Interreg CENTRAL EUROPE

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SMART CIRCUIT

INDUSTRY INTERVIEW / AUDIT SERIES + MAPPING ON NEEDS, CHALLENGES & INTERESTS

D3.2.2 - A report for A3.2

Version 1

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Document control

Document Summary	
Project Number	CE0100007
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Work Package	WP3 UPGRADE! Enhance CE Production Value Chains w/ Digital/Technology-Driven Circular Service Solutions
Activity	A3.2 BUILD! Understanding the Needs & Challenges of Industry Eco-System in 4 Production Value-Chains, to Build Strategic Clusters & Action Plans for Transnational Pilot & Solution
Deliverable	D3.2.2 Industry Interview /Audit Series + Mapping on Needs, Challenges & Interests
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PP	Restricted to other programme participants	
RE	Restricted to a group specified by the consortium	
CO	Confidential, only for members of the consortium	CO

Document History							
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D0.1	Draft version 1	Internal	Draft Report Ready for Review by Deliverable Lead	MCR/PRO	PRO	06.02.2024	Strong first version of full deliverable
D0.2	Draft version 2	Internal	Draft Report Ready for Review by All Project Partners	MCR/PRO	All PPs	08.02.2024	Integrated comments.
Final	Final Version	Internal	Final version	PRO	All PPs	15.02.2024	Final version

A. Executive Summary

1. Project Overview

SMART CIRCUIT's objective is to champion DIH network & actor's role to fast-track the uptake of digital/tech driven Circular Economy to enable a resource-efficient & competitive transition in CE manufacturing. Project Partners (PPs) foster 3 transnational solution systems (WP1: the Circular Innovation Academy (CIA), WP2: the Circular Industry Strategy Lab (STRATLAB), WP3: the Circular Industry Factory (FACTORY) to bring multi-stakeholder (Enterprise/Policy/RTO/BSO, etc.) benefits & deliver a transnational approach at the intersect of digital/RIS3/circular economy strategies. PPs build capacities, reduce barriers, leverage finance & promote closing-the-loop through the identification, dissemination and implementation of key circular economy knowledge and principles within 3 key value chains (Electronics/ICT, Textile, Construction) and a combined cross-value chain (emphasizing regional specificities).

The Circular Industry Factory (FACTORY) is delivered through a jointly implemented transnational system (A3.3) consisting of 4 co-created Transnational Pilots to support CE Manufacturing Eco-System enterprises (D3.2.3) engage with the value-creation opportunities of digital-technology driven Circular Economy. The method helps key players adopt circular principles & creates an operational support framework cascading from the CIRCUIT (A3.1). The main sectoral focuses are on Construction, Textile, Electronics & cross-sectoral circular production/tech value-chains.

The purpose of the FACTORY is to:

1. A3.2 BUILD! sets a capacity baseline and engagement pool with 60 enterprises (5/PP) from the CE manufacturing value-chains. This pool is interviewed on challenges, needs and perceptions regarding circular economy and industry future (D3.2.2). Circular capacity of enterprises is measured. Outcomes are mapped to establish circular service clusters, informing the transnational pilot & solutions. Led by 4 TFs (A3.1), Action Plans are formed as a strategic planning activity for the pilot activities in A3.3 and linked to A1.1 insights.
2. A3.3 TEST! puts A3.2 plan into action and champion one transnational system of 4 jointly designed and tested pilots to promote uptake of circularity in production chain (PPs work in 2 test pilots, 1 mandatory for all and 1 chosen sector). Pilots upgrade classic DIH services and promote transfer of knowledge and technology between territories.
3. A3.4 EXPAND! uses lessons and tangible outcomes of 4 transnational Pilot tests (D3.3.1&2) and creates 1 Transnational Flagship Solution for delivering sustainable support to Industry and promoting widespread dissemination and capitalization of services towards long-term upgrade of CE manufacturing value-chains.

2. Scope of Document & Summary

This document provides the summary and analysis of 62 industry interviews done by the PPs. This report creates a baseline for the creation of D3.2.3 carried out by PP6. Based on D3.2.1 (Guidance document to deliver A3.2) including interview guide & implementation paper to address 62 enterprises (5/PP + 2), this report raises awareness and build a common understanding on cross- CE manufacturing value-chain needs, challenges & interests on digital/technology driven circular economy, through mapping & action planning rules to guide starting phase of pilot factory development. The report creates a baseline for D3.2.3 under the lead of PP6/SIIT to form one action plan to address needs and match successes to support CE industry increase capacity to access circular services, linked to strategic benchmarking (A2.2), setting up operational scope & plan of the Pilot Factory (AT3.3) in relation to the CIRCUIT's Task Forces (TFs) and Service Portfolio

Actions. Based on D3.2.1 and for the development of D3.2.3, this document is structured to map the outcomes of the conducted interview series and to enable PPs to organize their further activities.

The report offers the following benefits:

1. Provides an overview and analysis of the conducted interviews
2. Establishes a baseline for further development of Activity 3.2 through the delivery of D3.2.3 (Period 2, Lead PP6/SIIT)

3. Audience

This document is directed at all project partnership members, because all members of the partnership should participate in WP3 ideation and implementation, more specifically A3.2 through this report. It should be considered an internal document, and the appropriate status should be reflected in the "Dissemination Level" table.

4. Change Control Procedure & Structure

PP3/PRO created this report, and it is under standard project change control, whereby PPs are requested to give feedback on the stated definition or tools in writing to the deliverable responsible (here PRO/PP3) in a timely manner (within 8 working days according to the Rules of Procedure). As per normal procedure, at any time partners believe a project methodology should change, the request should be brought to the work package or work stream leader and Lead Partner (in this case KPT/LP, Project Management Lead and TECOS/PP8, the FACTORY WP3 Leader) to consolidate feedback from other partners, and integrate and disseminate the final agreed changes. A new version of the document should be created, and recorded in the document's "Document History" table.

Content

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B. Introduction

This report builds upon D3.2.1 (guidance document) to provide a detailed analysis of industry interviews conducted by the project partners (PPs) and establish the groundwork for the development of D3.2.3 - 1 action plan to address needs and match successes to support CE industry increase capacity to access circular services through strategic benchmarking (A2.2), setting up operational scope & plan of the Pilot Factory (A3.3) in relation to the CIRCUIT's Task Forces (TFs).

1. Background and the Project overview

SMART CIRCUIT's objective is to champion DIH network & actor's role to fast-track the uptake of digital/tech driven CircEc to enable a resource-efficient & competitive transition in CE manufacturing.

The project is structured as follows:

- WP1 CAPACITIES! Creates enhanced, circular capacities across central Europe digital innovation hub (DIH) eco-systems, to better implement policies and promote an uptake of circularity in Industry through the establishment, validation & expansion of the CIA Solution.
- WP2 LEVERAGE! develops, tests & expands a permanent transnational policy/strategy solution in the Strategy Lab (STRATLAB), to reduce implementation barriers and help diverse TGs leverage access (processes and finance) to innovative circular solutions and services.
- WP3 UPGRADE! design, pilot and roll-out service-solutions (1 system, 4 DIH Solution Portfolios) to the CE Manufacturing Eco-System, to create shared value and permanently upgrade CE production value-chains with digital/tech driven circular economy services and support.

The Circular Industry Factory (FACTORY) is delivered through a jointly implemented transnational system (A3.3) consisting of 4 co-created Transnational Pilots to support CE Manufacturing Eco-System enterprises (D3.2.3) engage with the value-creation opportunities of digital-technology driven Circular Economy. The method helps key players adopt circular principles & creates an operational support framework cascading from the CIRCUIT (A3.1). The main sectoral focuses are on Construction, Textile, Electronics & cross-sectoral circular production/tech value-chains.

The purpose of the FACTORY is to:

1. A3.2 BUILD! sets a capacity baseline and engagement pool with 60 enterprises (5/PP) from the CE manufacturing value-chains. This pool is interviewed on challenges, needs and perceptions regarding circular economy and industry future (D3.2.2). Circular capacity of enterprises is measured. Outcomes are mapped to establish circular service clusters, informing the transnational pilot & solutions. Led by 4 TFs (A3.1), Action Plans are formed as a strategic planning activity for the pilot activities in A3.3 and linked to A1.1 insights.
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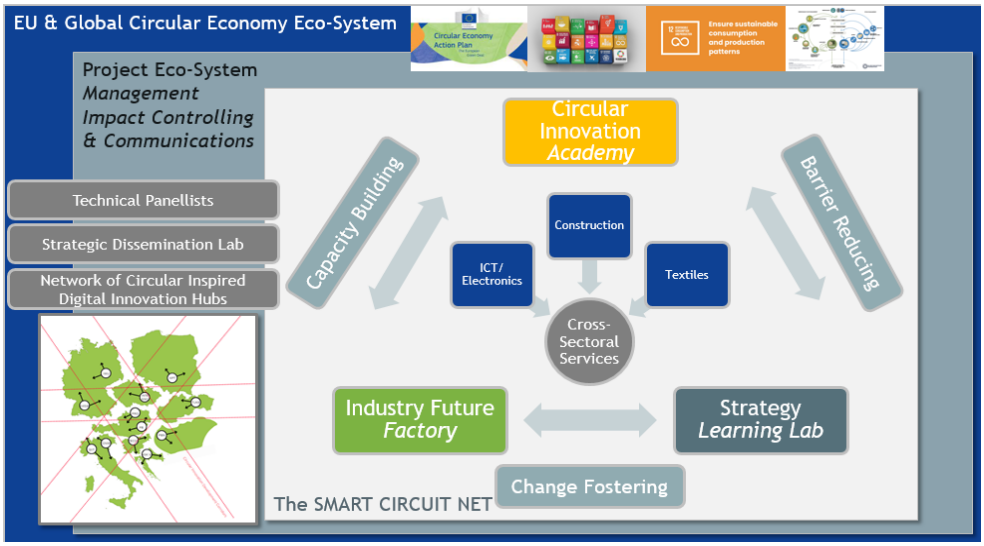

Figure 1 SMART CIRCUIT Eco-System Overview (source: Project Generated, 2023)

WP3 is led by PP8/TECOS and aims to build, test, implement and expand long-term sustainable systems to upgrade CE production chains by enabling enterprises to 'feel & touch' the benefits of digital/technology-driven circular economy services & experiment with innovation within circularity to add value, achieve aims and overcome functional challenges. A3.2, sets a capacity baseline & engagement pool with 60 enterprises (5/PP) from the CE manufacturing value-chains. This pool is interviewed (baseline audit) on challenges, needs & perceptions regarding circular economy & industry future (D3.2.2). Circular capacity of enterprises is measured, outcomes are mapped to establish circular service clusters, informing the transnational pilot and solutions. Led by 4 TFs (A3.1), action plans are formed, as a strategic planning activity for the pilot activities in A3.3 and linked to A1.1 insights. WP3 impact translates directly in the communication Work Stream A3.2: 60 videos (enterprises interviews), 4 synopsis video supported by infographics to show synthesis per Task Force value chain.

WP3 activities directly linked to one key project result:

- Circular Industry Futures Factory Solution (FACTORY, Result 4) is linked to OT3.1 (Pilot) and OT3.2 (Solution) and is vertically integrated into the work plan in A3.2, A3.3 and A3.4 (and evaluated in A3.5). The FACTORY aims to deliver enterprises the chance to experience the value-creation opportunities of digital/tech.-driven circular economy in manufacturing. In that way, it helps key industry in need of 'closing-loops' (high resource use and high potential for circularity) and accesses critical market & policy support to navigate the adoption, implementation of technologies. The FACTORY uses services, experience and network of the CIRCUIT to test, implement and expand a transnational approach delivering service-solution support to industry players and close loops in 3 key sectoral value-chains: construction, textile and electronics and fostering cross-sectoral services

to production (in line with the EU Circular Economy Action Plan-CEAP), to allow wider adoption and consolidated transnational technology portfolios for circular technology/production value-chain.

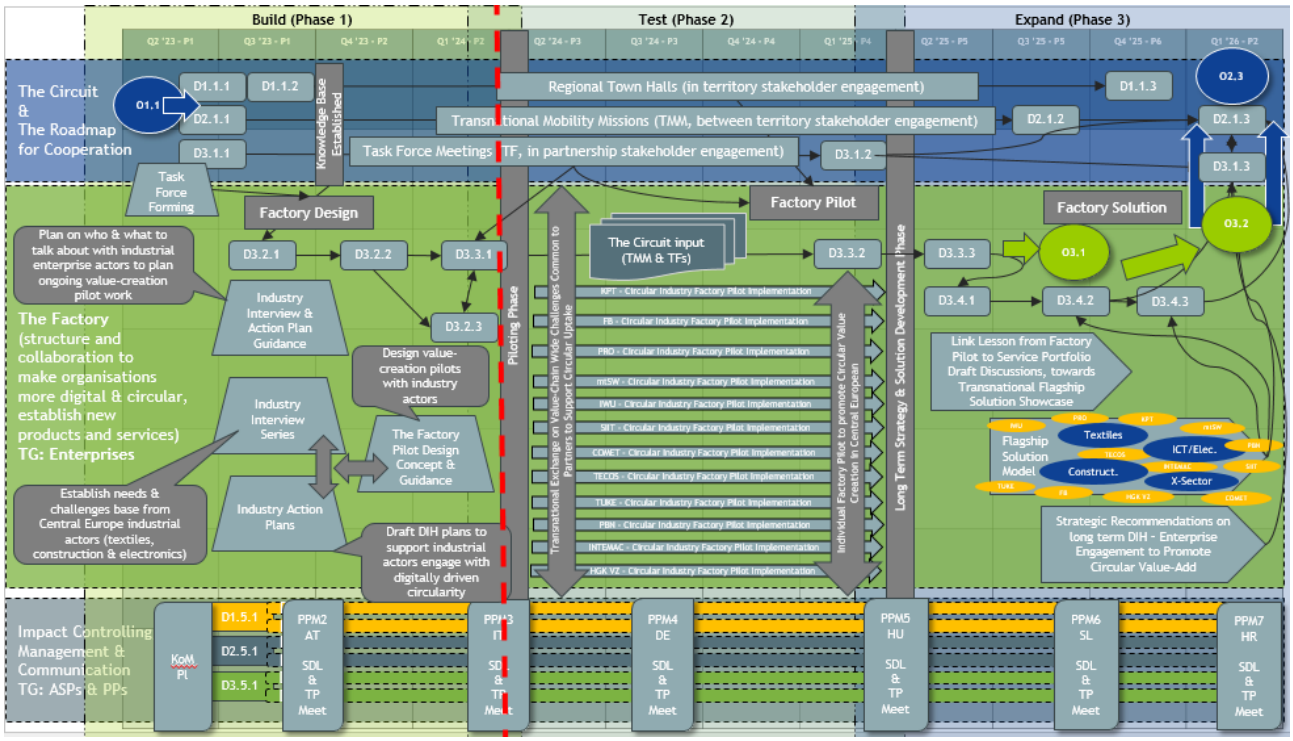

Figure 2 Plan-on-a-Page for FACTORY (source: Project Generated, 2023)

WP3 outputs are the following ones:

- The Circular Industry Factory (FACTORY) “See & Feel” Pilot, 1 Transnational System Designed and Implemented to Help Enterprises Take-Up Digital /Tech-Driven Circular Solutions and Services
- The Circular Industry Factory (FACTORY) Solution: Service Portfolios & Flagship Projects for Wider Spread Value-Creation using Digital/Technology Driven Circular Economy

2. Contribution from Activity Description and Cross-project Knowledge

Activity 3.2 BUILD! Understanding the Needs & Challenges of Industry Eco-System in 4 Production Value-Chains, to Build Strategic Clusters & Action Plans for Transnational Pilot & Solution aims to build, test, implement & expand long-term sustainable systems to upgrade CE production chains by enabling enterprises to ‘feel & touch’ the benefits of digital /technology-driven circular economy services & experiment with innovation within circularity to add value, achieve aims and overcome functional challenges. AT3.2, sets a capacity baseline and engagement pool with 60 enterprises (5/PP) from the CE manufacturing value-chains. This pool is interviewed (with baseline audit) on challenges, needs and perceptions regarding circular economy and industry future (DT3.2.2). Circular capacity of enterprises is measured. Outcomes are mapped to establish circular service clusters, informing the transnational pilot and solutions. Led by 4 TFs (AT3.1), Action Plans are formed, as a strategic planning activity for the pilot activities in AT3.3 and linked to AT1.1 insights.

3. Contribution from Deliverable Description

D.3.2.1 Industry Interviews /Audits & Action Planning Guidance for Circular Pilot Factory

One interview guide and implementation paper to address 60 (5/PP) enterprises to gain cross- CE manufacturing value-chain perspectives on needs, challenges and interests on digital/technology driven circular economy, with mapping and action planning rules to guide starting phase of pilot factory development.

D.3.2.2 Industry Interview /Audit Series + Mapping on Needs, Challenges & Interests

One report on outcomes of 60 (5 /PP, 60 Total) Interviews. Spotlight on the challenges/needs of industry (technical, regulatory, financial, etc) and analysis and mapping of outcomes to develop circular innovation solution/service profiles for the CIRCUIT TFs. Sets baseline for circular value-add themes.

D.3.2.3 Industry Action Plans, to Address Needs & Demonstrate Digital-Circular Technical Value-Add

One IT-based action plan to address needs and match successes to support CE industry increase capacity to access circular services and link to strategic benchmarking (AT2.2), setting up operational scope and plan of the Pilot Factory (AT3.3) + connection to the CIRCUIT's TFs, Service Portfolio Actions.

C. Literature Review

Prior to delving into the analysis of the interviews conducted by the project partners (PPs), and exploring the challenges and opportunities companies identified in their circular transition cycle, we will provide a theoretical overview, drawing upon key concepts identified by other researchers.

The adoption of circular practices holds the potential to yield diverse benefits for companies. Stringent regulatory requirements are increasingly shaping the landscape, while changes in consumer behaviour are tilting towards a circular mindset. Simultaneously, ongoing technological advancements, including AI, IoT, smart sensors, 3D printing, blockchain, and machine learning, are emerging as valuable tools for optimizing processes.

These transformative shifts in the business landscape are particularly impactful for European companies. To maintain competitiveness, companies must proactively embrace change and embark on the journey of transforming traditional business models into more sustainable ones. This strategic shift not only aligns with evolving regulatory and consumer expectations but also positions companies to harness the efficiency and innovation potential offered by cutting-edge technologies.

Certainly, every transformative change within a company encounters a certain degree of resistance, coming from management, employees, and various stakeholders. Esty and Simmons (2011) articulate a comprehensive journey through four distinct stages in a company's evolution toward circularity and sustainability:

1. **Eco-Resistance:**

   This initial stage is marked by a reluctancy to embrace change, often fuelled by a lack of understanding regarding regulatory and scientific approaches, along with a failure to appreciate the urgency of addressing climate change.

2. **Eco-Acceptance:**

   Transitioning to this phase, companies begin to acknowledge and implement changes mandated by new laws and regulations. This stage signifies a shift toward compliance and a growing acceptance of sustainability measures.

3. **Eco-Efficiency:**

   Moving further along the continuum, companies recognize the tangible benefits of cost reduction achievable through the adoption of sustainable and circular practices. Here, the focus pivots towards realizing energy savings, minimizing waste generation, optimizing resource usage, and incorporating recycled materials.

1. **Eco-Advantage:**

   At the pinnacle of maturity, companies grasp that innovation and strategic implementation of modern technologies can confer a competitive advantage. Their primary commitment centers around addressing sustainability challenges, such as pollution, and actively mitigating harmful effects on the ecosystem.

To successfully navigate the transformative journey with a company, it is essential to have a clear understanding of its current stage. This understanding paves the way for crafting a tailored approach. When faced with initial resistance to embracing circular economy practices, the first step involves understanding the ecosystem dynamics, as well as anticipating potential regulatory changes and pressures. In instances where the company perceives circular practices merely as a regulatory obligation, the next strategic move is to illustrate the significant benefits related to cost savings. Transitioning from compliance to recognizing the financial advantages serves as a logical progression. Once the company acknowledges the potential for cost savings, the focus should then shift towards consulting them about the opportunities for innovation and the potential to gain a competitive edge.

1. Circular Maturity Model

After understanding the current state of the overall company's perspective on circularity adoption, an analysis of their internal practices is necessary to assess their circularity maturity. Once the level of maturity is defined, an action plan for progressing along the circularity path within the company can be drafted.

Uhrenholt and colleagues (2022) have developed a circular maturity model based on assessing circular practices of companies among six dimensions as follow:

- **Value creation** - The models utilized for generating and capturing value from circular economy activities (e.g., sales models, take-back programs, life-extending services) and promoting environmentally positive performance (e.g., resource and emissions savings, and regeneration).
- **Governance -** The mindset and skills (both internally and with external partners) required for enabling and acting on the circular transformation (e.g., circular competencies, learning, and training culture).
- **People and Skills -** The mindset and skills (both internally and with external partners) required for enabling and acting on the circular transformation (e.g., circular competencies, learning, and training culture).
- **Supply Chain and Partnership** - The stakeholders external to the organization required for the exchange and optimization of materials, products, and activities (e.g., shared visions and activities, engagement with external experts).
- **Operations and Technology** - The equipment and systems in place for performing CE activities (e.g., machinery and tools, systems aiding the scheduling and identification of appropriate treatment according to value potential).
- **Product and Material** - The characteristics of the products that enable circular strategies and activities (e.g., extended life cycle, simple disassembly, and refurbishment).

Through this model, Uhrenholt and colleagues (2022) have identified 6 different stages in regards to the company's circular maturity as follow:

- **None:** The primary focus is on compliance with legislative measures to minimize costs that could arise from non-compliance.
- **Basic:** Organizations begin developing a foundational understanding of the circular economy, defining organizational needs, and formulating strategies.
- **Explorative:** Organizations initiate the exploration of circular initiatives with the goal of understanding the potential and value of the circular economy to build knowledge.
- **Systematic:** Companies start implementing circular practices into their daily operations, accompanied by defined responsibilities and the structured development of resources. This stage may involve conflicts between traditional business models and circular activities.

