Interreg Danube Region

Co-funded by the European Union

Plan-C

Definition of machine applications and circular life cycle phases to be elaborated

Deliverable D.2.2.1

Responsible Partner: ICMF

Document Content

1. Introduction

D.2.2.1 – Definition of machine applications and circular life cycle phases to be elaborated, is part of one of the activities within Specific Objective (SO) 2 - Transformation of the MACHINE INDUSTRY into a circular economy, using a design thinking methodology, which main objective is to demonstrate the MACHINE INDUSTRY in the Danube Region how to transform towards a circular economy in practice. The SO2 structure is as follows: To cope with the challenges of the machine industry in regard to circularity (problem space), PPs and companies create and prototype innovative machine life cycle phases (solutions space) and derive business models from that, along the whole machine life cycle, summarized as circular machine solution (transfer phase).

D.2.2.1 is the first step in developing a Transnational strategy for accelerating circularity in the machine industry. The Transnational strategy will serve companies of the regional/transnational machine industry ecosystem of the Danube Region as a framework for their transformation process.

Specifically, this is part of the Activity 2.2 - Solution Space: From design thinking of life cycle phases to the development of circular solutions in the machine industry. This activity aims at developing innovative answers to transform the current (linear) life cycle phases into phases that are in line with the circular economy. The participating companies will increase their know-how and will start to change their behavior towards a more sustainable business.

At first, the PPs define relevant machine application fields for prototyping in line with regional machine ecosystem characteristics, and define the machine life cycle phases to be innovated during piloting: e.g. circular machine conceptualization + engineering, sustainable production of metal parts, tools and machines, maintenance during the use phase, circular solutions for end of machine life, etc. This is exactly what D.2.2.1 is about.

After this, each of the defined life cycle phases will be analyzed, ideated, and enhanced towards circularity aspects, and finally prototyped (low fidelity), by applying a design thinking approach. This piloting with local companies will be implemented in workshops in the PP regions. The resulting single machine life cycle steps from piloting, framed to circularity aspects will be combined into one circular machine life cycle concept, leading to the solution, how companies from the machine industry can enter a circular economy. This solution, the Guideline for circularity in the machine industry will be established to initiate change in the regional ecosystems.

Accordingly, Activity 2.2 (Solution Space: From design thinking of life cycle phases to the development of circular solutions in the machine industry) includes the following deliverables:

D.2.2.1 – Definition of machine applications and circular life cycle phases to be elaborated

D.2.2.2 – Creation of innovative, circular machine life cycle phases

D.2.2.3 – Transnational peer-level capacity building

D.2.2.4 – Drafting documents about circularity in machine industry, incl. dissemination

2. Task

In order to complete the Activity 2.2, the first task is D.2.2.1, so defining the machine applications and life cycle phases which will be further elaborated during the pilot design thinking workshops.

First, the machine applications, relevant in the local ecosystems of the PPs, are defined.

As a second step, the partners define which circular machine life cycle phases will be elaborated in detail in the PP regions during the piloting (D.2.2.2).

ICMF, as the leader of Activity 2.2, intending to fulfill the aim of D.2.2.2, organized an online workshop for partners, during which machine applications and life cycle phases were defined. The workshop was held via Zoom on September 10, 2024, from 11:00 to 12:00.

3. Analysis

ICMF structured the workshop to first discuss with partners the importance of integrating circular practices and mechanisms into the business models of companies operating in the machine industry.

Integrating circular practices and the circular economy into the business models of companies in the machine industry is crucial for fostering long-term sustainability, efficiency, and competitiveness. The machine industry often involves high resource consumption, waste production, and reliance on finite raw materials.

Circular practices, such as designing products for durability, reparability, and recyclability, help companies reduce material waste, lower production costs, and minimize environmental impact. By adopting closed-loop systems, where products and materials are reused or repurposed, companies can reduce their dependence on virgin resources and mitigate supply chain risks.

Furthermore, a circular approach enhances innovation, allowing businesses to explore new revenue streams through product-as-a-service models or remanufacturing, while also meeting growing regulatory and consumer demands for sustainable practices.

