A Literature Review of Approaches for Assessing Product Sustainability Performance in Early Phases of the Product Innovation Process

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Abstract: Decisions made in early phases of the product innovation process heavily influence the sustainability performance of a product. This study presents a literature review of approaches for assessing product sustainability performance in early phases and identifies and analyses six main challenges and opportunities from a strategic sustainability perspective: (i) finding the right combination between qualitative and quantitative approaches; (ii) avoiding reductionism; (iii) managing trade-offs; (iv) conceptualizing and defining sustainability; (v) thinking strategically; and (vi) considering both negative and positive impacts. The review also found that the terms *assess, evaluate,* and *measure* are all used in relation to sustainability performance. Based on an analysis of semantics and etymology, the study describes differences between the terms and how they should be used, arguing that *assess* and *evaluate* are more suitable when describing sustainability performance, while *measure* can be used in relation to indicators that can form part of an assessment or evaluation.

Keywords: Sustainable Design, Eco-design, Life Cycle Assessment, Indicators, Literature Review

1 Introduction

Humanity is operating outside the safe space defined by the planetary boundaries framework, increasingly risking to destabilize the Earth systems that support society (Richardson et al., 2023). In 2023, the world has experienced new records of extreme weather events and annual global greenhouse gas emissions. Meanwhile, current commitments to counter climate change are far from reaching the Paris Agreement target (United Nations Environment Programme, 2023). Simultaneously, society is facing social challenges such as violent conflicts, hunger, and corruption, and progress toward UN Agenda 2030 targets is too slow (United Nations Department of Economic and Social Affairs, 2023). Product development and manufacturing companies are central actors in the sustainability transition as they provide society with products, technology, goods, and services, while also having negative impacts on the environment by consumption of natural resources and energy (Benn et al., 2018). The majority of the impact of a product over its life-cycle is determined by decisions made in the early phases of the product innovation process (McAloone and Tan, 2005; Parolin et al., 2024), and it is during product development that the socio-technical meaning and role of products start to form (Gaziulusoy et al., 2013). However, anticipating and assessing product sustainability performance is especially challenging in these early phases, primarily due to large uncertainty, lack of data, and time constrains (Schöggl et al., 2017). Researchers as well as practitioners have also highlighted the need at companies to be able to quantitatively measure sustainability in order for it not to be disregarded or down-prioritized in decision-making contexts (Arena et al., 2009; Hallstedt et al., 2015). These challenges are further amplified by the complexity of sustainability, which requires a systems perspective that considers both ecological, social, and economic aspects. Companies must be strategic in their sustainability efforts, which means developing solutions that contribute to society's transition in ways that also benefit the own organization (Broman and Robèrt, 2017). Some commonly used terms when communicating about sustainability performance are *assess, evaluate*, and *measure.* Which term that is used can have an impact on the interpretation of the claims made for the results from an approach as the choice of terminology might imply ontological and epistemological differences in the view of sustainability. The aim of this research is to review existing approaches for assessing, evaluating, and measuring product sustainability performance in early phases, and to analyze their potential to support strategic decision making. The following research questions (RQs) are addressed:

RQ1: What are current approaches in the academic literature to assess, evaluate, or measure the sustainability performance of products in early phases of the product innovation process?

RQ2: What are challenges and opportunities with such approaches from a strategic sustainability perspective?

RQ3: Which of the terms *assess, evaluate,* and *measure* are most appropriate to use in the context of sustainability performance of products from a strategic sustainability perspective?