- **Integrative:** Collaboration becomes the main driver for more effective and efficient circular operations.
- **Regenerative:** The organization has achieved absolute decoupling of value creation and resource consumption.

Criteria for evaluation of each dimension and categorizing the company into one of the six circular maturity stages could be found in the following table:

Table 1 Circular economy maturity reference model (source: Uhrenholt and colleagues, 2022)

	Value Creation	Governance	People and Skills	Supply Chain and Partnership	Operations and Technology	Product and material
None	No value is created from CE activities. Waste and emissions are only a concern when imposing cost.	No attention is paid to the circular agenda, and it is not present in the strategy.	No skills for CE are present in the organisation, nor is training for CE in place.	No CE-related engagement with business partners or knowledge institutes.	No activities related to CE are taking place internally or in the supply chain.	The product and its materials are not designed or optimised for CE.
Basic	Waste management generates income. Emissions and waste reductions are achieved through simple "Avoid and Reduce" initiatives.	Simple initiatives emerge sporadically in the organisation. CE has no critical role in the strategy.	No formal training. Few knowledgeable and/or curious resources.	No activities with an explicit focus on CE. Simple environmental improvements with economic benefits are realised.	Simple changes are made to operations to reduce waste and emissions. Operational principles (e.g., just-in-time) are in place to avoid waste.	Product performance and material composition are optimised from traditional cost and quality perspectives.
Explorative	Value is generated through learning and experience in explorative activities regarding CE principles. Sustainability still imposes a trade-off with the traditional performance measures from a lack of appropriation.	Few organisational resources are (partially) allocated to CE. CE is present in the corporate strategy, but it is not operationalised.	Search for knowledge results in sporadic learning activities for dedicated resources. CE is in focus when recruiting.	Explorative projects are executed with a single external partner. Few, one-off, engagements with knowledge institutions take place.	Simple workstations are set up to explore disassembly for R-strategies. Due to the lack of formal procedures, activities in operations and supply chain are hand-held.	Explorative activities around "Design for X" and real-time product health are performed for future product releases. The recycling quality of existing products and materials is tested.
Systematic	Value generation and capture increase as appropriation of CE increases. Trade-offs among performance measures persist from long time lag of previous decisions.	CE is incorporated into the organisational design while the CE strategy is operationalised with defined objectives and activities.	Formal training and knowledge dissemination for critical employees occurs.	Projects with external partners and knowledge institutions are formalised.	Circular processes are formalised alongside existing forward operations. Investments are made to meet expectations of efficiency and effectiveness.	New products and materials are designed for narrowing, slowing, closing, regenerating, and connecting circular strategies.
Integrative	The focus of appropriation is turned outwards, targeting supply chain optimisation. Multiple circular loops are generating value, for which internal processes and design are effective.	The CE strategy focuses on the supply chain while CE is well- established internally.	CE competencies are part of employee DNA. Formal training with supply chain partners is operationalised.	Infrastructure enabling the exchange of physical and digital resources is well established.	Advanced technology is implemented for automating supply chain information flow for optimising the physical flow of materials and products.	Product health data are available throughout the supply chain, enabling prolonged life cycles and maintaining products in circular loops.
Regenerative	Value is generated from optimised use and cascades between all circular loops.	CE is embedded in the strategy and management of the organisation.	CE competencies are strategically prioritised throughout the organisation and with external partners.	The supply chain facilitates a seamless flow of materials, waste, and information.	Internal and supply chain processes are designed for CE to provide effective and efficient processing of products and materials.	Products are designed for CE, hence material use is minimised while product life cycle is maximised.

This model provides a comprehensive understanding of the circular maturity of companies across various business functions. It facilitates an insight into the current status of companies and establishes the next set of goals they need to achieve. By applying this model, we aim to assess the circular maturity of 62 interviewed companies and generate an overview of the overall progress in circularity at the international level.

Evaluating the circular maturity of companies will lay a solid groundwork for creating the action plan. It involves assessing the current transition level of companies and identifying the path they need to traverse to achieve circularity.

2. Barriers and Enablers

It is evident that companies encounter numerous challenges in their transformation process, influenced by factors such as regulations, competitors, new technologies, employees, and customers. To gain a comprehensive understanding of the barriers companies face in their pursuit of circularity and explore effective mitigation strategies, we will closely examine the challenges companies encounter in circular transition and possible ways to overcome them.

A model of Barriers and Enablers for the Adoption of Sustainable Manufacturing by Manufacturing SMEs created by Säfsten and colleagues (2022) provides an overview of barriers and enablers for Small and Medium-sized Enterprises (SMEs) operating in the manufacturing sector during their circular transition.

This model specifically considers barriers and enablers for SMEs, while our sample encompasses micro and large enterprises as well. Our analysis will delve into the challenges faced by the interviewed companies in the circular transition process, seeking synergies with the SME-focused model from Säfsten and colleagues (2022).

This broader perspective offered by this model will serve as a comprehensive knowledge base, supporting the identification of effective strategies for companies to overcome the challenges inherent to their circular transition.

The authors have identified seven main categories of barriers and enablers:

1. Organizational, managerial, and attitudinal – managerial skills, organizational culture and structure, and attitudes and beliefs);
2. Training and skills development - receiving or giving instruction, training programs in order to ensure human resources have the necessary skills and knowledge;
3. Technological – machinery, equipment, devices and technology;
4. Financial – aspects of economic or financial nature affecting the longevity of the enterprise
5. Informational – information and knowledge;
6. Market and business concept - SMEs' relations with suppliers, customers, and other stakeholders within the business context that prevent or facilitate the adoption of sustainable manufacturing;
7. Governmental – factors emerging from governmental policy.

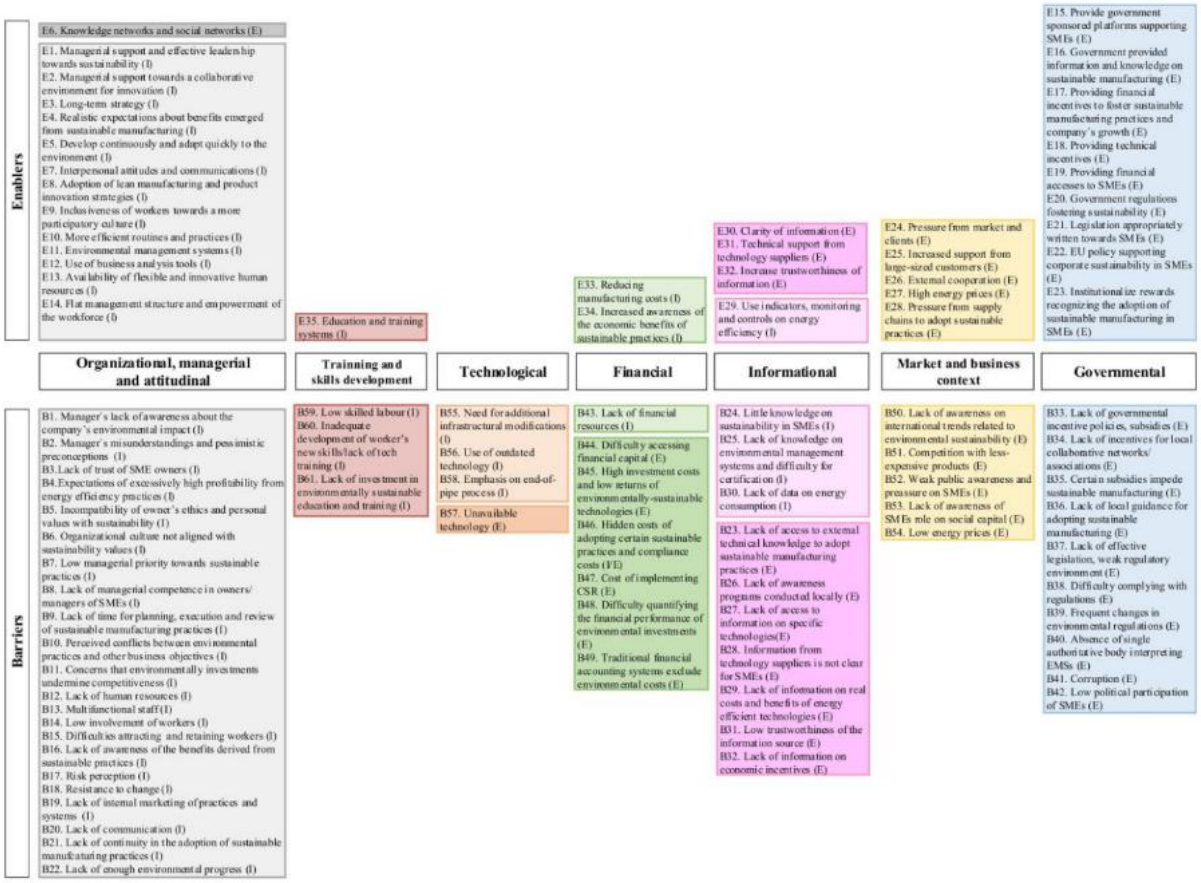

Figure 1 Barriers and enablers for the adoption of sustainable manufacturing in manufacturing SMEs (source: Säfsten and colleagues, 2022)

The authors have concluded that among the numerous barriers identified, their frequency of occurrence varies. They have highlighted certain barriers that have been mentioned or identified more frequently:

1. Lack of access to external technical knowledge to adopt sustainable manufacturing practices;
2. Low skilled labour;
3. Lack of awareness of the benefits derived from sustainable manufacturing practices;
4. Lack of financial resources;
5. Manager´s misunderstandings and pessimistic preconceptions;
6. Lack of time for planning, execution and review of sustainable manufacturing practices;
7. Little knowledge on sustainability in SMEs;
8. Difficulties accessing financial capital;
9. Resistance to change;
10. Lack of effective legislation and/or weak regulatory environment;
11. High investment costs and low returns of environmentally technologies.

The authors observed that certain barriers could be effectively addressed by the enablers extracted from the literature. This study indicates a predominant occurrence of Organizational, Managerial, and Attitudinal (OMA) enablers, followed by market and business context, and governmental enablers.

Consequently, enablers within these categories frequently played a partial or direct role in mitigating the identified barriers.

These critical enablers are expected to address the highest number of identified barriers:

1. Knowledge networks and social networks;
2. Increased support from large customers;
3. External cooperation;
4. Provide government-sponsored platforms supporting SMEs;
5. Environmental management systems;
6. Government provided information on sustainable manufacturing;
7. Managerial support and effective leadership towards sustainability;
8. Education and training systems to improve operations;
9. Pressure from supply chains to adopt sustainable manufacturing.

Once the company ensures a comprehensive understanding of its ecosystem, considering both internal and external barriers, specific enablers can be employed to effectively mitigate the challenges imposed. As each company represents a unique ecosystem, the transition necessitates a situational approach.

Once the company is cognizant of its ecosystem and the benefits achievable through the implementation of circular practices, it is crucial to monitor the progress of the circular transition.

After analyzing the challenges identified by the 62 interviewed companies, our focus will shift to finding synergies with the most frequently encountered barriers from the Barriers and Enablers model. If similarities are found, we will analyze the key enablers from the model and utilize them to address the challenges identified by the companies.

D.Methodology

The methodology section provides an overview of the process that will be followed to collect and analyze data in order to generate D.3.2.2 Mapping Needs, Challenges & Interests through Industry Interviews.

1. Survey Design

The survey was designed as the final output of D3.2.1 within the guidance document for Activity 3.2 under the lead of PP8/TECOS. The main aim of the survey was to identify the challenges and opportunities that enterprises perceive in the circular transition, along with assessing the role digital/tech solutions could have in the process. The survey consists of 22 mandatory questions and four groups of additional questions containing multiple sub-questions. Enterprises were not obliged to answer the additional questions.

The survey and interview questions focused on gaining insights across the following dimensions:

1. Company details;
2. Company size and sector;
3. Circular and digital strategy;
4. Risks, challenges, and trends companies face in their sector;
5. Risks, challenges, and trends companies face in circular transition;
6. Understanding of how companies use digital/tech solutions for circular transition;
7. Opportunities companies recognize in circular transition;
8. Organizational capacity regarding human resources trained and specialized in circular transition;
9. The impact of current regulations and incentives and the support enterprises would like to see in the future from public authorities.

The survey contains only open-ended questions, which allow interviewees to explain all the details regarding their business practices connected to the topic. The chosen method creates an unstructured dataset, which requires qualitative methods for data analysis.

The full survey can be found in the Appendix section 1.

2. Target Groups

The target group for the survey and mapping analysis comprises enterprises operating in Textile, Construction or ICT/Electronics sector. To get a broad perspective, the survey was conducted on an international level, involving enterprises from nine countries: Austria, Hungary, Germany, Slovenia, Slovakia, Italy, Croatia, Czech Republic, and Poland. In total, 62 enterprises were analyzed (5/PP): 10 from the textile sector, 10 from the construction sector, 17 from the ICT/Electronics sector and 25 from the other sectors. Figure 2 provides an overview of the sectoral split of the interviewed companies.

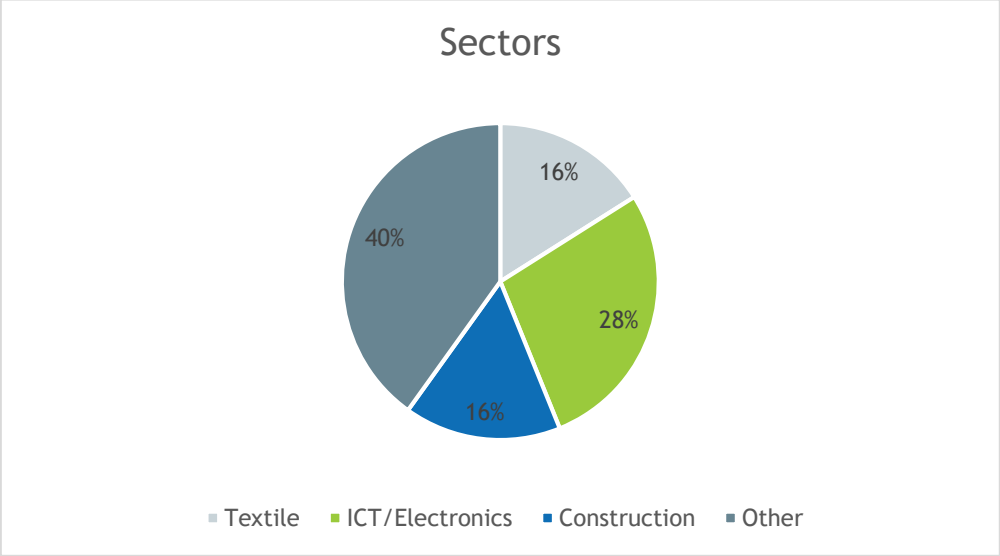

Figure 2 Sectors of the Interviewed Companies (source: Author Generated, 2024)

The information is collected from enterprises of all sizes, including micro (27%), small (31%), medium (21%), and large companies (21%).

The chart below in Figure 3 offers an overview of the number of enterprises analyzed from each category:

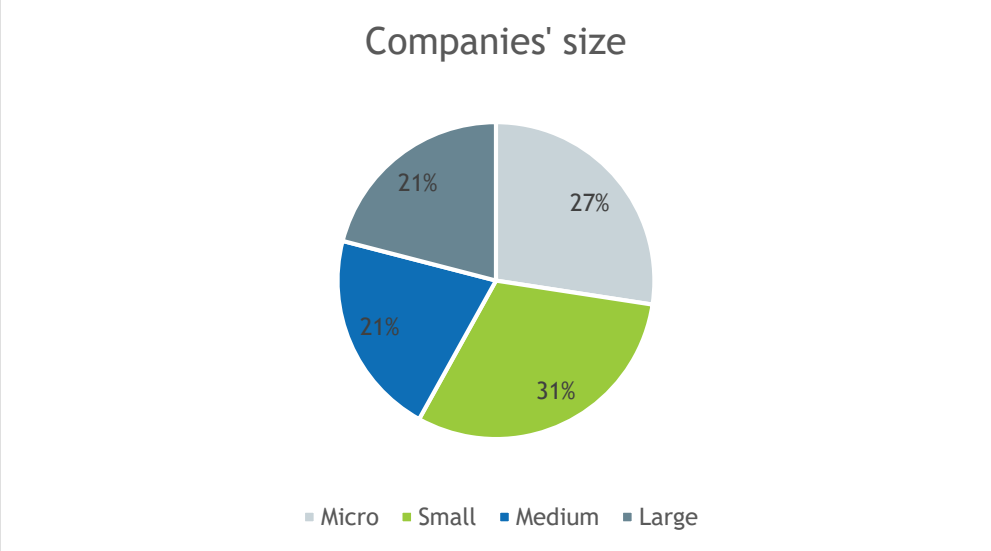

Figure 3 Size of the Interviewed Companies (source: Author Generated, 2024)

3. Collection of the Data

The data collection process was a collaborative effort among all partners. Each partner was tasked with conducting interviews with five companies operating in the Textile, Construction, or ICT sectors. Additionally, partners had the option to interview companies from other sectors.

Partners utilized surveys provided as the final output of D3.2.1, as outlined in the guidance document for Activity 3.2.

Table 2 shows the planned timeline for conduction of interviews and development of deliverable 3.2.2 and 3.2.3.

Table 2 Initial Timeline for D3.2.2 (source: Project Generated, 2023)

Task to achieve	Deadline	Responsibilities (RACI methodology)
Identifying the pool of companies	5.11.2023	R: TECOS; A: All PPs
Implementation of interviews	17.12.2023	R: PRO; R: All PPs
D3.2.2 Draft version	15.01.2024	R: PRO; R: TECOS, All PPs
D3.2.2.Final version	10.02.2024	R: PRO; R: TECOS, KPT

During the implementation interviews, certain delays have emerged, due to limited availability of companies over the holiday period, which caused onward delay in delivering actions according to the original plan. A new timeline has emerged to mitigate future delays:

Table 3 New Timeline for D3.2.2 (source: Project Generated, 2023)

Task to achieve	Deadline	Responsibilities (RACI methodology)
Identifying the pool of companies	5.11.2023	R: TECOS; A: All PPs
Implementation of interviews	26.01.2024	R: PRO; R: All PPs
D3.2.2 Draft version	06.02.2024	R: PRO; R: TECOS, All PPs
D3.2.2. Final version	15.02.2024	R: PRO; R: TECOS, KPT

The process to collect data unfolded as follows:

Figure 4 The Report generation process (source: Author Generated, 2024)

Each partner was tasked with identifying a pool of potential companies from their ecosystems to contact for interviews and subsequently collaborate with towards implementing circular practices.

To initiate cooperation with these companies, partners reached out to them and scheduled interviews. These interviews could be conducted online or in person, in either English or the native language, depending on agreements between PPs and the companies.

Following the interviews, partners transcribed them and completed the survey in a Word document. If the interviews were conducted in the native language, partners translated all content into English.

After submitting the draft versions, interviews were reviewed by PP3/PRO to address any misunderstandings. Feedback was provided, and PPs made necessary additions or corrections before submitting the final version.

The table below offers an overview of the number of companies interviewed by each partner:

Table 4 The number of interviewed companies by PP (Source: Author Generated, 2024)

No.	Partner's name	Abbreviation	Interviewed companies
PP1	Krakow Technology Park ltd.	KPT	5/5
PP2	Research Burgenland GmbH	FB	5/5
PP3	PROFACTOR GmbH	PRO	5/5
PP4	Fraunhofer IWU	IWU	5/5
PP5	microTEC South West e.V.	mtSW	5/5
PP6	SIIT Ligurian Technological	SIIT	5/5
PP7	COMET Scrl	COMET	5/5
PP8	Slovenian tool and die development centre	TECOS	5/5
PP9	Pannon Business Network Association	PBN	6/5
PP10	Technical University of Kosice	TUKE	6/5
PP11	Intemac Solutions ltd	INTEMAC	5/5
PP12	Croatian Chamber of Economy Varaždin County Chamber	HGK VZ	5/5

4. Data Analysis Mehods

This section describes the process of data analysis which created the baseline for interpretation of the findings and discussion in the Results and Discussion sections.

4.1. Summary of Findings and Presentation of the Results

For the creation of this report, we studied 62 interviews (5 per project partner + additional two interviews). Information from the industry was collected in the survey described above. Each question was analyzed independently, and general conclusions were drawn in the end. The analysis was done anonymously, excluding enterprise names for data privacy and result validity. The questions were open-sourced, and the data received from the companies was unstructured. Companies did not face any limitations when it came to number of challenges, trends, opportunities, and regulations they had to identify, which means they were free to name all the factors they encountered. By identifying patterns in the companies' answers, we developed the categories.

The process began by consolidating and organizing the data into a single Excel spreadsheet. After cleaning the data, we performed an exploratory data analysis to gain a deeper understanding of the context and relationships between variables. Subsequently, we employed thematic analysis to derive the results. This involved developing thematic codes, which we organized into themes. Utilizing Excel spreadsheets, we quantified the findings by assigning numerical values and illustrated key insights through various charts.

To gain insight into companies' understanding of circularity, we analyzed their circular strategies. Assessing whether companies had necessary indicators was crucial for tracking progress and achieving goals. We also examined the presence of staff specifically trained for scaling circular transitions, including the role of circular transition managers.

Subsequently, we delved into the challenges faced by companies in their respective sectors to obtain a comprehensive overview. We then explored the opportunities and trends recognized by companies in the domain of circular transition. Additionally, we analyzed the regulations and support companies sought from their ecosystems.

The second part of the analysis involved a more focused examination of each task force—Textile, Construction, and ICT/Electronics. This phase comprised 10 companies from the Textile sector, 10 from Construction, and 17 from ICT/Electronics. By concentrating on a smaller sample, we gained deeper insights into the specific information provided by each.

The analysis process in this stage followed the same approach as the initial analysis. Initially, we assessed the challenges encountered by companies within their sector or those specifically related to their business. These challenges were categorized into themes, with each category later described in more detail in the Results section. Following the analysis of challenges, a similar process was applied to identify opportunities.

When evaluating the support companies sought from their ecosystems, we examined both general aspects and specific regulations mentioned by companies, providing further clarification where necessary. The final step involved analyzing the technologies and digital tools companies found useful for scaling their digital transition.