As governments and markets increasingly favor sustainable development, companies that fail to adopt circular principles may face higher costs and reputational risks. Ultimately, circular economy integration supports the long-term resilience and adaptability of machine industry businesses in a rapidly evolving global landscape.

To define the machine applications, ICMF has analyzed in detail various industries globally, with a special focus on the Danube region, and mapped the following industries as the most promising candidates for adopting circular economy principles:

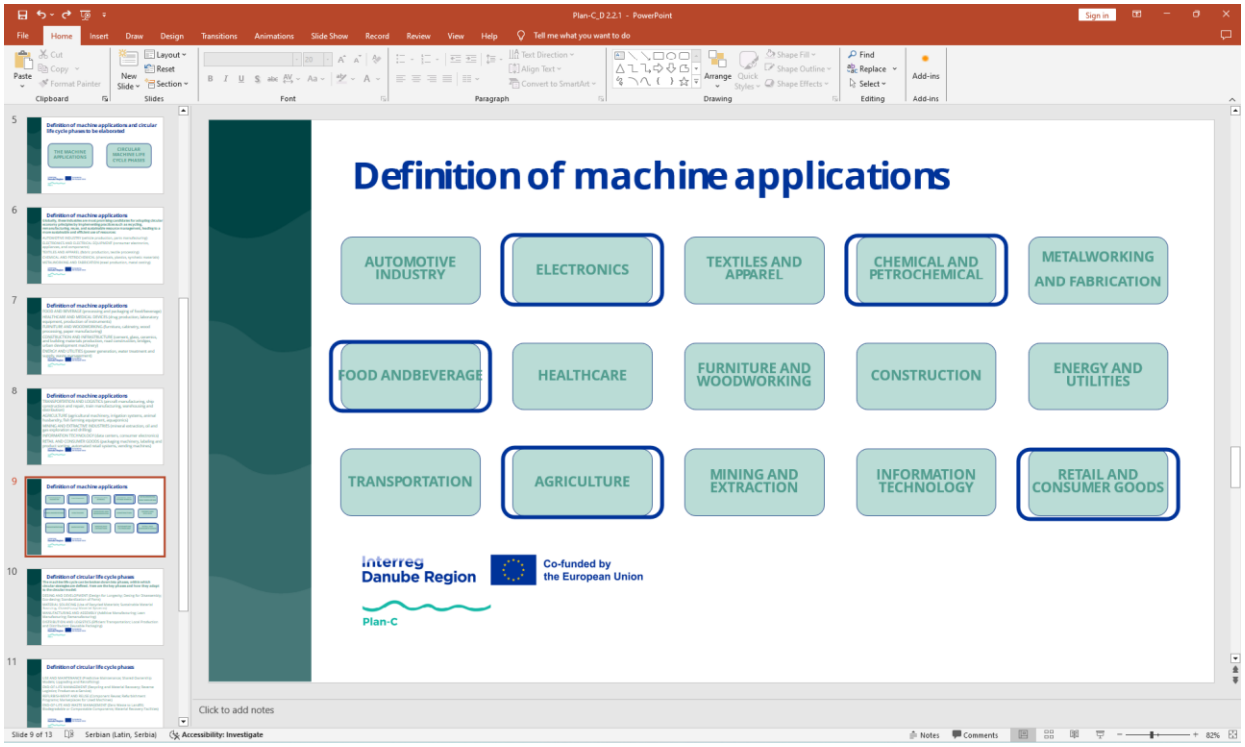
1. Automotive industry (vehicle production, assembly, and parts manufacturing, vehicle refurbishing)
2. Electronics and electrical equipment (manufacturing of consumer electronics, appliances, and components)
3. Textiles and apparel (Fabric production, garment manufacturing, and textile processing)
4. Chemical and petrochemical industry (production of chemicals, plastics, and synthetic materials)
5. Metalworking and fabrication (steel production, metal casting, and machining processes)
6. Food and beverage (processing and packaging of food/beverage products)
7. Healthcare and medical devices (drug production, packaging, medical equipment manufacturing, laboratory equipment, production of instruments)
8. Furniture and woodworking (manufacturing of furniture, cabinetry, and wood products, paper manufacturing and recycling facilities)
9. Construction and infrastructure (cement, glass, ceramics, and building materials production, road construction, bridges, urban development machinery)
10. Energy and utilities (power generation, water treatment and supply, waste management and recycling)
11. Transportation and logistics (aircraft manufacturing, ship construction and repair, train manufacturing, warehousing and distribution)
12. Agriculture (agricultural machinery, irrigation systems, animal husbandry, fish farming equipment, aquaponics, greenhouse technology)
13. Mining and extractive industries (mining machinery, drilling equipment, and exploration, drilling, and refinery machinery for oil and gas)
14. IT (servers, cooling systems, data storage hardware, and consumer electronics – computers, smartphones, and networking equipment)
15. Retail and consumer goods (packaging machinery, labeling and product sorting, automated retail systems, vending machines)

