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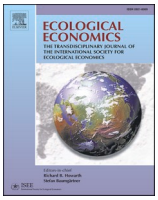

Better or different? A reflection on the suitability of indicator methods for a just transition to a circular economy

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ABSTRACT

Indicator-based methods have long been used as assessment tools in relation to measuring and purportedly enabling sustainable transitions. Common limitations of indicator approaches are well documented in the literature, and include both technical issues related to data availability and the handling of complexity, and epistemological challenges such as the nature of trade-offs and risks associated with reductionism. Nevertheless, such methods remain popular due to their ability to convey complex information related to timely issues in a synthesised way to policy- and decision-makers. In light of this, and the burgeoning literature on indicators for a Circular Economy (CE), we aim to reflect on the extent to which such methods are suitable for engendering a transformative social and ecological transition to a just CE. To do so, we examine the broad literature on the limitations of indicator methods by considering an archetypal three step process of selection, framing, and implementation. As critical CE scholars keen to repoliticise CE by embedding principles of justice, we ask to what extent indicator methods serve our transformative purposes, and whether our stance towards such methods should be to do things better or different? Our answer to this is: both. Yet we emphasise the need to reconceive 'better' as moving beyond fixes to technical problems to address more fundamental epistemological challenges and rethink the purpose of an indicator approach as not a technical tool, but a politicised artefact for shaping alternative narratives.

1. Introduction

Approaches to sustainability assessment are as multitudinous and varied as attempts to define sustainability itself (Pope et al., 2017; Ramsey, 2015). Slowly evolving from the diffusion of impact assessment into governance & management spheres from the 1960s, sustainability assessment has emerged as a broad paradigm, imagining itself as a core tool for transitioning towards a normatively conceived 'better' society (Pope et al., 2004). Thus, we may understand sustainability assessment as an ex ante tool for "directing decision-making towards sustainability" (Pope et al., 2017: p205). The openness of sustainability as an umbrella concept or 'empty signifier' (Brown, 2016), presents issues and opportunities for assessment: on the one hand, much time is sunk into working out what sustainability might mean before considering how to assess it; on the other hand, it must be recognised that competing normative ideals such as eco-socialism or corporate green growth can shape their own assessment methods. The case of the Circular Economy (CE), also an umbrella concept characterised by multiple and competing narratives (Bauwens et al., 2020; Lowe and Genovese, 2022), occupies a similar state, with the literature on sustainability assessment for a CE rapidly expanding whilst displaying a lack of consensus on which metrics should be considered for measuring the transition towards circular futures (Calzolari et al., 2022; Roos Lindgreen et al., 2020; Saidani et al., 2019).

Indicator-based approaches remain central to the sustainability assessment paradigm. Dao et al., (2017, p640) define indicators as "an indirect and/or a partial measure of a concept that is relevant for a given purpose". Such a definition captures the often built in recognition among practitioners and researchers that the indicator, as a methodological construct, is fundamentally limited; it is a pragmatic, perhaps best choice placeholder for reducing intangible complexities to something measurable (Goertz and Mahoney, 2012). Within the philosophy of science and adjacent literature, this has been reflected in debates relating to the role of theoretical and statistical models in producing constructed knowledge about the state of an empirical system (Tal, 2013). Indicators have thus been framed within the sustainability assessment literature both in terms of method as a core category of 'assessment tool' (Gasparatos and Scolobig, 2012), as well as operationalisable representations of concepts which reflect a given discourse

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(Pope et al., 2017). This reflects a dual purpose to indicators, and indeed assessment methods more broadly, not only are they useful for measuring stuff, they communicate what we think is important to measure. Thus, in this work we understand an indicator to be a conceptual artefact that is intended to quantify an attribute relating to the state of the system under examination; we view the construction or choice of an indicator as inherently political and embedded in normative value systems.

This work represents a critical exploration of indicator-based methods, drawing on contributions from various domains within the broad sustainability assessment literature. Through this, we aim to critically discuss to what extent indicator approaches may be suitable for catalysing a transformative social and ecological transition in the context of a *Just* CE. The onboarding of the critical framing of just transitions (Velicu and Barca, 2020) into our conceptualization of a CE contrasts with dominant ecomodernist approaches (Genovese and Pansera, 2021) and reveals further tensions in the application of indicator approaches. To illustrate this, we collate shortcomings discussed in the literature relating to three steps of an archetypal indicator approach: selection, framing, and implementation. In considering these challenges, as well as various proposed solutions, we reflect upon two potential avenues to take for an indicator approach to support the transition to a just CE: 'better', or 'different': as critical CE scholars, should we be making incremental adjustments to make our indicator frameworks better, less reductionist, more rigorous, or should we think to change our approach, rejecting an indicator approach entirely and pursuing other creative avenues?

We conceive of our contribution as an intervention, proposing an open question which should provide scholars and practitioners pause for thought. It is not a systematic literature review on the shortcomings of indicator approaches, nor a prescriptive handbook on how things could be done better, but a call to be reflexive in the face of dominant methodologies, prompting the question of better or different with respect to research design; as such, the aim of this paper is to provide a series of questions rather than a series of answers. Section 2 presents a brief background, first by outlining exactly what we mean by *indicator methods* within this work, before outlining the CE context and how assessment has typically been conceptualised within this paradigm. Through an analysis of literature that discusses methodological aspects of indicator approaches to assessment, Section 3 develops a framework for critique, surveying both technical and episto-ontological challenges associated with these methods. Section 4 launches into our discussion, drawing on this assessment literature to ask whether future CE indicator studies should do better or different: here we provide both a reflexive outline of questions that should be addressed for doing 'better', and what alternative pathways could be considered in order to do 'different'. We conclude with the suggestion that perhaps there is space for both better and different.

2. Background

2.1. An outline of Indicator methods for sustainability

Whilst a number of individual indicators have occasionally gained prominence on their own in wider discourse, such as carbon emissions or Gross Domestic Product (GDP), the majority of sustainability assessment methodologies seek to incorporate a number of broad dimensions into a single framework. This imperative to include a disparate range of dimensions relates to wider debates about holism, synergies, and trade-offs within the sustainability discourse, and the widely employed 'three pillar' framing of environmental, social, and economic dimensions of sustainability (Boyer et al., 2016; Brown et al., 1987; Goodland and Daly, 1996). Composite indicator approaches, which combine a number of individual indicators into a single framework, thus have a long history of being employed for sustainability assessment (Kwatra et al., 2020). We can differentiate between two different types of composite indicator approach here, which we refer to as an *aggregated* approach versus a *dashboard* approach. An aggregated indicator is formed when a selection of individual indicators are combined into a single numerical framework. Prominent examples of aggregated indicators include the 'Genuine Progress Indicator' (GPI), which collapses 26 indicators across explicitly defined economic, environmental, and social categories into a single metric (Berik, 2020), and the Dow Jones Sustainability Indices, which weight environmental, social, and economic factors to rank companies according to their 'sustainability performance' (Knoepfel, 2001). The dashboard approach refers to unflattened frameworks which amount to a curated selection of singular indicators, such as the 231 indicators employed by the UN Sustainable Development Goals (SDGs) (United Nations, 2017), or the 26 indicators included in the OECD Green Growth framework (OECD, 2017).

The perceived benefits of aggregated approaches to composite indicators, such as the GPI, relate to their reduction of complex and diverse phenomena into a singular metric, allowing for both simplicity in communication and straightforward benchmarking (OECD et al., 2008). As outlined by Saltelli (2007), the manipulation of individual indicators into a single numerical value is a non-trivial task, and decisions must be made about weighting the importance of individual indicators, and considering the mathematical techniques employed for aggregation. Such complexity can leave the framework open to serious critique relating to analytical rigour (Burgass et al., 2017). Whilst the aggregated approach is inherently reductionist in nature (also due to the compensatory dynamics introduced by the aggregation process itself), there is much evidence that stakeholders, from policy makers to business and media actors, strongly value the simplicity afforded by aggregate tools (Luzzati and Gucciardi, 2015; Saltelli, 2007).

The indicator dashboard is an alternative approach which skips the aggregation step, instead presenting a curated selection of individual indicators. This is the favoured approach of some scholars who are critical of the reductionism of single quantity aggregate indicators or monetary approaches being used to guide the transition to a sustainable future (Berik, 2020). The necessary shortcomings of the dashboard approach are a potential overload of information, and the divergent manner in which they may be interpreted. Costanza et al. (2016) suggest that the two approaches may be used in combination to mitigate the weaknesses of each. Often secondary methods, such as non-compensatory multicriteria decision making (MCDM) methods, are suggested as a means by which individual indicators within a dashboard can be prioritised and compared (Garcia-Bernabeu et al., 2020; Martinez-Alier et al., 1998). The present work, from the approach conceptualised in Section 3, concerns itself with the use of dashboard methods rather than aggregated approaches to composite indicators.

