Circular and Dynamic Manufacturing Supply Chain Orchestration and OptimiSation

D6.11 Report on training activities and platform M18			
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Abbreviations

MWCapital	Mobile World Capital Barcelona Foundation
CM	Circulation Manufacturing
CMS	Circulation Manufacturing
EXDs	Experiments for demonstrations
SCPO	Supply Chain Process Orchestration and Execution Tool
SCOP	Supply Chain Optimisation Tool
IoT	Internet of things
EC	European Commission
WP	Work Package

Executive Summary

This deliverable includes the preliminary findings of an early observatory activity and the developed training approach. The CIRCULOOS project wants enabling micro, small, and medium-sized enterprises (MSMEs) to become integral members of the Circular Manufacturing (CM) value chain. By leveraging cutting-edge tools and methodologies, CIRCULOOS aims to foster transparency, sustainability, and efficiency in supply chains. These tools integrate end-to-end supply chain orchestration, dynamic sustainability assessments, cybersecure data sharing, and advanced technologies such as Machine Vision and AI. These advancements will support the creation of innovative circular business processes, resulting in sustainable production practices that span the entire product lifecycle.A key pillar of this vision is the upskilling and reskilling of MSMEs and small mid-caps through Task 6.5, "Strategy for Skills Development to Foster Circular Manufacturing." This initiative identifies skills gaps and offers targeted training to empower businesses in adopting IoT, CM, and reliable supply chain technologies. Through collaborative efforts with consortium members and Digital Innovation Hubs (DIHs), the project ensures the comprehensive coverage of industry needs while fostering resilience and sustainability in SMEs.

The project uses a structured methodology for analysing skills requirements and designing training sessions. The skills observatory distinguishes between training methodologies and observational analyses to identify sectoral needs. Customer journey analysis further helps the understanding of SME requirements, enabling tailored training solutions aligned with circular manufacturing goals. Existing benchmarks of training programs across Europe provide a foundation for integrating diverse competencies, from core technical skills to entrepreneurial and business ones.

Through collaborative focus groups and a robust framework for knowledge exchange, CIRCULOOS seeks to close the skills gap while supporting MSMEs in adopting innovative circular practices.

1 Introduction

1.1 Project Introduction

The overall vision of CIRCULOOS is to deliver the tools to enable MSMEs become full members of the Circular Manufacturing value chain. These tools orchestrate and continuously optimise the supply-chain end-to-end and integrate planning and execution monitoring to enable transparent and on-time communication. Combining these with direct calculation of the product sustainability and circularity profile, for both internal and external partners, this environment will enable them to configure and execute disruptive circular manufacturing processes for sustainable production that covers the entire life cycle of products; either by recovering the value of product that ended-up as waste or from recycled and remanufactured products.

To achieve this objective the project aims to deploy:
- Circular end-to-end supply chain orchestration for collaborative workflows which incorporates planning and execution metrics and integrates advanced and multimodal visualisation and analytics. The visualisation is delivered by comprehensive Digital Twins of the supply chains formulated, the factory processes and product design phases.
- Supply Chain Optimisation that monitors the global (across the supply chain) and local (within the factory) processes and execution, inputs and outputs and configuration parameters, to enable data-driven AI decision making, this way supporting continuous optimisation of targeted and measured performance and sustainability parameters.
- Dynamic Sustainability Assessment functionalities that investigate alternative supply-chain scenarios (varying in terms of materials used, processing technologies, suppliers involved and/or activated circular economy practices) in place of the existing schemes, quickly measuring their performance in terms of environmental sustainability and circular economy profile.
- Supply Chain Data Spaces for seamless, multi-level data flow across the supply chain partners, supporting the reuse of materials in novel products, the extension of the life-cycle of finished products (remanufacturing), and data-driven decisions for collaboration of parties offering matching services in the most dynamic and efficient way.
- Cybersecure and trustworthy data sharing across the supply chain by employing a distributed, trusted and efficient Identity and Access management system, that together with the associated trust framework will coordinate the identities of all IoT objects and ensure trustworthy data sharing among its members, aligned with the trust framework that is being implemented in EBSI.
- CM specific tools for the automatic recognition of recyclable parts by modern Machine Vision tools and Advanced Robotics, to enable optimised flows in the selection process.
- Novel circular business processes will be demonstrated supporting reusing, reducing, and recycling material in production and consumption systems. The new collaborative production models will provide quantifiable results on the sustainability increase across the supply chain, in terms of efficient use of raw materials, of by-products, of waste and energy and of emissions reduction. CIRCULOOS leverages the above with the RAMP integrated innovation IOT platform and the European network around it to deliver a CM ecosystem and platform for Manufacturing SMEs.
- Skills upskilling and reskilling will be provided in RAMP and through online courses, webinars, and best practice guides and success stories based on the pilots and Experiments for Demonstration (EXDs).

1.2 Task's objective and KPIs

By identifying the current skills gaps and offering specialized training services, Task 6.5 Strategy for Skills Development to Foster Circular Manufacturing (MWCB, M9-M42) aims to empower and strengthen SMEs and small mid-caps' capacities in these technologies by supporting the transfer of knowledge on IOT/CM and reliable supply chains and building resilience. Training needs will be evaluated following a benchmark that comprises a comprehensive and up-to-date list of available courses, in-depth desk research, and input from partners and external stakeholders. On the one hand, because of their expertise in the subject, the members of the multidisciplinary consortium will assist in identifying the needs in this new environment. On the other hand, as its members are the first to worry about the effects of implementing manufacturing circular processes, the European Digital Innovation Hubs (DIHs) will help to guarantee full coverage of the demands.