4.2. Building a Discussion Section

To construct the Discussion section, we utilized key findings from the results section and interpreted them alongside two models to uncover synergies. The first model employed was the Circular Maturity Model developed by Uhrenholt and colleagues (2022). This model facilitated an understanding of the current circular maturity level of the interviewed companies by utilizing an established framework. Each company was evaluated across six categories: value creation, governance, people and skills, supply chain and partnership, operation and technology, and product and material. Categories were numerically rated from 1 (None) to 6 (Regenerative), allowing for the calculation of each company's average maturity level. Subsequently, we aggregated the data to illustrate the distribution of maturity levels among all companies. Additionally, we computed the maturity level for each company across all six dimensions to identify areas requiring the most support.

In addition, we employed the Barriers and Enablers model by Säfsten and colleagues (2022) to identify potential solutions for addressing the challenges encountered by the interviewed companies. This model identifies nine key enablers that can be applied to most of the barriers identified. After pinpointing the primary challenges faced by the companies, we established a connection with the model by aligning the challenges with the corresponding key enablers, thereby providing potential ways for addressing these challenges.

4.3. Research Limitations

During the generation of this report, certain limitations have been encountered. Firstly, the data was collected from a single person within each company, which may be influenced by their personal understanding and knowledge. Additionally, each company selectively provided information, withholding some data that could impact their privacy.

Secondly, the interview process introduces another layer of potential bias. Each company was interviewed by the PP, who then interpreted the responses and provided insights.

Finally, there is the inherent limitation of the researcher's subjective interpretation during the analysis, which may be influenced by their own understanding of the information provided.

E. Results

This section gathers all the key results that have emerged from the analysis of the 62 interviews. Results are presented on two different levels. The international level provides a comprehensive overview of challenges all companies face, trends, and opportunities they see in utilizing digital technologies across Central Europe. Following that, the results are grouped and discussed at the task force level (Textiles, Construction, ICT/Electronics).

1. Cross-Sectoral Analysis

As companies strive to remain competitive, embracing a circular transition has emerged as the next logical step. Through the analysis of 62 companies interviewed from 9 different countries, this report supports the understanding of this journey from the company's perspective. Firstly, an overview of the identified challenges, trends, regulations, and opportunities that companies recognize in the circular transition is provided. Secondly, companies' capabilities in implementing circularity is addressed by assessing their circular maturity. Six categories are analyzed: value creation, governance, people and skills, supply chain and partnership, operations and technologies, and products and materials. Based on this analysis, a clearer picture on companies' knowledge of circular practices and implementation is generated. This analysis should provide strong insights to develop the Action Plan (D3.2.3) supporting companies to transverse along the circular maturity line. In order for the next steps to be created, ways to address challenges need to be identified. Using the model of Barriers and Enablers, this analysis matches challenges faced by companies to the most common enablers identified. One of the main enablers to foster the uptake of circular economy principles, bridge the circularity gap and turn challenges into opportunities is by applying digital/tech solutions.

1.1. Key uptakes

Recognizing regional differences is crucial for a comprehensive understanding of each company's distinct challenges and opportunities. Diverse regulations, varying stakeholders, and unique market dynamics, including the purchasing power of customers, contribute to the diverse experiences and knowledge companies have in circular transition. However, learning from each other, across regions is also critical to build cooperation and territorial cohesion.

This section provides an overview of all the similarities EU companies share on their circular journey. The main focus will be on circular strategies, sectoral and specific challenges, opportunities identified by companies in circular transition, trends, regulations, and support they would like to see from policymakers, as well as the tools they perceive as useful for scaling circularity.

1.1.1. Circular Strategy

Achieving circular transition requires fundamental changes in organization. It's essential to embed circularity into the organizational culture and undergo a complete transformation of the business model. In order to properly implement changes, employees and management have to show understanding of circularity and recognize the benefits it offers, not just for the planet, but also for the company itself. To set the right direction, a strategy for circular transformation has to be implemented. The assessment of companies' circular strategies is based on the number of components they incorporate out of the nine identified. Circular strategies of 62 companies from nine European countries have been analyzed, and the following results have emerged:

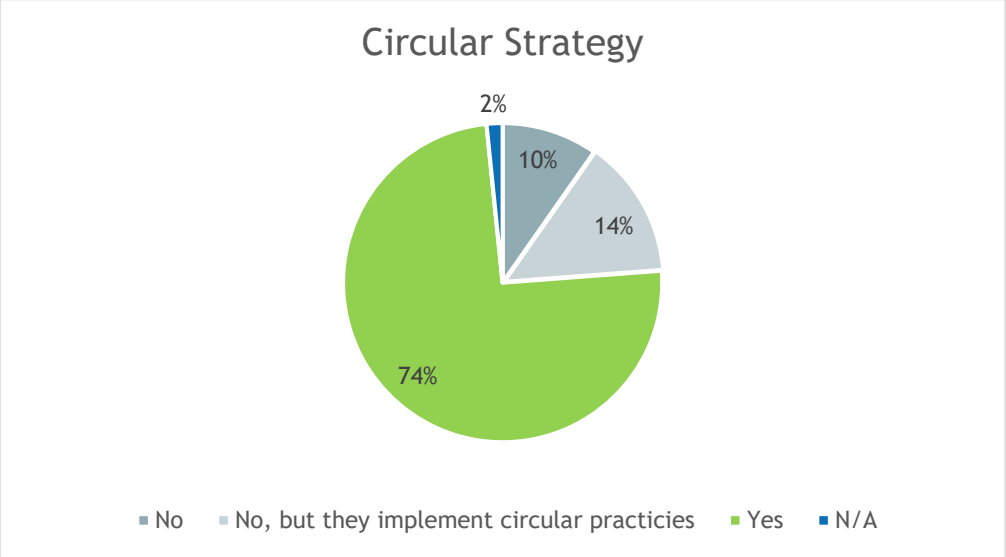

Figure 5 The % of companies that have formulated a circular strategy (source: Author Generated, 2024)

In total, 74% of the companies (46 out of 62) have an official circular strategy. While nine companies (14%) do not have a specific strategy in place, they actively implement certain circular practices, recognizing the importance of this shift to maintain competitiveness. Typically, these circular initiatives originate from directors but are not formalized into a comprehensive strategy. Conversely, six companies (10%) lack both a circular strategy and any implementation of circular practices. The remaining company did not provide a response to this question.

The diversity of circular strategies is shaped by various factors, including the sector of operation, company size, levels of knowledge and education on circular strategies, financial capabilities, and support from public authorities.

Interestingly, our analysis reveals that, on average, companies focus on only 3.5 out of the 9 elements of a circular strategy. While specific results remain anonymous, this average highlights the need for companies to broaden their approach. The first step towards a circular transition for companies is to develop and formalize a comprehensive circular strategy.

Despite the array of influencing factors, distinct patterns have been identified:

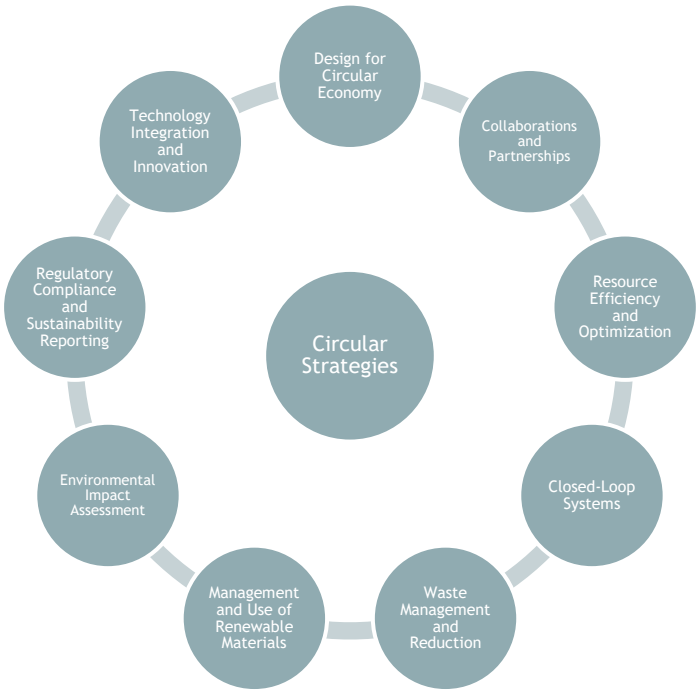

Figure 6 Essential Components of Companies' Circular Strategies (source: Author Generated, 2024)

1. **Technology Integration and Innovation** - Companies acknowledge technology as a pillar for scaling circularity. Leveraging advanced technologies such as IoT, AI, big data analytics, machine learning, and Digital Twins enables companies to streamline processes, lower costs, and enhance efficiency. Additionally, companies prioritize transitioning to paperless offices through digitalization initiatives. By implementing new technologies, companies aim to enhance the quality of their products and maintain foster innovation.
2. **Resource Efficiency and Optimization** - The primary focus is on optimizing resource use to achieve maximum output while minimizing waste, reducing negative environmental impact, and implementing R-strategies (reuse, recycle, repair) whenever possible.
3. **Design for Circular Economy** - The goal is to design products in a manner that facilitates easier integration back into the circular loop and extending their lifecycle. Following the end of their initial use, products should be easily recyclable, repairable, reusable, or remanufacturable. Through enhanced product design, companies strive to offer sustainable solutions to customers, attracting new ones in the process.
4. **Closed-Loop Systems** - At the core of the circular economy lies the concept of a closed-loop system, where products are reused, repaired, remanufactured, and recycled after reaching the end of their lifecycle. Recognizing the paramount importance of this approach, companies integrate it as a central component of their strategies.
5. **Regulatory Compliance and Sustainability Reporting** - Some companies recognize the importance of sustainable reporting and have already incorporated this aspect into their circular strategies. To ensure compliance with new regulations, companies are actively developing their reporting systems.
6. **Environmental Impact Assessment** - To minimize their environmental impact, companies have integrated environmental impact assessment into their practices. The primary methodologies they employ include Life Cycle Assessment (LCA) and carbon footprint calculations.

7. **Collaborations and Partnerships** - Companies recognize the opportunity in establishing long-term partnerships with their suppliers. Additionally, they aim to foster collaboration with diverse stakeholders, for example by participating in funded projects and engaging with research and development institutions.
8. **Management and use of renewable materials** - To achieve circularity, companies are transitioning towards the use of sustainable and recycled materials. They also prioritize sustainable procurement and sourcing practices. Recognizing the importance of these efforts, companies focus on establishing long-term partnerships with suppliers.
9. **Waste Management and Reduction** - To minimize waste production, companies prioritize recycling and finding ways to reuse materials. Additionally, some companies are implementing zero waste policies to prevent waste generation altogether.

We can conclude that all components of circularity are interconnected and mutually influential. For instance, to establish a closed-loop system, products must be designed for circularity, thereby reducing waste. Similarly, the establishment of sustainable sourcing and the use of sustainable materials require collaborative, long-term relationships with suppliers. Technological solutions play a vital role in decision-making, enhancing supply-chain traceability, optimizing processes, and achieving resource efficiency.

Based on these insights, it becomes evident that a comprehensive strategy covering all key elements identified by the analysis is essential for a successful circular transition.

1.1.2. Circular Indicator

After establishing goals and defining the circular strategy, it becomes imperative to develop specific indicators that enable companies to effectively track their progress. These indicators serve as essential benchmarks, allowing for continuous monitoring and evaluation of the implementation of circular initiatives.

The results of our analysis indicate that only 26% of the companies (16) have defined circular indicators, while the majority, comprising 74% (46 companies), have not yet defined such indicators.

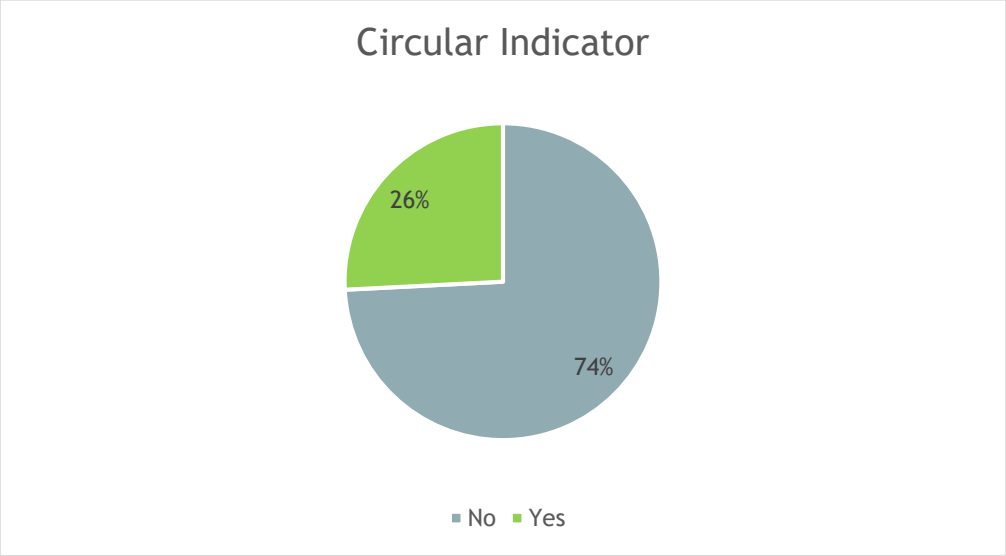

Figure 7 Circular Indicator (source: Author Generated, 2024)

1.1.3. Circular Transition Manager

For a company to have a clearly formulated strategy and indicators, it's essential to have dedicated staff specializing solely in circular transition. While the majority of companies have staff partially involved in circularity, it's not their primary function. Additionally, for a few companies, only the CEOs address the circular transition; however, due to insufficient information on the extent of their involvement, we won't analyze this data. Our focus will solely be on the existence of a Circular Transition Manager (CTM) and other employees dedicated exclusively to circular transition.

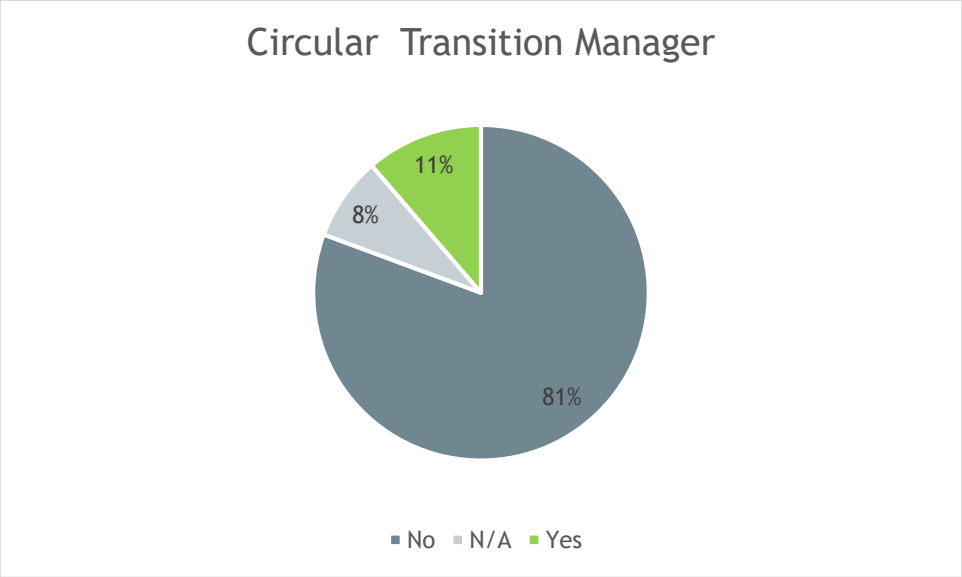

Figure 8 Circular Transition Manager (source: Author Generated, 2024)

Only 11% of the companies (7) have a designated individual whose primary role is overseeing circular transition. The majority, comprising 81% (50 companies), do not have a dedicated person solely focused on circularity, while 8% (5) did not provide an answer to the question.

1.1.4. Sectoral Challenges

The circular transition and integration of circular activities into the core business pose significant challenges. Companies face numerous barriers when contemplating the implementation of circular practices. The main challenges identified include:

1. **Regulatory Environment and Compliance** - The primary challenge arises from regulatory changes, as companies may lack awareness of these changes, struggle to adapt promptly, or begin adaptation efforts too late. Moreover, the evolving nature of regulations introduces uncertainty, compounding the challenges companies face.
2. **Lack of Qualified Workforce and Training** - Various factors contribute to the challenges companies face in acquiring a qualified workforce. These include lack of digital skills, limited understanding of circularity, resistance to change, and insufficient training and education for employees.
3. **Lack of Cooperation** - Companies frequently face hurdles in establishing collaborations with stakeholders, particularly when participating in EU-funded projects. These difficulties often stem from the complexity and duration of the application process.
4. **Technology Dynamics, Adoption and Risks** - The development of new technologies presents several challenges for companies. Rapid changes often lead to technological obsolescence, necessitating

quick adaptation and flexibility. Additionally, the increased reliance on technologies raises cybersecurity concerns and questions about data safety and protection.

5. **Sustainable Supply-Chain Management** - Potential challenges include supply chain disruptions, dependency risks, and logistical operation challenges, which are further intensified by global logistics uncertainty.
6. **Sustainable Resource Management** - Potential challenges include achieving resource efficiency, navigating the trade-off between sustainability and cost-effectiveness, minimizing environmental impact, and ensuring the sustainable sourcing and collection of materials.
7. **Market Dynamics** - The dynamic economy and global events pose various challenges for companies, including fluctuating raw material prices, differing quality standards, market readiness for sustainable practices, and price inflation and fluctuation.
8. **Customers Awareness and Preferences** - Main challenges include customer education, meeting customer expectations, and responding to market fluctuations and demands.
9. **Financial Challenges** - Companies face various financial challenges, including the high costs associated with implementing circular practices, the capital required for initial investments, and the need to adapt to rapid market changes.
10. **Environmental Challenges** - The main challenges encompass climate change impacts, compliance with environmental regulations, and efforts to minimize negative environmental impact.
11. **Competitiveness** - Maintaining and achieving competitiveness presents a significant challenge in today's fast-changing environment.

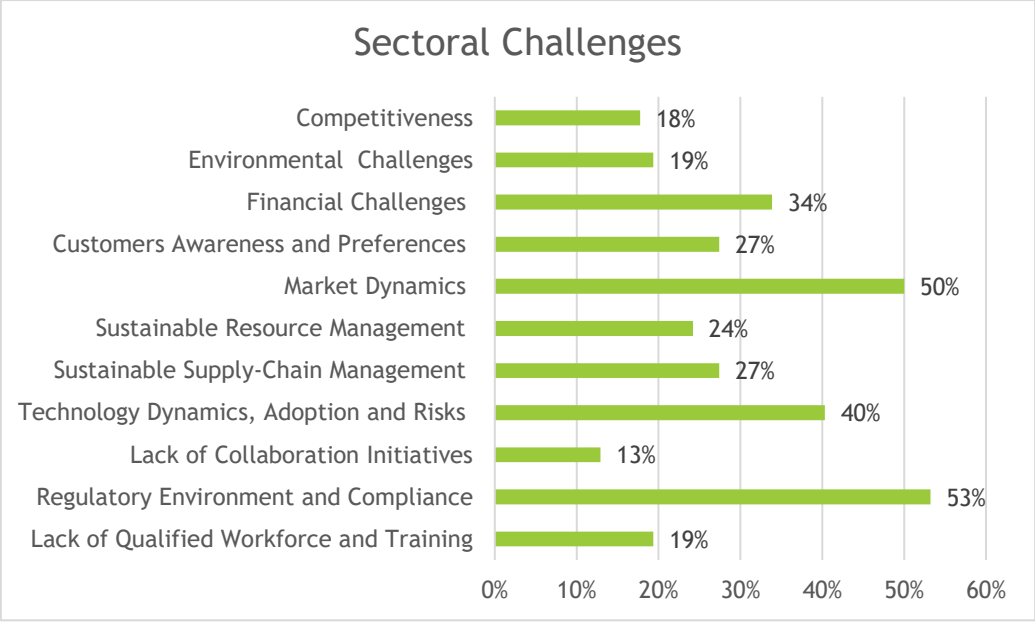

Figure 9 Sectoral Challenges (source: Author Generated, 2024)

The intensity of challenges affecting companies is depicted in the following graph. According to the conducted analysis, the most significant challenge for companies is regulatory changes and compliance, with 53% of companies identifying this as a difficulty they face. Following closely, unstable market dynamics pose a significant challenge for 50% of the identified companies. Additionally, technology dynamics, adaptation, and obsolescence affect 40% of the companies.

1.1.5. Trends

Today's markets are extremely dynamic, characterized by rapid technological development, constant changes, and shifts in customer preferences. All these trends significantly influence companies and their business practices. That's why staying abreast of trends is crucial for maintaining competitiveness. Regarding circularity, the following international trends have emerged:

1. **Technology advancements** - Companies have identified several key trends, including digital transformation, integration of AI, machine learning, smart manufacturing initiatives, utilization of IoT for product tracking and digital monitoring of consumption patterns. Regulatory Compliance and Standards - Compliance with regulations and standards regarding sustainability.
2. **Circular Practices and Innovation** - Waste reduction, closing the loop, supply chain traceability, material sourcing and collection, circular design, circular products etc.
3. **Regulatory Compliance and Standards** - Compliance with regulations and standards such as ESG, legislations concerning food and energy usage, carbon taxation, green product standards, Green Claims Directive, EPR Regulations etc.
4. **Customer Behaviour and Expectations** - Current trends indicate a shift in customer mindsets, with a growing demand for inexpensive products, coupled with an increasing importance placed on health-conscious lifestyles. Moreover, customers are setting higher standards and requirements for products and services.
5. **Environmental Initiatives** - Sustainable initiatives encompass various actions aimed at promoting environmental responsibility and ethical practices. These include enhancing brand recognition, obtaining certifications, and calculating carbon footprints.
6. **Financial Incentives** - These include tax benefits, subsidies for research and development (R&D), grants for implementing Circular Economy (CircE) initiatives, tax incentives for reuse, and carbon dioxide (CO_2) taxes. Such initiatives provide incentives for companies to adopt environmentally friendly practices and contribute to a greener economy.

