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SEEBalance® - a Newly Developed Approach for the Evaluation of Social Impacts Along Value Chains.

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Improving the socio-ecological performance of products in the design stage is essential to achieve sustainable patterns of production and consumption in line with the aims of the UN Sustainable Development Goals or the EU Action Plan for a Circular Economy. To reach the ambitious aims these and other agreements set out for 2030, sustainability needs to become an integral part of product development and innovation processes. Looking beyond 2030, it can be expected that sustainability and circularity-related stakeholder requirements will furthermore increase in number and rigor.

However, at present, many companies are already challenged by existing requirements. Sustainability considerations in product development are, thus, often confined to ensuring compliance with legislation and to capitalising on clear-cut efficiency improvements. More comprehensive multi-criteria approaches are facing several barriers, among which, the balancing of socio-ecological with technical and functional product requirements serves as a primary challenge. For this balancing to be effective, sustainability criteria must be integrated into the conventional design process and be aligned with the underlying theories and models of design. While the former is addressed by an increasing number of conceptual and empirical studies, the latter is still mostly unexplored. Thus, the purpose of this paper is to analyse, to which extent and how established theories and models of design have been intertwined with approaches for sustainable product development (SPD).

To answer this research question, we conducted a bibliometric and a systematic literature review and qualitative and quantitative content analyses. As input for these analyses, we used a total of 3036 journal articles from the past 20 years. Articles were extracted from the Scopus-database using a set of keywords focusing on the fields of eco-design, design for sustainability and sustainable product development by Brones and de Carvalho (2014), which we extended to include publications on design for circularity. Building on a comprehensive review by Chakrabarti and Blessing (2015), we created a second set of keywords that covered a total of 27 theories and models of design. Both sets were then used in conjunction.

The bibliometric analysis of all 3036 papers uncovers the conceptual and network structure of SPD literature by applying multiple correspondence analysis and natural language processing routines on keywords and abstracts. Furthermore, it provides an insight into historical co-citation and country collaboration networks. The systematic review and the content analysis revealed that only 5 out of 27 theories and models of design were used in 31 out of the 3036 papers analysed. These results indicate a need for strengthening the design-theoretic foundation of SPD approaches, for which we outline potential directions. By doing so, this paper aims at providing a foundation for a closer alignment of SPD and engineering design practices. Such an alignment may foster a more seamless integration of sustainability into product design and contribute to safeguarding the competitiveness of companies to 2030 and beyond.