1.3 Phases of analysis and methodology design

The methods used to carry out the analysis and methodology design for the skills observatory within Task 6.5 are depicted in Figure 1. Background and context investigation are the first actions to be done. It begins by defining a skills observatory and a training approach. The second phase is creating the data collection instruments needed to analyse the demands and needs of SMEs. To compare and validate the consortium's training design, three tools are created: a survey, a customer journey, and a focus group. An outline of potential technical, technological, business, and management subjects is provided at the conclusion.
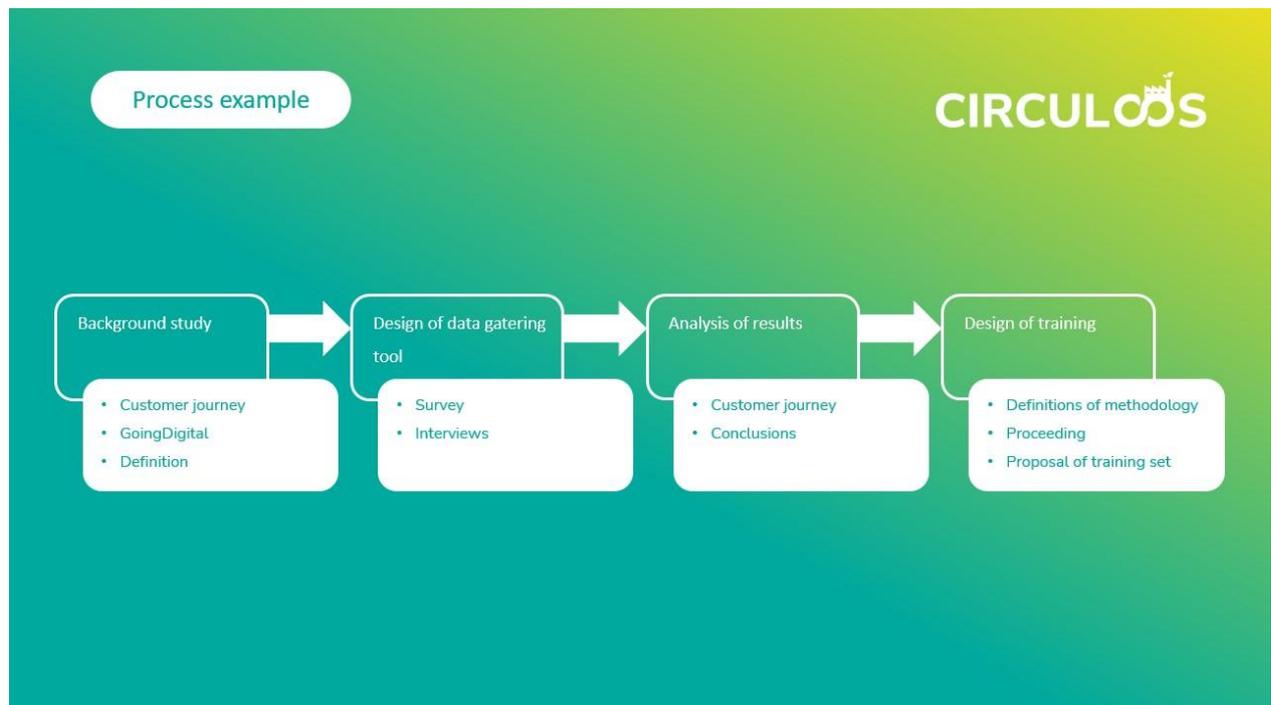

Figure 1. Phase of analysis and Methodology design

2 CONTEXTS

2.1 Skills observatory vs. training methodology

It is important to distinguish between the two functions—the skills observatory and the training methodology, which will be defined—to comprehend the actions in this work. Along with a customer journey analysis, Task 6.5 will involve developing a survey and a focus group to learn about the needs of the SMEs taking part in the Experiments for Demonstration and Validation (EXDs) and the pilots.

An active study of the abilities needed to embrace a new technology or method of working is called a skills observatory. It also involves figuring out how prevalent certain abilities are in each industry. It is necessary to first define the target groups and scope of a skills observatory. The scope and target groups can be modified later when more information becomes available. Various research methods, such as literature reviews, surveys, questionnaires, and panel discussions, can be used to collect data for a skill observatory. While a training methodology describes the primary approach taken to enhance a target group's abilities and proficiencies. Timelines, learning objectives, training methods, abilities, and competencies are all specified at varying levels of detail by the methodology. It is possible to combine a training technique with a skills observatory.

To identify the pertinent skills in the context of CIRCULOOS, this deliverable includes the preliminary findings of an early observatory activity and the developed training approach. Both the training technique and the skills observatory's structure are modeled around the Mobile World Capital Foundation's GoingDigital initiative. The purpose of the GoingDigital training program is to provide management teams and industry leaders with the necessary knowledge to start a digital transformation. The program was created for several verticals, including infrastructure, water management, civil engineering, agriculture, and the automobile sector.

2.2 Customer Journey

A customer journey analysis is used by the Going Digital Program to identify the competencies needed for SME users to successfully adopt new technologies. The company IDEO was the first to develop and deploy a customer journey as a marketing tool to enhance service design. The tool later used as a model for the creation of various value propositions, such as training programs, customer products, and product service systems.

By first identifying and then detailing the customer's contacts with the product, as well as her/his motives and feelings during the various touchpoint phases, a customer journey maps the various experiences that a consumer has with a product or service. Therefore, a customer journey is a straightforward yet effective method for teaching a business about the needs and requirements of its consumers. This information can then be used to specify the kind of experience, communication channels, and touchpoints that the company would like to provide to its customers. Additionally, the customer journey model is used to establish the skills observatory and evaluate the proficiency of various corporate profiles within the organization.