2 Background

Strategic decision making, in any context, e.g. society, organizations, or product innovation, requires an understanding of the desired outcome to be achieved. This is also the case when planning and acting towards sustainability. Thus, there is a need to understand what the desired future sustainable state looks like to be able to act strategically to get there. However, detailed descriptions of a sustainable future are difficult to agree on and become easily obsolete. On the other hand, general descriptions and definitions are difficult to operationalize (Broman and Robèrt, 2017). The Framework for Strategic Sustainable Development (FSSD) presents a unifying definition of sustainability based on eight first-order sustainability principles (SPs), which describe the root-causes of unsustainability. The principles are: "In a sustainable society, nature is not subject to systematically increasing (1) concentrations extracted from the Earth's crust, (2) concentrations of substances produced by society, (3) degradation by physical means; and people are not subject to structural obstacles to (4) health, (5) influence, (6) competence, (7) impartiality, and (8) meaning making" (Broman and Robèrt, 2017). These principles can be used as boundary conditions for a long-term vision of sustainability. Based on this vision, backcasting can be applied to identify strategic actions that lead towards the vision in a step-by-step way. As the SPs describe the basic mechanisms of destruction, up-steams in cause-and-effect chains, they also facilitate systems thinking by allowing the myriad of symptoms of unsustainability, e.g. climate change, biodiversity loss, erosion of trust in society, etc., to be related to a few underlying root-causes. The FSSD views the ecological, social, and economic dimensions of sustainability as nested interdependent systems, where the economic system is part of, and dependent on, the social system, which in turn is part of and dependent on the ecological system (Mebratu, 1998). For product development companies, applying such a strategic and systems perspective in the early phases of the innovation process allows to anticipate changes on increasingly sustainability-driven markets, and ensures that actions lead in the direction of the long-term vision, while avoiding sub-optimization (Hallstedt, 2017; Schulte and Knuts, 2022).

The product innovation process describes all activities needed to take a new business activity from initial ideas of a product, to planning, design, and reaching the intended users (Ulrich et al., 2020). Product innovation can be divided into two sub-processes, "product development" and "realization". Product development is covering the processes and activities to envision, design, and plan for the commercialization of the product, while realization represents the production, distribution and sales of it (Roozenburg and Eekels, 1995). In the early phases of the product innovation process, during the product planning phase, goals and strategies are formulated to capture the idea of what is to be innovated, which then guide the generation and development of concept ideas. It is in these early phases that the potential to influence the sustainability performance of a product is largest because of the higher degree of design freedom compared to later phases. However, access to data is often limited in these early phases, partly caused by difficulty to find relevant and reliable data from stakeholders in the value chain, making it challenging to confidently determine the sustainability performance of a concept (Chebaeva et al., 2021). The majority of the sustainability-related impacts take place in the extended product-life cycle, making it essential to incorporate life-cycle thinking when designing and developing a product (Hallstedt et al., 2013). Sustainable Product Development in this research means that a strategic sustainability perspective and life-cycle thinking are integrated and implemented into the early phases of the product innovation process (Hallstedt and Isaksson, 2017).

3 Method

A systematic literature review was conducted to explore and investigate approaches to address the sustainability performance of products in the early phases of the product innovation process. The review followed the process suggested by Tranfield et al. (2003), by first planning the review, followed by a second stage where the review is conducted and data is collected, analyzed, and synthesized. Finally, in the third stage, the findings from the review are reported and disseminated. In the planning phase, a review protocol was established containing, e.g., the search strategy, and the inclusion and exclusion criteria. The protocol was used as a means of documenting the review process to ensure transparency and replicability. A data collection form was prepared based on guidance from Miles and Huberman (1994) and Blessing and Chakrabarti (2009) with information on document identification, bibliographic meta-data, and a brief summary and comment of the paper content. A search query was created based on RQ1, combining terms from three areas, see the left part of Figure 1. It was used to search among the titles and keywords of publications in the Scopus and Web of Science databases. Inclusion and exclusion criteria were then applied in steps according to the process described in the right part of Figure 1, to narrow down the scope and find relevant papers for detailed review and analysis that focus on approaches that are possible to use in the early phases of product innovation. In total, 59 unique publications fulfilled all inclusion criteria and were selected for full-text analysis.

Each publication was classified based on categories, such as sustainability dimensions considered (ecologic, social, economic), data types used (quantitative or qualitative), product life cycle stages addressed, and product innovation phase to be used in. Findings from the papers were then iteratively restructured and clustered based on the classification. To generate meaning from the collected data, a qualitative analysis approach using tactics such as noting patterns, clustering, counting etc., was deployed as described by Miles and Huberman (1994). This was combined with using the FSSD as a lens to identify the challenges and opportunities mentioned in RQ2. To address RQ3, the semantic meanings and etymology of the terms *assess*, *evaluate* and *measure* were investigated using dictionaries, and the use of the terms in the selected publications was documented in the data collection form.