Twelve companies did not provide an answer to this question. Therefore, our analysis is based on a sample of 50 companies, as displayed in Figure 10.

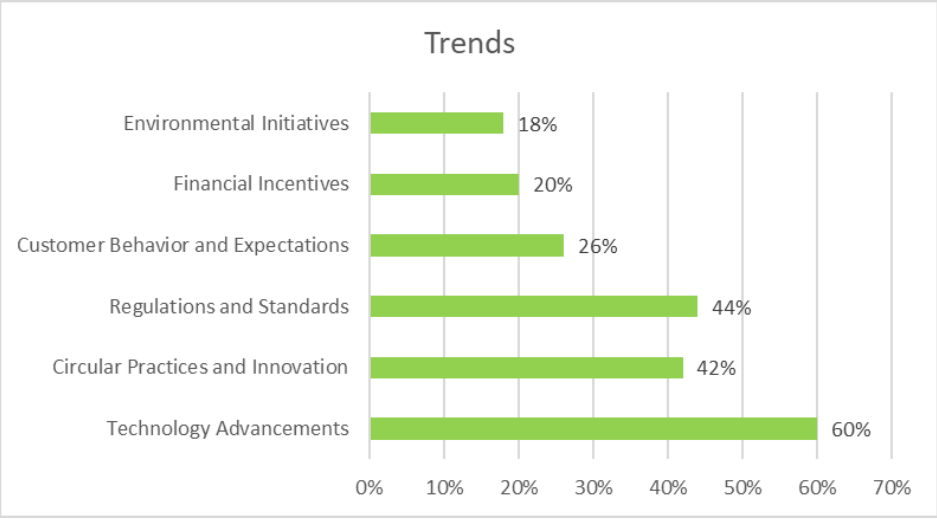

Figure 10 Trends (source: Author Generated, 2024)

When considering trends, a majority of companies (60%) identify technological advancements as the primary trend. Following closely, 44% of companies recognize regulatory compliance and standards as significant. Additionally, 42% of companies acknowledge the implementation of circular practices as a key trend.

1.1.6. Opportunities

Despite companies considering financial feasibility as a primary factor for implementing circular practices, many opportunities have been identified:

1. **Resource Efficiency and Optimization** - Opportunities to optimize resource usage and implement circular practices for sustainable resource management.
2. **Waste Reduction** - Focus on closing the loop and circular design principles to minimize resource wastage throughout the product lifecycle.
3. **Integration of Advanced Technologies** - Leveraging advanced technologies such as AI, IoT, and digital platforms to enhance efficiency, productivity, and safety in circular processes. Implementation of data-driven planning and decision-making to optimize resource utilization and reduce environmental impact.
4. **Market Growth** - Opportunities to tap into market growth driven by increased demand for sustainable products and services.
5. **Collaboration and Project Participation** - Collaboration with stakeholders, suppliers, and international partners to drive circular initiatives and projects.
6. **Environmental Impact Reduction** - Opportunities to minimize environmental impact through sustainable transport solutions, renewable energy adoption, and resource optimization.
7. **Customer Engagement and Education** - Engagement with customers through circular business models, sustainable transport solutions, and online platforms. Education initiatives to raise awareness among customers about the benefits of circular practices and environmentally-friendly products.
8. **Maintaining Competitiveness and Market Differentiation** - Strategies to maintain competitiveness through product innovation, market differentiation, and leadership in sustainability.
9. **Supply Chain Optimization and Traceability** - Optimization of supply chains through traceability, standardization, and collaboration with suppliers. Integration of circular principles into supply chain management to ensure transparency and reduce dependence on virgin resources.
10. **Sustainable Value Creation and Brand Recognition** - Focus on building brand recognition and attracting eco-aware customers.
11. **Innovations** - Innovations in product design, production processes, and business models to attract new customers and maintain competitiveness.
12. **Cost Reduction** - Utilization of circular practices to reduce costs.

The analysis is based on a sample of 62 companies, as displayed in Figure 11.

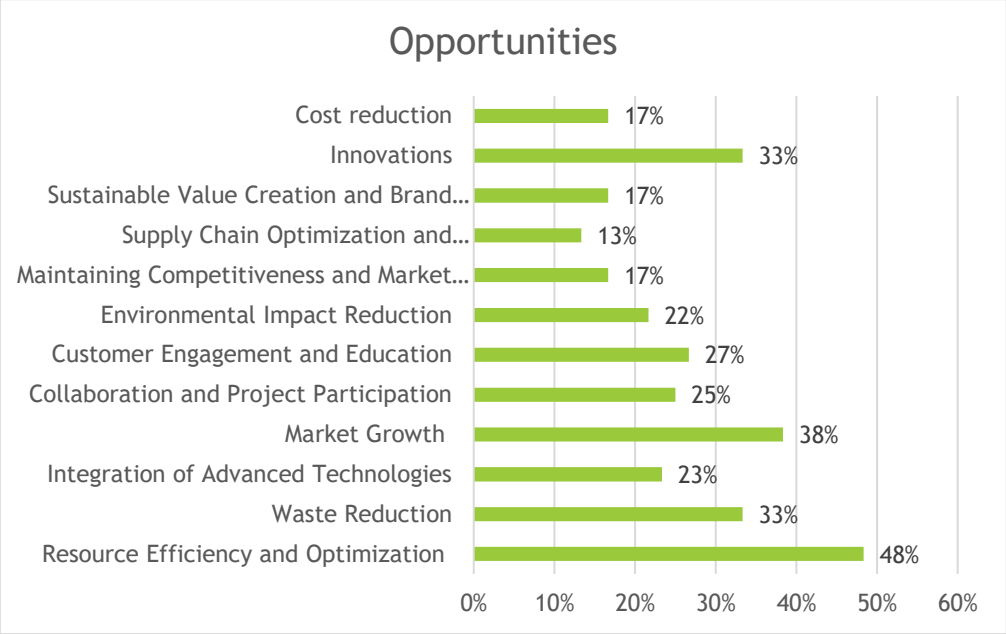

Figure 11 Opportunities in Circular Transition (source: Author Generated, 2024)

The primary opportunities companies see in circular transition include achieving resource efficiency and optimization (48%), followed by market growth (38%), and reductions in waste (33%) and innovations (33%).

1.1.7. Regulations and Standards

As companies embark on the journey to achieve circularity, the support from public authorities at regional, national, and EU levels is essential. The main objective of this section is to analyse the support companies seek from public authorities.

Companies require support in the following aspects:

1. **Financial Support and Incentives** - Access to financial incentives, funding programs, and reasonably priced loans to support investments in circular practices. Shorter application procedures for funds and support for high-risk technologies to encourage innovation in circular transition.
2. **Regulatory Guidance** - Assistance in navigating regulations and standards related to circular economy practices and sustainability.
3. **Research and Development Collaboration** - Support for research and development collaborations, innovation hubs, and incubators to foster innovation in circular solutions.
4. **Educational programs, workshops, seminars, and training** initiatives to educate and raise awareness among employees and direct & indirect stakeholders about circular economy practices.
5. **Consultancy services** - support with implementing circular economy practices to enhance knowledge and skills.
6. **Networking Opportunities and Cooperation** - Networking events, collaborations, partnerships, and project participations to facilitate knowledge exchange, partnerships, and collaboration with suppliers and customers. Promotion of B2B and B2G collaborations, consultations on sustainable practices, and support with international connections.
7. **Market Awareness and Promotion** - Public awareness campaigns, consultations on sustainability reporting, and market awareness initiatives to promote circular products and practices. Support for

exhibition appearances, promotion of certifications, and assistance with attracting new customers and increasing market share.

8. **Policy and Regulatory Framework** - Support for the development of policies and regulatory frameworks that promote circular economy practices and sustainability. Assistance with legal changes, fiscal policies, and financial instruments to create a more stable economic environment for circular transition.

Eleven companies did not provide an answer to this question. Therefore, our analysis, displayed in Figure 12, is based on a sample of 51 companies.

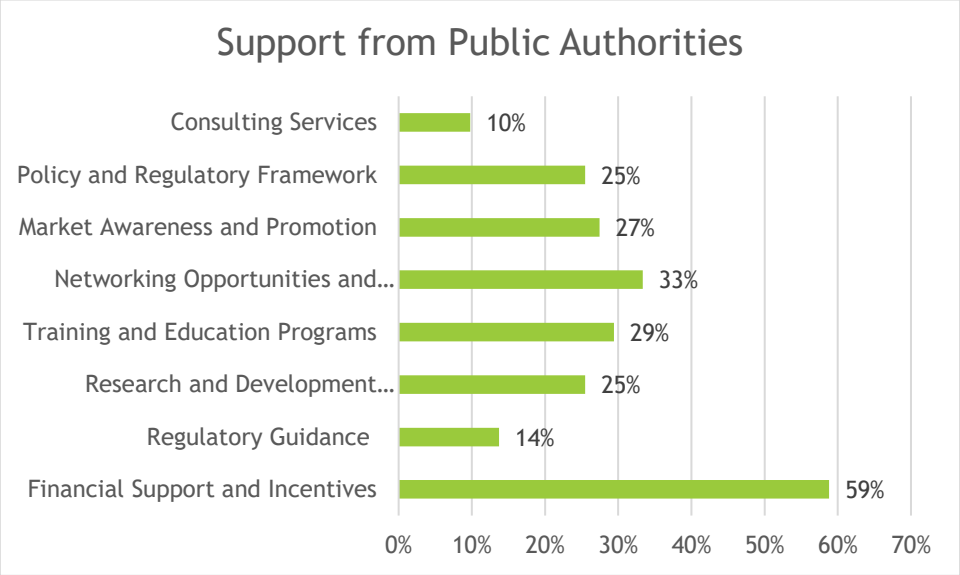

Figure 12 Support from Public Authorities (source: Author Generated, 2024)

Half of the interviewed companies (59%) have highlighted financial incentives as crucial support required from public authorities. Furthermore, 33% of companies are seeking networking opportunities and collaboration. Additionally, 29% of the companies are seeking assistance with training and education, while 27% of companies are in need of support from public authorities to raise public awareness and promote circular practices, along with assistance in formulating policy and regulatory frameworks.

2. Task Force Level

This section delves into specific sectors, analyzing the challenges (e.g. regulatory) and opportunities especially through identified technologies/for scaling circularity encountered by companies in Textiles, Construction, and ICT/Electronics.

2.1. Textile Sector

To comprehensively understand the journey towards circular transition in the textile industry, this analysis is based on nine international textile companies. The analysis focuses on the challenges these companies face, opportunities they identify in scaling circularity, the regulations and standards being applied within the industry and the technologies companies perceive as useful to uptake circularity.

2.1.1. Specific Challenges

As we have observed, companies encounter various challenges in their transition towards circularity. Depending on the sector in which a company operates, its challenges will shift or evolve in specific directions.

The challenges identified in the textile sector include:

1. **Regulatory Environment Challenges** - Adapting to evolving regulations and standards governing circular practices, ensuring adherence to technical standards and regulatory framework, navigating carbon taxes and regulatory disparities across regions, addressing political regulations and documentation requirements impacting circular initiatives.
2. **Technological Integration and Innovation** - Challenges in integrating advanced technologies for circular processes, the lack of digital traceability in tracking materials and processes, implementing user-friendly technologies to facilitate adoption and usage. Higher automation will support quicker production and increase quality, but it could reduce flexibility for product changes due to programming.
3. **Competitiveness** - Maintaining competitiveness in a rapidly evolving environment. Staying competitive in terms of digitalization and automation is crucial for long-term success.
4. **Economic Challenges** – Balancing cost-effectiveness with sustainability goals in circular initiatives, financial barriers and investment constraints regarding circular transition, dealing with market fluctuations and economic instability impacting circular endeavors.
5. **Resource Management Challenges** - Challenges related to the scarcity of resources required for circular practices and addressing challenges in recycling processes, reducing waste generation, no sourcing recycled materials. Additionally, it involves navigating the complexity of materials, particularly in the textiles industry.
6. **Quality Assurance -** Ensuring high-quality standards for recycled materials used in production and maintaining product quality standards while incorporating recycled materials.
7. **Market Acceptance** - Gaining acceptance and trust from consumers and stakeholders for circular products.
8. **Workforce -** The shortage of skilled labor and expertise in circular practices and resistance within the organization to adopt circular principles and practices.

9. **Business Model Adaptation -** Adapting traditional circular models to incorporate practices such as innovation, technology implementation, service-oriented systems, take-back systems, and closed-loop systems.
10. **Implementing Circularity** – Embedding circularity into the organizational culture, values and practices.
11. **Supply Chain and Collaboration** - Lack of partnerships with circular-oriented partners to enhance supply chain resilience, adapt to industry shifts and changes in supply chain dynamics, and promote responsibility and sustainability across the supply chain. Additionally, there is a lack of logistics for the collection of used plastics, including collection, sorting, and cleaning.
12. **Consumer Preferences and Market Trends** - Aligning products and services with customer expectations for sustainability and performance, addressing price sensitivity and performance concerns among consumers and gaining acceptance and demand for sustainable products in the market.

Figure 13 Challenges in Textile Sector (source: Author Generated, 2024)

Analysis, displayed in Figure 13, has shown that the biggest challenge for companies is regulatory compliance and changes, which represent a problem for 80% of interviewed textile organisations. Following that, economic challenges influence 70% of companies. Customer preferences, along with market trends, and resource management challenges significantly influence companies and their activities, with 60% of companies identifying these two aspects as challenges. Integration of advanced technologies, quality assurance and supply chain and collaboration impact 50% of the interviewed companies. Implementing circularity, together with market acceptance and competition, affects 30% of companies. The remaining factors— workforce, and business model adaptation—pose a challenge for only 20% of companies.

2.1.2. Opportunities in the Textile Sector

The market is experiencing a notable shift towards circularity, a trend that holds considerable potential to impact businesses and their operations. This transition towards circular practices presents substantial opportunities for companies.

Companies have identified the following opportunities in the textile sector:

1. **Market Expansion and Customer Acquisition** - This encompasses opportunities for market growth, attracting new customers, and entering new markets, turnover and employee growth.
2. **Product Innovation and Development** – The primary focus is on product innovation, collaboration with suppliers for innovation, and implementing circularity. This includes the use of secondary materials and simplifying their use (e.g., batch-flexible production). Application of Design for Circular Economy principles ensures that products are easy to repair, disassemble, and recycle, thereby promoting the recycling of fabrics and designing for a longer lifespan.
3. **Competitiveness Enhancement** - Companies see the opportunity to enhance competitiveness by offering green products, complying with customer demands, and following trends. Additionally, strategies for achieving a better market position are explored.
4. **Environmental Sustainability and Responsibility** – the focus is on minimizing environmental impact, reducing waste, and lowering emissions and carbon footprint.
5. **Collaboration and Partnership** - this theme involves collaborative opportunities with stakeholders and strategic partnerships and R&D collaborations for example for new software solutions such as digital twin.
6. **Supply Chain Optimization** - Addresses opportunities for short supply-chain, a shift towards local sourcing practices, and implementation of service and take-back systems.
7. **Value Creation from Waste** - Initiatives aim to create value from waste, improving resource efficiency and addressing the growing waste problem. This includes zero-waste solutions, such as transforming printed plastic sheets into high-value products, which surpass traditional downcycling practices.
8. **Transparency and Accountability** - The focus is on transparency enhancement opportunities, implementation of Life Cycle Assessment (LCA), and minimizing environmental impact measures.
9. **Cost Reduction and Efficiency** – Implementing circular practices could lead to cost reduction and improved efficiency. Utilizing digital/tech-driven solutions for scaling circular transition involves integrating IoT sensors and data analytics for real-time monitoring of processes, predictive maintenance, and resource optimization. These solutions enhance efficiency, reduce waste, and lower operational costs. Additionally, extensive automation (driven by high efficiency demand and a shortage of skilled labor) further contributes to cost reduction and efficiency improvements.

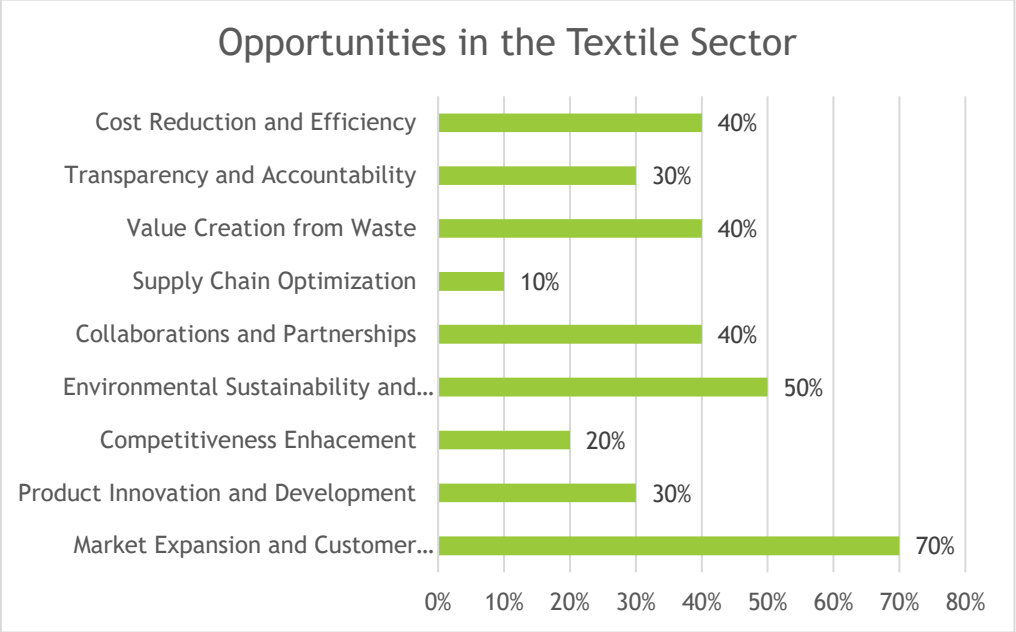

Figure 14 Opportunities in Textile Sector (source: Author Generated, 2024)

As displayed in Figure 14, companies prioritize Market Expansion and Customer Acquisition as the primary opportunity in their circular transition, with 70% emphasizing its importance. Additionally, all other opportunities are perceived with similar significance by companies. Supply chain optimization (10%) and competitiveness enhancement (20%) are recognized to a lesser extent.

2.1.3. Regulations, Standards and Support in the Textile Sector

Depending on the sector, various regulatory compliance is required. Each sector has a different impact on the environment and people, so the initiatives imposed by public authorities vary accordingly.

Results from the textile sector align closely with the findings from the overall analysis. Companies in the textile sector require support in the following areas:

Figure 15 Support Textile Companies Need from Regional Authorities (source: Author Generated, 2024)

- **Collaboration and Networking** - Networking events, collaborations, partnerships, and project participations to facilitate knowledge exchange, partnerships, and collaboration with suppliers and customers.
- **Regulatory Guidance** - Assistance in navigating regulations and standards related to circular economy practices and sustainability.
- **Educational programs, workshops, seminars, and training** initiatives to educate employees and stakeholders about circular economy practices.
- **Financial Incentives** - Access to financial incentives, funding programs, and reasonably priced loans to support investments in circular practices. Shorter application procedures for funds and support for high-risk technologies to encourage innovation in circular transition.
- **Market Awareness and Promotion** - Public awareness campaigns, consultations on sustainability reporting, and market awareness initiatives to promote circular products and practices. Support for exhibition appearances, promotion of certifications, and assistance with attracting new customers and increasing market share.
- **Consultancy services** - support with implementing circular economy practices to enhance knowledge and skills.
- **Waste Management and Supply Chain Integration** - represent the sector-specific areas where support is needed. This focus involves establishing public authorities' assistance for waste management systems, facilitating supply chain integration, and organizing local initiatives for secondary materials.

Specific regulatory initiatives mentioned by companies operating in the textile sector include:

- **Stronger regulation in REACH** – REACH is the Regulation on the registration, evaluation, authorization and restriction of chemicals. Many dangerous chemicals that have been used in textiles and footwear for years are banned or restricted in the European Union (EU). These chemicals include certain azo colors, certain dye substances, chromium VI, certain phthalates, and many more.
- **Green Claims Directive** - Aims to regulate misleading environmental claims that companies make in their advertising and product labelling. Such misleading claims prevent consumers from choosing greener and more circular products and services.
- **Tax incentives for reuse** - By offering tax incentives for reuse, companies can be incentivized to establish systems facilitating material reuse. This approach will decrease the use of new materials and lead to a significant reduction in waste.
- **Carbon Tax** - The implementation of a carbon tax influences companies to reduce their carbon footprints. Given that the textile industry is one of the key emitters, such a measure could have a significant environmental impact.
- **Ban on Textile Waste Export to Africa** – An effort to reduce the amount of waste exported from Europe to African countries.
- **Regulations Related to Household Waste** - Aim to address environmental concerns associated with the disposal and management of textile waste generated by households. These regulations may encompass various aspects, such as waste collection, sorting, recycling, and disposal methods.
- **Open data standards for tracing materials and products** – These standards refer to standardized formats and protocols that enable the transparent and interoperable exchange of data related to the origin, composition, and lifecycle of materials and products throughout the supply chain. These standards facilitate the sharing of information among stakeholders, including suppliers, manufacturers, distributors, and consumers, to track the movement and transformation of materials and products from their source to their final destination.
- **Mandatory Textile Collection** - regulations or policies implemented by governments or authorities that require individuals, businesses, or organizations to collect and properly dispose of used textiles. These regulations are aimed at reducing textile waste and promoting recycling and circular economy principles within the textile industry.

2.1.4. Digital Tools/Technologies in the Textile Sector

Companies recognize the following benefits from implementing digital/tech solutions:

- fast material changes within production while maintaining product quality;
- recording of KPIs in the process by sensors;
- recording of material characteristics for used plastics and prediction of processing (AI);
- monitoring and logging of VOC emissions;
- ensuring real-time quality control;
- optimizing resource utilization;
- improving supply chain transparency;
- platforms to enable companies to offer their products as services;

- promoting the concept of "use instead of ownership" and;
- extending the lifespan of products.