The customer journey is composed by a clearly defined set of phases for customer involvement, a list of properties that must be specified for each phase, and a methodical approach that may be used to construct it. Tincher (2013) provides an extended description of the customer journey.

The customer journey has the following phases:

- Awareness: The client learns that the good or service is available. Touchpoints that ensure clients learn about the value proposition must be specified in a customer journey design.
- Consideration: The client can compare the value proposal to personal or professional standards and has a basic comprehension of it.
- Decision: Following a clear procedure, the customer chooses to interact with the value proposition. A customer journey's design must ensure that this procedure is streamlined and that the likelihood of abandoning during this stage is kept to a minimum.
- Delivery and use: the client puts the technology into practice and utilizes it. The customer experiences the value proposition's functionalities at this point.
- Advocacy and loyalty: Constant interaction and feedback loops with customers affect their degree of technological engagement and happiness. Giving after-sales services is one aspect of this phase; on the other hand, building relationships that will help the value proposition expand is another.

For every phase, the following qualities are most frequently analysed.

- Customer goals: at every point of the journey, what is your customer looking for?
- Touchpoints: What channels may be established to notify the client at each stage?
- Expected experience: how is your customer experiencing this phase? Typical aspects to focus on include emotional experience, problem-solving perception, and business perspective.

It is especially important to remember that there are two different kinds of customer journey-related activities: customer journey propositions and customer journey analyses. The first examines how consumers interact with a current good or service. Design experience is the subject of the second one. In this study, the training methodology is created using the customer journey proposition, and the observatory function is structured using the customer journey analysis. These two stages typically take a long time, and businesses can easily become distracted. Making the customer transition during these two stages far more efficient and goal-oriented is the aim. Several management members from a single organization attending the session generates motivation for starting this kind of transformation process.

The following elements form the foundation of the Going Digital program:

a) The purpose of the inspiration session is to raise awareness of the technologies and the potential effects they may have on business models and company operations.
b) Examples and cases: Provide instances of businesses that have implemented Industry 4.0 technology and the results they have obtained.
c) Configuration and design workings: employees of the organization have the chance to learn how to create a new value chain using the technologies for a hypothetical scenario. The business case has also been developed.
d) Plan design: the organization has a clear understanding of the potential effects that integrating digital technology can have on their business as the digitalization plan is established.

The businesses are put in touch with suppliers during the sessions. Depending on the industry's complexity and the clients' needs, the duration can range from eight to twenty-four hours. Accelerating the digital transformation of businesses based in Catalonia was the goal of the program created for ACCIO, the Catalonian Trade & Investment agency.

2.3 CIRCULOOS Processes knowledge scope

The project focuses on developing tools to enable MSMEs become full members of the Circular Manufacturing value chain. According to Senior Research Scientist, Carl Christian Røstad circular manufacturing stays for the concept that creates systems where resources, materials, and products are reused, remanufactured and recycled. One of the primary goals of circular manufacturing is to minimize waste and pollution.

Circular Manufacturing Systems (CMS) refer to "systems that are designed intentionally to close the loop of products/components, preferably in their original form, through multiple lifecycles" (Asif, 2017). What are the technologies associated with circular manufacturing? The following list refers to the technologies or tools that will be used to implement the project:

- ☐ Agile Circular Manufacturing Supply Chains Architecture
- ☐ Supply Chain Process Orchestration and Execution Tool (SCPO)
- ☐ Supply Chain Optimisation Tool (SCOP)
- ☐ Distributed Identity and Access Management Framework
- ☐ Supply Chain Risk Management Process
- ☐ Federated Blockchain Network Infrastructure
- ☐ RAMP circularity platform and ecosystem as sustainable resource
- ☐ IA

2.4 Benchmark of trainings

During the reporting period, the first activity a) A Training Benchmark: desk research, partners and network (M03-M13) was completed. A list of training related to Circular Manufacturing was created by conducting exhaustive research on Google and requesting the sector ecosystem and partners to contribute through the webinar *Apply to the CIRCULOOS Expression of Interest!* The list contains 13 inputs, mainly online training (8). The only entities to provide formal training are EIT Manufacturing with MSc in Zero Defect Manufacturing for a Circular Economy and KTH International Technical University with MG2043 Circular Manufacturing Systems 6.0 credits.

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1	Own research	EIT Manufacturing	CircularDev Summer School: Be the Next Manufacturing Entrepreneur	link	Summer School	Blended	1-2 week	1.500 €	Dublin
2	Own research	EIT Manufacturing	MSc in Zero Defect Manufacturing for a Circular Economy	link	Master	On site	2 years	16.000 €	Varios
3	Own research	KTH international technical university.	MG2043 Circular Manufacturing Systems 6.0 credits	link	Course	On site	2 years	N/A	Stockholm
4	Own research	TwinRevolution	TwinRevolution e-learning course: Exploring Twin Digital and Green Transition in Manufacturing Industry	link	webinar	online	50 hours	Free	Online
5	Own research	AIMPLAS Plastics Academy	Online course on Mechanical Recycling of Plastic Materials	link	webinar	online	40 hours	392 €	Spain
6	Own research	BUSGoCircular	BUSGoCircular trains the trainers on circularity in design and construction	link	webinar	online	7,50 hours	free	Online
7	Own research	Green Growth	A Handbook for trainers: The circular economy applied to the construction industry	link	Handbook for trainers	online	N/A	free	Online
8	Own research	FURN360	FURN360: Circular business training	link	Course	online	N/A	free	Online