In this way, machine applications are defined, i.e. industries that have great potential for a circular transformation. ICMF additionally singled out 5 industries that, according to the results of the previous research, appear to already have somewhat ready technology, knowledge, and skills for the process of circular transformation and are prepared to implement circular business models to a certain extent.

Those industries are:

- Electronics and electrical equipment
- Chemical and petrochemical industry
- Food and beverage
- Agriculture
- Retail and consumer goods.

Based on this analysis and 15 defined machine application fields, the partners had to vote for those they considered the most relevant, primarily in the context of local conditions (and importance) for the implementation of circular economy principles and the transformation level of the Danube region.



After the part of the workshop that was dedicated to machine application fields, a part that focused on machine life cycle phases and the potential for their circular transformation followed.

The machine life cycle can be broken down into 8 phases, and within them, different circular strategies are defined and implemented. Those 8 phases (and strategies within them) are:

1. Desig and development
   Design for Longevity: Create machines with a longer lifespan by using durable materials and modular designs that allow for easy upgrades and repairs;
   Design for Disassembly: Ensure that machines can be easily disassembled into components for repair, refurbishment, remanufacturing, or recycling at the end of their life;
   Eco-design: Incorporate sustainable materials and energy-efficient technologies into the design phase to reduce environmental impact throughout the machine's life cycle;
   Standardization of Parts: Use standardized components that can be easily replaced or upgraded, reducing the need for custom parts and simplifying repairs.
2. Material sourcing
   Use of Recycled Materials: Prioritize the use of recycled or renewable materials in the manufacturing of machines to reduce reliance on virgin resources;
   Sustainable Material Sourcing: Source materials from suppliers who adhere to sustainable practices, ensuring the minimization of environmental impacts and ethical labor practices;
   Closed-Loop Material Systems: Implement closed-loop systems where materials can be continuously recycled back into new products without losing quality.

3. Manufacturing and assembly
   Additive Manufacturing (3D Printing): Utilize 3D printing to produce parts on demand, minimizing waste and enabling on-site production of components;
   Lean Manufacturing: Adopt lean manufacturing techniques to minimize waste, reduce energy consumption, and optimize resource use during production;
   Remanufacturing: Implement remanufacturing processes where used machines or components are restored to like-new condition, extending their lifecycle.

4. Distribution and logistics
   Efficient Transportation: Use optimized logistics to reduce transportation emissions, such as through route planning, load optimization, and the use of electric or low-emission vehicles;
   Local Production and Distribution: Encourage local production to reduce transportation distances and associated emissions, while supporting regional economies;
   Reusable Packaging: Implement reusable or returnable packaging solutions to minimize packaging waste in the supply chain.