Furthermore, companies see opportunities for optimizing sorting and recycling processes, developing decision support tools for textile channeling, and integrating digital solutions that enhance traceability and sustainability into their business model. This integration not only improves their value chain efficiency but also aligns with evolving customer expectations and environmental regulations, fostering greater transparency and efficiency in material sourcing, usage, and recycling practices, as well as promoting more sustainable practices and products.

They have identified the following technologies that could assist them:

1. Digital Technologies:
   - Blockchain
   - Internet of Things (IoT)
   - Artificial Intelligence (AI)
   - Machine Learning (ML)
   - Digital platforms for networking
   - Digital tools for disassembly and recycling guidance
   - Data management
   - Digital twins
2. Platforms & Tools, including robots:
   - Reverse Supply Chain Management Software
   - Circular Design Software
   - Waste Sorting robots
   - Traceability platforms
   - Life Cycle Assessment (LCA) tools
   - Traceability solutions - fixed chips
   - Platforms for product-as-a-service models

Specific Examples:

- **Plastic Finder** - Digital application or software designed to facilitate the identification, tracking, and management of plastic materials within various contexts, such as supply chains, waste management systems, or environmental monitoring initiatives.
- **Value Chain Generator (VCG.AI)** - Innovative digital platform or software solution designed to streamline and optimize value chains across various industries and sectors. Leveraging artificial intelligence (AI) and advanced analytics, VCG.AI offers a range of functionalities aimed at enhancing efficiency, reducing costs, and maximizing value creation throughout the value chain.
- **Enterprise Resource Planning (ERP) System** - ERP system tailored for the textile sector plays a crucial role in optimizing operational efficiency, enhancing supply chain visibility, ensuring product quality and compliance, and enabling strategic decision-making to drive business growth and competitiveness in the textile industry.
- **Customer Relationship Management (CRM) System** - Software solution designed to manage and analyze interactions with current and potential customers across various touchpoints throughout the customer lifecycle.

2.2. Construction Sector

In order to gain a thorough understanding of the transition towards circular practices within the construction industry, we will undertake an analysis of ten construction companies. This analysis centres on the challenges encountered by these companies, the opportunities they recognize in advancing circularity, the regulations and standards governing the industry, and the technologies perceived as beneficial for scaling circular initiatives.

2.2.1. Specific Challenges in the Construction Sector

Following the analysis of challenges encountered by construction companies, the following conclusions emerged:

1. **Workforce Challenges** - Companies in the construction sector face a **lack of qualified personnel**. Human resource management becomes crucial in addressing staffing needs effectively. There is also a deficiency in **training and education programs** for employees.
2. **Regulatory and Standards Challenges** - These include frequent changes in regulations and standards, which can disrupt project planning and execution. The mismatch between evolving EU standards and market development poses compliance challenges. Moreover, slow procedures for temporary construction projects and the absence of specific laws on modular construction add to the regulatory burden.
3. **Technology Adoption and Integration Challenges** - Embracing advanced technologies presents significant challenges for construction companies. Integrating these technologies into existing workflows can be complex and time-consuming. The adoption of new technologies requires careful planning and investment. Digitalization of internal processes is essential for enhancing efficiency and productivity. However, the lack of suitable digital tools for material management poses a hurdle in realizing the full potential of technology adoption.
4. **Financial and Market Challenges** - Financial obstacles, including high acquisition costs and financing difficulties, can strain project budgets and profitability. The presence of price-sensitive clients exacerbates pricing pressures on construction firms. Furthermore, a shrinking market due to economic fluctuations and industry trends adds to the competitive landscape, requiring companies to adapt their strategies accordingly.
5. **Reducing Environmental Impact** - Reducing the carbon footprint of construction activities and minimizing waste generation necessitates collaborative efforts across the industry.
6. **Customer and Market Readiness Challenges** - Market unreadiness affects the adoption of sustainable construction methods, while customer resistance towards change complicates project implementation. Moreover, limited understanding from certain clients about the benefits of sustainable construction practices poses communication challenges.
7. **Waste Management Challenges** - Waste management challenges in the construction sector revolve around the complexity of recycling composite materials and ensuring the cleanliness of construction waste sorting processes. Implementing effective waste management strategies requires innovative solutions and collaboration across the construction value chain to minimize environmental impact and optimize resource utilization.
8. **Resource Efficiency and Optimization** - Achieving resource efficiency presents a significant challenge for the construction sector. Companies struggle to accurately track material usage and optimize processes.

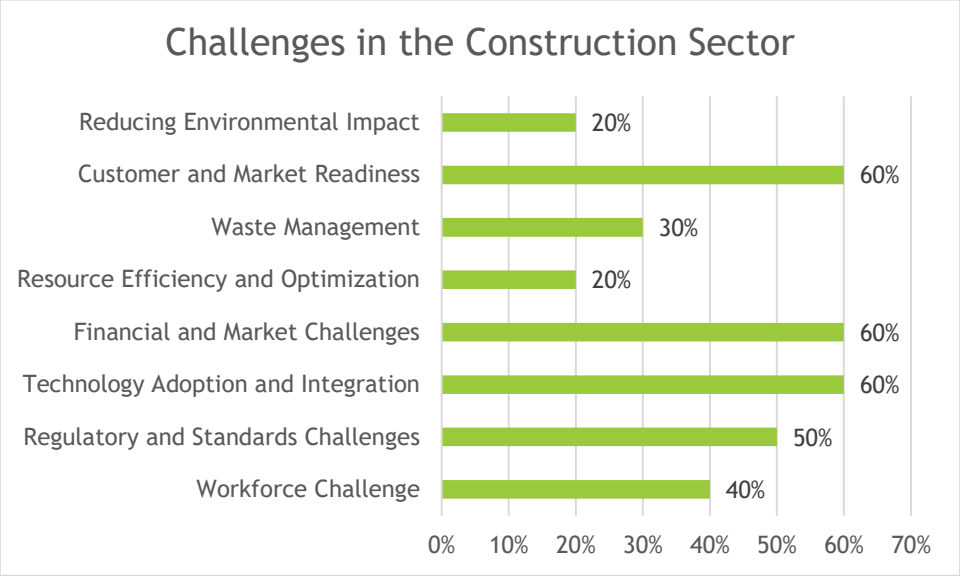

Figure 16 Challenges in Construction Sector (source: Author Generated, 2024)

As presented in figure 16, the interviewed companies representing the construction industry face their greatest challenges in customer and market readiness, financial hurdles, and technology integration and adaptation. Over 60% of companies reported encountering these difficulties in the sector. Additionally, regulatory standards and challenges, at 50%, and workforce challenges, at 40%, pose significant obstacles. Other factors such as waste management (30%), reducing environmental impact (20%), and resource efficiency and optimization (20%) have a somewhat lesser impact on companies.

2.2.2. Opportunities in the Construction Sector

Companies in the construction sector have identified several opportunities that could arise from circular transition. These include:

1. **Resource Efficiency** - By implementing efficient resource management strategies, they aim to reduce costs and environmental impact while maximizing resource utilization.
2. **Waste Reduction** - Construction companies are recognizing the importance of optimizing resource usage and minimizing waste generation throughout the construction process.
3. **Integration of Advanced Technologies** – Technologies could be used to streamline operations, enhance safety measures, and improve overall productivity. By leveraging tools such as Building Information Modeling (BIM), Internet of Things (IoT) sensors, and robotics, companies can achieve greater efficiency and effectiveness in their construction projects.
4. **Environmental Impact Reduction** - This includes initiatives to reduce carbon emissions, promote sustainable transport options, and adopt eco-friendly construction practices to mitigate environmental impact and contribute to sustainability goals.
5. **Cost Reduction** - Efforts to reduce costs through efficient resource management and waste reduction are crucial for construction companies.
6. **New Business Opportunities** - New business opportunities through collaborations with stakeholders, aiming to optimize operations while creating value and driving growth in the industry.
7. **Circular Design and Circular Practices** - Embracing circular design principles and adopting circular practices offer opportunities for process optimization, material reuse, and lifecycle traceability in construction projects. By implementing strategies such as closed-loop systems and sustainable material sourcing, companies can contribute to a circular economy and minimize waste generation.

8. **Customer Awareness and Market Trends** - There is growing awareness among construction companies about the importance of attracting eco-conscious customers and aligning with market trends favoring sustainability. By catering to the demand for environmentally sustainable construction practices, companies can enhance their market positioning and attract a broader customer base.
9. **Innovation and Collaboration** - Innovation in recycling technologies, collaborations with suppliers, and effective resource management are key drivers for waste reduction and sustainability in construction projects. By fostering a culture of innovation and collaboration, companies can drive continuous improvement and stay ahead in a competitive market.

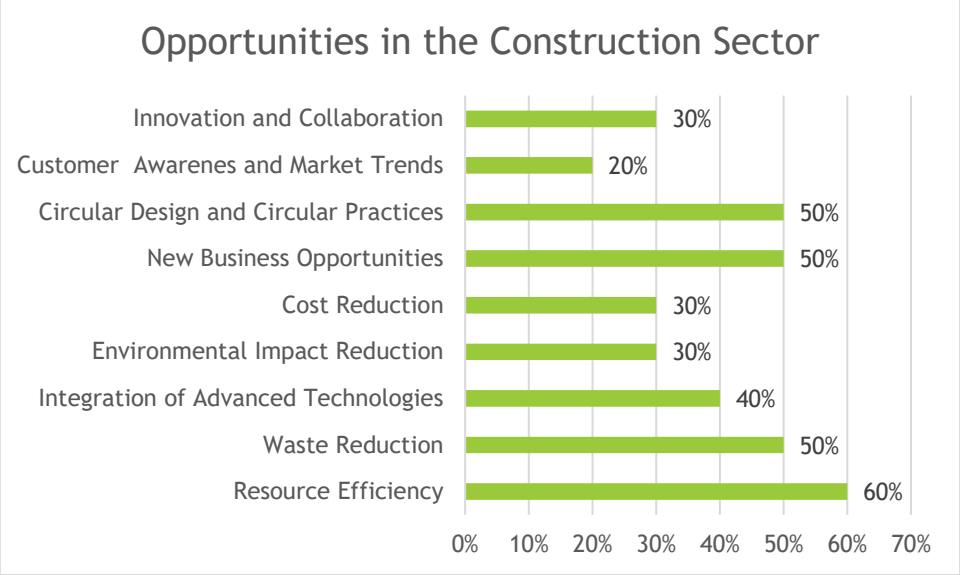

Figure 17 Opportunities in the Construction Sector (source: Author Generated, 2024)

As presented in figure 17, the interviewed construction companies identify resource efficiency as one of the primary opportunities stemming from the implementation of circular practices, with 60% of the companies in agreement. Following closely behind, 50% of the companies recognize the significant benefits of implementing circular design and practices, identifying new business opportunities, and reducing waste. Additionally, 40% of companies see opportunities in integrating advanced technologies, while 30% prioritize innovation and collaboration, cost reduction, and environmental impact reduction. Finally, 20% of companies acknowledge the importance of customer awareness and market trends in driving circularity.

2.2.3. Regulations, Standards and Support in the Construction Sector

The construction sector companies are actively seeking following forms of support from their ecosystem:

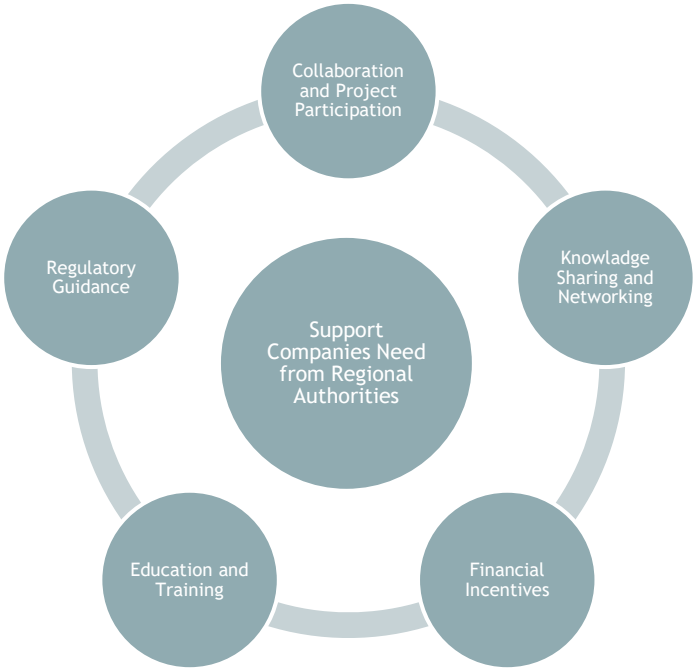

Figure 18 Support Construction Companies Need from Regional Authorities (source: Author Generated, 2024)

Companies in the construction sector require support in the following areas:

1. **Knowledge Sharing and Networking** - Engaging in networking events, collaborations, partnerships, and project participation to foster knowledge exchange, build partnerships, and collaborate with suppliers and customers. This includes efforts to establish a local cluster or consortium of companies and stakeholders.
2. **Regulatory Guidance** - Assistance in navigating regulations and standards related to circular economy practices and sustainability.
3. **Educational programs, workshops, seminars, and training** initiatives to educate employees and stakeholders about circular economy practices.
4. **Financial Incentives** - Access to financial incentives, funding programs, and affordable loans is provided to support investments in circular practices. Shorter application procedures for funds and support for high-risk technologies are offered to encourage innovation in the circular transition. Companies can benefit from tax incentives, grants, and recognition.
5. **Consultancy services** - support with implementing circular economy practices to enhance knowledge and skills.

Specific regulatory initiatives and standards mentioned by companies operating in the construction sector include:

- **Energy use regulations** - These regulations aim to reduce energy consumption, promote energy efficiency, and increase the use of renewable energy sources in the construction industry. Examples include the Renewable Energy Directive (RED), Building Energy Performance Certificates (EPCs), the Energy Efficiency Directive (EED) etc.
- **Norms regarding fire safety and acoustics** – These norms refer to building codes, standards, and regulations that address the design, construction, and maintenance of buildings with regards to fire protection and sound insulation.
- **Flood remediation standards** - Flood remediation standards refer to guidelines, regulations, and best practices aimed at mitigating and addressing the effects of flooding on buildings and infrastructure.
- **Concrete certification only - EN 206** – Concrete certification, specifically adhering to the EN 206 standard, ensures compliance with European norms for concrete production. This certification guarantees that concrete products meet specified quality, performance, and durability requirements, contributing to the overall reliability and safety of construction projects.
- **Lack of laws on modular construction** - The absence of laws governing modular construction poses challenges for companies venturing into this emerging sector. Without clear regulatory frameworks, companies face uncertainty and difficulty in navigating legal requirements, leading to potential compliance issues and operational inefficiencies.
- **The current EU standards** may lag behind market advancements, particularly concerning the adoption of new technologies and materials.
- **ISO 14001 Environmental Management System** – This standard provides a framework for organizations to establish, implement, maintain, and continually improve an effective environmental management system.

2.2.4. Digital Tools & Technologies in the Construction Sector

Companies recognized numerous benefits of implementing digital technologies, including improving efficiency, enhancing speed of delivery and customer satisfaction, quality improvement, process optimization, more efficient planning processes, reducing dependency on imports, advancing digital innovation, building capabilities, enhancing traceability and efficiency in recycling processes, managing and analyzing data regarding waste processing, alignment with environmental goals, digitalization for monitoring construction waste streams in municipalities, and easier tracking of material flow.

They have identified the following technologies that could assist them:

1. **Digitalization and Data Management:**
   - Cloud Computing
   - Carbon accounting
   - Data analytics
   - LCA software
2. **Advanced Technologies:**
   - IoT
   - AI
   - Blokchain
   - Augmented Reality
   - Virtual reality
   - Smart grids
   - Collaborative Robotics
   - Digital Twins

Specific Examples:

- **Continuous Improvement Programme (CIP)** - A system designed to help companies continuously find ways in which to help employees work more effectively: Under CIP anyone can suggest ways to do a specific task better, faster, more safely, or more efficiently.
- **Manufacturing Execution Systems (MES)** - Computerized systems used in manufacturing industries to manage and control production processes. MES software collects and analyzes real-time data from various sources on the factory floor, enabling manufacturers to monitor, track, and optimize their production operations.
- **Enterprise Resource Planning (ERP)** - Integrated software system that organizations use to manage and automate many aspects of their business processes. ERP systems are designed to improve operational efficiency, enhance decision-making, and support business growth by providing a unified platform for managing and optimizing core business processes across the entire organization.
- **Advanced Planning and Scheduling (APS) Applications** - Software tools used by manufacturing companies to optimize production planning and scheduling processes. These applications leverage algorithms and mathematical models to analyze production data, forecast demand, allocate resources, and generate optimized production schedules.
- **Building Information Modeling technology (BIM)** - A digital process used in the architecture, engineering, and construction (AEC) industry to create and manage detailed 3D models of buildings and infrastructure projects.
- **Computer-Aided Design (CAD) Technology** - A digital tool used by architects, engineers, designers, and drafters to create precise and detailed 2D and 3D models of objects, products, buildings, and other designs.
- **Virtual waste marketplace - CYRCL** – An innovative digital platform designed to facilitate the buying, selling, and trading of waste materials and by-products among businesses and industries.

2.3. ICT/Electronics

To comprehensively grasp the shift towards circular practices within the ICT & electronics sector, we will conduct an examination of 17 companies operating within this industry. This analysis will focus on the obstacles faced by these companies, the opportunities they identify in promoting circularity, the regulatory frameworks governing the sector, and the technologies deemed advantageous for expanding circular initiatives.

2.3.1. Challenges in the ICT/Electronics

After analyzing 17 international companies, the subsequent challenges were identified:

1. **Regulatory Compliance and Standards** - Companies encounter challenges related to regulatory compliance and standards governing the ICT/electronics sector. This includes addressing cybersecurity threats, navigating legal complexities, and complying with evolving environmental regulations while staying ahead of changing market demands. Regulations encompass numerous electronic questionnaires, particularly pertinent to electronics and microelectronics products. The primary aim is to ensure compliance with strict packaging regulations, which include meeting cleanroom film standards, adhering to customer specifications, and fulfilling sustainability requirements.
2. **Technological Innovation and Integration** - Rapid technological advancements present challenges such as technological obsolescence and the need to adopt and integrate new technologies. Companies must balance innovation with risk management and address challenges in transitioning to circular practices using digital/tech solutions. The technological risk arises when larger demo systems are piloted for the first time in the field. Despite thorough preparation during the design phase, unforeseen factors in real-world conditions can lead to imbalances and unmet requirements. Testing and prototyping in controlled lab environments may not fully anticipate field challenges, posing inherent risks in implementation.
4. **Supply Chain Disruptions** - Disruptions in the supply chain impact the continuity of material supplies and contribute to instability in demand. Challenges include ensuring continuity of material supplies and addressing disruptions in supply chains and logistics operations.
5. **Security Threats and Cybersecurity** - Security threats and cybersecurity concerns arise amidst rapid technological advancements. Companies must adapt to changing market demands while addressing limited resources for cybersecurity measures to ensure data protection and system security.
6. **Challenges in Circular Practices Implementation** - Implementing circular practices poses challenges such as complexity, lack of infrastructure, and the need to align circularity with business interests. This requires cooperation with authorities and incentives schemes.
7. **Market Dynamics and Competitiveness** - Rapid technological changes impact strategic planning and competitiveness in the market. Companies face challenges in entering international markets and forming strategic partnerships while staying competitive amidst rapid innovations.
8. **Cost Management and Investment** - Initial investments and costs of implementing new technologies pose financial obstacles. Companies must balance investment decisions with efficiency gains and stay aware of technological advancements to manage costs effectively.
9. **Customer Acceptance** - Customer acceptance of circular practices is crucial for business model adaptation. For instance, the "Software as a Service" model might face challenges because customers may not be ready to purchase software independently. Companies face challenges in educating and involving customers in circular initiatives to drive acceptance and participation.

10. **Stakeholder Engagement** - Collaboration with suppliers and customers drives innovation and reduces costs. Companies must engage stakeholders effectively to foster innovation and drive adoption of circular practices.
11. **Environmental Impact and Sustainability** - Companies face challenges in achieving resource efficiency, minimizing environmental impact, and addressing higher production costs associated with sustainability concerns. Designing for circularity and establishing closed-loop systems are essential for addressing sustainability challenges.

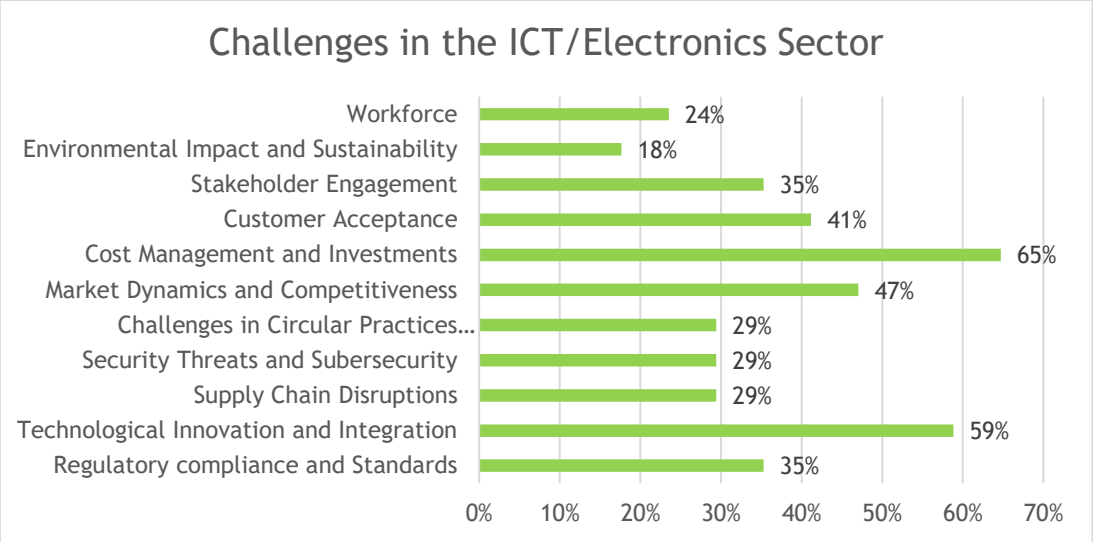

Figure 19 Challenges in the ICT/electronics Sector (source: Author Generated, 2024)

The predominant challenge, expressed in figure 19, faced by the interviewed companies in the ICT/Electronic Sector (65%) revolves around cost management and initial investment. Following closely, technological innovation and integration pose significant challenges for 59% of the companies. Customer acceptance, market dynamics, and competitiveness emerge as additional challenges, with 47% of the interviewed companies encountering these obstacles. Subsequently, stakeholder engagement and regulatory compliance standards present further challenges for companies. With lesser intensity, challenges in circular practices implementation, security threats, and cybersecurity, as well as supply chain disruptions, are reported by 29% of the companies. Lastly, the lack of a qualified workforce affects 24% of companies, while environmental impact and sustainability concerns impact 18% of the companies, albeit with less severity.