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			course for the furniture and woodworking sectors						
9	Own research	CIRCOVET	circular economy practical training materials for plastic manufacturing industries	link	MOOC	online	N/A	free	Online
10	Own research	NTNU	VB8001 - Sustainable and Circular Manufacturing Summer School	link	Summer School	On site	1 semester	N/A	Trondheim
11	Own research	Green Industry Platform	Circular Economy for Industry	link	Course	online	N/A	free	Online
12	External input	ImpactX	CVC FAST FORWARD - Remanufacturing the future	link	Factsheet	online	N/A	N/A	
13	External input	Circo	Circo	link	Workshop	on site	1 day	N/A	NL

Table 1 List of circular manufacturing training

Training providers are almost all coming from European-funded projects. Each training has been summarized to give an overview of the content available, in addition to extracting the competences and skills acquired when completing the training.

1. **CircularDev Summer School: Be the Next Manufacturing Entrepreneur:** The CircularDev Summer School 2023, offered by EIT Manufacturing Master School, is a hybrid program focused on cross-sectoral digital circular economy training and business development. Held from July 13 to August 3, 2023, at University College Dublin, the program provides participants with knowledge in critical areas such as circular business models, design thinking, customer discovery, competitor analysis, and sustainable leadership. Through lectures, teamwork, and hands-on projects, students engage in ideation sessions, stakeholder analysis, revenue and funding models, and brand storytelling. The program also includes industrial site visits, lab tours, and expert talks from industry leaders on topics such as carbon impact, circular economy strategies, and innovation ecosystems. The summer school culminates in a final pitch, where teams present their business ideas developed over the three-week course, showcasing their understanding of circular economy principles and startup strategies.

2. **MSc in Zero Defect Manufacturing for a Circular Economy:** The MSc in Zero Defect Manufacturing for a Circular Economy is a two-year double degree program that integrates advanced manufacturing technologies with sustainable practices to minimize waste and defects. It is part of the EIT Manufacturing Master School and offers various combinations of entry and exit universities, including Aalto University, University of Trento, Grenoble INP, and University College Dublin. The curriculum is divided into technical courses (e.g., machine design, production engineering), specialization courses (e.g., circular economy, quality management), and innovation & entrepreneurship (I&E) modules. The program includes hands-on projects, summer schools, and concludes with a master's thesis. Key themes include digital production, data analytics, sustainable manufacturing, and leadership in innovation, equipping students to lead in both circular economy and zero-defect manufacturing.

3. **MG2043 Circular Manufacturing Systems 6.0 credits:** The Circular Manufacturing Systems (MG2043) course, part of a Master's program in Mechanical Engineering, focuses on the emerging field of circular economy and its application in manufacturing. The course explores key areas such as business models, product design, supply chains, and information and communication technology (ICT) that enable circular manufacturing systems (CMS). Students will learn to strategically transition businesses from linear to circular models, study systemic perspectives of CMS implementation, and evaluate economic and environmental impacts. The course includes a combination of quizzes, project assignments, and seminars for assessment.

4. **TwinRevolution e-learning course:** Exploring Twin Digital and Green Transition in Manufacturing Industry: This innovative e-learning course is designed to drive the shift towards sustainable and digitally advanced practices in the manufacturing industry. Open to

all learners, it provides a thorough understanding of the "twin transition"—the integration of green and digital transformations in manufacturing companies. The course is structured into four comprehensive modules:

- Introduction to the Twin Transition: Gain insight into the manufacturing processes in industries like furniture and textiles, understanding the principles and necessary changes to move towards sustainability.
- Circular Economy Applied in Manufacturing: Learn how industries are transitioning from linear to circular economies, focusing on the need for change and the role of the circular economy in sustainable manufacturing.
- Industry 4.0 Technologies in Manufacturing: Explore concepts and trends in Industry 4.0, learning how to identify and select technologies crucial for modern, digital manufacturing processes.
- Twin Green and Digital Transition: Examine the intersection of green and digital innovations, focusing on technologies and skills that promote circular and sustainable processes in manufacturing.

The course, part of the TwinRevolution project and co-funded by Erasmus+, concludes with a final assessment and is designed to be completed in 50 learning hours.

5. **Online course on Mechanical Recycling of Plastic Materials**: The course "Mechanical Recycling of Plastic Materials" is an online training program aimed at enhancing skills in recycling plastics as a key component of sustainability. It is organized by AIMPLAS and is accessible throughout the year, with a duration of 40 hours and the flexibility of completing it within two months. The course is modular, interactive, and delivered entirely in English. The Key Objectives are the followed: Understand plastic waste characteristics and recycling processes ; Learn about complementary recovery processes, recycling equipment, and material additivation ; Study the identification and characterization of recycled materials ; Review legislation and certifications relevant to recycled plastics. Target Audience are focus on personnel and managers in recycling and companies utilizing recycled materials, but industrial partners and customers are prioritized for registration.

6. **BUSGoCircular trains the trainers on circularity in design and construction:** BUS-GoCircular develops a "Train the Trainers (TtT)" programme, that addresses application of the Circular Economy interventions in the construction value chain framework and the Circular Construction Skills qualification framework. All trainers together form the "BUS-GoCircular learning community" composed of leading training organisations across Europe focused on new skills for circular construction. These trainers will develop a tailored training plan which they will later implement in their own environment.