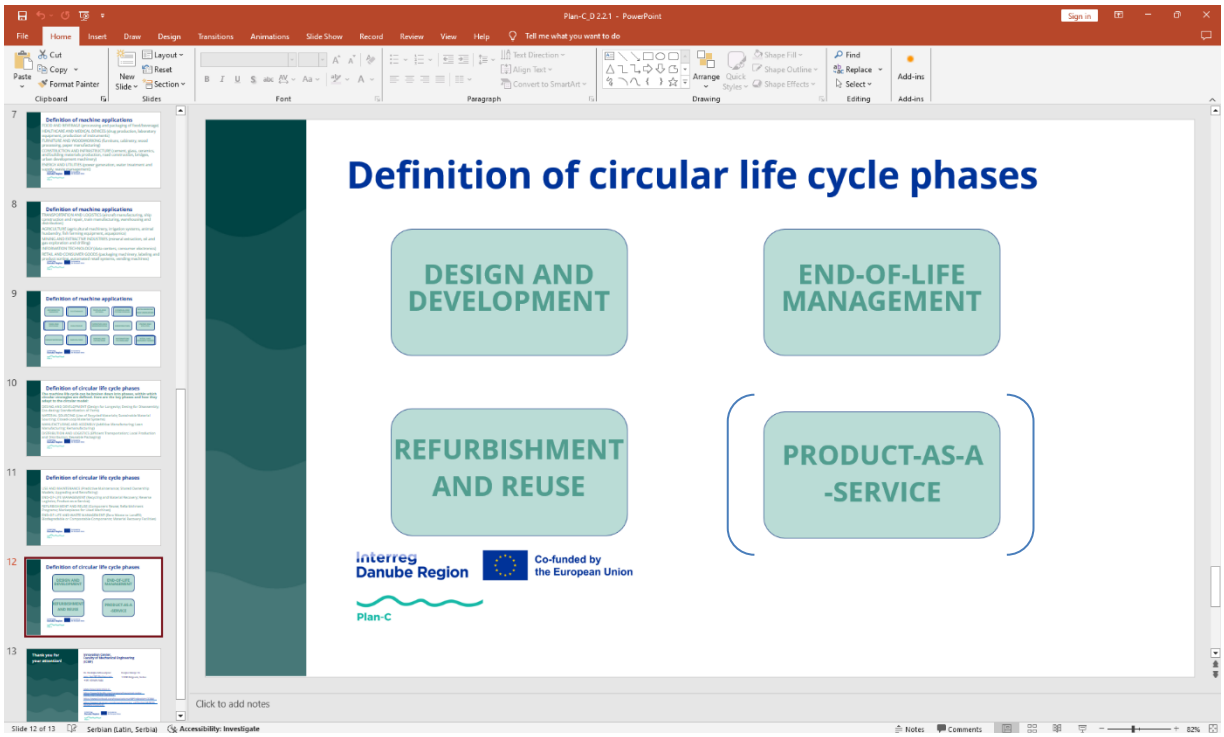
5. Use and maintenance
   Predictive Maintenance: Utilize IoT and AI technologies to monitor machine performance and predict maintenance needs, reducing unplanned downtime and extending machine life;
   Shared Ownership Models: Promote shared ownership or leasing models where machines are used by multiple entities, maximizing utilization and reducing the need for new machines;
   Upgrading and Retrofitting: Provide options for upgrading or retrofitting machines with the latest technologies rather than replacing them, prolonging their useful life.

6. End-of-life management
   Recycling and Material Recovery: Develop systems for the effective recycling of machine components and recovery of valuable materials at the end of the machine's life;
   Reverse Logistics: Implement reverse logistics systems to take back used machines for refurbishment, remanufacturing, or recycling;
   Product-as-a-Service (PaaS): Transition from selling machines to offering them as a service, where the manufacturer retains ownership and is responsible for maintenance, upgrades, and end-of-life disposal.

7. Refurbishment and reuse
   Component Reuse: Encourage the reuse of functional components from decommissioned machines in the manufacturing of new or refurbished machines;
   Refurbishment Programs: Establish refurbishment programs where used machines are restored to working condition and resold, reducing the need for new production;
   Marketplaces for Used Machines: Create platforms or marketplaces for the sale of refurbished or second-hand machines, promoting reuse.

8. Waste management
   Zero Waste to Landfill: Implement strategies to ensure that no components of the machine are sent to landfills, through recycling, composting, or other waste management techniques;
   Biodegradable or Compostable Components: Design certain components to be biodegradable or compostable, reducing the impact of waste disposal;
   Material Recovery Facilities: Develop specialized facilities for recovering and processing materials from end-of-life machines.

ICMF singled out the phases: Design and development, End-of-life management, and Refurbishment and reuse as the phases of the machine life cycle in which there is the greatest potential for circular transformation.