With sustainability assessment (and CE discourse) typically sitting within highly interdisciplinary bodies of literature it is natural to expect various tensions between methodological approaches. In particular, the lack of a comprehensive view of sustainability measurement, along with the absence of shared epistemological foundations has led to duplications of effort and incomplete and partial framings of the problem (Mura et al., 2018). It thus remains important to reflect upon the social construction of indicators, and their historical and institutional context, something discussed by Jenkins (2019) in relation to national statistics. Following an empirical study of the construction of an indicator framework, Jenkins suggests that the result not only reflects the social relations between its creators, but a pre-existent privileging of ideas. In this manner the indicator is more than a technical tool for measurement, but a political artefact that creates and shapes new realities (Rodriguez et al., 2020). Here, Heink and Kowarik (2010) make a distinction between descriptive and normative use of indicators, crudely referred at one point as 'scientific' vs 'political', with the former describing the state of a system, e.g. the number of employees, and the latter with reference to (explicit or implicit) objectives or goals, e.g. the percentage of women in a company board. The authors strongly caution ambiguous conflation between these two uses. The case of GDP growth provides a well known

example here of the conflation between these two uses; there exists a wealth of literature on the historical development of GDP as a wartime tool, its institutionalisation, shifting purposes, and increasing criticism of its dominance over more appropriate measures of wellbeing (Kubiszewski et al., 2013). For O'Neill (2012), GDP has "undermined the goal of economic welfare that it was supposed to support because people have ended up serving the abstract (but quantitative) indicator instead of the concrete (but qualitative) goal" (p222). Thus we must approach indicator methods with an amount of reflexivity, being mindful how these measurement tools are shaped by and in turn may act to shape political reality (Kovacic and Giampietro, 2015).

The philosophy of measurement has been discussed extensively across various bodies of literature, particularly in relation to epistemological and ontological aspects (Goertz and Mahoney, 2012; Leplège, 2003). Within this literature, distinction has been made between the norms and practices across the social versus natural sciences, qualitative versus quantitative research paradigms, and realist versus subjectivist epistemologies (Micheli and Mari, 2014). Such differences lead to divergences in the way assessment is conceived in practice, such as the importance of conceptualisation and definition (Goertz and Mahoney, 2012), how the validity of indicators are understood (Adcock and Collier, 2001), the commensurability of indicators with an empirical reality (Michell, 2005), the use of abstract and idealised models (Tal, 2013), and the very purpose of measurement (Mari, 2003). In particular, Tal (2013) argues that, especially within economic disciplines, the reliance on models and indicators has led to a situation where these are considered as de facto measuring instruments in themselves.

2.2. Assessment for a circular economy

Assessment approaches are widespread not only within broad considerations of sustainability, but across related sub-domains and concepts. Our interest within this work focuses specifically within the CE discourse, as an 'umbrella concept' for competing paradigms which advocate for the reduction of societal dependence on systems of linear material and energy throughput (Genovese and Pansera, 2021; Korhonen et al., 2018; Oliveira et al., 2021). Whilst first conceptualised by Pearce and Turner (1990), interest in CE has grown significantly in the past decade, spurred by industrial actors, an embedding within China's Five-Year Plans, the advocacy of the Ellen MacArthur Foundation (EMF), the uptake of the term by the European Commission (Bleischwitz et al., 2022; Ellen MacArthur Foundation and ANSYS Granta, 2019; European Commission, 2020; Homrich et al., 2018).

Sustainability assessment approaches within the CE literature are diverse, and have been reviewed in various contexts across several recent works. Corona et al. (2019) review 'circularity metrics', which they argue should "provide an indication of how well the principle of CE is applied to a product or service" (p1), evaluating them against criteria relating to their 'validity' or ability to represent progress towards a normatively conceived CE. Their analyses demonstrate a typically narrow scope employed by metrics, in some cases reduced to simple consideration of material recirculation (such as recycling rates and percentages of secondary raw materials incorporated in the production processes). The authors deem such approaches as inadequate for anticipating potential rebound effects (Zink and Geyer, 2017), as well as requiring complementary approaches if used for sustainability assessment. These findings are supported by Rigamonti and Mancini (2021) who conclude that "circularity indicators, alone, are not able to assess the overall environmental performance of circular strategies" (p1941). Vinante et al. (2021) review 'circular economy metrics' at the firm level. Noting a lack of shared language for CE assessment techniques, a large number of metrics that are present in only a single source, and varying interpretations of CE, the authors suggest that the current literature resists standardisation. The authors also question to what extent CE metrics should incorporate, and overlap with sustainability related metrics more generally.

We thus see a recurrence of the debates surrounding broader dashboard vs aggregate approaches to composite indicators. A large number of composite indicators exist, which seek to measure circularity, this includes the EMF's Material Circularity Indicator (MCI), which is intended to "assess the circularity of companies' flows of products and materials" (Ellen MacArthur Foundation and ANSYS Granta, 2019, p9), through focusing on the origin and destination of material flows and providing an indication of how much a product's materials recirculate within the supply chain (ibid., p11). Such single dimensional tools are the subject of various critiques, and there currently exists no 'best practice' or 'standard' tool for assessing circularity (Lonca et al., 2018; Moraga et al., 2019; Rigamonti and Mancini, 2021). With current measurement systems, circular does not mean "sustainable", and thus many approaches have been keen to complement circularity measures within a broader framework, often amounting to a dashboard approach. Indeed, the EMF itself, in the latest iteration of its methodology, encourages the MCI to be considered alongside a set of complementary 'risk' and 'impact' indicators such as supply chain risk and energy usage (Ellen MacArthur Foundation and ANSYS Granta, 2019, pp40–45).

An important distinction must therefore be made between assessment tools, often centred on aggregate indices, for measuring 'circularity', and tools assessing the transition to a CE which warrant the consideration of extra dimensions, typically taking a dashboard approach. It is worth highlighting here how a dashboard approach can allow for a broader normative orientation than the measurement of a singular concept like circularity. Several authors have therefore analysed CE assessment methods with respect to their coverage of the 'three pillars' of sustainability (Calzolari et al., 2022; Roos Lindgreen et al., 2020; Vinante et al., 2021; Walzberg et al., 2021). For Roos Lindgreen et al. (2020), CE 'assessment tools' are for "facilitating information exchange, monitoring progress, inform[ing] decision-making, and improv[ing] circular business investment decisions" (p2). Noting that "the absence of broadly accepted metrics [have] been described as a barrier to transitioning to a CE" (p2), the authors subsequently analyse 74 individual tools applied at the micro level (i.e. products, & firms). Their results show limited coverage of the three pillars of sustainability, and a lack of guidance related to implementation across the whole selection. These findings are echoed by Calzolari et al. (2022) who focus on CE indicators for analysing supply chains, systematically reviewing the literature and assessing prior work on its coverage of economic, environmental, and social dimensions. The studies examined focused primarily on economic and environmental dimensions with relatively little attention given to the social one; only 18% of studies included some sort of social dimension, compared to coverage of 80% and 66% for environmental and economic ones respectively. Even where social dimensions were present, Calzolari et al. argue that they are often simplistic, focusing on quantitative rather than qualitative aspects, such as basic measures of jobs created, which do not investigate work conditions. At the firm level, Vinante et al.'s (2021) study reveals only 2% of identified metrics relating to the social dimension. Indeed, the marginalisation of qualitative social dimensions, and lack of consideration given to justice is a recurrent theme throughout the wider critical literature on sustainability assessment (Boyer et al., 2016).

Of the methodologies examined by Roos Lindgreen et al. (2020), a common approach to developing an assessment framework involves a preliminary literature review of relevant factors, followed by external input from stakeholders or 'experts' to refine a set of indicators. Roos Lindgreen et al. (2020) conceptualise descriptive, normative and prescriptive elements that such assessment methods should consider. In the normative element, it has been emphasised that it is important to focus on means over ends; this is particularly important in CE practices where circularity itself is not a sufficient goal, as reduced negative impacts do not necessarily follow (Harris et al., 2021; Walzberg et al., 2021). The nature of the *transition* is thus important here, not just the outcome but how we get there. Walzberg et al. (2021), analyse CE 'assessment methods', using the framework of scope, temporal resolution, data

requirements, data granularity, material efficiency potential, and sustainability completeness. They conclude that "no method is able to answer questions about the CE holistically" and thus suggest that combining existing approaches may be necessary. A similar study by Parchomenko et al. (2019) collates frequent elements of CE metrics, and suggests the need to focus on economic processes, from extraction to use, in order to identify gaps and minimise the amount of overlaps in the selection of indicators.