7. **A Handbook for trainers: The circular economy applied to the construction industry:** The document, "Handbook for Trainers: The Circular Economy Applied to the Construction Industry," is a guide created under the Erasmus+ Programme. It aims to introduce and promote the principles of the circular economy (CE) within the construction sector. The handbook is divided into four main units:
1. Circular Economy Basics:
   o Defines the concept of CE as an alternative to the linear economy.
   o Highlights principles such as reducing waste, reusing materials, and regenerating natural systems.

- o Introduces tools like the 9R framework and the Butterfly Diagram for implementing CE in technical and biological cycles.
2. Application in Construction:
   - o Describes the environmental impacts of traditional construction practices.
   - o Explains tools for monitoring circularity, such as Life Cycle Assessments (LCA), Environmental Product Declarations (EPD), and Material Passports.
3. Strategies for Circularity:
   - o Covers design approaches for deconstruction and adaptability, sustainable material selection, and extending the life of products and buildings.
   - o Explores business models for CE, including shared platforms, waste recovery, and product-as-a-service.
4. European Circular Economy Policy:
   - o Details the European Green Deal, emphasizing carbon neutrality, sustainable growth, and biodiversity restoration.
   - o Discusses initiatives like the New Circular Economy Action Plan and Renovation Wave, which promote sustainable construction practices.

The handbook provides theoretical frameworks, practical strategies, and policy insights to support sustainable innovation in construction.

8. **FURN360: Circular business training course for the furniture and woodworking sectors:** FURN360 offers an innovative training curriculum for the furniture sector, specifically for the office furniture and contract sectors, adapted to the future trends and needs of the whole society in terms of circular economy. FURN360 training course provides the necessary skills and knowledge regarding key principles of circular economy; challenges, opportunities and barriers in the furniture sector; offers tools that facilitate circular transformation, such as management of new circular business models, sustainability strategy, green marketing and latest trend technologies.

9. **Circular economy practical training materials for plastic manufacturing industries:** New training material answering to companies' needs, covering all the value chain of plastics is being developed. With this aim, first, the methodology and then the curricula are being set to ensure the adaptation of the material to be used in I-VET and C-VET teaching systems. Once the contents are developed, it will be tipped over MOOCs/NOOCs that will be available and accredited through micro-credentials to develop a platform for learning and connecting. Finally, strong links will be generated amongst academia, VET centres and companies to enable pilot validation of the material. Nine modules split in different levels will be available and accredited in six EU languages considering from the very beginning the needs of the companies and validated by 80 companies and 200 students of the sector.

10. **VB8001 - Sustainable and Circular Manufacturing Summer School:** The summer school on circular manufacturing provides an in-depth exploration of sustainable development and circular economy principles through a structured series of modules. The curriculum covers fundamental concepts, system and product design, key manufacturing processes, and advanced modeling techniques for circular systems. Students will engage in lectures, group work, presentations, and industrial case studies, culminating in a project report that integrates theoretical knowledge with practical applications. Participants will gain advanced knowledge in sustainable development, circular manufacturing systems, and modeling methods. They will develop skills to analyze, challenge, and apply circular manufacturing concepts to industry cases, while also exploring novel business models and product-service

systems. The course emphasizes critical thinking, system-based analysis, and effective communication of research findings. Evaluation is based on an individual final report, with no prior knowledge required, although familiarity with sustainability concepts is recommended. Course materials include scientific articles, handouts, and industry data, with preparatory reading provided.

11. **Circular Economy for Industry:** The Circular Economy in Industry course provides participants with a fundamental understanding of the circular economy, with a particular focus on industry and manufacturing. The course is designed primarily for policymakers and government officials, although it is also open to practitioners, private sector representatives, students and other stakeholders. Organized in 10 modules, the course defines the basic concepts of the circular economy, explains its different phases, discusses economic and trade aspects, and gives a preliminary introduction to renewable energy.

12. **CVC FAST FORWARD - Remanufacturing the future:** designed to promote circular manufacturing through chain collaboration. It offers companies in the manufacturing industry a structured approach to building sustainable circular value chains. The program is facilitated by the Circular Value Center with support from organizations like Yellowchess and ImpactX, focusing on collaborative innovation, co-creation with chain partners, and practical implementation. Participants work on defining their roles, developing circular business models, and creating actionable plans during facilitated sessions and workshops. The program emphasizes reducing resource usage, aligning chain partner strategies, and fostering long-term sustainability. Success stories, such as a 75% reduction in CO_2 emissions in cleanroom packaging, showcase its impact. Participation is free, requiring only a time commitment, and culminates in a detailed project plan and potential access to subsidies, research, and expert support.

13. **Circo:** The CIRCO method is based on an academic framework of the Technical University of Delft. It is called 'Products that last' and it is written by C. Bakker & M. den Hollander, e.a. This framework explains five circular business models and six circular design strategies. CIRCO expanded this framework with tools and insights, so it is useful and relevant for businesses. The method offers practical design tools, inspiring cases and examples, and it offers trainer support and interaction.

The training programs mentioned in section 2 (2.4. Benching training) focuses on diverse skills and competencies in circular manufacturing and the circular economy. In table 2, the main competences and skills have been extracted from the programs to align the CIRCULOOS training design with the existing needs. Five categories have been identified: Core technical competences, entrepreneurial and business skills, practical and project-based skills, teaching and training skills, soft skills. These competencies and skills prepare participants to lead sustainable innovations, design circular solutions, and drive systemic change in industries adopting circular manufacturing principles. Participants of the session will be asked to give their feedback on whether the identified competencies and skills are adaptable for the CIRCULOOS' training.

