The role of Industrial Symbiosis in Circular Economy

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Due to multi-layered bills of materials, material flow management becomes significantly more difficult. Significant organisational adjustments are needed to make the shift to circular economy (CE) material flows, from restructuring supply chain operations to instilling a sustainable attitude in product designers. Since managing reverse cycles and reuse & remanufacturing processes necessitates systemic adjustments across a wide range of domains, from product development to production and supply chain management, decisions made by operations managers will unavoidably influence the transition towards CE models.

The shift to circular business models affects operations managers' decisions since it calls for changes in a number of sectors, including manufacturing, supply chain management, product development, and reverse cycle management. The changes made by the CE, such as disassembly and the reverse flows needed for remanufacturing or reuse, cause problems with production scheduling. Only with complete supply chain management collaboration can closed loop solutions be put into practice. Logistics and supply chain management must thus adapt to the new economic paradigm.

Partnerships between companies are therefore essential since they facilitate information exchange and teamwork. A few businesses have already achieved a high level of integration, which enables them to establish symbioses and industrial eco-parks that maximise their direct and reverse flows. Trash recovery from supply networks is becoming simpler because to major advancements in reverse logistics.

In addition to the expected number of recycled materials and parts for remanufacturing, managers developing a CE business model must ascertain the amount of generated and virgin materials that will be needed. In terms of the technological cycle (material circularity and repair), reverse logistics and the CE are closely related. Additionally, both are related to the concept of sustainability.

Industrial sustainability embodies the broad idea of a creative, regenerative, and constructive economy. Thus, "Industrial Sustainability" refers to a set of assumptions, rules, and analytical tools for the productive system that aim to eliminate resource waste, use resources and raw materials wisely, match output to customer wants, and reverse logistics. Examples of transformational solutions that must be employed to address challenges related to CE growth and transition include industrial symbiosis, eco-industrial parks, and industrial ecology and its tools.

Industrial symbiosis presents as its primary practices those related to cleaner production and ecodesign, to decrease the environmental impact and waste production over a product's life cycle and increase process performance and efficiency. This approach is based on the exchange of by-products and residues in planned complexes of co-located manufacturing plants. Due to the increased intensity of the use of resources located in an industrial or urban complex, industrial symbiosis adds value to the initial inputs/resources and results in mutually profitable transactions and more efficient processes, making it one of the key factors of reverse logistics.

A group of integrated technical resources that combine hardware, software, and telecommunications to facilitate communication and business process automation are collectively referred to as information and communication technology. Using industry 4.0 and 3D printing technologies, the CE promotes the development of techniques for collecting and processing municipal garbage by promoting a reuse and recycling culture.

From three perspectives, information systems provide different tools for collaboration: knowledge generation, knowledge sharing, and knowledge application. Because of this, the digital platform makes it easier to transmit data through information systems that use new processes, technologies, and solutions for both direct and reverse logistics.

By facilitating process design and offering tools like Material Flow Analysis, Ecodesign, and Cleaner Production to assist businesses in implementing sustainability, industrial ecology unites the relationship between business and the natural environment.