Harris et al. (2021) note a disconnect between the assessment of systems at different levels, in particular the micro (product) and macro (economy) level. This might also be due to the fact that the definition of indicators at the meso-level (e.g., sub-national territorial systems, industrial sectors or supply networks), which could provide a useful link between micro and macro perspectives (Harris et al., 2021), is still underdeveloped (Vinante et al., 2021), despite some notable contributions (see e.g. Gambarotto et al., 2022). This revelation emphasises the importance of seeing the wood for the trees in the development of CE assessment approaches (Saidani et al., 2019). As is occasionally noted, material circularity isn't necessarily a desirable goal in and of itself (Genovese and Pansera, 2021; Harris et al., 2021; Lonca et al., 2018).

It is important to be mindful of the normative perspective at a societal scale, even when focusing at the micro level. It is for this reason that the three dimensions of social, economic, and environmental sustainability are often used as a central core for normative analysis. The normative element of CE has been debated within more critical strands of the CE literature. Genovese and Pansera (2021) critique the dominant technocratic and eco-modernist framing of CE, whereby market capitalism and economic growth are assumed to be compatible with the long-term health of socio-ecological systems, alongside a problematic faith in technological solutions to unfolding crises. Calisto Friant et al. (2020) suggest that this status is in part the result of the early discourse being dominated by business and policy actors who have specific political and economic agendas, and have thus used the CE as a "narrative device for greenwashing" (p1). Pansera et al. (2021) therefore argue that the CE must be politicised, and "implausible socio-technical imaginaries" brought into question (p472). We join the growing number of authors calling for more radical and transformative conceptualisation of a CE (D'Amato, 2021; Ortega Alvarado et al., 2022; Rask, 2022; Vanhuyse et al., 2022). In doing so, we explicitly adopt the framing of a 'just transition' (Velicu and Barca, 2020; White, 2020) to conceptualise a 'just CE' centred on principles of social and environmental justice.[1] It is our belief that indicator frameworks that solely focus on circularity, or even loosely defined social, economic, and environmental goals are insufficient for building towards a transformative just CE. Our core question within this work thus relates to the wider epistemological debates around measurement frameworks, and we ask to what extent indicator frameworks are fundamentally limited in terms of transformative potential.

3. Challenges for indicator methods

Due to their ubiquity, the academic literature is awash with criticism of indicator approaches to sustainability assessment. In this work we conceptualise criticism levelled at indicators along a spectrum from technical issues to episto-ontological challenges. Thereby we cover e.g. the technical challenges that surround data collection, to the strong critique of reductionism which objects to the idea of 'measuring the unmeasurable'. This roughly maps with the realist versus subjectivist approaches to measurement discussed in the epistemology of measurement literature and presented in Section 2.1. We thus use an alternative framework to Verma and Raghubanshi (2018) who conceptualise 'internal' and 'external' challenges to indicator approaches, with the former relating to methodology, weighting, dealing with boundaries, and complexity, and the latter regarding barriers to implementation such as data constraints, a lack of political will, and failure to build consensus.

We further characterise the dashboard approach to indicators into the following sequential steps, which relate to methodological choices that must be taken. 1) The selection process: which indicators to select as relevant, who should decide and how; 2) The assessment framework: including theoretical framing, and how the indicators are combined, aggregated, or contrasted; and 3) Implementation: how assessment is carried out in practice. Reduction of this workflow into a linear 3-step process is primarily for illustrative purposes, as we acknowledge the iterative complexity that exists in most empirical applications. These three steps cohere somewhat with Adcock and Collier (2001) framework for the research tasks involved in conceptualisation and measurement: conceptualisation, operationalisation, and scoring. These authors too consider this to be an iterative process. Table 1 illustrates many of the challenges to indicator based approaches outlined in critical literature across each of these steps, spanning technical and episto-ontological dimensions. Many of these challenges exist throughout the process and are difficult to attribute to a single step, there is thus inherent fluidity to the boundaries of this table.

The following subsections analyse in detail the issues and challenges of indicator approaches within each of these three steps. Thus the contents of Table 1 are fleshed out with reference to the academic literature which offers critical perspectives to methods of sustainability assessment. In examining each step of the archetypal indicator dashboard approach we critically consider their transformative potential, and aim to outline the challenges that may be faced by scholars and practitioners who wish to develop or refine CE indicators.

3.1. Selection of indicators

The selection of indicators to appear within a dashboard is a non-trivial process, with an innumerable combination of possible factors that could be included and ways to combine them. Pertinent methodological questions that must be answered at this stage relate not only to which indicators are relevant, but cover who should determine so, and how. Robeyns and Byskov (2021) suggest that approaches for indicator

Table 1
Challenges of indicator based approaches as identified within the literature. Note these categories are fluid and challenges may span a number of categories. These issues and challenges are elaborated throughout Section 3.

Step	Technical Issues	Episto-ontological Challenges
1) Selection	● Determining problem scope ● Getting the right coverage ● Different understanding of terms ● Quality criteria ● Which stakeholders? How can they input?	● Reductionism: can complex socio-environmental factors be reduced to a series of indicators? ● Measuring the immeasurable: marginalisation of social / qualitative aspects
2) Theoretical framework	● Absence of theory ● Handling complexity ● Difficulty of comparing disparate factors ● Weighting & normalisation	● Trade-offs as inherent? ● The whole is bigger than the sum of its parts ● Depoliticisation ● Arbitrariness
3) Implementation & outcomes	● Data constraints ● Limited resources ● Lack of political will ● Failure of consensus	● Lack of pluralism ● Difficulty of observing and measuring outcomes

[1] These are contested concepts themselves. Embedded in emancipatory struggle, Meira et al. (2023) delimit the ecological justice literature into four related concepts of social metabolism, ecological distribution conflicts, climate & ecological debt, and working class environmentalism.

selection range from "substantive proposals with elaborate theoretical underpinnings", through procedural methods, and what they describe as "atheoretical" approaches based on survey data and statistical techniques. It should also be noted that a significant number of studies using indicators take an ad hoc approach and do not explicitly identify their selection process.

3.1.1. Which indicators are relevant?

A first approximation of which indicators to include within a project is best determined through the definition of the problem scope, surrounding questions of context, goals, and spatio-temporal aspects (Pope et al., 2017). Whilst empirical studies tend to be grounded in a specific case (see e.g. Rossi et al., 2020), it is not uncommon for authors to seek more generalised frameworks of indicators. A broader question to be grappled with at this stage concerns the epistemology of measurement, and the nature of the indicator set. Here a number of interpretations of the resultant indicator set may be forwarded: it may be 'definitional', i.e. a claim to truth as to how the concept should be understood, or instead a single contribution to wider debates and discourse (Robeyns and Byskov, 2021). Divergence may be seen here between authors who reject universalising frameworks, either from a relativist epistemology which emphasises context specificity (Micheli and Mari, 2014) or from more critical decolonial, or feminist perspectives (Hukkinen, 2003; Kaika, 2017), and those, particularly in policy spheres, who may view a standardised set of indicators as desirable, for e.g. benchmarking (Elgert and Krueger, 2012). Thus, which indicators are relevant is tightly bound up with the scope of the research design, and its methodological orientation. Järvenpää and Länsiluoto (2016) highlight how institutional logic, i.e. the norms and values of dominant institutional orders, such as profit and economic growth oriented logics, shape the selection and development of indicators. This prompts a need for reflexivity in indicator selection, not just asking which indicators are relevant, but reflecting upon why.

The nature of indicators as proxy measures means that coverage is an important issue, with the breadth of coverage often viewed as a key determination of success. This breadth has been conceptualised across a number of dimensions, often realised as coverage across the three pillars. Other components of breadth suggested for CE indicators include consideration of the temporal dimension (Figge et al., 2018; Moraga et al., 2020), full consideration of labour aspects (Llorente-González and Vence, 2020), and process-oriented coverage (Moraga et al., 2019; Parchomenko et al., 2019). The focus on coverage prompts the questions of gaps and overlap, both of which have been problematised in the literature. The concept of 'Mutually Exclusive and Collectively Exhaustive' has been discussed, for example, in relation to supply chains and life-cycle approaches in order to avoid problems associated with double counting (Lenzen et al., 2007).