Competencies	Sub competencies	Description
Core Technical Competencies	Circular Economy Principles	Understanding circular business models, lifecycle analysis (LCA), and environmental impact assessments

		Knowledge of tools like the 9R framework, Butterfly Diagram, and Material Passports
		Transitioning from linear to circular systems in industries like plastics, construction, and manufacturing
	Sustainable Manufacturing	Design for adaptability, deconstruction, and sustainable material selection
		Strategies for zero-defect manufacturing and waste reduction
		Familiarity with Industry 4.0 technologies and their role in circular processes
	Advanced Manufacturing Technologies	Application of digital production, data analytics, and modeling for circular systems
		Practical knowledge of recycling processes, equipment, and materials
		Understanding mechanical recycling and complementary recovery processes for plastics.
Entrepreneurial and Business Skills	Innovation and Leadership	Sustainable leadership in innovation ecosystems.
		Exploring and implementing circular business models like product-as-a-service and waste recovery.
	Business Development	Ideation, stakeholder analysis, customer discovery, and competitor analysis.
		Creation of revenue and funding models.
		Circular value chain collaboration and co-creation strategies.
	Green Marketing and Branding	Developing sustainability strategies and green marketing approaches
		Effective brand storytelling for circular business ideas.
Practical and Project-Based Skills	Hands-On Application	Industrial site visits, lab tours, and case study analysis.
		Final projects integrating theoretical knowledge with practical applications (e.g., business pitch or project report).
	Collaborative Skills	Co-creation with industry and academic partners
		Developing and validating training materials with companies and learners.
	Digital Skills for Twin Transition	Integrating digital and green transformation strategies in manufacturing
		Using digital tools to enhance sustainable processes.
Teaching and Training Skills	Training Development	Creating training programs tailored to circular construction and manufacturing needs.
		Facilitating trainer communities and supporting capacity building for circularity.

	Educational Material Design	Development of modular and interactive learning materials (e.g., MOOCs, NOOCs)
		Ensuring alignment with industry needs through accreditation and micro-credentials.
Soft Skills	Critical Thinking and System Analysis	Evaluating systemic impacts of transitioning to circular models
		Conducting strategic analyses for circular economy implementation.
	Communication and Presentation	Evaluating systemic impacts of transitioning to circular models
		Conducting strategic analyses for circular economy implementation.
	Teamwork and Collaboration	Participating in teamwork during ideation sessions, group work, and co-creation activities.
		Collaborating with cross-sectoral partners and stakeholders.

Table 2 Programmes main competencies and skills

3 SMEs needs analysis

3.1 Implications for demand analysis

Core technical competences, Entrepreneurial and business skills, practical and project-based skills, teaching and training skills, soft skills are the subjects to be investigated in this analysis study of the needs of SMEs. Details on the research tools used to gather this data are provided in the section that follows. To better identify the specific needs of SMEs and adjust the anticipated customized training kit, a questionnaire and focus group are being developed. A customer journey analysis will be conducted internally using the GoingDigital methodology, and it will be discussed with the SMEs to learn about their experiences working with Experiences and RAMP from the start of the project. To comprehend the various purposes that the training components can serve, the questionnaire, focus group, and customer journey activities are necessary. Functions range from teaching skills to comprehending the importance of a certain technology and its operation. The stages of the technology adoption cycle are followed by the customer journey. Even though online training is increasingly becoming a popular educational medium, certain training roles and stakeholder types may need a face-to-face approach to meet their learning goals.

3.2 Focus group questions

The objective of the focus group is to collaboratively identify and address the training needs required for the successful adoption and implementation of circular manufacturing practices, with a particular emphasis on the advanced technologies and methodologies developed within the CIRCULOOS project. By engaging consortium members such as technical partners, European Digital Innovation Hubs (DIHs), SMEs, and other stakeholders, the focus group aims to bridge current skills gaps and design effective, tailored training programs that empower SMEs and mid-caps to transition to agile, circular supply chains. The group also seeks to establish a sustainable framework for knowledge exchange and capacity building, ensuring that participants can integrate innovative tools such as IoT/CM technologies, supply chain optimization federated blockchain networks, and industrial AI into their operations while building resilience and fostering sustainability.

Below, the agenda proposal for the focus group, organised in M18, will have a duration of 40 minutes. To ensure the quality of the answer provided by CIRCULOOS' partners, the questions will be sent days before. To start with a brief overview and goals of task 6.5 will be presented as much as the key CIRCULOOS technologies and their implications for skills development. Before starting with the specific questions prepared for the session, the audience will be informed about how to use the digital board (e.g. Mural) used to collect the answers.

The session will focus on identifying the specific skills and competencies required to implement CIRCULOOS technologies. Partners will have to answer questions related to their companies and their workers expectations. How the skills needs will be implemented in the companies. The focus area questions will help to shape the training curricular. Finally, the companies will have to design a portrait of their employees to ensure building the most appropriate training for them. Figure 2 indicates all the steps that will be taken during the focus group.

CIRCULOOS

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PART 1

Profile Meeting

PURPOSE
In this first board we are presenting ourselves and identifying the benefits and core promises of the technology implementation.

SETUP

COLOURS ASSIGMENT   TIME 20 MINS

STEPS

1. Fill out your profile (13 min).
2. Present your profile (7 min).

TIPS FOR COMPLETING

1. Before the workshop, make sure you have read the board and draft some ideas.
2. Here we add some helpful questions to complete the boards:
- My team: Who is involved in this experiences? Identify the manufacturer and technology provider.
- My background: Which are your company's main manufacturing process challenges?
- New technologies: How will you use the technology on the manufacturing chain.
- Expectations: What will be the expected impacts of adopting the new technologies at a company level? Do you expect any benefits for the workers? What will be the advantages for the final customers? Any other impact?
- My workers' expectations: What are your workers' expectations?