2.3.2. Opportunities in the ICT/Electronics Sector

Companies have identified the following opportunities in ICT/Electronics Sector:

1. **Resource Efficiency** - Companies recognize opportunities to optimize resource usage, focusing on efficient resource management and waste reduction strategies. This includes utilizing advanced technologies to streamline processes, improve efficiency, and support circular initiatives, as well as investing in warehouse and material management optimization to ensure precision and efficiency.
2. **Waste reduction** - Companies perceive an opportunity in minimizing waste generation through the implementation of waste reduction strategies. This includes extending product lifespan through repair, refurbishment, and upgrading, as well as transforming production defects into valuable outputs to minimize waste and optimize resource use.
3. **Implementation of Advanced Technologies** - There is a push towards integrating advanced technologies to streamline processes, improve efficiency, and support circular initiatives.

Companies recognize opportunities in promoting the smart use of data and digital solutions, scaling operations using machine vision, AI, digital product passports, and robotics, and integrating IoT and big data analytics to drive sustainable practices on a larger scale.

4. **Collaborations and Partnerships** - Collaboration with stakeholders and international partners is seen as essential for driving circular transition, fostering innovation, and accessing new markets
5. **Circular Design and Closing the Loop** - Embracing circular design principles and closing the loop on product lifecycles offer opportunities for process optimization, material reuse, and minimizing environmental impact. Companies recognize opportunities in enhancing product durability and repairability to promote circularity and minimize waste throughout the product lifecycle.
6. **Customer Engagement and Market Expansion** - Engaging customers in sustainable practices, offering green products and services, and expanding into new markets driven by eco-aware consumers are key opportunities. Companies recognize the importance of customer engagement and market expansion to drive the adoption of circular practices and promote sustainability.
7. **Cost Reduction** – Implementing circular practices can lead to operational efficiencies, cost reduction, and resource optimization, enhancing competitiveness and profitability. Companies recognize opportunities in implementing circular practices to improve cost management and drive efficiency gains.
8. **Reduction of Environmental Impact** – Implementing circular practices could bolster companies' performance in reducing their environmental footprint. By embracing circularity, companies can minimize waste, optimize resource usage, and contribute to environmental sustainability.

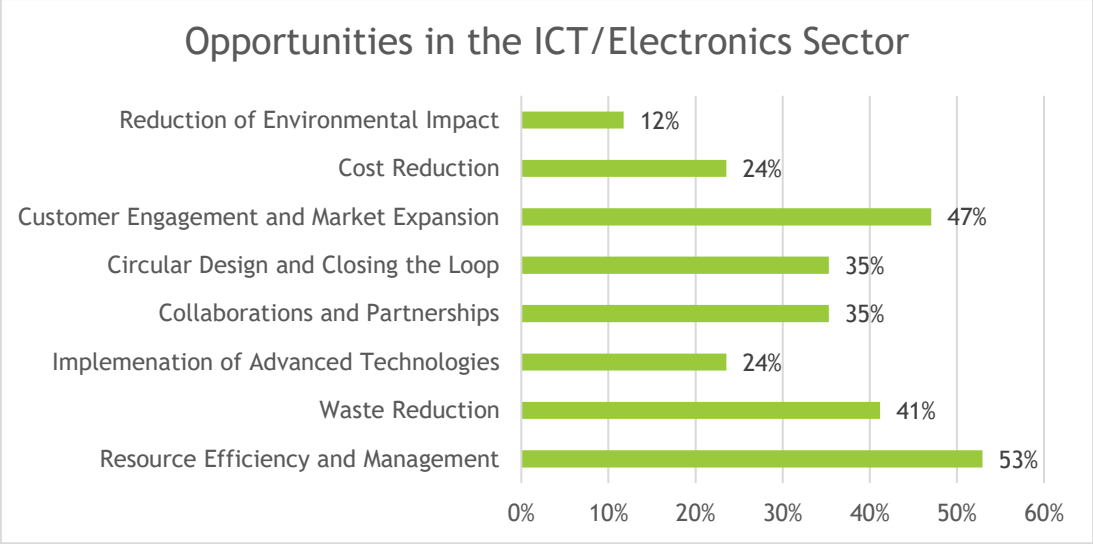

Figure 20 Opportunities in the ICT/Electronics Sector (source: Author Generated, 2024)

As displayed in figure 20, over half of the interviewed companies, totalling 53%, identify resource efficiency and management as a primary opportunity in transitioning to circular practices. Subsequently, customer awareness and market expansion rank as significant benefits, with 47% of companies acknowledging their importance. Waste reduction follows closely behind at 41%. Additionally, circular design and closing the loop, along with collaborations and partnerships, emerge as key opportunities for companies.

2.3.3. Regulations, Standards and Support in the ICT/Electronics Sector

Companies identified following aspects in which they need support from their ecosystems:

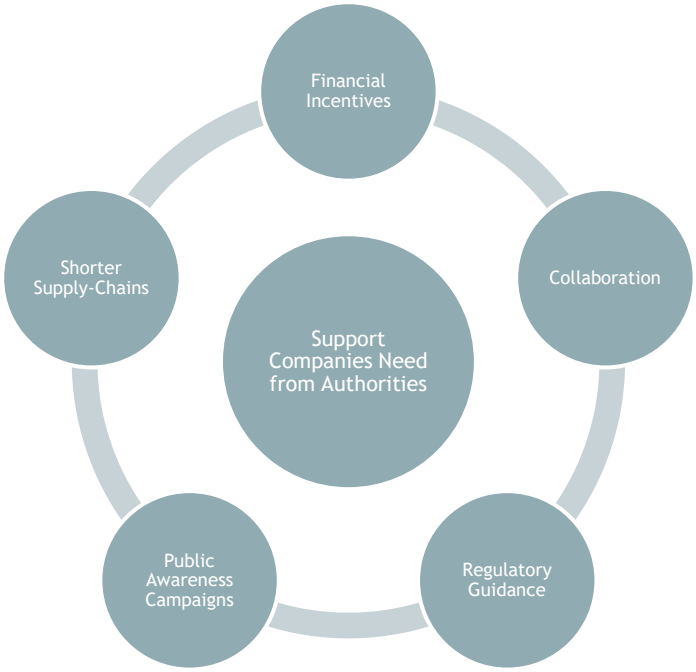

Figure 21 Support ICT/Electronics Companies Need from Authorities (source: Author Generated, 2024)

1. **Financial Incentives** - Initiatives such as tax breaks and financial incentives are crucial for encouraging companies to adopt circular practices. These incentives can include reduced taxes for investing in sustainable technologies or achieving high rates of material recovery, stimulating widespread adoption and investment in circular economy solutions.
2. **Collaboration and Partnership Initiatives** - These initiatives focus on fostering collaboration and partnerships within and outside the industry to drive innovation and sustainability. They include collaboration platforms facilitating communication between different stakeholders, collaboration with industry and research entities to leverage expertise, research and development collaboration for joint projects, and partnerships aimed at achieving common goals. The establishment of innovation hubs focused on circular economy technologies can provide a physical and collaborative space and foster idea exchange, experimentation, and the development of sustainable solutions.
3. **Regulatory Guidance and Compliance** - Navigating regulatory frameworks can be complex for companies aiming to align their practices with circular economy principles. Clear guidelines and assistance in understanding and adhering to legal obligations are essential to ensure compliance and promote sustainable practices.
4. **Public Awareness and Education Programs** - Raising public awareness and providing education programs about circular economy principles are key to driving societal change. These programs aim to raise awareness and educate stakeholders about sustainability, smart cities, and IoT systems.
5. **Market Awareness** – Efforts to raise market awareness about sustainable products and practices are essential for driving consumer demand. Market awareness campaigns and certifications highlighting adherence to sustainability standards play a vital role in promoting the adoption of circular economy solutions in the marketplace.

Specific regulations that could influence ICT/Electronics sector that were recognised by the companies are:

- **General Data Protection Regulation (GDPR)** – The EU regulation on data protection and privacy for all individual citizens of the European Union (EU) and the European Economic Area (EEA)
- **Lightning regulations** - These regulations aim to ensure the safety of buildings and structures by establishing requirements for the design, installation, and maintenance of lightning protection systems.
- **Right-to-repair legislation** - laws or regulations that aim to give consumers the ability to repair their own electronic devices or have them repaired by third-party repair shops. These laws typically require manufacturers to provide access to repair manuals, diagnostic tools, and replacement parts to consumers and independent repair businesses. The goal of right-to-repair legislation is to promote sustainability, reduce electronic waste, and empower consumers by giving them more control over the repair process for the products they own
- **Waste Electrical and Electronic Equipment (WEEE) Directive** - EU directive that aims to reduce the environmental impact of electronic waste by promoting the recycling and proper disposal of electrical and electronic equipment. The directive imposes responsibilities on manufacturers, distributors, and consumers to ensure that electronic products are collected, recycled, and disposed of in an environmentally friendly manner. It sets targets for the collection, recycling, and recovery of electronic waste and requires member states to establish systems for the collection and treatment of such waste. The WEEE Directive also encourages the design of products that are easier to recycle and aims to raise awareness about the importance of recycling electronic waste
- **Extended Producer Responsibility (EPR) Regulations** - Policies that hold manufacturers responsible for the entire lifecycle of their products, including their eventual disposal or recycling. These regulations require producers to take financial and operational responsibility for managing the collection, recycling, and disposal of the products they put on the market. EPR aims to incentivize producers to design products that are easier to recycle, reduce waste generation, and minimize the environmental impact of their products.
- Programs or initiatives that encourage businesses to use **eco-friendly labels** on their products. These labels indicate that a product meets certain environmental standards or criteria, such as being made from sustainable materials, having minimal impact on the environment, or being energy-efficient.

2.3.4. Digital Tools and Technologies in the ICT/Electronics Sector

Transitioning to digital and technical solutions offers numerous benefits for companies in the ICT/Electronics sector. By embracing these solutions, companies can reduce their reliance on specialists, automate repetitive tasks, improve daily operations, and mitigate risks effectively. Moreover, the adoption of digital tools enables organizations to decrease energy consumption, optimize resource utilization, and enhance recycling processes. Streamlining logistics operations, eliminating manual data entry, and improving resource management efficiency are additional advantages.

Furthermore, integrating tracking systems into operations promotes resource-saving practices, resulting in cost reductions and increased operational safety. These systems also facilitate efficient material recovery, data-driven decision-making, and supply chain transparency. Predictive maintenance, remote monitoring, and control are made possible through the utilization of digital tools, ensuring that products are used efficiently and maintained appropriately. Additionally, IoT devices play a crucial role in tracking product usage and identifying when repairs or recycling are needed, thereby extending product lifespan and promoting responsible sourcing and disposal practices. Overall, these technological advancements empower companies to plan effectively and make informed decisions for a sustainable future.

1. **Digitalization and Data Management:**
   - Data analytics tools
   - Data Analytics Platforms
   - Collaborative software and platforms for sharing innovation
   - Mechanical digitalization tools
   - Supply Chain Management Platforms
   - Lifecycle Assessment Tools
   - Circular Design Software
2. **Advanced Technologies:**
   - IoT (analytics platform, asset tracking, resource management)
   - AI
   - Machine Learning
   - Blokchain
   - 3D Printing
   - Digital Twins
   - Machine Vision
   - Virtual reality
   - Automation
   - Robotics

Specific examples raised by the interviewed companies:

- **Board++** - An ad-hoc software platform capable of managing all activities from the entry of materials to shipping.
- **EggPOS** – A software system designed for managing sales transactions and related tasks, such as inventory management, customer management, and reporting, typically used in retail or hospitality settings.

F. Discussion

This section will set the stage for crafting the final deliverable (D3.2.3) of Activity 3.2, aimed at creating Action Plans to enhance circularity within European manufacturing enterprises (Textile, Construction, ICT/Electronics). The analysis findings will be translated into actionable steps to tackle all identified challenges.

1. Circular Maturity

To determine the most suitable approach for each company and gain insight into their perspectives, we classified them according to their level of circular maturity. This process allows us to grasp each company's current position and identify the areas where action is needed.

Using the Circular Maturity Model developed by Uhrenholt and colleagues (2022), we categorized companies based on six different circular dimensions: value chain, governance, people and skills, supply chain and partnerships, operations and technology, and product and material. Through this analysis, companies were assigned to one of six levels of circular maturity: None, Basic, Explorative, Systematic, Integrative, and Regenerative.

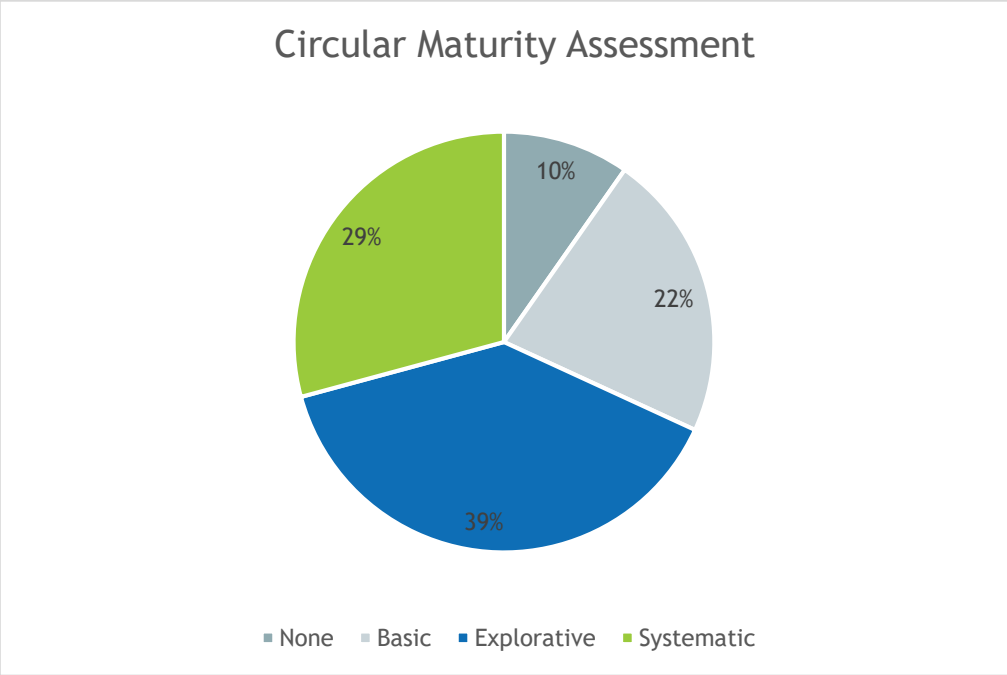

Figure 22 Circular Maturity of the Interviewed Companies (source: Author Generated, 2024)

Out of the 62 interviewed companies, none were categorized as Integrative or Regenerative, indicating that circular maturity among the companies remains limited. To advance to different levels of circular maturity, each of the six variables representing circular practices must be suitably addressed. Within our sample displayed in figure 22, 10% of the companies have not developed circular practices, 22% are at the Basic level of circular maturity, 39% are in the Explorative phase, and 29% are in the Systematic phase.

It is the belief of this author that the primary focus of actions should be on assisting companies in reaching the systematic level of circular maturity. This entails having formalized circular practices that are operationalized with defined objectives and activities. Additionally, staff specifically devoted and trained for circular transition should be present, and participation in projects and collaborative initiatives with

stakeholders is essential. Investments should be made to meet the expectations of efficiency and effectiveness, and new products and materials should be designed to align with circular strategies aimed at narrowing, slowing, closing, and connecting the circular economy loops.

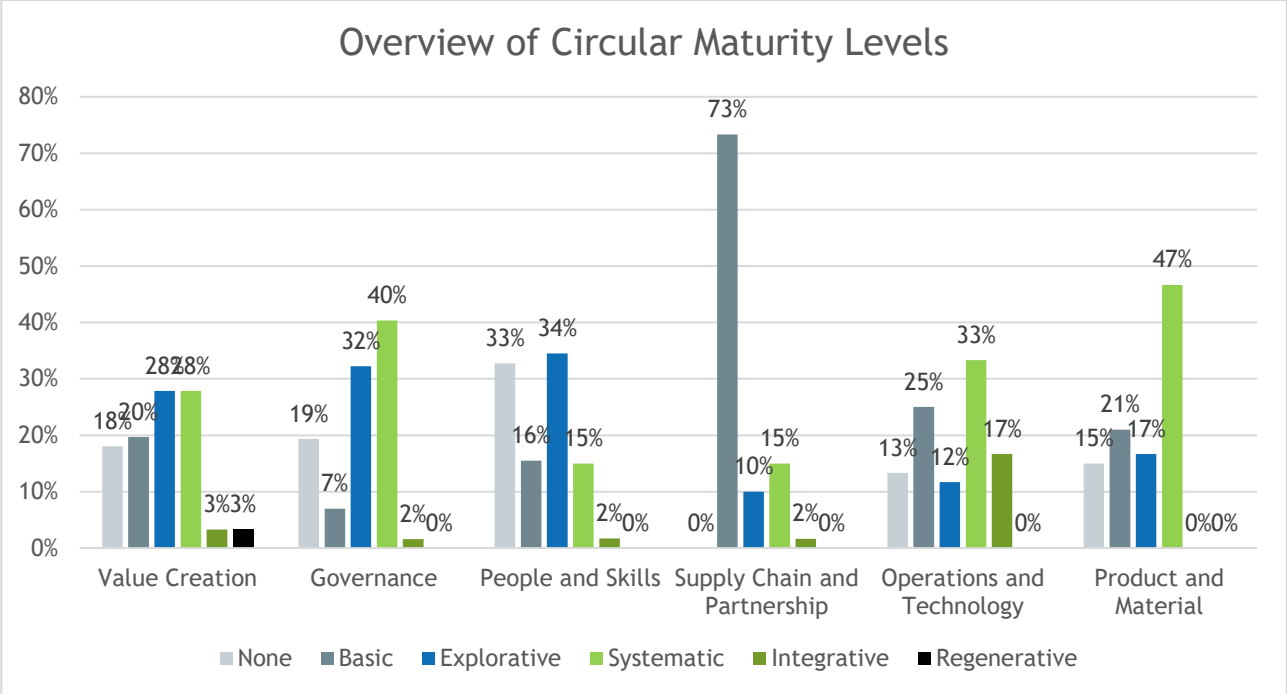

Figure 23 Overview of Circular Maturity Levels (source: Author Generated, 2024)

Figure 23, above, provides a detailed overview of maturity across all six variables, aiding in the identification of weak spots in the development of circular practices. The full data-set has been analysed and categorised accordingly.

In terms of Value Creation, an observation of the first four levels (none, basic, explorative, systematic) reveals evenly distributed results, suggesting that the disparities between maturity levels are not significant. This implies that companies have the potential to narrow the gap toward circular value creation with appropriate guidance and strategic initiatives. However, the low presence of Integrative (3%) and Regenerative (3%) levels of circular maturity indicates that companies must exert considerable effort to reach higher levels of circular maturity.

Regarding governance, the majority of companies have developed a circular strategy and demonstrate a basic understanding of its importance. Although 74% of the companies claim to adopt a circular strategy, our findings reveal that these strategies are often incomplete, lacking essential elements. Out of the nine identified elements crucial for a comprehensive circular strategy, companies, on average, incorporate only 3.5. While some components are present, achieving a full circular transition requires a more comprehensive strategy.

This discrepancy underscores a significant gap in companies' understanding of what constitutes a circular strategy and the necessary components for its successful implementation.

However, in the People and Skills dimension, it is evident that 30% of companies do not have staff responsible for circular transition. Only 15% have dedicated personnel for this purpose, highlighting the need to enhance organizational structures by creating teams or appointing managers responsible for monitoring and implementing circular practices.

In Supply Chain and Partnership, a large number of companies (73%) have only reached a basic level of maturity. This underscores the importance of providing partnership opportunities and fostering long-term relationships with suppliers.

On the other hand, in Operations and Technologies, companies have shown better results. 17% have reached the Integrative level, indicating adoption of advanced technologies. However, support in this dimension is still necessary.

In terms of Circular Products and Materials, companies have achieved a higher level of maturity, with nearly half (47%) shifting their focus towards designing and producing circular products.

2. Identified Challenges and Synergies with Barriers and Enablers Model

To comprehensively tackle the challenges encountered by the interviewed companies, our objective is to investigate synergies between the key enablers delineated in the Barriers and Enablers model by Säfsten and colleagues (2022) and the challenges identified at the international level in our analysis. This approach provides a comprehensive overview of all potential solutions and methods.

Table 5 Challenges and Key Enablers in Circular Transition (source: Author Generated, 2024)

Challenges	Key Enablers
Lack of qualified workforce and training	Education and training systems to improve operations, Knowledge networks and social networks, Provide government-sponsored platforms supporting SMEs
Lack of collaboration initiatives	External cooperation, Provide government-sponsored platforms supporting SMEs
Regulatory environment and compliance	Provide government-sponsored platforms supporting SMEs, Government provided information on sustainable manufacturing
Technology dynamics, adoption and risks	Education and training systems to improve operations
Sustainable supply-chain management	Education and training systems to improve operations, Increased support from large customers
Market dynamics	Increased support from large customers, External cooperation
Customers awareness and preferences	Knowledge networks and social networks
Financial challenges	Increased support from large customers
Environmental challenges	Environmental management systems
Competitiveness	Managerial support and effective leadership towards sustainability

Companies can address the challenge of a lack of qualified workforce by implementing education and training systems and leveraging knowledge networks to educate employees. Social networks can also be

utilized during the recruitment process to find qualified personnel. Additionally, governments can offer access to education and training platforms.