One perennial observation in studies that analyse existing indicator sets, from urban sustainability (Cauvain, 2018; Opp, 2017), to the CE (Calzolari et al., 2022; Kirchherr et al., 2017; Roos Lindgreen et al., 2020), is the marginalisation of social dimensions, and a bias towards quantitative physical and environmental factors. This gap may be seen to stem from the 'quants–quals' divide, and both epistemological objections to reductionism, and the technical challenges with reducing complex social phenomena such as wellbeing and inequality to numerical quantities (Kubiszewski et al., 2018; Syrovátka and Schlossarek, 2019). This, according to Satterthwaite (1997) means that directly measurable indicators get more attention than they perhaps deserve, both in academic studies but also in policy circles. The marginalisation of the social dimension in the CE literature perhaps also reflects its historical legacy, with prominent roots in the field of industrial ecology, shaped by scholars in engineering disciplines, and reflecting worldviews which see solutions as technical rather than political (Genovese and Pansera, 2021); this is also testified by the fact that, for instance, Social Life-Cycle Assessment has seldom been employed to evaluate CE strategies (Luthin et al., 2023). The implications of this uneven coverage are thus wider than questions of technical rigour, with the selection of important factors dictating political imperatives. A useful comparison can be made here to the wide ranging discourse on the centrality of GDP to policy globally, and its numerous shortcomings (Kubiszewski et al., 2013). The marginalisation of social elements is a clear problem from the perspective of justice oriented conceptualisation of a CE and the consideration of transformative potential.

3.1.2. Says who?

The selection of indicators is subjective: which factors are deemed as relevant depends on who we ask. Various relevant stakeholders have been explicitly identified within the literature including firms, employees, customers, governments, researchers, and waste management actors (Shah and Bookbinder, 2022). Purvis et al. (2023) draw on responsible innovation and the principle of inclusion to suggest that CE stakeholder selection should encompass all actors involved in the production process, as well as groups potentially impacted by the transition process; the goal of realising such a 'CE public sphere' is contrasted however with the challenge of engaging a broad range of stakeholders in practice. A just approach clearly favours the creation and engagement of new publics here (White, 2020).

Turcu (2013) differentiates between expert-led (top-down) and citizen-led (bottom-up) approaches to indicator selection. Turcu argues that the former approach is rooted in scientific positivism (p699) and open to missing important factors on the ground; citizen-led approaches are embedded in a 'participatory philosophy', but risk becoming rudderless without a steer to foster change. Turcu thus advocates an approach that combines these two directions. Within the CE literature, all three of these practices are observed, including the use of Delphi approaches to quantify expert/stakeholder views (Padilla-Rivera et al., 2021; Prieto-Sandoval et al., 2018). Droege et al. (2021) co-develop a CE assessment framework with public sector actors, and argue that the absence of stakeholder involvement is a crucial factor leading to failure of adoption of such frameworks.

One of the challenges that comes from a multi-stakeholder approach to selection is the subjectivity of understanding, and divergent interpretations of a single term. This is particularly the case in relation to umbrella concepts such as the CE, where the ambiguity of definitions can lead to communication barriers and disagreements about priorities (Berry et al., 2022; Korhonen et al., 2018). Cohen (2017) suggests that such issues may be overcome by carefully defining terms, though as has been noted by other authors (Ramsey, 2015), this is itself a non-trivial and perhaps impossible task. Indeed, Goertz and Mahoney (2012) argue that from an epistemological perspective, definition and measurement are not always separable, and one does not necessarily straightforwardly lead to the other.

Whilst stakeholder involvement is largely seen as best practice, this masks the challenges that come with the selection of relevant stakeholders themselves. Colvin et al. (2016), for example, highlight how the selection of stakeholders can reify existing inequalities and injustices, and suggest that the conscientious researcher must look beyond the 'usual suspects'. Illustrating the problem of selection bias, Robeyns, (2005) writes that "every policy maker or researcher is situated in a personal context and therefore needs to pay special attention to avoid biases that are introduced by his or her background" (p206). This is a key consideration, and issues of e.g. gender, race, geographic location, socioeconomic status, and the social relationship to production, must be kept in mind when considering the 'sufficiency' of democratic procedures. Power dynamics and agendas are also important, and the deliberation between stakeholders and 'experts' brings to light fundamental questions about the nature and meaning of democracy.

3.1.3. How?

Howard et al. (2019) present the design of a framework of CE indicators for use by large multinational organisations, and follow a somewhat typical approach that is worth sketching here. The authors

begin by reviewing CE related indicators employed within a selection of practitioner literature, these are classified according to common themes such as 'energy use', and 'water waste'. A process-oriented theoretical frame is then elaborated which presents a conceptualisation of the CE and maps this to practices identified in the indicator review. Nika et al. (2021) take a similar approach, but stress the importance of a combined expert and participatory approach to CE indicator selection, taking a synthesised database of indicators, injecting some theory, and then asking identified stakeholders to rank indicators in terms of importance; statistical methods are then used to refine the theoretical framework. Such approaches are typical, yet as the literature notes, and Table 1 details, each of these steps brings challenges and limitations.

The use of statistical techniques here sees variation throughout the literature, hierarchical ranking in terms of the number of occurrences in the literature is common (Saidani et al., 2019; Vinante et al., 2021), this may lead to weighting in terms of relevant importance (Calzolari et al., 2022). Relative weights may also be derived through ranking and rating by stakeholders (Garcia-Bernabeu et al., 2020), or through the use of preference eliciting methods such as the Analytic Hierarchy Process (AHP) and its variants (D'Amato, 2021). Some authors have also used more advanced statistical techniques such as structural equation modelling (Trần et al., 2022) and correlation analysis (Căutișanu et al., 2018) to refine sets of indicators. Additionally, data reduction techniques such as principal component analysis and factor analysis, can be used to reduce the dimension of the set of indicators considered, or even compute weights (Lafortune et al., 2018; Lamichhane et al., 2021).

Within the literature we find numerous examples of criteria for the selection process. For example, Robeyns (2005) suggests four quality criteria for the selection process: 1. explicit formulation; 2. methodological justification; 3. different levels of generality, e.g. descending from ideal theory to pragmatic lists; 4. exhaustion and non-reduction - no dimensions that are relevant should be left out. Another set of criteria which is popular with some authors (Hák et al., 2016; Maxwell et al., 2015) is 'SMART' (specific, measurable, ambitious, realistic, and time-bound). Other suggestions include minimum acceptability thresholds (Pope et al., 2004), and a differentiation between indicators which should be seen as constraints, i.e. with a minimum threshold that should be met, and indicators without such a threshold that should simply be maximised (Mori and Yamashita, 2015). These proposals can complement specific suggestions for CE concepts and processes outlined in 3.1.1. The intentionality of these lists of criteria is to bring theoretical rigour, yet it is hard to escape the feeling that regardless of what rigour is injected, the narrowing down of an infinite set of possibilities into a countable number of singular indicators is inherently arbitrary. It is also worth noting that there is no shortage of alternative quality criteria for choosing indicators.

This wider episto-ontological challenge of arbitrariness is existential, and a reason that many critical scholars employing indicator approaches emphasise context specificity over universalism. Robeyns (2005), for example, challenges the idea of a universal list of indicators on the grounds of goals varying depending on context; limits to knowing the experience of others; and the legitimacy of the selection process. Thus, pragmatism is necessary for any successful approach at selecting and applying a set of indicators. This requires acknowledging limitations, whether epistemic or technical. It is here, in identifying a relevant context for specificity, that an axiological or political framing may provide some further grounding through a link to theory. It is for this reason that we adopt the just transition framework, contrasting with the dominant eco-modernist approach (Genovese and Pansera, 2021), to emphasise our conceptualisation of the CE as necessitating wider socio-economic transformation. Adopting such a political and theoretical grounding in many ways rejects a consensus based or universalist approach. In the next section we turn to consider how a framework might be built on such groundings.

3.2. Building a framework

We understand a framework as a formal organisational structure which outlines core concepts and theoretical principles. A key element of framing relates to grounding the approach in theory in order to circumvent the most basic accusations of arbitrariness (Valdés, 2018). We also conceive the framework of covering aspects of operationalisation, particularly surrounding key questions of how the selection of indicators are combined, aggregated, or contrasted; here the framework must consider both how complexity is handled, as well as the nature of trade-offs between indicators. The framework thus includes elements of conceptualisation (Goertz and Mahoney, 2012), consideration of how CE is to be understood, and also operational aspects relating to coherence between indicators and the validity of the dashboard (Adcock and Collier, 2001).

3.2.1. Theory? What theory?

Cohen (2017) critiques the blind application of indicators without a theoretical framework or underlying principles, suggesting that this leads to tradeoffs and uncritical acceptance of economic goals. Keirstead and Leach (2008) argue that weak theoretical framing contributes to indicators being picked arbitrarily through pragmatism and expediency. Pope et al. (2004) also argue that a coherent framework based on well-defined principles is necessary to emphasise interconnections and interdependencies, avoiding trade-offs as much as possible. To Davidson et al. (2012), sustainability assessment is hampered by its "lack [of] conceptual frameworks that provide an epistemological link between a definition of sustainability and the indicators that measure it" (p58). Goertz and Mahoney (2012) note that a focus on 'operationalisation' over 'conceptualisation' is something of a norm within quantitative research paradigms, and that within such paradigms the selection of indicators may be judged to construct the concept itself; this differs, they argue from qualitative paradigms where concepts are instead constructed through a semantic process. Under this observation, Davidson et al.'s (2012) objection, which we share, may be considered as a broader critique of assessment approaches purely rooted within quantitative paradigms.