1. Create your profile (10 Min)

Fill out the different areas of your profile.

Thermolympics — My team, My background, My expectations, New technologies, My workers' expectations

Contenedores Lolo — My team, My background, My expectations, New technologies, My workers' expectations

Khoani — My team, My background, My expectations, New technologies, My workers' expectations

B&A — My team, My background, My expectations, New technologies, My workers' expectations

ITI Hungary — My team, My background, My expectations, New technologies, My workers' expectations

Circu Leren — My team, My background, My expectations, New technologies, My workers' expectations

Plennid — My team, My background, My expectations, New technologies, My workers' expectations

Herso — My team, My background, My expectations, New technologies, My workers' expectations

PART 2

Skills needs -
Implementation

PURPOSE
The idea of this second board is to understand the implementation methodology and steps you will follow as well as your skill needs to perform this implementation

SETUP

COLOURS ASSIGMENT | TIME 25 MINS

STEPS
1. Read and answer the questions regarding the skills' needs for the implementation of the technologies in your KTE.

TIPS FOR COMPLETING
1. Before the workshop, make sure you have read the questions in the board and draft some ideas of answers.
2. During the workshop you will be able to countinue answering the questions. You can also include images if needed.

Thermolympics

ITI Hungary

Khoani

B&A

Contenedores Lolo

Circu Leren

Plennid

Herso

PART 3

Skills needs -
Focus area

PURPOSE
The focus areas for training and capacity building in circular manufacturing emphasize developing skills and knowledge across critical technologies and frameworks.

SETUP

COLOURS ASSIGMENT | TIME 80 MINS

STEPS
1. Read and answer the questions about the skills needs regarding your information and data awareness. In that case, include your answers in your sector's column using your colour

TIPS FOR COMPLETING
Before the workshop, make sure you have read the board and draft some ideas.

	Plastic		Leather			Wood		
1 How can architecture frameworks be effectively applied to design and implement circular supply chains within the manufacturing industry?								
2 What are the key functionalities and benefits of orchestration tools in managing circular supply chain operations efficiently?								
3 How can data analytics and modeling enhance the optimisation of circular supply chains to improve resource efficiency and sustainability?								
4 What are the best practices for implementing secure frameworks that facilitate stakeholder collaboration in circular supply chains?								
5 What strategies can be employed to identify, assess, and mitigate risks associated with circular manufacturing ecosystems?								
6 How can blockchain technology improve transparency and traceability in circular supply chain networks?								
7 How does the RAMP platform enable resource-sharing and collaboration among manufacturing SMEs for sustainable operations?								
8 What are the key applications of AI in enhancing decision-making processes within circular manufacturing systems?								

Figure 2 Mural template for the focus group

The session will close with a first analysis of the results obtained through summarizing the key takeaways. The final results will be sent to the partners afterwards and will be used to design a questionnaire to be send to DIHs and furthermore to create the training.

3.3 Key focus areas

The focus areas for training and capacity building in circular manufacturing emphasize developing skills and knowledge across critical technologies and frameworks. These include understanding and applying architectural frameworks for agile circular supply chains and training in tools such as Supply Chain Process Orchestration (SCPO) and Optimization (SCOP) to enhance operational efficiency and data-driven decision-making. Additionally, the program targets competencies in secure collaboration through Distributed Identity and Access Management frameworks, and risk management skills for assessing and mitigating challenges in circular ecosystems. Emphasis is also placed on leveraging Federated Blockchain Networks for transparency, utilizing the RAMP Circularity Platform for sustainable resource sharing, and integrating Industrial AI applications to drive innovation and support decision-making in circular manufacturing. Table 3 shows the key focus areas:

Focus Area	Description	Key Competency
Agile Circular Manufacturing Supply Chains Architecture	Understanding and applying architecture frameworks for circular supply chains.	Circular supply chain frameworks

Supply Chain Process Orchestration and Execution Tool (SCPO)	Training in using and customizing orchestration tools for circular operations.	Orchestration tool expertise
Supply Chain Optimisation Tool (SCOP)	Data analytics and modelling for optimizing circular supply chains.	Data-driven supply chain optimization
Distributed Identity and Access Management Framework	Knowledge of secure frameworks for stakeholder collaboration.	Secure collaboration methods
Supply Chain Risk Management Process	Skills to identify, assess, and mitigate risks in circular ecosystems.	Risk assessment and mitigation
Federated Blockchain Network Infrastructure	Understanding blockchain's role in ensuring transparency and traceability.	Blockchain transparency skills
RAMP Circularity Platform and Ecosystem	Familiarity with the platform as a resource-sharing tool for sustainable operations.	Resource sharing through RAMP
Industrial AI Applications	Training on integrating AI for decision-making in circular manufacturing.	AI-driven decision-making

Table 3 List of CIRCULOOS key focus areas

The focus group is expected to deliver several key outcomes that will drive the successful implementation of Task 6.5 and support the CIRCULOOS project. By conducting a thorough evaluation, it aims to identify specific gaps in technical, entrepreneurial, and practical skills, laying the groundwork for a comprehensive training needs assessment. This process will ensure that the unique challenges faced by SMEs and mid-caps in adopting circular manufacturing practices are clearly understood.

Building on this assessment, a customized training roadmap will be developed. This plan will focus on creating modular and scalable training programs, tailored to address the identified needs. The roadmap will serve as a strategic guide, providing targeted capacity-building initiatives that are both effective and adaptable to the diverse contexts of participating organizations.