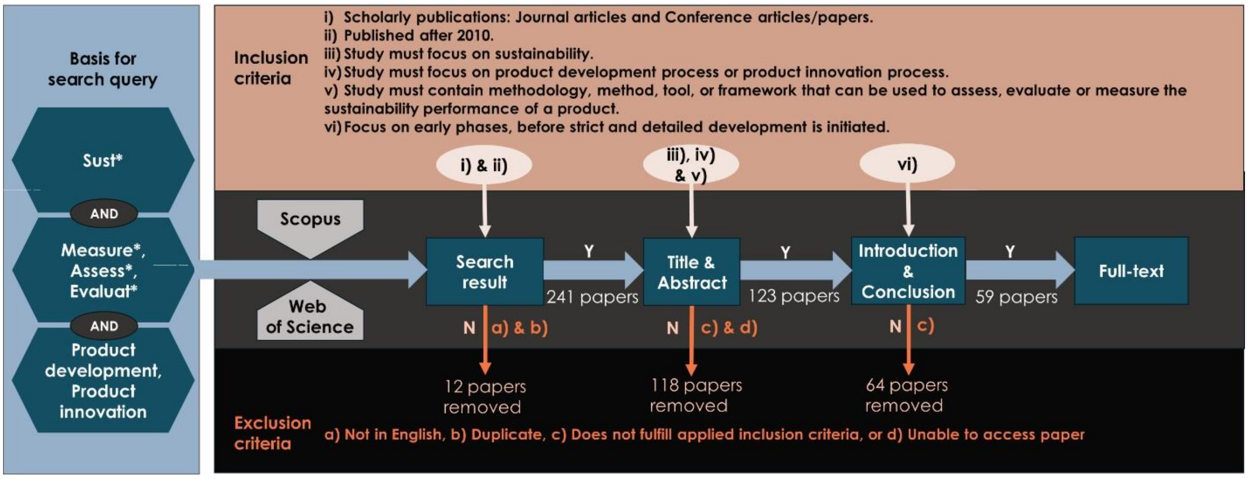

Figure 1. Overview of the literature review process with the applied inclusion and exclusion criteria to identify relevant publications.

4 Results & Discussion

For the reviewed period, 2011-2023, 59 papers were reviewed in full-text and the distribution is shown in Figure 2. A total of 36 journal papers from 20 different journals were identified. Journal of Cleaner Production was the most common with 10 papers, followed by Sustainability with 4 papers, and Sustainable Production and Consumption with 3 papers. The remaining 23 papers come from 12 different conferences, with most contributions from the International Conference on Engineering Design (ICED) with 6 papers, followed by the Global Conference on Sustainable Manufacturing (GCSM) with 3 papers. CIRP Design Conference, CIRP Lifecycle Engineering Conference, International Design Conference (DESIGN), and International Engineering Research and Innovation Symposium (IRIS) all contributed with 2 papers each.

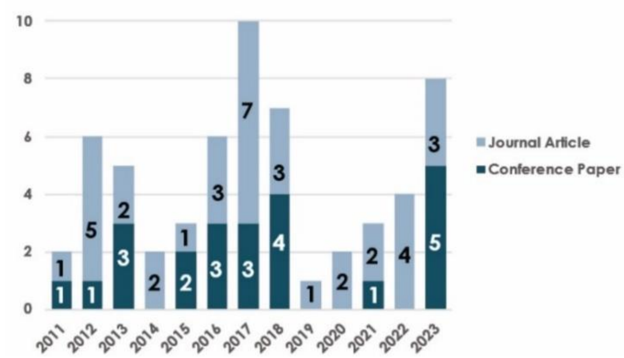

Figure 2. Publications per year and type in the studied period 2011-2023.

4.1 Current approaches to assess, evaluate or measure sustainability performance

This section addresses the first research question, "What are current approaches in the academic literature to assess, evaluate or measure the sustainability performance of products in early phases of the product innovation process?".