Whilst the need for an underlying theoretical framework is convincing from a methodological perspective, it is less clear that it is a silver bullet for solving issues of trade-offs and arbitrariness. As Cohen (2017) admits in his discussion relating to urban sustainability assessment, there is a clear lack of consensus on what guiding principles should be contained within such a framework. That a lack of consensus for a broad universalising theoretical frame should be considered a problem is, we suggest, a consequence of depoliticisation, both with respect to CE, and sustainability assessment more widely. More specifically, this depoliticisation is realised through the construction of a common sense that presents itself as 'ideologically neutral' and acts to marginalise radical or alternative discourses (Tulloch and Neilson, 2014), most notably in terms of dominant ecomodernist and technocratic paradigms. Genovese and Pansera (2021) refer to the CE as a "highly contested political project", and as outlined in Section 2.2 a growing body of literature is conscious of this. A core element of the theoretical framework is the political angle, and the ultimate aims of its normative perspective, as highlighted by Martins (2022); this is not something which should be glossed over or left to implicit interpretation. An example of this is provided by O'Neill (2012), who, before presenting a framework of indicators for assessing the transition towards a degrowth-based economy, clearly spells out the political underpinning. Thus a framework for a just CE needs to explicitly contextualise the justice element, and in doing so make a clear claim in differentiating its political grounding to other approaches.

The nature of the theoretical framework maps well to the basic questions of research design relating to scope, intentionality, and coverage. Framing and indicator selection are inherently linked, as we have already explored with reference to the three pillars, and other

devices for determining suitable coverage. Whilst the reductionism of a simple three pillar approach can be critiqued, such devices are necessary for ensuring some form of coherence in indicator selection. To confront criticism of simplicity or reductionism, a number of authors suggest the need to draw from a diverse set of methods to generate robust assessment, a methodological pluralism as it were (Gasparatos et al., 2009). As Marchionni (2008) suggests, "an environment favoring a variety of methods, theories, and perspectives, some of which are incompatible, is conducive to scientific progress" (p330). Methodological pluralism is emphasised by Popa and Guillermin (2017) beyond the technical and operational elements of method, in terms of epistemological (many legitimate types and sources of knowledge exist), ontological (many legitimate modes of being exist), and axiological (many legitimate normative values exist) dimensions. Here it is necessary to note however that not all worldviews are compatible, and that a coherent theoretical framework may necessitate the exclusion of indicators which lie in contradiction with the framework's underlying principles: for example 'intensity' indicators linked to GDP may be incompatible with a framework based upon 'degrowth' (Rodriguez et al., 2020). It is therefore important to make the distinction of pluralism within frameworks to pluralism between frameworks, with the former leading to incoherence.

3.2.2. Trade-offs

The nature and existence of trade-offs between competing factors is a core topic of concern within the sustainability assessment literature. Trade-offs are considered by some to be inherent to indicator approaches, whilst others focus on supposed 'win-win' paradigms and suggest that tensions may be avoided through careful selection of indicators and a robust theoretical framework (Gibson, 2013; Hahn et al., 2010; Van der Byl and Slawinski, 2015). Empirical examples of trade-offs occurring as well as examinations of how stakeholders grapple with them are abundant within the literature. In a classic work, Caldwell (1984) examines numerous cases of failed development projects, with the common theme of their prioritisation of short term economic gains over longer term ecological aspects. There is a key political angle here, and one of the most recurrent criticisms of the three pillars paradigm relates to the equal importance it often gives to economic and environmental dimensions (Purvis et al., 2019). As Purvis et al. (2019) argue, the three pillar paradigm itself is a historical product of wider political struggles which has become depoliticised through its institutionalisation and mainstreaming. Within the CE discourse, trade-offs have been conceptualised and problematised in relation to firm profit and sustainability dimensions (Ünal and Sinha, 2023), the marginalisation of developing countries in global supply chains (Schroeder et al., 2018), and the unclear relation between circularity and minimisation of primary production (Schaubroeck, 2020; Zink and Geyer, 2017).

Within the wisdom that accepts trade-offs as a problem to be fixed, there exist a number of technical solutions for addressing trade-offs between indicators. These largely relate to methods of weighting and normalisation. Whilst the dashboard approach in its purest sense seeks to avoid aggregation of indicators, it is not uncommon to see hybrid approaches employed. MCDM approaches appear frequently within the literature as a means for interpreting dashboards (Gasparatos and Scolobig, 2012; Gavade, 2014). Here indicators may be weighted in terms of relative importance through various methods which have been briefly outlined in Section 3.1.3. Nevertheless, the subjective nature of the weighting process means that a high degree of arbitrariness is necessarily introduced (Böhringer and Jochem, 2007), along with potential compensatory effects and 'quotas of substitution' introduced by aggregation methods, which might imply the adoption of weak sustainability paradigms[2] (Pollesch and Dale, 2015; Valdés, 2018).

Alongside the prioritising of particular indicators over others, another issue relates to how the context in question relates to wider systems at broader hierarchical scales. This is particularly pertinent for the CE which must be considered within a wider global context. The existence or possibility of rebound effects should be further underlined here, whereby an increase in 'circular' practices leads to unanticipated increases in production (Zink and Geyer, 2017). Further, international trade and unequal ecological exchange should be considered in any transformative approach to a CE based upon principles of justice (Barrie and Schröder, 2022; Rivera-Basques et al., 2021; Salazar et al., 2021). Here especially it is important to be critical in regards to frameworks that take a Eurocentric approach to CE without considering wider geopolitical impacts (see, de Boer et al., 2021).

3.2.3. Handling complexity

As noted by Burgass et al. (2017), one of the inherent weaknesses of using a simple dashboard of indicators, is an overload of information. The SDG indicators remain a prominent example of this, despite the broadness of the ground covered by the 231 indicators, it remains very difficult to monitor, understand, and analyse all 231 indicators concurrently. Indeed this brings to light the dichotomy between breadth and depth, when a single expert is not likely to have the sufficient expertise to grapple with such a broad range of dimensions. Of course for the SDGs this is less of a problem, as the sets are not necessarily designed with the intentionality to be all used together. Nevertheless such breadth makes it difficult for an actor or policy maker to look down upon this framework and parse the societal trajectory (Blok et al., 2015).

As Berik (2020) suggests, even if the stakeholder is able to parse the dashboard, it remains difficult for the researcher or designer of the tool to have a clear understanding of how the stakeholder interprets it. This links back to the issue of varied interpretation, it is likely that the more complex the tool, the wider the breadth for interpretive variability. This impacts the reliability of benchmarking: results aren't directly comparable if the assessment has been interpreted in a different way. Steps have been suggested to mitigate this, such as Cohen's (2017) suggestion to clearly define terms, but as Turcu (2013) found through empirical work, "what seemed obvious and important to experts at the 'top' of indicator development seemed to be less so to citizens at its 'bottom'" (p713). One challenge for CE research here, is that despite increasing permeation in the last 5–10 years, there is still uneven awareness and understanding of the concept among relevant actors (van Langen et al., 2021).

3.3. Implementation

Roos Lindgreen et al. (2020) suggest that "assessment approaches carry real-world value only when they are implemented" (p16). Yet this final step is surprisingly under-explored. Indeed, many studies present the development of a framework, but stop short of demonstrating its use. The nature of implementation is dependent on the context of the case, and the assessment may be undertaken by the stakeholders, the researchers, or a combination of both.

3.3.1. Collecting data

Assessment is dependent on data; data collection is thus a core component of implementing an indicator framework. The common challenges of data collection are therefore of importance here.

[2] Arising from early debates from the 1980s, the concept of 'weak sustainability' implies substitutability between economic, social, and environmental capital; this lies in contrast with 'strong sustainability' which rejects such substitutability (Wilson and Wu, 2017).

Obviously, a distinction needs to be made here in terms of the challenges for collecting data at the micro- and macro-levels. Saidani et al. (2019) outline how this can be particularly problematic for CE assessment, at a micro-level, within firms who often do not have sufficient access to data, or there are issues of commercial sensitivity surrounding its use. Additionally, the complexity of product supply chains might mean that many organisations might find it difficult achieving its full visibility. However, at such a level, approaches based on Life-Cycle Assessment (LCA) and Material Flow Analysis provide a suitable framework for assessing products, along with access to secondary databases which can be used for benchmarking purposes and supplementing missing inputs (Harris et al., 2021).

