Circular Manufacturing 4.0

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Humanity faces dramatic challenges, as humanity is exhausting nature's budget progressively each year. At the same time, waste is growing exponentially; consumption reduction, reusing and recycling are no longer options but vital for sustainable human activities on earth. Hence, recovery and management of end-of-life (EOL) products and pollution reduction are becoming increasingly important for industry and open up new business challenges and opportunities for many industries in the manufacturing supply chain.

The concept of a circular economy aims to address these issues by closing the material loop across the full supply chain towards sustainable economic and environmental development[1], and it will allow the world economy to potentially earn close to a trillion US dollars per year. The circular economy is not limited only to the recycling of raw materials, but it encourages the reuse, remanufacturing and recycling of EOL products, thereby at the same time aiming to contribute to a fairer social economy and an improved quality of life for future generations. Yet, although it emerged decades ago, significant barriers prevent its full adoption in the manufacturing industry. Major impediments are a lack of information on the product life cycles and shortage of technologies for circular manufacturing strategies. Further, due to their ever-shorter lifecycles and planned obsolescence, high technology products become obsolete rapidly making reuse by repair no longer a viable option. The emerging manufacturing paradigm Industry 4.0 – key are smart factories in which flexible manufacturing entities communicate across the supply chain – seems to be an excellent solution.[2] However, research on taking advantage of Industry 4.0 technologies (e.g. Internet-of-Things (IoT)) to unlock the full potential of circular manufacturing is just starting and concrete case studies are lacking.[3]

Besides intelligent approaches for disassembly, remanufacturing, and recycling, the implementation of closed-loop supply chains (CLSCs) needs to be considered by manufacturers to ensure recovery of EOL products. To overcome issues regularly encountered using CLSC approaches, e.g. the large uncertainties in the product flows due to the unpredictable conditions of the EOL products, the use of intelligent IoT strategies would allow the collection of data throughout complete product life cycles to define the most optimal processing to be applied upon product recovery. An academic case study on a real-world product (modular smartphone – Fairphone-2®) was recently developed considering a novel CLSC model based on a prediction of the state of EOL product degradation using different levels of product IoT device implementation.[4]

The proposed models' objective is to maximise the manufacturing company's profits by using the knowledge of the EOL product's condition as provided by the IoT device implemented (e.g. Cloud service connected sensors). It could be shown that significant gains can be made by the manufacturing company when full implementing such IoT devices. In addition, the study presents a flowchart to support managerial decisions on optimal CLSC design policy execution, opening up the possibility of such intelligent CLSC strategies for real business implementation.

References

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