial incentives to support further transformation from a linear economy towards a circular economy.

CONCLUSION

Circular business models are concepts aimed at minimizing waste and using resources efficiently throughout the life cycle of products. Unlike traditional linear "make-consume-dispose" models, circular models seek to close cycles through reuse, recycling, and extending the life of products. Key models include:

- Circular supply chains, where renewable and recycled materials are used.
- Resource recovery, where businesses recover value from waste, for example by recycling or converting waste into energy.
- Sharing models that encourage resource sharing, such as shared car rentals or coworking spaces.
- Product-Service-Models (PSS), where businesses offer products as a service, extending their lifespan through maintenance and updates.
- Life cycle extension, which includes repairs, refurbishments, and redesigns to keep products in circulation longer.

These models promote innovation, reduce the burden on the environment and bring long-term economic sustainability.

The use of circular business models in the European Union has gained importance in recent years as companies and policymakers increasingly recognize the need to implement sustainable practices. These models are crucial for the transition from a linear to a circular economy, which aims to use resources more efficiently and minimize waste.

The EU Industrial Strategy and the Green Deal provide the political framework for promoting circular business models. The EU has placed a clear focus on reducing resource consumption and extending the lifespan of products. *In 2023, the circular economy rate in Europe stood at 11,8%*, indicating that the continent performs relatively well compared to other regions. However, progress remains limited, and linear-dominated systems are still prevalent.

Despite political support, there are significant challenges in implementing circular business models, particularly for small and medium-sized enterprises (SMEs). Many SMEs face a lack of awareness, financial uncertainties, and planning difficulties. Studies (including analyses from our original research) show that SMEs often lack the necessary resources or knowledge to successfully implement circular models.

The integration of new partners (partnerships) plays a key role in the implementation of circular business models. It is crucial as companies can support each other in overcoming the challenges of the circular economy and developing innovative solutions. Partnerships enable SMEs to expand their competencies, use resources more efficiently, and access

new markets. Here are some key aspects that highlight the importance of partnerships in this context:

- *Expansion of Core Competencies* – collaborating with various stakeholders, such as suppliers, recyclers, and IT specialists, allows companies to enhance their core competencies. These partnerships help develop specific skills necessary for implementing circular business models, particularly in areas like reverse logistics and data management.
- *Efficient Resource Utilization* – new partnerships enable the effective management of resource flows. By working with specialized partners, such as those in raw material recovery, companies can improve access to recycled materials and reduce dependence on primary resources.
- *Financial Support and Risk Sharing* – partnerships with financial institutions can facilitate access to the necessary funding to support investments in circular business models. This support is especially relevant for companies pursuing innovative approaches like hardware-as-a-service, which often require significant upfront investments.
- *Pilot Projects and Testing Environments* – collaborating with new partners enables SMEs to conduct pilot projects to test circular business models on a smaller scale. These testing environments help minimize risks and validate the concept before broader implementation.

The future of circular business models in the EU largely depends on the ability to transform existing linear systems. Research indicates that a systematic approach is necessary to understand the dynamics required to shift current business practices toward circular models. This involves both economic and social innovations as well as adjustments in consumer behavior.

In summary, circular business models represent a promising approach to combining environmental sustainability with economic efficiency. While the EU has already made significant progress, much remains to be done to implement these models on a broader scale and fully realize their benefits.

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