Things are even less straightforward when wishing to compare national and international contexts where some manner of standardisation is desired (Dahl, 2012). Avdiushchenko and Zając (2019) suggest that progress is being made in the European context towards standardised data sets for CE indicators, however currently comparison with other Geographical areas such as China is not feasible. Harris et al. (2021) argue that Multi-Regional Input-Output (MRIO) analysis can be employed in order to assess environmental performances at a macro-level, adopting similar indicators to the ones utilised in micro-level LCA. However, despite the increasing standardisation of MRIO data, some of the assumptions in terms of environmental implications appear to be very rudimentary and prone to simplifications (Stadler et al., 2018). Here it is necessary again to reflect, as Jenkins (2019) reminds us upon the wider social relations at play in the development, creation, and mainstreaming of data infrastructures. A key consideration here from the perspective of global justice is the unevenness of data across the Global South, and the wider implications this has for further entrenching global inequalities and the dominance of Eurocentric research paradigms (Kinyondo and Pelizzo, 2018).

Ideally what relevant data exists or is available is considered in the selection of indicators. Though an over attention to this may undermine the coverage of the theoretical framework, and indeed is a major reason we see the marginalisation of qualitative and social indicators. Thus, the implementation process must also grapple with what to do in the absence of data, what to do when data is incomplete or outdated, and how uncertainty should be handled. Even within the CE literature a large number of statistical techniques have been proposed to confront some of these issues. Esbensen and Velis (2016) discuss 'Theory of Sampling' and Monte Carlo simulation with respect to quantifying uncertainty; Gupta et al. (2019), Awan et al. (2021) and others suggest that data mining, machine learning, and 'big data analytics' may provide methods for obtaining and analysing data. Other methods for using inference to account for missing data are discussed by Curley et al. (2019).

3.3.2. Stakeholder engagement

Issues of stakeholder engagement have been discussed above in terms of who stakeholders should be, divergent interpretation, and questions of democracy. More technical challenges here relate to availability and time commitment, and how to engage in a meaningful, mutually beneficial, ethical way. Most authors agree that engagement should occur as early as possible and throughout the development process, not just when it comes to implementation (de Gooyert et al., 2017; Turcu, 2013). Yet this is sometimes a challenge due to time commitments and limited resources, as well as stimulating interest. As Purvis et al. (2023) note, whilst we may wish to strive towards an inclusive process which engages a CE public sphere throughout the process of indicator development and deployment, this is often at odds with a desire to remain flexible and reactive to unfolding findings and developments.

The nature of engaging with multiple stakeholders means that often assessment approaches strive to build consensus, e.g. in terms of indicator selection, interpretation, and translation to next steps. Yet building consensus is not always possible, particularly when stakeholders have divergent values and priorities (Berry et al., 2022). Even if consensus can be reached, this may not be translated to action, and Gahin et al. (2003) cite a lack of political will as a real barrier to realising tangible outcomes from assessment exercises. When considering matters of justice in relation to a CE, it is particularly important to be mindful of how research outputs may contribute to greenwashing, and take steps to minimise this possibility (Roos Lindgreen et al., 2022).

3.3.3. Outcomes

There is often an inherent assumption in assessment approaches that by measuring the right things we can catalyse positive change (de Olde et al., 2018). Gahin et al. (2003) explicitly critique this assumption, questioning the proliferation of indicator approaches with very little reporting of outcomes: "are indicators helping to make a difference in the community, or do they just become another report to gather dust on the shelf?" (p661). The authors go on to examine five studies which report on assessment, classifying outcomes along a spectrum from intangible to concrete to measurable, with most identified outcomes falling at the intangible range of the spectrum. Indeed, "actual change as measured by the indicators was not found in any of the case studies" (p663). Despite their age, these findings are worrying, and reflect a clear failure of these methodologies to catalyse change.

The existence of intangible outcomes that "provide the foundation for future change" (Gahin et al., 2003, p665) suggests an alternative way for framing the goals of indicator based assessment; yet these are difficult to observe. The structure of academia means that projects are usually finite in length and resources, and there is often no time to explore wider impacts. Indeed many indicator studies do not implement their frameworks, or even identify an end user. Out of the 74 CE studies analysed by (Roos Lindgreen et al., 2020), 27% do not identify an end-user, and the remaining studies are often vague in their description, e.g. 'policy makers', 'managers', and 'companies'. Much of the CE literature suffers from an overly technocratic worldview in which delivering a tool or framework is the end in itself.

3.4. Summary

The challenges outlined within Section 3 emphasise the fluid boundaries of Table 1. Whilst the artificial separation of process into three distinct steps is blurred by the permeation of stakeholder engagement, theoretical framing, and data requirements throughout the process, there is also an unclear distinction between technical and episto-ontological challenges. Indeed we may argue that many of the technical issues, such as the existence of data, weighting, defining terms, and finding consensus have broader epistemological roots. Again, the epistemology of measurement presents a useful frame for considering these elements, and it is helpful to remain aware of the divergences in which assessment methodologies are conceived across different research paradigms (Goertz and Mahoney, 2012; Mari, 2003).

The indicator approach is inherently reductionist (Gasparatos et al., 2008). It is arguably not possible (or desirable) to combine indicators which are based on different epistemological worldviews into a single framework. It is for this reason that the critical literature is difficult to parse as a coherent whole, particularly within a methodological paradigm which tends to frame sustainability issues as technical and scientific problems rather than political and social challenges (Genovese and Pansera, 2021). Any study designing indicators of circularity, or indeed broader sustainability assessment relating to a CE needs to seriously consider the challenges outlined above. It also needs to confront the politics inherent in any theoretical framing. As de Olde et al. (2018) have pointed out, each new indicator framework adds to an already crowded field of existing assessment approaches. Academics and practitioners should thus consider what it is that their novel approach is adding. We frame this dilemma as a juncture between better indicators or different methods.

4. Better or different?

Whilst the problems associated with sustainability assessment are well elaborated within the literature, a clear approach to overcoming them is not, perhaps indicating that there is no easy way forward. There is no shortage of proposed solutions to technical issues (Bockstaller and Girardin, 2003; Gan et al., 2017), but we should also consider that there seems to exist as many critical papers attempting to integrate various disparate frameworks as there are frameworks themselves. Despite this, there remains little progress in this area. Kaika (2017) argues that this should give indicator advocates some caution to their view that complex factors such as socio-environment quality can be reduced to a series of indicators. To Kaika, these "old methodological tools" have failed, and new grassroots approaches are required which reject consensus.

This final section offers a reflection on the suitability of indicator methods for catalysing the transformative social and ecological transition necessary for a just CE. Crucially we question the incrementalist nature of indicator paradigms and question the extent to which they inhibit transformative potential. We call on our fellow CE scholars to reflect upon the challenges to indicator methods outlined in Table 1 and throughout Section 3 before beginning a new study or research project utilising indicator methods. This reflection, we argue, presents two avenues:

i) Doing better: taking into account the critical literature, both of indicator approaches and of CE, as well as various proposed solutions to technical issues and questions of rigour, and reflecting on politicisation and theories of value;
ii) Doing different: rejecting an indicator based approach entirely, and considering alternate methods whatever they may be.

As such, the following subsections present each of these two avenues, building on the technical issues and episto-ontological challenges outlined throughout Section 3.

4.1. Better

Numerous studies exist attempting to develop 'better' indicator sets for a CE, by e.g. better involving stakeholders through participatory approaches (Nika et al., 2021; Padilla-Rivera et al., 2021; Prieto-Sandoval et al., 2018), synthesising other indicator sets (Avdiushchenko and Zając, 2019; Saidani et al., 2019), selecting indicators for better coverage of 'three pillars' (Calzolari et al., 2022; Rossi et al., 2020), or systematic approaches to weighting (Garcia-Bernabeu et al., 2020). Various technical solutions exist for addressing many of the challenges outlined in Section 3, e.g. relating to data availability, methods of comparison, engagement of stakeholders, and a lack of coherent framing. We should also consider the impacts of new developments in data science and how these are shaping the paradigm of sustainability assessment (Nishant et al., 2020), though there is a need to be conscious of the ethical impacts of such methods, particular ownership and security of data, and the implications of uneven coverage across the Global North & South (Kinyondo and Pelizzo, 2018). Most of the observations relating to the challenges of indicator methods outlined in Section 3 come from works which encourage improvements to current practice, doing better as it were. Whilst we are sceptical of the transformative potential of indicator approaches, it is necessary to emphasise the perceived benefit of such methods play a key role in their adoption.