The types of approaches found in the reviewed literature can be categorized as a methodology, method, guideline, or tool. Gericke et al. (2017) explain these terms as follows: in short, a methodology is an approach that specifies how activities are to be organized and performed in a process by applying methods, guidelines, and tools as well as how to manage the design process. A method describes how to achieve a specific result by listing specifications on what information to use as input, how to sequence actions and what tools to use. Guidelines consist of statements of what to do when in specific situations. A tool is an artefact, object or software that can be used to perform some specific action However, the use of these terms in the reviewed literature of this study was observed to be inconsistent. All identified approaches from the reviewed literature are presented in Figure 3. Many of the approaches found in the papers are incorporating elements or adaptations of other approaches. Life cycle management approaches were most frequent and identified in 32 papers. The individually most common approach was different variants of Life Cycle Assessment (LCA) adapted for use in the early phases of product innovation. The identified LCA approaches were based on ISO 14040 (e.g. Bonou et al., 2016; Luthe et al., 2013) or streamlined variants such as Prospective LCA (Eigner et al., 2013; Ostermann et al., 2023), Ex-ante LCA (Fernandez-Dacosta et al., 2019), Fast Track LCA (Klaassen et al., 2020), and Simple LCA (Yang and Chen, 2012). Multi-Criteria Decision Models were also a common type of approach found to handle multiple product and sustainability aspects e.g. Analytical Hierarchy Process (Shin and Colwill, 2017), TOPSIS (Turan et al., 2016), and Multi-Attribute Value Theory (Stoycheva et al., 2022). The CAD-based approaches make use of product design information like the Bill of Materials (BOM) and combine it with other software tools for establishing the environmental impacts with LCA (e.g. Chu et al., 2012; Luthe et al., 2013; Ong et al., 2016). An assistance system for guiding product developers in selecting an approach, depending on desired effort and accuracy, from a set of three different assessment methods building on Life Cycle Sustainability Assessment (LCSA) was presented by Quernheim et al. (2023). While most approaches focus on minimizing negative sustainability impact, Mörsdorf and Vielhaber (2023) present a methodology for designing products where the positive impacts are maximized while negative impacts are avoided, reduced or compensated for. In Hallstedt (2017), a method for identifying sustainability criteria to be used for decision support is presented together with a qualitative measurement scale called the "Sustainability Compliance Index" (SCI). The SCI is also used in other approaches (e.g. Hallstedt et al., 2023; Hallstedt and Isaksson, 2017). A customizable tool called "Checklist for Sustainable Product Development" using yes/no questions structured in categories was developed and tested by Schöggl et al. (2017). Chiu and Chu (2012) present a literature review with a classification of different approaches to work with sustainability performance, where the categories "Metrics" and "LC Costing" includes assessment approaches related to sustainability aspects.

Figure 3. Clustering of approaches presented in the reviewed literature. The text in underlined italics in each cell indicates the name of the specific approach or which existing approach that it is adapted from. Some papers are found in multiple cells since they are combining elements from multiple different approaches. A secondary cluster filter in different colors is also applied to the cells to indicate which approaches that share similar focus.

4.2 Challenges and opportunities with current approaches from a strategic sustainability perspective

This section addresses the second research question, "What are challenges and opportunities with such approaches from a strategic sustainability perspective?". First, differences between quantitative and qualitative approaches are described. After that, the sustainability dimensions included in the different approaches are discussed, followed by what life-cycle phases that are addressed, and finally what impacts that are in focus.

The early phases of the innovation process are characterized by high uncertainty and low availability of quantitative data, which is also the case when it comes to sustainability. At the same time, practitioners request quantitative approaches as the results are perceived as more trustworthy and easier to manage alongside other quantitative metrics, e.g. financial or performance-related metrics (Arena et al. 2009). A majority of the reviewed papers present quantitative (51%) or semi-quantitative approaches (36%), while purely qualitative methods were found in 13% of the papers. Among the reviewed papers that present quantitative aproaches, a majority build on some form of LCA and focus on a few selected sustainability aspects. Usually, these are environmental aspects for which quantitative data is available. This, however, entails the risk for sub-optimization. On the other hand, Buchert et al. (2015) avoid the use of semi-quantitative scores and argue that they are "more subjective since they leave room for interpretation". Similarly, Hallstedt et al. (2023) developed a sustainability assessment tool that provides a qualitative estimation of a level instead of a concrete quantitative value and found that some users found it challenging to interpret and trust the qualitative result. However, given the lack of detailed data in the early phases, it is difficult to translate qualitative estimations into precise quantitative results. Therefore, contrary to the user perception, quantitative assessments risk providing a false sense of objectivity and certainty, which can undermine informed decision-making. This is especially the case for more advanced approaches that can turn into black boxes, where the user is largely unaware of how the quantitative result was created. Quantitative approaches should therefore strive for high levels of transparency, e.g. regarding uncertainty, and require trained users who have a nuanced understanding of the meaning and trustworthiness of the quantitative values.