To enhance collaboration initiatives, governments could provide networking platforms for companies to identify and connect with sustainable suppliers and potential business partners. External cooperation can also facilitate collaboration efforts.

Addressing regulatory environment and compliance challenges can be achieved through platforms that offer comprehensive information on new regulations and standards, either provided by the government or through sustainable manufacturing resources.

To bridge challenges related to advanced technologies, companies can focus on educating and training employees to effectively use new technologies. Leadership structures can also benefit from education and training to better understand the usability and benefits of integrating advanced technologies.

Enhancing sustainable supply-chain management can be achieved with support from larger customers, who can assist smaller companies in adapting to new trends and regulations. Additionally, education and training initiatives can contribute to improving supply-chain management practices.

To address market dynamics uncertainty and financial challenges, companies can mitigate risks by increasing support from large customers and engaging in external cooperation efforts. Partnering with large customers can provide stability in terms of orders and standardization, fostering a more predictable business environment. Furthermore, forming partnerships with large companies can incentivize smaller companies to adopt circular practices, especially considering Corporate Sustainability Reporting Directives and other regulatory influences. These partnerships not only offer economic benefits but also contribute to broader sustainability goals and regulatory compliance.

Addressing customer awareness and preferences can be achieved through knowledge networks and social networks, which are effective channels for attracting new customers.

Environmental challenges can be addressed through the implementation of environmental management systems.

Competitiveness can be attained by strong leadership and management guiding the company in the right direction.

3. Setting the Right Direction

After conducting a detailed analysis, various challenges faced by companies have been uncovered in their transition to a circular model. While solutions may differ depending on the company, some key factors for successful implementation of sustainable practices remain consistent across the board.

Firstly, having dedicated staff to oversee the circular transition is paramount. A designated circular transition manager can guide other employees through the process and oversee these activities, effectively. Additionally, it's essential for companies to establish a clearly defined and formalized circular strategy. Including employees in the formation of this strategy not only fosters deeper understanding but also encourages innovation and improvement. Management buy in is crucial, yet decentralization of these principles across the workforce is equally important. For employees to embrace and effectively implement circularity, it must be integrated in the core organizational values.

By integrating circularity into the core values and corporate culture of the company, it becomes ingrained in every aspect of operations. To track progress in the circular transition, companies need appropriate indicators. Surprisingly, over 50% of the companies we analyzed lack established methods for measuring their environmental performance. Addressing this gap is crucial for monitoring and improving sustainability efforts effectively.

After conducting the analysis, we observed that only 19% of the companies have identified ways of measuring their circular progress, using circular indicators. We grouped the indicators they utilize into four categories:

1. Environmental Performance Indicators:
   - Measurement of gas and dust emissions levels
   - Reduction of synthetic pesticides and chemical fertilizers inputs
   - Lowering negative environmental index for human and nature (low or nontoxic chemicals)
   - HEPA Corporate Sustainability Assessment
   - Life Cycle Assessment (LCA)
   - Carbon Footprint calculation
   - Life Cycle Costs (LCC)
2. Sustainability Standards and Certifications:
   - Obtaining and maintaining ISO14001 certification
   - BRCGS compliance
   - ESG compliance
3. Waste Management and Recycling:
   - Amount of waste recycled
   - Content of recycled materials in raw materials used for production
   - Waste production index
   - Waste management index
   - Percentage of recycled content used in materials
   - Raw materials avoided/displacement factor
   - Use of secondary material within the injection molding process
4. Energy Efficiency and Consumption:
   - Environmental audit for energy consumption
   - Energy efficiency indicators
   - Energy consumption in the form of electricity
   - Decrease of energy demand

It's imperative for companies to understand the significance of circular indicators and begin utilizing them to monitor their progress in mitigating environmental impact and advancing circularity. This stands out as one of the pivotal actions required. Numerous platforms and programs are available, offering diverse options for calculating impact.

It's crucial to emphasize that each company should develop a specific set of indicators tailored to track the progress of their unique actions. Therefore, a positive step that SMART CIRCUIT could support, is the development of a distinct set of metrics or indicators for each of the task forces (Construction, Textile, ICT/Electronics), considering that circular practices and objectives may vary across industries.

4. Digital/Tech solutions

Digital and technological solutions have emerged as pivotal tools for addressing the challenges and leveraging the opportunities presented by the circular transition. Companies recognize the utility of digital and tech solutions, viewing the integration of advanced technologies as a primary opportunity.

While challenges may arise in implementing these technologies, such as lack of knowledge, employee resistance, and high initial investments, the benefits they offer are substantial. When the right technology is deployed, it can lead to cost reduction, process optimization, resource optimization, enhanced traceability of supply chains, and many other benefits.

Table 6 Usability of Digital Tools/Technologies (source: Author Generated, 2024)

Digital Technologies/Tools	Potential Usability
Digital platforms	Enhance customer engagement and promote awareness of circular practices through interactive digital interfaces. Utilize digital marketplaces and intermediaries to facilitate transactions and collaborations within the circular economy. Implement digital platforms for transparent waste management to track and optimize waste streams. Employ digital tools to monitor the consumption of raw materials, enabling better resource management and sustainability.
Digital tools	Utilize digital solutions to streamline resource management and reduce waste generation, promoting sustainability across operations. Implement digital tools for analyzing and optimizing energy consumption in buildings, ensuring efficient use of resources and reducing environmental impact. Embrace digital technologies to modernize food processing operations, improving efficiency, quality control, and sustainability throughout the food production process.
Life Cycle Assessment (LCA) Software	For the design of more sustainable and recyclable products. Evaluating the environmental impact of materials and processes, aiding in making more sustainable choices
AI	Utilizing predictive inventory management, resource optimization, and quality control in manufacturing, companies can efficiently extend the lifespan of machinery and components. This optimization process includes sorting materials more efficiently and identifying the best recycling methods, contributing to waste reduction and sustainable production practices
Machine Learning	By managing and analyzing data related to waste processing, companies can enhance decision-making, optimize energy consumption, and streamline the recycling process, leading to more efficient and sustainable operations
Blokchain	Transparency and traceability of existing supply chains
Big Data Analytics	Predictive inventory management harnesses data insights to anticipate demand, reducing overproduction and minimizing waste. Additionally, big data enables resource optimization by providing real-time insights into material requirements and usage, fostering sustainable practices in product design and resource allocation.
IoT	Enables better tracking and sustainable sourcing in industries. These devices monitor and optimize resource usage, minimizing waste generation. With service-oriented models facilitated by IoT connectivity, industries can manage resources more effectively, fostering a circular flow of materials and energy. Real-time

	monitoring and asset tracking further enhance efficiency and sustainability.
Tools for Compliance Monitoring	Digital solutions for adhering to environmental regulations and standards.
Circular Design Software	Tools facilitating product design for durability and recyclability
Energy management Systems	Digital systems that monitor and manage energy consumption can significantly reduce the carbon footprint of the manufacturing processes
Machine Vision	Quality control in manufacturing
Cloud based platforms	These tools enable the management and analysis of data related to waste processing, facilitating improved decision-making, optimized energy consumption, and streamlined recycling processes.
Digital twin development	Real-time insights into material requirements and usage, optimizing resource usage and reducing waste throughout the product lifecycle.
AI driven robots	By optimizing production lines in real-time, robots effectively reduce waste and energy consumption.
Additive manufacturing	Resource efficient production

Table 6 summarizes the usability of all digital technologies/tools companies are aware of and demonstrates their basic understanding of the usability and the opportunities they could gain.

Implementation of digital tools could mitigate the identified challenges and help companies optimize their processes; Table 7 provides an overview of ways to link challenges to digital tools.

Table 7 Challenges that could be Addressed by Implementing Digital Tools (source: Author Generated, 2024)

Challenges	Digital Tools
Lack of qualified workforce and training	Automation, robotics, digital platforms for education and training
Lack of collaboration initiatives	Digital platforms for networking
Regulatory environment and compliance	Digital platforms for information
Sustainable supply-chain management	Blockchain, IoT, AI
Customers awareness and preferences	Digital platforms for raising customer awareness, digital campaigns, analytics on customers preferences
Financial challenges	Implementation of advanced technologies
Environmental challenges	Platforms for calculation of environmental impact (LCA)
Competitiveness	Implementation of advanced technologies

The Lack of Qualified Workforce and Training - Can be addressed through increased automation and robotics, which can compensate for workforce shortages. Additionally, digital platforms can provide employees with valuable training and insights into circular practices.

Lack of Collaboration Initiatives - The lack of collaborative initiatives can be mitigated by leveraging digital platforms to connect with suppliers offering sustainable products and complying with regulations and standards. This enables companies to establish a sustainable supply chain, ensuring adherence to environmental and ethical practices.

Regulatory Environment and Compliance - The Regulatory Environment and Compliance challenge can be addressed through digital platforms that provide comprehensive information on current regulations specific to each sector. These platforms offer detailed guidance on compliance requirements, facilitating faster information exchange and enhancing companies' resilience to regulatory changes.

Sustainable Supply-Chain Management – Can be facilitated through blockchain technology, which enables traceability and transparency of all materials throughout the supply chain.

Customers Awareness and Preferences - By utilizing digital platforms for raising customer awareness and launching targeted digital campaigns, companies can effectively communicate their sustainable practices and initiatives to a wider audience. Additionally, analytics tools enable companies to gain insights into customer preferences, allowing them to tailor their offerings to meet the evolving demands of environmentally conscious consumers.

Environmental Challenges - To tackle environmental challenges, companies can leverage platforms that facilitate the calculation of environmental. These platforms provide valuable insights into the environmental footprint of products and processes, enabling companies to make informed decisions to minimize their ecological impact.

Financial Challenges and Competitiveness - Financial challenges and competitiveness can be indirectly addressed through the utilization of digital tools and platforms. By optimizing processes, improving product quality, and reducing costs, companies can enhance their competitiveness in the market. Digital tools enable streamlined operations, efficient resource utilization, and real-time monitoring, leading to improved financial performance and a stronger position in the competitive landscape.

5. Making Next Steps – Task Force Level

In this section, we'll outline key elements that need to be addressed in each sector (textile, construction, ICT/electronics) to scale circular transition effectively.

5.1. Textile Sector

We have identified many challenges in the textile sector, but the one that affects most companies is compliance with regulations and standards, along with rapid changes in these regulations. It is crucial for companies to start building their capacities to be prepared for the forthcoming changes.

Therefore, companies need a stable source where they can track all the changes regarding regulations, laws, and standards on national and international levels. The usability of digital/tech solutions could be beneficial in creating a platform where all this information will be provided. The platform would include all the information about current regulations, directives, and standards, along with details about upcoming regulations and their timelines, helping companies get ready. It would also provide clear requirements for each regulation, law, or standard, outlining the key actions companies need to take. If companies need further clarifications, they could get assistance and consultancy services.

Additionally, companies have found it necessary to receive regulatory guidance from authorities, which will help them better understand the new requirements.

Companies in the textile sector also face economic difficulties, such as deciding between sustainability and cost-efficiency, coping with market instability, and struggling with resource dependency and disruptions in supply chains. To address these challenges, companies could benefit from assistance with various funding applications and guidance throughout the process, along with access to independently verified information on the economic benefit of specific technologies that simultaneously add circular-value. Moreover, forging partnerships could help strengthen supply chain stability. Collaboration platforms could facilitate the identification of suitable partners who share similar goals and values regarding circularity, thereby enhancing materials sustainability.

By enhancing the traceability of their supply chains through blockchain technology and utilizing various resource tracking platforms, companies can ensure the authenticity and quality of their sources, thereby making their products more sustainable. This approach can improve their environmental ratings and lead to the attainment of various certificates. Consequently, they will enhance their visibility in the market and attract more customers, addressing challenges related to customer preferences and market trends.

Engaging with customers through digital platforms and social media can further increase visibility, reach new customers, and foster brand loyalty. These platforms also serve as effective channels for educating customers and promoting responsibility campaigns.

To make their products more circular and comply with new regulations concerning waste and textiles, companies should focus on circular product design. Utilizing circular design software can assist them in creating products that are easily disposed of, reused, and recycled. Establishing a take-back system is crucial in addressing these challenges, and advanced technologies can optimize the process and planning involved.

The primary focus should be on compliance with regulations, finding solutions to economic challenges, and ensuring that products align with market trends and meet customer requirements, all while enhancing the quality and circularity of products and processes.

5.2. Construction Sector

One of the main challenges in the construction sector is the lack of customer and market readiness. Customers are not yet fully aware of the benefits of circular practices and their potential impact. Cost considerations often overshadow sustainability concerns, creating a dilemma between cost-efficiency and sustainability. To address this challenge, education initiatives should be implemented for customers and other stakeholders involved in the construction process. Leveraging digital platforms and social media can help disseminate information to a wider audience. Additionally, specific regulations and standards should be established to incentivize customers to adopt sustainable practices, which can start with public-procurement laws associated to the adoption of circularity practices.

Another significant challenge in the sector is the weak regulatory framework. Many laws and regulations related to sustainable construction, smart buildings, and smart cities are currently lacking or insufficient. Companies recognize the benefits of implementing advanced technology, but limitations in education and finances may hinder their ability to do so. Assistance is needed to choose and implement the right technologies, where Digital Innovation Hubs could play a vital role. These hubs provide platforms for employee training and education on new technologies. Given the construction sector's workforce shortage, automation and digital solutions can alleviate this issue. Advanced equipment such as sensors and exoskeletons can enhance workplace safety and productivity. Technologies like Building Information Modeling (BIM), Internet of Things (IoT), and robotics can lead to greater efficiency and effectiveness in construction processes.

Companies in the construction sector can achieve resource efficiency by integrating digital and technological tools into their processes. For example, Building Information Modeling (BIM) software enables efficient project planning, reducing material waste by optimizing design and construction phases. IoT sensors can monitor resource usage in real-time, allowing for better management of materials and equipment. Drones and aerial imaging provide accurate data for site surveys and inventory tracking, minimizing excess material orders. Additionally, digital platforms for supply chain management streamline procurement processes, ensuring timely delivery of materials and reducing delays. By harnessing these technologies, construction companies can optimize resource utilization, minimize waste, and improve overall project efficiency.

Circular design and circular practices are among the identified opportunities for scaling the circular transition within companies. Circular design and practices in the construction sector involve rethinking traditional linear approaches to building and infrastructure development, aiming to minimize waste, maximize resource efficiency, and promote sustainability throughout the entire lifecycle of structures.

This includes designing buildings and infrastructure with materials that can be easily disassembled, reused, or recycled at the end of their lifespan. For example, modular construction techniques allow for the prefabrication of building components off-site, reducing construction waste and enabling easier dismantling and repurposing in the future.

Circular practices also involve adopting renewable energy sources, integrating green technologies like solar panels, energy-efficient HVAC systems, and smart building management systems to reduce energy consumption and environmental impact.

In the construction sector, the primary focus should be on utilizing digital tools to scale up the circular transition, adopting sustainable materials and practices for buildings and infrastructure, integrating smart systems, and educating employees and the public to enhance awareness and understanding of circularity principles and the value it can bring. Work with policy-makers on suitable regulatory frameworks would also bring significant benefits, particularly in areas around integrating circularity into public procurement models.

5.3. ICT/Electronics Sector

Financial challenges are a major concern for companies in the ICT/electronics sector. With technology evolving rapidly and constant advancements, there's a constant struggle to balance efficiency gains with investment decisions. Making the right choices about where to invest in new technology is vital given the fast pace of change. Digital innovation hubs, offering test-before-invest options, can be a valuable resource in helping companies navigate these decisions.

In the ICT/Electronics sector, companies recognize resource efficiency as a key opportunity in scaling circular transition, and advanced technologies play a key role in the process. IoT devices could track product usage, identify repair or recycling needs, and thereby extend product lifespan while promoting responsible sourcing and disposal practices. Blockchain technology offers another avenue for enhancing resource efficiency by improving traceability across supply chains. By ensuring the validity of sources and materials used in products, blockchain enhances transparency and accountability in the sourcing process. Additionally, the adoption of Artificial Intelligence (AI) and Machine Learning (ML) algorithms can optimize resource management and efficiency in the sector. By analyzing various datasets, these technologies enable companies to identify patterns and trends, leading to data-driven decisions that minimize waste, enhance operational efficiency, and reduce energy consumption. Digital Twins, serving as virtual replicas of physical assets or systems, allow companies to simulate and optimize processes, predict performance, and identify areas for improvement. This simulation capability contributes to enhanced resource management and efficiency across various operations.

Many companies in this sector lack awareness of current and upcoming regulations concerning electronic waste reduction and management. Few have recognized the significance of compliance with specific standards and regulations. To address this gap, companies need to be informed about potential regulations and how to adapt to them. Providing assistance and training for employees is crucial to ensure they understand new laws, regulations, and best practices they need to comply with. This proactive approach can help companies stay ahead of regulatory changes and implement effective waste reduction and end-producer responsibility strategies. The utilization of digital tools and solutions could prove beneficial in this process.

To address the challenges in the ICT/Electronics sector and gain a competitive advantage, it is essential to take action on several fronts. This includes adopting new standards, implementing new technologies, building capacities and financial capabilities, and providing training for employees.

6. Consideration to build the Actions Plan D3.2.3

This section will outline the key considerations for constructing Action Plan D3.2.3 based on the findings from industry interviews and the main insights gained from the literature review.

The primary concern in addressing challenges and scaling circular transition is compliance with regulations. Companies acknowledge the significance of regulatory frameworks in achieving circularity and recognize the need to adapt to evolving requirements. However, obstacles such as insufficient information, delayed awareness, and regulations lagging behind technological and market trends prevent progress. To overcome these challenges, open digital platforms can be established to provide comprehensive information and guidance. Additionally, offering consulting services, organizing educational and training events, and engaging policymakers to update laws in alignment with market dynamics are essential steps forward.

The integration of advanced technologies is essential for achieving process optimization, waste reduction, resource efficiency, and supply chain transparency, all of which are crucial for companies embarking on their circular journey. However, companies often face financial constraints and market uncertainty, making them hesitant to adopt new technologies. To overcome this barrier, providing companies with the necessary knowledge, funding, and guidance becomes imperative.

For successful implementation of changes, companies require proper training and education for their employees. By offering platforms for education and training, companies can motivate employees to be more creative and adaptable to changes. Additionally, employees will gain the necessary knowledge for effectively utilizing new technologies.

The final action required is establishing a proper organizational structure to guide the changes. Firstly, companies need to designate a person responsible for overseeing the circular transition and monitoring the process. Additionally, a comprehensive circular strategy must be developed to ensure thorough and fundamental implementation of the changes. Involving all employees in the strategy's creation will help them better understand its importance and effects. Finally, circular indicators should be developed so that companies can track their progress on their circular journey.

While general challenges may be consistent across sectors, the specific regulations, technologies, and circular indicators vary for each industry. Therefore, it's essential to examine each sector individually and tailor actions accordingly, adopting a situational approach. This ensures that strategies are aligned with the unique characteristics and needs of each sector and company.

G. Conclusions & Next Steps

1. Conclusions

The key objective of this report was to consolidate insights gathered from the SMART CIRCUIT Industry Interview Series, focusing on the challenges, trends, and opportunities encountered by companies in their journey towards circularity, aiming to establish a foundational framework for crafting action plans. Through the analysis of data provided by 62 companies operating in CE manufacturing sectors, evident patterns emerged, revealing common challenges faced across industries despite sector-specific nuances.

Organizational deficiencies present a significant obstacle for companies striving towards circularity, evidenced by the absence of dedicated personnel, underdeveloped circular indicators, and the lack of formalized strategies.

To foster meaningful change and facilitate the transition towards circular practices, it is imperative to assess the circular maturity level of each company. This evaluation not only assesses the current state of development but also lays the groundwork for creating strategic pathways for progress.

In the journey towards circular transition, companies face numerous challenges that must be addressed to enhance their position in the market. These challenges include the lack of qualified workforce and training, insufficient collaboration initiatives, navigating regulatory environment and compliance, managing technology dynamics, adoption, and associated risks, establishing sustainable supply-chain management practices, understanding market dynamics, addressing customer awareness and preferences, overcoming financial challenges, mitigating environmental concerns, and enhancing competitiveness. Each of these challenges require strategic solutions to drive progress towards circularity and sustainable business practices.

Amidst these challenges, digital tools and solutions emerge as useful assets. Each obstacle encountered by companies presents an opportunity for technological intervention, highlighting the transformative potential of tech-driven solutions.

Furthermore, the regulatory landscape profoundly influences companies' operations and business strategies. While compliance with regulations is non-negotiable, companies seek tailored support mechanisms to effectively navigate regulatory challenges.

The action plans (D3.2.3) should primarily concentrate on offering solutions aimed at mitigating challenges by leveraging digital tools and technologies outlined in the discussion section. It's essential to carefully consider the regulatory framework and the specific ecosystems of each company to tailor the solutions effectively. This approach ensures that the action plans are not only comprehensive but also aligned with the unique needs and circumstances of each organization, maximizing their effectiveness in driving progress towards circularity.

2. Next Steps

This section outlines the initial actions that partners need to undertake. Table 8 provided below presents the essential steps, ensuring that the activity is completed on schedule. Responsibilities are assigned and delineated using the RACI methodology (R: Responsible, A: Accountable, C: Consulted, I: Informed).

Table 8 Final Timeline (source: Author Generated, 2024)

Task to achieve	Deadline	Responsibilities (RACI methodology)
D3.2.2 Review of the report	07.02.2024	R: MCR; Review: PRO
D3.2.2. Review of report	14.02.2024	R: MCR; Review: all
D3.2.2 Official version issued	15.02.2024	R: PRO;
D3.2.3. Draft	29.02.2024	R:SIIT R: TECOS and KPT, All PPs
D3.2.3. Final	05.04.2024	R:SIIT

Based on the insights gained from this report, the final deliverable of AT3.2 will be produced, laying the foundation for the development of D3.2.3. This deliverable will consist of an IT-based action plan designed to address the identified needs and leverage successes to bolster the capacity of the CE industry to access circular services. Additionally, it will contribute to strategic benchmarking (A2.2) and establish the operational scope and plan of the Pilot Factory (A3.3).