For practitioners considering an indicator approach, we suggest that the three 'sequential steps' outlined in Section 3 provide a suitable basis for various challenges that must be considered in better research design. Whilst we offer some suggestions for confronting articulated challenges and doing better in the subsequent subsections, we do not purport to offer solutions, but instead offer some threads for opening up various questions that we believe should be confronted in order to do better.

4.1.1. Selection

Perhaps the most commonly levelled critique of indicator selections is one of arbitrariness (Valdés, 2018). In many ways this can be addressed through a clear articulation of the link understood between conceptualisation and measurement, i.e. epistemological questions related to whether conceptualisation precedes measurement (Goertz and Mahoney, 2012). With a strong theoretical framework, perhaps based on conceptualisation of CE, arbitrariness can be reduced. It is also important to remain aware of some of the inherent challenges related to measurement of qualitative and social concepts, here there may be tensions between ensuring appropriate coverage and addressing marginalisation, and the practicalities of assessment and data requirements. There is no clear solution to this through indicator methods, though questions relating to the purpose of the framework may be helpful in prioritising.

4.1.2. Theoretical framework

We argue that any indicator dashboard needs a clear theoretical framework, including adequate grounding in debates and concepts within the wider literature. In the context of CE this means confronting aspects relating to the goals of a CE (Harris et al., 2021), the inclusion of social dimensions (Vanhuyse et al., 2022), and the handling of trade-offs and complexity. A second aspect relates to the epistemology of measurement, and its relation to conceptualisation. Pope et al. (2004) suggest that effective assessment of sustainability first requires that the concept of sustainability be well-defined; whilst we may object to a universalist definition of sustainability or CE, that does not preclude the development of a context specific conceptualisation for the identified purpose. Such conceptualisation can also be responsive to critiques within the literature such as the absence of social dimensions. If we are mindful of the reasons why social and qualitative indicators are marginalised or left out of studies, we can seek to remedy this in our own work; even if this means a less than adequate approximation to measuring the immeasurable. Finally, we may view indicator approaches as technocratic and neutered of political ideology, yet with the right theoretical framework we can politicise our selection of indicators and reject greenwashing or perpetuation of the status quo. As Kovacic and Giampietro (2015) argue, this requires reflexivity, or as Purvis et al. (2023) argue, a deeper consideration of principles relating to responsible research and innovation, including anticipation, inclusiveness, and responsiveness.

4.1.3. Implementation outcomes

The importance of reflecting on the purpose and anticipated outcomes of an indicator study should not be underestimated. We strongly discourage attempts to develop universalist frameworks for CE indicators, which for various reasons outlined in Section 3, we judge doomed to failure. Instead we encourage authors to focus on the novelty of their contribution, so as not to add 'yet another' indicator dashboard to the literature. Context specificity may thus be an important lens here, and working closely with appropriate stakeholders in a similar manner as outlined by Turcu (2013). Gahin et al. (2003) present a useful frame of reference for the conceptualisation of outcomes, ranging from intangible to concrete to measurable. The barriers to realising measurable outcomes should be seriously engaged with and realistically assessed. On the other hand, intangible outcomes may represent valuable and worthwhile outcomes, this may include providing a discussion fora for marginalised voices, facilitating new working relationships, and encouraging value shifts. Here it is useful to reflect on the purposes of measurement, and perhaps adopt novel ways of thinking. As political constructions, the value articulation potential of indicator frameworks has perhaps hitherto been underexplored in terms of transformative potential. Alternatives to GDP are relevant examples here in their role as rhetorical devices for challenging hegemonic narratives.

4.1.4. Towards better research design

Table 2 illustrates a set of questions (column 3) relating to research design which correspond to each sequential step (column 1), and the critical challenges (column 2) which are detailed within the subsections of Section 3. In contrast to Section 3, these sequential steps are presented in reverse order here in a way that encourages a holistic approach to the research design, considering the final outcomes and purposes of the approach prior to questions relating to methods. This, we suggest as an important departure from how indicator frameworks have been typically developed within some of the literature, where selection of indicators precedes deeper consideration of how the framework is applied. The purpose of the study, how it will be applied, and intended outcomes should be carefully considered initially, and these should inform any subsequent decisions relating to the theoretical framework and indicator selection. The questions presented in column 3 derive from the challenges presented from the literature in corresponding sub-sections, these are not meant to be exhaustive, but cover a broad base which we feel are important for any research design to consider. First, the anticipated outcomes and purpose of the assessment methods need to be fully considered, ideally with space for realising outcomes built into the project timeframe. Second, the framework should be embedded in theory, with not only consideration of relevant bodies of literature, but an explicit understanding of the episto-ontological orientation in relation to measurement. Finally, authors should design, and communicate a clear approach to the selection of indicators; this should as far as possible avoid arbitrariness.

Doing better represents a pragmatic approach. We can acknowledge all shortcomings and limitations, and yet still adopt an indicator based approach due to the receptiveness of stakeholders, or a desire to reduce complexity down to a more tangible level. Yet as proponents of methodological pluralism may point out, this is never the only route available to us, and as de Olde et al. (2018) caution, too many alternative and competing frameworks makes for confusion and contradicting results. What if we were to do things different?

4.2. Different?

As Kaika (2017) argues, and the study by Gahin et al. (2003) suggests, perhaps indicators are failed tools that should be abandoned in search of alternatives with the potential for radical transformation. This is a core concern if we are aiming to embed principles of justice and consider the transition to a CE as one of broad social transformation, rather than an incremental ecomodernist preferencing of technological fixes. What is novel and interesting about producing yet another indicator set, even if it is 'better' than the last? As pointed out in Purvis (2020) whilst there exist a plethora of proposed fixes to technical issues, there remains little progress in the literature as a whole to move past recurrent critiques of these methods. This methodological groundhog day should give strong advocates of indicator approaches some pause for thought. Kaika (2017) argues that 30 years after the Brundtland report we remain reliant on the same failed methodological, political, and technological frameworks, suggesting that it is beyond time that we changed our questions and methods. This wholesale rejection of indicator approaches bridges the technical issues and episto-ontological challenges outlined in Table 1 as fundamentally linked.

Table 2
Some questions to ask in the research design of an indicator approach, relating to each of the critical challenges detailed in Section 3.

Step	Critical Challenges	Questions to aid research design
1) Implementation & outcomes	What outcomes are desired? (3.3.3) Stakeholder engagement (3.3.2) Data collection (3.3.1)	What is the purpose of the study? What is the context of application? What is the novelty? What changes should be catalysed by the study? Are these realistic? What is the political orientation?
2) Theoretical framework	What theory? (Section 3.2.1) Handling complexity (Section 3.2.3) Confronting trade-offs (Section 3.2.2)	What literature strands is the study embedded in? How are key concepts understood? How is the epistemology of measurement conceived? What is the axiological orientation?
3) Selection	Which indicators are relevant? (Section 3.1.1) Says who? (Section 3.1.2) How should indicators be selected? (Section 3.1.3)	Does the concept to be measured define the selection or vice versa? How will arbitrariness be minimised? Will measurability or coverage be prioritised? How does selection reflect the political/axiological orientation and the theoretical framework?

The dominance of indicator approaches has led in many places to an implicit conflation between the indicator as a measurement tool (e.g., an object that serves a purpose) and the indicator as definitional, ceasing to be the means to an end but becoming the end in itself. A prominent example of this phenomenon is the usage of GDP as an indicator for social progress, which according to O'Neill, (2012) ended up undermining "the goal of economic welfare that it was supposed to support because people have ended up serving the abstract (but quantitative) indicator instead of the concrete (but qualitative) goal" (p222). This is depoliticisation under yet another guise: we become focused on metrics without questioning the underlying structures that perpetuate injustices. A transition to a just CE cannot be realised without confronting racialised capitalism and neocolonialism. A standard framework of indicators is ill-equipped to envisage anything beyond an incrementalist adjustment to the status quo.

Perhaps we could conceive a set of 'radical & transformative' indicators that would set out the path to a just CE; after all, if indicators are definitional, why not reclaim a better definition? We begin to see here how the emperor has no clothes: the implicit logic behind an indicator approach is that the use of indicators themselves will catalyse change. Yet the 'right' indicators need to be 'achievable', according to proposed criteria, and need buy-in from stakeholders. Thus the selection is unambitious by design, even if we are to believe, contrary to the suggestions by Gahin et al. (2003), Kaika (2017), and de Olde et al. (2018), that the framework will be successfully implemented and lead to tangible change. So far, the academic literature has been more concerned with the development and use of indicators, rather than with the careful analysis of the transformations induced by their adoption (Ottaviani et al., 2021). We need only to look at the failure of carbon trading systems (Pearse and Böhm, 2014), progress towards even the most meagre carbon emissions targets, and the creation of 'intensity' metrics linked to GDP (Rodriguez et al., 2020), for reasons to be doubtful about the success of coordinated use of metrics. A radical and transformative indicator set then is a contradiction of terms. We do not doubt that indicator frameworks have their uses, but we should be careful to ascribe them any more hope than an accounting approach for observing broader societal evolution.