Looking at what sustainability aspects that are used in the reviewed approaches, it was found that 56 of the 59 papers include aspects for the ecologic sustainability dimension, while 33 papers include economic aspects, and 29 papers contain social sustainability aspects. Most of the reviewed approaches are addressing more than one sustainability dimension simultaneously, and it was even more common to include aspects from all three, see Figure 4. Although all three sustainability dimensions are included in many studies, the number of aspects per dimension varies, as well as their depth used to probe for sustainability. For example, only focusing on greenhouse gas emissions, as done in some studies (e.g. Ameli et al., 2017; Ostermann et al., 2023) is far from sufficient to cover the complete ecological dimension, just like the social dimension cannot be covered only by aspects on salary or working hours. The social dimension in particular is found to often being reduced to few, technocentric aspects on a micro level. In a similar way, focusing on single life cycle phases (e.g. Choudry et al., 2018a; Ong et al., 2016; Panuju et al., 2022) cannot represent a complete life cycle of a product solution. Reducing the complexity of sustainability to a few selected aspects or life cycle phases is likely to result in sub-optimization, where improvements in relation to some aspect or life cycle phase cause new or more severe problems in relation to other aspects or life cycle phases. It can also be noted that the reviewed approaches provide little guidance on how to handle trade-offs between different sustainability aspects, which is something that is requested by practitioners (Faludi et al. 2020).

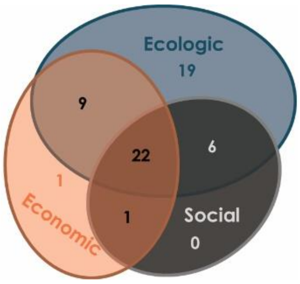

Figure 4. Sustainability dimension that are addressed. Almost all papers include the ecologic dimension.

Even if it has been possible to identify and map the papers based on sustainability aspects, most studies do not specify the definition of sustainability that is used as a conceptual foundation for the presented approaches. Which conceptual understanding of sustainability that is used as a foundation is decisive for the design of decision-support for integrating a sustainability perspective in early phases. The studies that are explicit (e.g. Quernheim et al., 2023; Shin and Colwill, 2017), oftentimes refer to the Triple Bottom Line (Elkington, 1997). However, this often implies that sustainability aspects are viewed as separate from other product performance criteria and that the relationship between the ecological, social, and economic dimensions is perceived as a trade-off or balancing act where, for example, some economic benefit must be sacrificed for the sake of ecological and social sustainability. In contrast, from a strategic sustainability perspective, the nested interdependent systems view of sustainability highlights that social and ecological sustainability are a prerequisite for economic sustainability. This is because if society is to continue for a long time, a transition to sustainability is inevitable. Hence, market forces will increasingly pose business opportunities (e.g. increasing demand, ability to attract top talent) for companies that contribute to this transition and business threats (e.g. legislative change, reputational damage) for companies that counteract the transition (Schulte and Hallstedt, 2018). Therefore, working strategically with sustainability is largely a matter of smart timing, i.e. finding smart stepping stones that lead in the right direction towards the vision of sustainability in ways that also provide sufficient return on investment along the way (Robèrt and Broman, 2017). The nested interdependent systems view of sustainability was used as a foundation in some of the reviewed approaches (e.g. Hallstedt et al., 2023; Schulte and Knuts, 2022; Schöggl et al., 2017).