To sustain long-term collaboration and knowledge-sharing, a robust framework will be established. This framework will facilitate ongoing exchanges among consortium members, European Digital Innovation Hubs (DIHs), and SMEs. By fostering this collaborative environment, the initiative ensures that expertise and resources are continually shared to strengthen collective capabilities.

Ultimately, these efforts will empower SMEs and mid-caps to adopt and integrate CIRCULOOS technologies effectively. By equipping them with the necessary skills and competencies, the focus group will support the transition towards circular manufacturing practices, enhancing resilience and sustainability within the sector.

4 Next steps: training design and uploading on the CIRCULOOS learning platform

Based on the previous, the CIRCULOOS training will be complemented with direct inputs from DIHs members and project members during the focus group session and the Training Needs Survey which will be disseminate in activities (e.g. webinar, workshops) organised by CIRCULOOS as much as during other actions involving the sector and DIHs. The tool will also provide evaluation and skills assessment functionalities. Furthermore, in order to create awareness in younger generations about the future of CM, 6 seminars will be implemented in highschools and universities, in which some workshops will be created involving the EDXs.
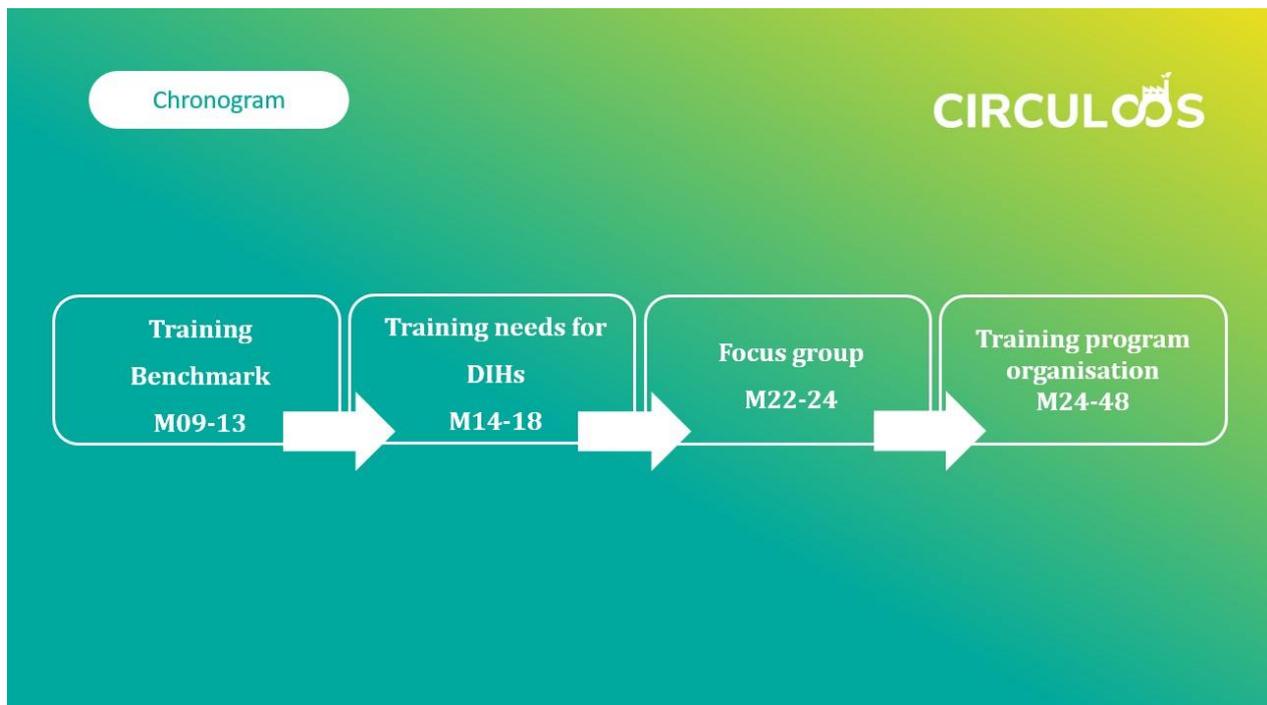

Figure 3 Training activities and platform Gantt

5 Conclusions

This deliverable has served to highlight CIRCULOOS Processes knowledge scope and to list the already existing training which has help to extract a preliminary numbers of the sector main competences skills. By establishing the methodology and explaining the tool (Focus group) used to identify the sector competences, the report contribute to respon to the main objective of the task 6.5 Strategy for Skills Development to Foster Circular Manufacturing (MWCB, M9-M42) which aims to empower and strengthen SMEs and small mid-caps' capacities in these technologies by supporting the transfer of knowledge on IOT/CM and reliable supply chains and building resilience. elaborate the CIRCULOOS training programme.

CIRCULOOS project represents a pivotal step in empowering MSMEs to adopt circular manufacturing principles and practices, addressing the urgent need for sustainable industrial processes. By integrating advanced tools, fostering collaboration, and providing tailored training solutions, the project paves the way for a resilient and innovative manufacturing ecosystem.

Task 6.5 plays an important role in this transformation by focusing on capacity building and knowledge transfer. Through a combination of skills observatory activities, customer journey analysis, and dynamic stakeholder engagement, the initiative aligns industry needs with training solutions that empower SMEs to thrive in a circular economy. The focus on sustainability, transparency, and innovation ensures that participants are well-equipped to navigate the complexities of the circular manufacturing landscape.

As the project progresses, the integration of feedback from stakeholders and the refinement of training methodologies will reinforce its impact. CIRCULOOS contributes significantly to the global transition towards a sustainable and circular manufacturing paradigm through the design of a collaborative ecosystem that bridges knowledge gaps and drives the adoption of advanced technologies.