4.2.1. Different how?

It is easy to critique dominant approaches, but less straightforward to propose and conceptualise alternatives. If we reject a dashboard of indicators for a just CE what do we create in its place? A smattering of alternative approaches to assessment may be found in the literature, which we further reflect upon in Table 3. Lowery et al. (2020) develop a methodology based upon storytelling; Purvis (2020) suggests modelling and simulation coupled with systems thinking; Lowe and Genovese (2022) suggest developing frameworks based upon a clear underpinning in theories of value; Whalen et al. (2018) present the use of games to facilitate learning about the CE through a systems thinking lens; Bontoux et al. (2020) demonstrate the use of a tool for exploring future

Table 3
Some suggestions on alternative approaches to indicator methods for catalysing a transformative approach to a just CE.

Proposal	Author	Scope of application	Pros	Cons
Dissensus thinking	Kaika (2017) Berry et al. (2022)	Abandoning consensus of *usual suspects* for an urgency driven citizen-led focus on areas of conflict	Awareness of power dynamics at play in 'consensus' approaches; building solidarities	Risk of decision paralysis; intense demands of process
Gamification	Whalen et al. (2018) Bontoux et al. (2020)	Facilitating and strengthening forward-looking strategic and systemic reflection; engagement with a large number of stakeholders and target audiences; awareness raising	Dynamic scenario exploration capabilities; promotion of holistic thinking	Gameplay conditions might lack realism
Storytelling	Lowery et al. (2020)	Combination of sustainability indicators with *stories* to interpret the transition towards a more sustainable society in local communities	Greater capability to mobilise stakeholders and induce transformations	Inherent conflicts between the reductionist logic of indicators and the richness of storytelling approaches
Modelling, simulation, and system thinking	Purvis et al. (2019)	Focus on simulating the transition process and modelling impacts	Thinking in terms of linked systems & impacts; Focus on evolution & transition not just results	Limited epistemological breadth; Barriers to communication; Technical expertise
Alternative Theories of Value	Lowe and Genovese (2022)	Definition of multi- dimensional value frameworks (with multiple numeraires), with the aim of overcoming value monism	Incorporation of different stakeholder perspectives and encouragement of methodological pluralism in the evaluation of CE initiatives	The epistemological compatibility of multiple theories of value might be checked
Responsible Research and Innovation	Inigo and Blok (2019); Purvis et al. (2023)	Constructing new socio-ethically grounded governance frameworks for the transition	Embedding stakeholders in research design; democratic oversight;	Challenge of consulting many individuals involved in process; difficulty of reaching consensus

scenarios with stakeholders; Purvis et al. (2023) present a framework based upon principles of Responsible Research & Innovation. Many critical authors have suggested an approach grounded in methodological pluralism, reconceiving the indicator set as just one piece of a wider toolkit. Indeed this is an approach already taken by some authors within the CE literature who propose methods for combining an indicator approach with other assessment approaches such as LCA (Rigamonti and Mancini, 2021). Again we must exercise reflexivity in asking ourselves what this toolkit, and the purpose of assessment, is for. Is it for helping businesses maintain profits whilst reducing environmental impacts? Is it for developing an evidence base for policymakers to design CE policy? Or is it about changing the narrative and engendering a transformative approach, by not only critiquing technocratic tools that do nothing to disrupt the status quo, but offering the beginnings of an alternative?

Kaika (2017) presents dissensus thinking as an alternative to the recurrent failure to build consensus, suggesting that a focus on sources of conflict, rather than seeking to neutralise dissent, can empower citizens, and "move beyond stale indicator frameworks [...] toward an urgency driven framework of global socio-environmental equality" (p99). Yet we also find ourselves constrained by a funding landscape which remains hostile to risky or unexplored methodologies (Franzoni et al., 2022). There is less space for failing in new ways. It is therefore important to consider what we wish our impact to be. If, as Gahin et al.'s (2003) study suggests, indicator approaches may have few tangible outcomes, we should ask ourselves what outcomes we value or desire. Perhaps intangible outcomes are enough: shaping new narratives and shifting old. Caniglia et al. (2020) argue that as researchers we should focus on creating the conditions for change to emerge, fostering learning, experimentation, and capacity building, rather than trying to direct processes of policy formation.

5. Conclusions

We judge indicator methods to be fundamentally limited in their potential for catalysing transformative change. Yet there is some irony in calling for an alternative, to do things differently, whilst only offering vague pointers, and a handful of suggestions from the literature, on how exactly to proceed. Nevertheless, experimentation is necessary, and the pressing environmental and social crises demand the exploration of new ways of doing. In this work, we have outlined the use of indicator dashboards for assessing sustainability in the context of the CE. Beginning from a broad overview of methods, and detailing existing approaches for assessment of the CE, we framed indicator limitations in terms of the 3 step process of indicator selection, framing, and implementation, alongside a duality of technical and episto-ontological challenges (Table 1). This framing device was used to consider and collate a broad range of critical literature on indicators, allowing us to reflect on their transformative potential for enabling a just transition to a CE. In light of a lack of evidence on the success of indicator methods for engendering such transformation, we pose the juncture for future research of *better* or *different*? To this question we offer the unsatisfactorily pragmatic answer of: both. There are no shortages of methodological criticism that we could take on board to improve the rigour of indicator research design, and Table 2 represents an attempt to outline core questions for developing better research here, yet it is unlikely that these would assuage the most critical expert voices which reject the desirability of indicator selection entirely. We suggest that seeking a different, alternative approach is desirable, particularly given the epistemic objections to indicator approaches, and real questions about their ability to catalyse meaningful change (Gahin et al., 2003; Kaika, 2017). Yet the direction of alternative travel is far from clear.

We therefore land at the answer that it is not either/or; instead we suggest that there is an urgent need for both better and different. As we conclude in Section 4.1, it is necessary however to conceive 'better' as going beyond fixes to technical challenges, but to address and engage with the various episto-ontological critiques present within the literature which we have outlined throughout Section 3. Here we suggest that better research design does not come from any solutions we may provide, but from asking and reflecting upon various fundamental questions relating to the approach, which we have presented non-exhaustively within Table 2. Here, we suggest the importance of considering each sequential step of the assessment design in reverse order, i.e. first considering the implementation, how it will take place, and what outcomes are intended, then considering the theoretical framework, and finally considering the methods by which selection should take place. This contrasts with typical approaches within the literature where indicator selection is prioritised ahead of deeper consideration on how the framework will be applied. We also conceive of better as being about rethinking the goals and aims of an indicator approach: a core necessity of this is the embrace of the political, and viewing assessment not as a bland technocratic tool for selecting optimal solutions, but something that can shape narratives, uncover overlooked avenues, and engage beyond the 'usual suspects'; to this aim, Section 4.1 offers some reflexive guidelines that scholars engaged in the construction of 'better'

indicators could follow. Doing 'different' echoes the frequent call for methodological pluralism (Caniglia et al., 2020; Lowe and Genovese, 2022; Turcu, 2013); conceiving the indicator set as a single part of a wider range of tools and practices. Here, Section 4.2 details a number of alternative approaches as conceived within the existing literature, including different ways of engaging stakeholders such as dissensus thinking, storytelling, and gamification, alternative methodologies such as modelling & simulation, and alternative theoretical orientations which incorporate responsible research & innovation, or consideration of theories of value. Our call for doing different here articulates an urgent need for further work which is creative in envisaging and embodying new methodologies.

A problem for critical scholars contributing to the CE literature is that the CE, regardless of its current status as an empty signifier, is difficult to assert as a desirable goal in itself. We can introduce the qualifier of a 'just' CE to infuse some expanded normativity, but it is hard to escape the feeling that the CE component of this new goal is redundant. This further emphasises the need to consider goals and desired contributions in research design. Engagement with concepts and methodologies that we may find epistemologically objectionable is often a necessity within research. As Lowe and Genovese (2022) suggest, there is a need to disrupt the apolitical conceptualisation of the CE and clearly articulate alternative theories of value relating to social and economic structures. The question then is how do we modify the tools that we are presented with, repurposing, rethinking, and shifting narratives. We should thus think of 'doing better' in terms of CE tools, not as tinkering at the edges, but turning these concepts and approaches inside out in the search for societal transformation.

Declaration of Competing Interest

The authors declare that they have no competing interests.

Data availability

No data was used for the research described in the article.

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