When addressing product sustainability performance, it was found that most approaches focus on identifying and reducing the negative impacts of the product (e.g. Djassemi, 2012; Santucci and Esterman., 2015; Winter et al., 2023) and that few approaches consider potential positive impacts (e.g. Mörsdorf and Vielhaber, 2023; Horn et al., 2018; Shin and Colwill, 2017). Positive impacts can be the value or benefit the product adds to society by helping to fulfill human needs but can also be related to positive effects in the value chain. By focusing only on identifying and reducing negative sustainability impacts, there is a risk that the root-causes for unsustainability remain untreated, leading to new sustainability problems emerging. This view could lead to a focus on developing products that only aim to be as little unsustainable as possible, rather than aiming to maximize the contribution to facilitating a transition towards sustainability. However, it remains unclear from the reviewed literature how such a positive effect of a product could be assessed in practice during the early phases of the innovation process. Also, there is a need for transparent ways for how to balance negative and positive impacts to avoid arbitrary weighting and the risk for green washing by pointing towards some positive impacts to justify negative impacts.

4.3 To measure, assess or evaluate sustainability performance

This section addresses the third research question, “Which of the terms *assess, evaluate* and *measure* are most appropriate to use in the context of sustainability performance of products from a strategic sustainability perspective?”.

The review of the literature shows that multiple terms are used in the context of product sustainability performance. The term “assess” is the most frequently used term among the studied papers and is used in all papers, followed by the term “evaluate” which is used in 53 of the papers. The term “measure” as a verb is appearing in 29 of the 59 papers. However, none of the papers explicitly defines, motivates, or distinguishes between the terms. There is also considerable inconsistency in the literature in how the terms are used, indicating that they might be used synonymously and without consideration of the differences between them.

The definition of the verb “measure” is “to find out the exact size or amount of something” (Cambridge Dictionary, 2023) or “to calculate the measurements of, or to determine the extent of by measuring” (Merriam-Webster, 2023a). Measure as a verb can be traced to Latin *mensūra* (Merriam-Webster, 2023a). “Assess” can be defined as “to determine the importance, size, or value of something”. The verb assess originates from the Latin word *assesser* which means “to sit beside, assist in the office of a judge” (Merriam-Webster, 2023b). “Evaluate” is defined as “to determine the significance, worth, or condition of something usually by careful appraisal and study”, or as “an attempt to determine relative or intrinsic worth in terms other than monetary”. The word “evaluate” originates from French “évaluation” which is derived from a combination of the Latin words *ex* and *valere* (Merriam-Webster, 2023c).

Even though the meanings of the three words are similar, they are not the same and their nuances may convey differences in the ontological and epistemological assumptions that are made in relation to what sustainability and sustainable development are and how knowledge about them can be obtained. Firstly, it should be noted that the concept of sustainable development, for example as defined in the Brundtland report, builds on a normative stance, namely that such development is desirable (Broman and Robèrt, 2017). Secondly, sustainability includes a qualitative dimension and there is no objective way to weigh different sustainability impacts in relation to each other. For example, to determine whether a product that causes high emissions that contribute to climate change is preferable to a product that causes high emissions that contribute to ozone layer depletion, or adverse human health effects. Thirdly, sustainability is a systems property, which means that products cannot be sustainable or unsustainable in and of themselves. Products can only contribute or counteract to the sustainability or unsustainability of the system they are part of (Gaziulusoy, 2015). The resulting complexity in identifying such a contribution or counteraction makes the reduction to criteria challenging when trying to describe the sustainability performance of a product. Given these three points, it is argued that the sustainability performance of a product cannot be “measured”, as the “exact size or amount” cannot be calculated or empirically determined. The words “assess” and “evaluate” are considered more suitable as they recognize the use of value judgement. However, while it is not possible to “measure” sustainability, it is possible to “measure” some sustainability indicators and this information can be used within an assessment or evaluation of the overall sustainability performance of a product. In practice this means that (i) both “assess”, “evaluate”, and “measure” have relevance in the context of product sustainability performance, but they convey different meanings and should thus be used in different instances; (ii) approaches should strive to combine measurements with assessments or evaluations in an optimal way based on the task, needs, and context at hand; and (iii) assessments and evaluations should involve multidisciplinary perspectives from several people within an organization to reduce bias and to make results more nuanced and reliable.

5 Conclusions

In response to RQ1 this study reviewed 59 papers from academic literature presenting current approaches to assess, evaluate, or measure the sustainability performance of products in the early phases of the product innovation process. While some papers present entirely new approaches, many studies build on existing methodologies, methods, or tools. The most frequently used foundation of the studied approaches was LCA which has been adapted for use in the early phases of product innovation.

