

Titolo: DIGital Twins for CIRCular Economy (DIGIT4Circle)

Codice MUR: P2022788KK

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Durata: 30/11/2023 - 29/11/2025 (24 mesi)

Budget totale progetto: 263.683,00 €

Budget UNIPD: 123.683,00 €

Abstract del progetto: DIGIT4CIRCLE revolves around the application of the Digital Twin (DT) paradigm to production processes in the Circular Economy (CE), in an effort of obtaining more sustainable supply chains based on recycling and reusing products. We argue that the biggest challenge in establishing digital representations of production processes does not concern the characterization of the individual stages, but rather is connected to the information flow that must be harmonized and spread to convey a meaningful representation.

Indeed, applying DT to individual instances of production processes to obtain a Manufacturing as a Service (MaaS) is a relatively established practice, but closing the loop to obtain a CE clashes with the problems of characterizing the myriads of events occurring during the lifecycle of a product that ultimately determined its termination.

To overcome this problem, DIGIT4CIRCLE proposes a middleware architecture to federate domain-specific application islands and converge towards a DT model that can be applied to a CE. In particular, the architecture itself combines 4 levels of applications of different domains of information technologies. First, we will develop a virtualized platform of convergence of digitized models to represent production processes. Second, we will feed data to the platform acquired via virtual reality (VR) instruments and quality of experience (QoE) evaluations to assess the individual experiences and events that may occur in the entire lifecycle of the product, from creation to use until termination, to understand the condition to establish for its possible recycling and/or reuse.

Third, we will apply machine learning techniques for the extraction of features, classification of functional behaviours, and detection of anomalies inside the production cycle, to abstract from the specific supply chain and enable the transition of the platform from particular to general, also allowing for portability and scalability. Finally, as a fourth part of the project, we will investigate the exchanges of information across the agents involved, which may be structural entities of different kinds (users/customers and producers) as well as multiple ownerships. This requires the creation of a protected dataspace with specific privacy-ensuring techniques to enable a seamless exchange of information and incentivize the adoption of the proposed techniques.

DIGIT4CIRCLE will strive to concretely merge all these components into a single architecture, which would represent a considerable innovation and technological advancement, as the development of practical instruments supporting DT and CE (even taken individually, and even more so if combined) is usually seen from a high-level perspective as a theoretical requirement, but rarely tackled in practice. Thus, it represents a leap forward in the development of dynamic industrial ecosystems towards sustainable-by-design green technologies.



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