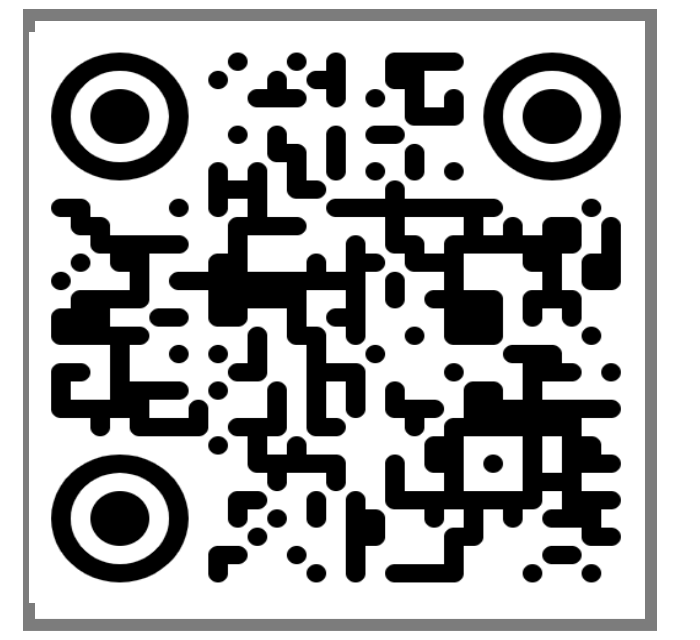


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Integrated Circularity and Sustainability Assessment of Manufacturing Systems



Background

Circular economy, as outlined by the Ellen MacArthur Foundation, advocates for a **shift from linear resource usage to sustainable, circular pathways**, emphasizing **renewable energy** and **waste reduction**. Initiatives, such as the European Green Deal, reflect global recognition of the need for integrating circularity with sustainability in economic practices. Tools such as Circulytics and the Material Circularity Indicator have been developed to quantify circularity, but there is **an increasing demand for methodologies that encompass also both environmental and social sustainability**. This need points to a crucial gap: true sustainability encompasses **environmental impacts** as well as **social implications**, necessitating comprehensive assessment methods in manufacturing and industry. In order to ensure that increased circularity in the industry and manufacturing systems actually leads to positive environmental and social impacts, there is a need for novel assessment methods that will include **all three dimensions of analysis**, rather than just circularity in isolation

