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From Linear to Circular Model: An Artificial Intelligence-Powered Approach in Fosso Imperatore

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Abstract : — The growing scarcity of resources and the mounting pressures of climate change, water pollution, and chemical contamination have prompted societies, governments, and businesses to seek ways to minimize their environmental impact. To combat climate change, and foster sustainability, Industrial Symbiosis (IS) offers a powerful approach, facilitating the shift toward a circular economic model. IS has gained prominence in the European Union's policy framework as crucial enabler of resource efficiency and circular economy practices. The essence of IS lies in the collaborative sharing of resources such as energy, material by-products, waste, and water, thanks to geographic proximity. It can be exemplified by eco-industrial parks (EIPs), which are natural environments for boosting cooperation and resource sharing between businesses. EIPs are characterized by group of businesses situated in proximity, connected by a network of both cooperative and competitive interactions. They represent a sustainable industrial model aimed at reducing resource use, waste, and environmental impact while fostering economic and social wellbeing. IS, combined with Artificial Intelligence (AI)-driven technologies, can further optimize resource sharing and efficiency within EIPs. This research, supported by the "CE_IPs" project, aims to analyze the potential for IS and AI, in advancing circularity and sustainability at Fosso Imperatore. The Fosso Imperatore Industrial Park in Nocera Inferiore, Italy, specializes in agriculture and the industrial transformation of agricultural products, particularly tomatoes, tobacco, and textile fibers. This unique industrial cluster, centered around tomato cultivation and processing, also includes mechanical engineering enterprises and agricultural packaging firms. To stimulate the shift from a traditional to a circular economic model, an AI-powered Local Development Plan (LDP) is developed for Fosso Imperatore. It can leverage data analytics, predictive modeling, and stakeholder engagement to optimize resource utilization, reduce waste, and promote sustainable industrial practices. A comprehensive SWOT analysis of the AI-powered LDP revealed several key factors influencing its potential success and challenges. Among the notable strengths and opportunities arising from AI implementation are reduced processing times, fewer human errors, and increased revenue generation. Furthermore, predictive analytics minimize downtime, bolster productivity, and elevate quality while mitigating workplace hazards. However, the integration of AI also presents potential weaknesses and threats, including significant financial investment, since implementing and maintaining AI systems can be costly. The widespread adoption of AI could lead to job losses in certain sectors. Lastly, AI systems are susceptible to cyberattacks, posing risks to data security and operational continuity. Moreover, an Analytic Hierarchy Process (AHP) analysis was employed to yield a prioritized ranking of the outlined AI-driven LDP practices based on the stakeholder input, ensuring a more comprehensive and representative understanding of their relative significance for achieving sustainability in Fosso Imperatore Industrial Park. While this study provides valuable insights into the potential of AIpowered LDP at the Fosso Imperatore, it is important to note that the findings may not be directly applicable to all industrial parks, particularly those with different sizes, geographic locations, or industry compositions. Additional study is necessary to scrutinize the generalizability of these results and to identify best practices for implementing AI-driven LDP in diverse contexts.

Keywords : artificial intelligence, climate change, Fosso Imperatore, industrial park, industrial symbiosis
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