Challenges and opportunities with the reviewed approaches were analyzed through a strategic sustainability lens to answer RQ2. The identified challenges and opportunities can be used as criteria to guide the selection or development of approaches for assessing sustainability performance in early phases, and can be summarized as follows:

Finding the right combination of qualitative and quantitative approaches: One of the challenges is practitioners' desire for quantitative assessment results, which are objective and reliable, as there is a risk that qualitative results are ignored or given less priority in decisions. However, early innovation phases are characterized by uncertainty and scarcity of data, making quantitative assessments difficult and imprecise. Hence, qualitative and quantitative approaches must be combined in a transparent way that fulfills user needs but recognizes uncertainty and the need for value judgement.

Avoiding reductionism: The review found that almost all papers address environmental sustainability aspects and about one third of the papers address all three sustainability dimensions. However, the approaches focus on a few selected sustainability aspects, which do not cover the full dimensions. Similarly, there is sometimes a focus on one or a few life-cycle phases. This reductionism is problematic given the systemic nature of the sustainability challenge and is likely to result in design decisions that cause sub-optimization or give rise to unintended consequences. Using first-order principles for sustainability up-streams in cause-and-effect chains, as proposed in the FSSD, may help to ensure that a holistic sustainability perspective is covered without drowning in a myriad of different sustainability impacts down-streams in cause-and-effect chains. However, support is needed for practitioners to be able to relate and apply the principles in their specific context and for how to collect data and make assessments in relation to the principles.

Managing trade-offs: The review found a lack of approaches that provide decision-support in trade-off situations, both in relation to trade-offs between different sustainability aspects and in relation to trade-offs between sustainability aspects and other metrics. Even though difficult, this is highly relevant for practitioners.

Conceptualizing and defining sustainability: Conceptually, most papers are unspecific as to how they define sustainability. The Triple Bottom Line is referred to in some approaches, but it risks creating a perception of sustainability as a balancing act or trade-off between the ecological, social, and economic dimensions. Other approaches build on a nested interdependent systems view of sustainability, which emphasizes that social and ecological sustainability are a prerequisite for economic success. This is especially relevant given the increasingly sustainability-driven markets where strategic sustainability proactivity has become a matter of smart risk management.

Thinking strategically: Only when having a clear understanding of the desired future sustainable state, it is possible to take strategic action towards it. A long-term strategic perspective must be considered in the assessment of a product's sustainability performance to ensure that it presents a smart stepping stone on the way towards the long-term vision. Thereby it can be avoided that investments are made in products that may be better than, e.g., the predecessor, but that never can become fully sustainable and thus lead development into a blind alley.

Considering both negative and positive impacts: With few exceptions, most of the reviewed approaches are only focusing on identifying and reducing negative sustainability impacts, primarily in relation to the environment. Not considering potential positive impacts results in an incomplete picture and misguided focus. It is not only necessary to minimize negative impact, but also crucial to consider and consciously design solutions that actively contribute to a transition towards sustainability.

Finally, in response to RQ3, the review found that all the studied terms *assess*, *evaluate* and *measure* are used in relation to sustainability performance. Based on an analysis of the semantics and etymology of the terms, it is proposed that *assess* and *evaluate* are more suitable to describe the sustainability performance of a product, given that it cannot be established precisely and objectively as it involves some degree of value judgement. However, sustainability indicators may be *measured* and be part of and inform an overall assessment or evaluation of a product's sustainability performance.

The main contributions to research and practice are both the collection and review of existing approaches to assess the product sustainability performance in early phases of the product innovation process, and a list of criteria to use when selecting or developing existing and new approaches to support strategic decision-making in these early phases. Based on the methodological choices made, this study also has limitations. The search strategy focused specifically on identifying approaches for use in early phases of the product innovation process. It is possible that there are approaches that were not explicitly designed for early phases that still could be relevant to use in these phases. Furthermore, this study did not look at the implementation rate of the reviewed approaches in industry and can therefore not draw conclusions in relation to the effectiveness of different kinds of approaches.

Future research should investigate current company preconditions, e.g. driving forces and needs, and practices, e.g. processes, methods, and tools, for assessing product sustainability performance. Furthermore, this study found that the concept of what exactly constitutes "sustainability performance" was not clearly defined in the reviewed literature and should therefore be further scrutinized.

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