Objectives

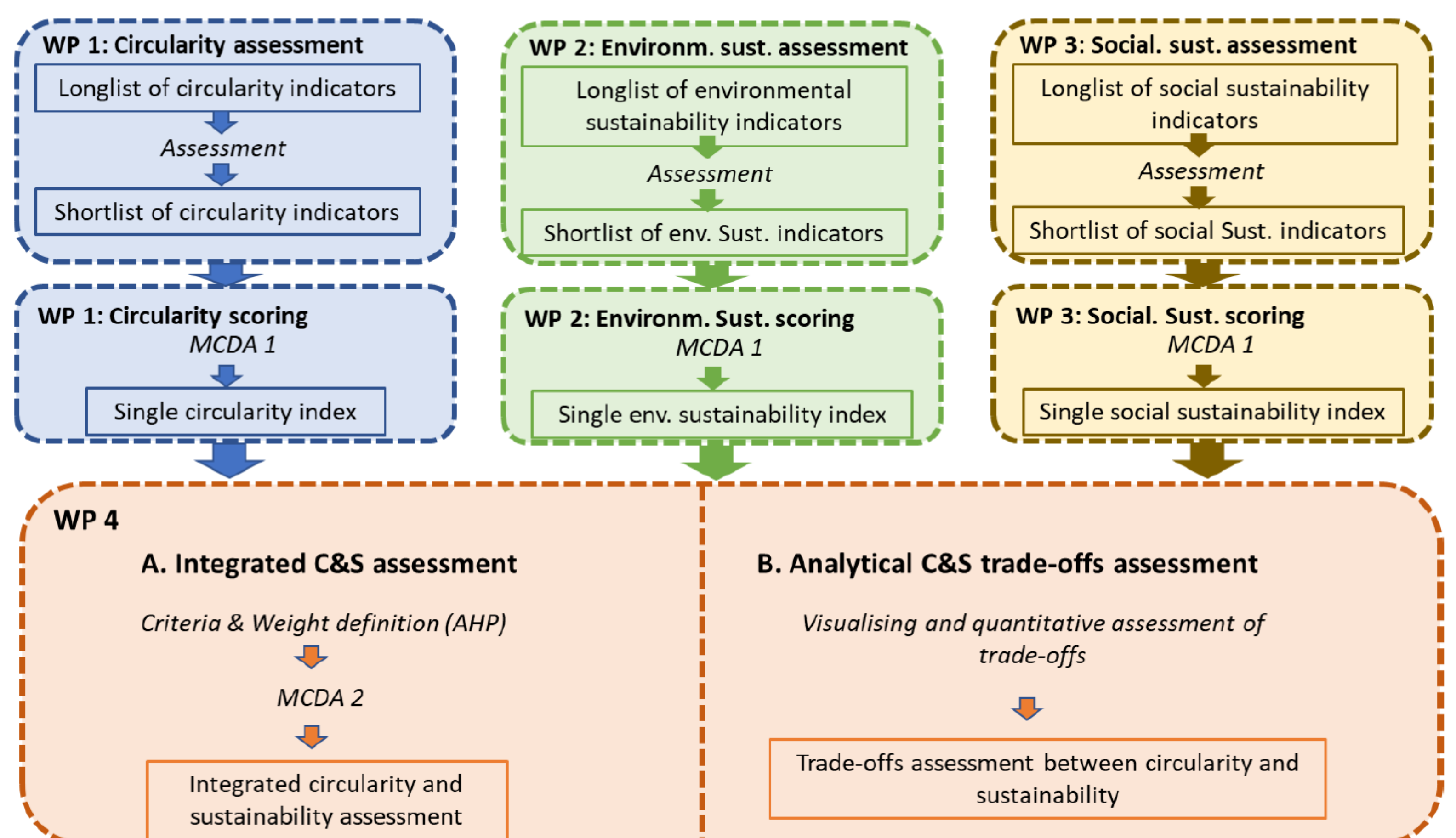
The project aims to develop a comprehensive assessment method for the manufacturing sector, focusing on understanding the environmental and social impacts of circular economy practices beyond their circularity. Objectives include:

1. Identifying **key indicators** for **circularity, environmental, and social sustainability**.
2. Creating an **integrated assessment method for comparing manufacturing options**, highlighting trade-offs between circularity, environmental, and social sustainability.

Research Methodology

The research methodology for assessing circularity, environmental, and social sustainability in manufacturing unfolds in key stages:

1. **Indicator Identification:** Through desk research, a comprehensive list of indicators from scientific literature and existing models is compiled, evaluated, and refined with expert input to create a shortlist for each sustainability dimension.
2. **Scoring System Development:** A scoring mechanism, based on Multi-Criteria Decision Analysis (MCDA), calculates composite scores for each dimension, integrating quantitative and qualitative indicators.
3. **Integrated Assessment and Trade-off Analysis:** Two main methods are developed: one for a holistic assessment across all dimensions and another to examine trade-offs between circularity, environmental, and social sustainability.
4. **Implementation and Validation:** The assessment methods are programmed in Python and validated through case studies and expert feedback via surveys, workshops, and conferences.



Expected Results

The project is expected to result in a nuanced assessment method that integrates circularity with environmental and social sustainability for manufacturing processes and products. This method will allow for the **ranking of various manufacturing options** based on a **composite score** that **reflects all three dimensions—circularity, environmental, and social sustainability**. Additionally, it will facilitate a deeper understanding of the **trade-offs** involved between these dimensions, providing essential insights for decision-making in the manufacturing sector. The composite scoring mechanism, developed through a **multi-criteria decision analysis approach**, will simplify the evaluation process by **combining a range of quantitative and qualitative indicators into a single, actionable metric**. This will enable manufacturers and policymakers to identify the most sustainable and circular options effectively.

Acknowledgements

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