H. Abbreviations

Abbreviation	Explanation
AEC	Architecture, Engineering and Construction
AI	Artificial Intelligence
APS	Advanced Planning and Scheduling Applications
B2B	Business to Business
B2G	Business to Government
BIM	Building Information Modeling Technology
CAD	Computer Aided Design
CE	Central Europe
CIP	Continuous Improvement Programme
CircEc	Circular Economy
CRM	Customer Relationship Management System
DIH	Digital Innovation Hubs
EEA	European Economic Area
EED	Energy Efficiency Directive
EPC	Energy Performance Certificate
EPR	Extended Producer Responsibility Regulations
ERP	Enterprise Planning System
EU	European Union
GDPR	General Data Protection Regulation
IoT	Internet of Things
LCA	Life Cycle Assessment
MES	Manufacturing Execution Systems
ML	Machine Learning
PP	Projcet Partner
RED	Renewable Energy Directive
STRATLAB	Strategy Lab
TF	Task Force
VCG.AI	Value Chain Generator
WEEE	Waste Electrical and Electronic Equipment
WP	Work Package

I. Appendix

Appendix 1 - Survey

Each partner had to complete:

- Five Industry Interviews with industry representatives
- Five video interviews with industry representatives

Governance **Name of the company being interviewed** **Date of establishment/years of operation**	
Company size/number of employees, number of units (locations)	
Name of the interviewee	
Way of interview being conducted, with date and time	
Interviewer	
End of interview if in person/online/phone	
TF associated with the interview **Sector (please note you should provide at least 1 interview from the three priority sectors chosen in SMART-CIRCUIT)** **Specific productive activity within economic sector**	
Circular economy indicator of circularity (if available)	
Does your company have a strategy for Scaling circular transition/circular model included? (1000 max characters summary)	y/n please describe it briefly with up to 5 main objectives, and if N, please describe why not
If the company has a Circular model what is the main objective of it - from choices below? • **Measures a Recourse use prevention (cleaner technology)** • **Reuse and recycled of materials** • **Recycling of household waste streams** • **Extension of lifetime**	
Does your company have a strategy for Scaling digital transition and if so, what is	*y/n please describe it briefly with up to 5 main objectives, and if N, please describe why not

the link between both? (1000 max characters summary)	
What are the main challenges- risks you are facing in your sector currently in general? (1000 max characters summary)	
What are the challenges your company is facing in circular transition- risks? How do you understand the usability of digital/tech solutions for circular transition? Would they be useful to you, are you aware of them? Do you employ them? (2000 max characters summary)	
What are the main opportunities you see in circular transition in scaling perspective and why? How do you plan on getting there? (1000 max characters summary)	
Organizational capacity How are your internal resources (staff, resources) organized and competent in the scaling circular transition field, and where do you need most support at. Do you have staff that is in charge of circular transition, and how are they employing digital solutions to achieve that goal? (max 1500 characters) • Do you have a circular transition manager (optional to share the name)? • How many people do you estimate is involved in circular transition?	
Value chain collaboration: In your specific sector, what are currently the main trends when it comes to utilizing digital/tech driven solutions for scaling circular transition and how will it impact your value chain, customers and business model (max 1000 character)	
From the trends, challenges and opportunities in the sector, which 5 would you see as the main ones, most impact to your company?	
And of those, which do you feel can significantly change your company's forward outlooks?	
Which trends are most likely to occur, and if so, what would be their impact on the company and sector? Which Regulations, and Incentives (max 1500 characters)	
If you look at the trends, challenges and opportunities to foster Scaling up circular transition, which of those can be	

supported by digital/tech driven solutions in your opinion? (max 1000 characters)	
How do you see the support of your regional/national CE ecosystem and what services, support would you like to see? (max 2000 characters)	
Are you aware of any tools, services, solutions that are based in digital/tech but support circular transition? Can you name some? (max 1500 characters)	
Additional optional question on circular transition • What is the predominant circular economy innovation model represented in the business model? • Which structural changes in the operation and organization will imply the adoption of the circularity practice? • Does the firm have previous experience with prevention oriented innovations? (cleaner production, industrial symbiosis, eco-design) • What was the last innovation implemented in the firm? (date) • Who(m) are involved in the decision making on the implementation of the circularity initiative?	
Additional optional questions on value chain • How will the circularity initiative impact your current clients? What new clients will be attracted? • What clients will refuse the circularity alternative? • Who will supply the resources technology and training), required to implement the circular economy initiative? • How will the circularity initiative affect the current suppliers? • Who will increase participation, who will reduce participation?	

• Which value chain actors are collaborating in the development and implementation of the circular economy initiative? • Who has implemented a similar circularity innovation? • Who will be interested in copying the circularity initiative?	
Additional optional questions on Environment Environment management a. Environmental impact analysis management b. Organization of environmental management activities c. Number of sustainability related certifications d. Use low -emission engines or fuels e. Efficient logistic systems Resource flow a. Use of electric power generation mechanism from renewable sources b. Use of renewable energy for various purposes c. Energy efficiency d. Inputs and outputs key resources (raw material, water, energy) Water reuse, energy saving Circularity gap 1. Effluent and waste management 2. Development of recycling activities	
Additional optional questions: Are you aware of a regional/national policy on circular economy? Since when? Are you aware of specific regulatory mechanisms are in place, affecting goal setting for firms in the sector? Since when? Are you aware of standards (certifications or technical standards) apply to the	

circularity initiative in your specific sector? (max 1500 characters)	
Do you consent to a short videotape of this meeting with highlighting main points?	*Y/n
Photo consent	*y/n

Appendix 2 - The List of Interviewed Companies

The list of all the companies participating in the analysis can be found below:

No.	Company name	Country	Sector	Clasiffication	Short description
1	STAM S.R.L	Italy	Construction	Medium-sized enterprise	STAM S.R.L (1997) STAM is a multidisciplinary engineering firm which provides high-tech and turnkey solutions in the following domains: Industry 4.0 & Robotics, Space & Defence, Security & Transport, Energy & Bio-circular economy.
2	DECATHLON ITALIA S.R.L	Italy	Textile	Large enterprise	Decathlon Italia S.R.L. (1993) manufactures and distributes sporting goods. The Company offers sports goods such as footballs, volleyballs, basketballs, hockey, boots, glasses, bags, clothing, shoes, rollers, accessories, and other related products.
3	FOS SPA	Italy	ICT/Electronics	Medium-sized enterprise	Founded in 1999, today FOS offers system integration and software development services, application and infrastructure outsourcing, research, development and prototyping of innovative technological solutions, telecommunications services.
4	Hiro Robotics	Italy	Electronic waste	Small enterprise	Hiro Robotics (2018) is leading the way in e-waste recycling with innovative use of robotics and AI. Their mission is to protect the planet from the repercussions of electronic discard to ensure a brighter cleaner future for all.
5	T&G	Italy	ICT/Electronics	Medium-sized enterprise	FOS SPA subsidiary
6	PEZZUTI GROUP	Italy	Polymers	Large enetrprise	Pezzutti Group (1966) is a strategic partner in the conception, co-design, mould building, development and production, including automation for mass production, of technical components and finished products, made of plastic materials and techno polymers.

7	RE49	Italy	Textile	Micro enterprise	RE49 Srl (2021) is a spin-off of the company Eredi Masolini Raimondo Snc. Nowadays, they are the most sustainable shoe brand in the world, producing unique Made in Italy products, according to the circular economy model. They produce producing shoes with recycled, recovered, animal-free, vegan materials.
8	SIOM TERMOPLAST Srl	Italy	Polymers	Small enterprise	SIOM Termoplast, established in 1976, offers co-engineering, aesthetic and sustainable design, prototyping, moulding and plastic moulding services.
9	Video Systems Srl	Italy	ICT/Electronics	Small enterprise	Video Systems Srl (1993) design and implement the most advanced artificial vision and intelligence solutions to offer innovative and high-performing quality control systems in all industrial sectors.
10	Gees Recycling Srl	Italy	Construction	Small enterprise	Gees Recycling Srl (2010) was established at the CHAMBER OF COMMERCE, INDUSTRY, CRAFTS AND AGRICULTURE OF PORDENONE. The statute includes the recovery and transformation of fibre-reinforced composites and rigid expanded thermosets into new double green construction materials, the R&D of technologies and industrial plants for recycling, and finally technological transfer.
11	Merit Poland ltd	Poland	Electronics	Large enterprise	Merit Automotive Electronics Systems (2016) is a global supplier of complex mechatronics modules and switches of the automotive industry.
12	Silgan White Cap Poland Sp. z o.o.	Poland	Packaging	Large enterprise	Silgan White Cap Poland is the leading global supplier of Value-Added closure systems made of metal or plastic for food and beverages packed in glass and plastic containers for more than 20 years.
13	Sunly	Poland	Construction Energy storage Green hydrogen	Large enterprise	Sunly (2019) supplies the Baltics and Poland with renewable energy by creating

					solar and wind parks that produce electricity in an environmentally friendly way. Besides developing renewable energy projects, they also manage a renewable energy and electrification portfolio of startups.
14	Insignes Labs Sp.z o.o.	Poland	Food Textile	Micro enterprise	Insignes Labs develops effective, environmentally friendly solutions that work across a range of crops and geographies, providing tools for sustainable crop protection. They help farmers reduce their reliance on chemical pesticides and synthetic fertilizers without sacrificing yield.
15	ICE CREAM PLANT	Poland	Food	Micro enterprise	ICE CREAM PLANT was founded in 1971, marking over five decades of dedicated craftsmanship in the production and distribution of delightful ice cream.
16	CEMENTUM, s.r.o	Czech Republic	Construction	Micro enterprise	CEMENTUM, s.r.o (2021) is a producer of sustainable concrete products with an emphasis on design and maximum use of secondary raw materials. The company's goal is to reduce the environmental impact of concrete products and save natural resources. The products use full replacement of natural aggregates with recycled construction and demolition rubble.
17	Compactive s.r.o.	Czech Republic	ICT/Electronics	Small enterprise	Compactive s.r.o. (2024) provides comprehensive services in the field of electrical installation, information and communication technologies. They design and deliver complete solutions for low-

					current and high-current electrical systems connected by data networks with information, communication and security systems, audio and video technology.
18	Dřevodílo Rousínov, s.r.o.	Czech Republic	Furniture production	Medium-sized enterprise	Dřevodílo Rousínov, s.r.o. (1945) specialises in complete interior furnishing services in both the private and commercial sectors. From professional 3D visualization, detailed production documentation, project management to modern manufacturing and final assembly with subsequent service. They also produce serial products, both furniture and POS products.
19	Plastia s.r.o.	Czech Republic	Manufacturing of plastics	Medium- sized enterprise	Established in 1993, Plastia s.r.o. offers a diverse portfolio of self-watering containers and a range of exterior and interior gardening tools. Their primary commitment lies in delivering products that blend functionality, exceptional design, and high quality.
20	Koma Modular, s.r.o.	Czech Republic	Construction	Large enterprise	Koma Modular s.r.o., established in 1992, specializes in implementing complex modular buildings. Their commitment to meeting high demands on aesthetic quality and utility value necessitates the involvement of an architect in the construction planning process.
21	Minerva Team Ltd.	Hungary	Textile	Medium- sized enterprise	Minerva Team Kft. (1999) is an enterprise based in Hungary. Its main office is in Nagykanizsa. It operates in the Apparel Manufacturing sector.
22	KANIZSA HÚS 2000. Kft.	Hungary	Food	Medium-sized enterprise	KANIZSA MEAT 2000 Ltd., established in 2000, focuses

					on wholesale and retail meat trading, prioritizing local sourcing and processing. Since its inception, the company has expanded its operations to include a cutting and packaging plant, catering to diverse clientele including institutions and hotel chains.
23	N-ferrum Construction and Service Ltd.	Hungary	Construction	Small enterprise	In the beggining (2006), the company dealt exclusively with reinforced concrete installation, which further developed into the production and sale of rebar. Then in 2010 - they started to deal with the complete general construction of steel structures halls.
24	DMS Inox Works Kft.	Hungary	Metal industry	Small enterprise	DMS Inox Works (2018) main activity is the design and manufacture of stainless steel, carbon steel and aluminum structures. Within this, various welding processes and locksmith industrial structural assembly are highlighted.
25	Kanizsa Rehab Nonprofit Limited Liability Company	Hungary	ICT/Electronics	Medium-sized enterprise	Kanizsa Rehab Nonprofit Limited Liability Company has its origins dating back to 1967. They work in electronics industry, specifically in electronic assembly, where they assemble circuit breakers. Additionally, they have a sewing workshop and a printing department as part of their operations.
26	ALLRYS EUROPE KFT	Hungary	Food sector	Micro enterprose	ALLRYS (2021) is a smart food crafted from natural ingredients, specifically designed for those who require energy replenishment during physical activities, intense mental tasks, or rigorous workouts.

27	EPLAN Software s.r.o.	Slovakia	Electrical, Automation, and Mechatronic Engineering.	Micro enterprise	EPLAN provides software and services for the fields of electrical engineering, automation and mechatronics. The company develops software solutions for the production of machines, equipment and switchboards.
28	PROCONT spol s.r.o.	Slovakia	Manufacturing, ICT	Small enterprise	They offer more than 30 years of experience in the area of industrial automation focusing on designing, manufacturing and supplying, in the area of process-control technology, automated handling solutions and robotics.
29	TELEGRAFIA, a.s.	Slovakia	ICT/Electronics	Medium-sized enterprise	Telegrafia, established in 1993, is the market leader in mass warning and notification systems.
30	TWINZO	Slovakia	ICT/Electronics	Small enterprise	Twinzo originated as a project within INFOTECH s.r.o. in 2014, initially centered on indoor positioning technology. Over time, their focus shifted towards delivering solutions for manufacturing challenges, particularly emphasizing 3D visualization. By 2019, this evolution culminated in Twinzo—a 3D live digital twin accessible on any device.
31	ALKON SV spol Ltd.	Slovakia	Construction	Small enterprise	ALKON (2009) specializes in architectural services, designer services, interior design, furniture design, industrial design, and architectural projects.
32	Heneken Group	Slovakia	Metal industry	Large enterprise	They started trading aluminum and expanded into other commodities like silicon, magnesium alloys, lead alloys, zinc alloys, and non-ferrous scrap. They also produce high-quality aluminum-based prealloys using modern technology.

33	AB objekt d.o.o.	Slovenia	Construction	Micro enterprise	AB objekt d.o.o. was established in 2008 and deals with architectural design, spatial planning and interior design, as well as providing building construction design and construction supervision.
34	ZAVOD KNOF SO. P.	Slovenia	Textile	Small enterprise	ZAVOD KNOF, established in 2008, operates six unique reuse boutiques and provides affordable second-hand clothing, sustainable fashion, and recycled home goods. Additionally, KNOF's online store offers a selection of top brands, vintic clothing, iconic furniture, and sustainable products, embodying a commitment to circularity and environmental responsibility.
35	Eggos d.o.o.	Slovenia	ICT/Electronics	Micro enterprise	Company EGGOS d.o.o. deals with development and sale of software and hardware. They offer complete software for retail and service activities.
36	CAP d.o.o.	Slovenia	Textile	Micro enterprise	Polymer group is an innovative lightweight polymer specialist which sets standards in marine & caravanning industry
37	EVEGREEN d.o.o	Slovenia	Other sector - Replacing plastic with sustainable materials, made by local agro, food or industrial waste	Micro enterprise	The company specializes in replacing plastic with sustainable materials sourced from local agricultural, food, or industrial waste.
38	Sonnenerde GmbH	Austria	Agriculture	Small enterptise	Sonnenerde, founded in 1998, produces high-quality soil, driven by a commitment to environmental stewardship. They established their own facility dedicated to crafting premium compost and soils. Their products meet professional standards and ensure optimal plant growth, reflecting their dedication to quality and sustainability.

39	Woschitz Group	Austria	Construction	Medium-sized enterprise	Woschitz Group (1998) is a construction company dealing with construction supervision, accompanying inspection, building physics and engineering, fire protection planning, real estate valuation, real estate brokerage, infrastructure construction, project development and structural engineering.
40	O.K. Energie Haus GmbH	Austria	Construction	Small enterprise	They specialize in the planning, production and assembly of the highest quality timber buildings up to turnkey execution.
41	Gugler GmbH	Austria	Other sectors	Medium-sized enterprise	gugler*,founded in 1989, is a model company for sustainable business focused on the common good, comprising gugler* DruckSinn print shop, MarkenSinn agency, and SinnBildung management consultancy—a beacon for communication and change.
42	M2 Consulting GmbH	Austria	Textile	Micro enterprise	Specializing in plastic innovations, M2C streamlines the journey from idea to manufacturing solution. With 20 years of market experience, they offer swift implementation plans, business development, and launch support. Additionally, their expertise in chemical aspects ensures compliance with regulations and the development of advanced products like odor traps and quality assurance devices.
43	Gumiimpex - GRP d.o.o.	Croatia	Other - Manufacture of other rubber products	Large enterprise	They produce rubber-technical product and offer services for tire repair and recycling of scrap car tires.
44	Oprema d.d.	Croatia	Other - Production of cooling and	Large enterprise	The company Oprema dd is a manufacturer of equipment for the catering industry,

			dispensing equipment		primarily refrigerators for cooling and dispensing beer, as well as devices for cooling and dispensing juices, wine, water, soda water, milk and nitro coffee.
45	Kostwein – proizvodnja strojeva d.o.o.	Croatia	Other - Production of packaging machines	Large enterprise	With their core competence process innovation they produce complete machines, modules and high-tech components for all branches in the machine industry.
46	Forum Toplice d.o.o.	Croatia	Other – Utility services	Small enterprise	The basis of their activity is the maintenance of the municipal infrastructure of the city of Varaždinska Toplica by performing the maintenance of unclassified roads, the maintenance of public and green areas and the maintenance of buildings.
47	EMS Elektromehanik Systeme d.o.o.	Croatia	ICT/Electronics	Medium-sized enterprise	They offer all assembly and disassembly services of all related parts and structures, including: transport technology, robots and related lines, shelving, industrial machines, steel structures and ventilation systems.
48	Mondas GmbH	Germany	ICT/Electronics	Small enterprise	Founded in 2018 as a spin-off of the Fraunhofer Institute for Solar Energy Systems ISE, Biberach University of Applied Sciences and PSE GmbH, they have developed into a software company that is fully committed to the goals of the energy transition and climate protection.
49	SolarSpring GmbH	Germany	ICT/Electronics	Micro enterprise	Founded in 2009 as a spin-off of the Fraunhofer Institute for Solar Energy Systems in Freiburg, Germany, the SolarSpring GmbH, membrane solutions has grown into a world market leader for membrane distillation technology.

50	endiio GmbH	Germany	ICT/Electronics	Small enterprise	endiio digitizes analogue systems and machines and implements maintenance-free and wireless sensor systems.
51	digiraster GmbH & Co. KG	Germany	ICT/Electronics	Small enterprise	They provide high-quality development services for all aspects of printed circuit boards. With a focus on prototype and small series production, our offer ranges from the layout of the printed circuit boards to the assembly and construction of complete mechatronic assemblies, including the necessary software.
52	acp systems AG	Germany	ICT/Electronics	Medium-sized enterprise	Their focus is to provide high-quality, optimised and economical solutions to enable client specific manufacturing processes. To do so they offer capabilities in the areas of automated handling and assembly, robotics and inspection as well as testing.
53	HDM	Austria	Other - Consulting	Micro enterprise	HDM is a consulting company founded in 2008 that helps clients implement circular solutions and pave their way toward sustainability.
54	THI TECHHOUSE GMBH	Austria	Other – consulting	Small enterprise	They offer functioning innovation support and development programs with a focus on the areas of forestry, timber industry, energy industry, agriculture, digitalization, sustainability, technology and corporate culture.
55	TIGER Coatings GmbH&Co KG	Austria	Other - Chemical industry ICT	Large enterprise	Founded in 1930 as a paint dealership, **TIGER Coatings** is now offering high-quality coating solutions – powder coatings and digital inks for industrial printing systems – guarantee long-term value retention and are used, for example, on facades,

					windows, car rims, furniture, refrigerators, machines, etc. worldwide.
56	STIWA Advanced Products GmbH	Austria	Other - Manufacturing	Large enterprise	By mastering comprehensive production and manufacturing technologies - in combination with innovative product technologies - STIWA Advanced Products GmbH supports their customers in gaining technological leadership in their markets.
57	Anonymous Company 1	Austria	Other - Manufacturing	Large enterprise	The company was founded in 1920 and their main field of business is production of machines.
58	A&E Produktionstechnik GmbH	Germany	Textile	Micro enterprise	A&E Produktionstechnik GmbH has been developing, producing and selling flexible injection solutions for single, multi-component and vertical injection moulding machines since 2002.
59	4D-LIGHTweight GmbH	Germany	Other - Design, development and manufacturing of components and systems	Micro enterprise	4D-LIGHTweight GmbH offers solutions in component design, optimization and production. As a supplier, they are characterized by the application of additive manufacturing technologies for achieving more efficient production of high-performance components through optimized material utilization.
60	Silbaerg GmbH	Germany	Textile	Micro enterprise	Their core competence is the production of the patented ALD-Tech. semi-finished fiber products that surround the wood core.
61	LSE	Germany	Textile	Small enterprise	LSE is a German company that operates in the textile sector, mainly dealing with development and production of components using textiles and electronic sensors.

62	1A Technologies UG	Germany	Textile	Micro enterprise	The company was founded in 2020, with its main focus on printing textiles for interior applications, sportswear, and plastic structure fixing.

Appendix 3 - Circular Maturity Assessment

The raw data regarding circular maturity assessment is accessible via the following link and is intended exclusively for project partners' use.

D3.2.2_Circular Maturity Assessment.xlsx