Additionally, and by the research and the previously done analysis of the current state-of-art, one strategy in particular stands out when it comes to the potential, efficiency, and success of the circular transformation process, and that is Product-as-a-service.

This emphasis was aimed at setting the basis for defining circular life cycle phases that will be elaborated during piloting within D 2.2.2.

4. Solution & Conclusion

After presenting the industries in which machines are applied and which have a high potential for circular transformation, the partners were asked to evaluate them and select the industries they consider most relevant, which will be the focus of piloting within D.2.2.2 - representatives of companies from those industries will be the target group for the implementation of design thinking workshops.

The results of the evaluation look like this:

Please choose 5 industries/fields in which machines are applied and used, which you consider to have the greatest potential for circular transformation and for which the implementation of design thinking workshops will be effective:

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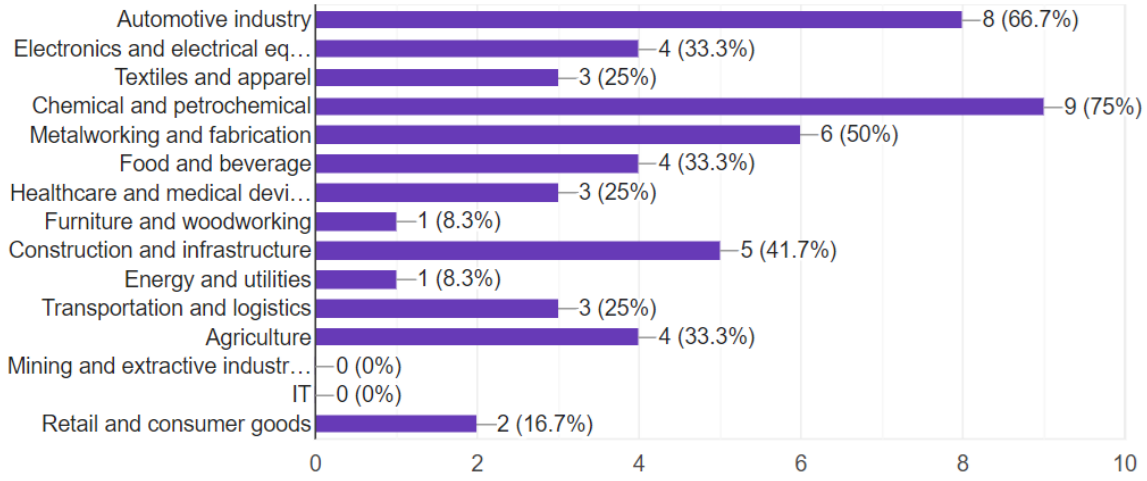
12 responses



The partners concluded that the first focus should be General machine production for various industries. In this way, a more comprehensive approach is ensured, and some machine application fields are not excluded, which may not give such efficient and measurable results at a higher level, but in separate cases of certain companies, in certain countries, there are excellent examples of the circular business models adoption.

Following this conclusion, and then following the results of the evaluation of the proposed specific industries, the defined machine applications are:

1. General machine production for various industries
2. Chemical and petrochemical industry (incl. plastics industry)
3. Automotive industry
4. Metalworking and fabrication
5. Construction and infrastructure

Each partner should choose 3 machine application fields/focuses they consider the most relevant for their country and implement design thinking workshops for companies from those sectors.

Regarding the definition of circular life cycle phases, the partners concluded that the focus of the design thinking workshops should be all 8 pre-defined and explained phases.

Although, indeed, some of them have already been proven to have recognizable and effective potential for the application of the circular economy mechanisms and principles, it is necessary to find as many innovative proposals and solutions as possible, and this will only be ensured if piloting is applied to all phases and through design thinking methodology attempts to circular solutions are reached for each of the life cycle phases of a machine. Representatives of the companies that will participate in the piloting within D.2.2.2 will be encouraged to think about the possibilities for introducing innovative, circular solutions in all phases of the life cycle of the machine, which should result in more diverse opportunities for circular transformation in practice and extremely efficiently fulfilled the goal of piloting itself, which will consequently enable the wider dissemination of good results and practices.