

# JUST2CE

A Just Transition to Circular Economy



The JUST2CE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003491

# CHAPTER 11

## Integrated indicators for the assessment of economic, social and environmental benefits

## Chapter 11. Integrated indicators for the assessment of economic, social and environmental benefits

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### Abstract

Despite the multiple inherent meaning of the word 'sustainability', scholars tried to implement different sustainability quantifiers, either as overall sustainability indicators or focusing on the different sustainability pillars, that include its environmental, economic, social and cultural dimensions. This contribution assesses, through a bibliometric analysis, the indexed peer-reviewed research and review articles discussing about the sustainability indicators or their specific implementation in relation to the existing sustainability pillars. From this analysis, it appears that they are primarily meant as tools to support decision-making, environmental protection and sustainability assessment. Alternative ways to represent sustainability, spanning from qualitative indicators to art-based research approaches, are also discussed. These tools, that cannot be seen as disentangled from their policy purpose and as separate from the imperative of social justice, should be understood both as instruments to produce new scientific knowledge and as instruments for supporting the process of political norm creation through the generation of narratives, which can be used to encourage the adoption of just circular economy solutions in real industrial processes, without neglecting environmental and economic well-being, as well as the need of diffused social benefits within the current and future generations.

**Keywords:** sustainability; sustainability indicators; social justice; qualitative indicators; art-based research

This contribution assesses, through a bibliometric analysis, the indexed peer-reviewed research and review articles discussing about the sustainability indicators. Then, alternative ways to support the envisioning of transition roadmaps toward more sustainable and just circular economy lifestyles are discussed.

### 11.1 Introduction

Back in 1987, sustainability was defined as “meeting the needs of the present without compromising the ability of future generations to meet their own needs”. Starting from this definition, the United Nations fixed different targets, such as The United Nations Millennium Development Goals (MDGs), which were 8 goals that UN Member States tried to achieve by the year 2015. Then, a list of 17 Sustainable Development Goals (SDGs) were introduced in 2015,

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trying to address the challenges that were still open from the MDGs. The SDGs were fixed as a starting point and desired list of universal objectives to ensure a sustainable lifestyle within a safe space for the planet by 2030. In parallel, the United Nations proposed an action roadmap, known as Agenda 2030, fixing 169 targets correlated with the SDGs (United Nations, 2015).

Despite these roadmaps and despite the huge technological progress done in supporting cleaner production processes, we are still far from reaching these goals. United Nations points out that in the year 2019 the material footprint per capita of high-income countries was 24 metric tons while that of lower countries was 2.5 metric tons<sup>12</sup>. These data raise evident concerns in terms of social and environmental justice and equitable distribution of available resources and environmental costs of current development patterns within and among generations (Cocklin and Moon, 2020).

Looking to existing conflicts, having different origins and triggers, it is easy to consider that geopolitical conditions, as well as the lack of transparency and accountability of some governments, can lead to a dangerous inertia, if not to favourable conflict conditions, that hamper the process of reaching the SDGs. There is an intrinsic problem of sincerity, which is critical for addressing global sustainability. Then, again, there should be a mechanism to guarantee the transparency and accountability of policy makers. In fact, without such a mechanism, the most likely outcome of any multilateral agreement consists in "empty promises, without consequence for those that made them" (King and Paris, 2021).

It is recognized that humans, through their activities have altered the planet, generating a visible impact, that has been especially related to a geological epoch, the Anthropocene, that has been included in geological time scales standardized classification. The primary effects of human activities, acting as a relevant geological process, consists in multiple inter-related environmental impacts, altering a previously existing safe space for humanity. For such a reason, the concept of planetary boundaries was introduced to account for large-scale environmental causes of major risks for sustainability and for all the biosphere.

The observed alterations require to be approached in a new way, needing a systemic representation to capture and model such a complex dynamics (Phillips, 2020). This idea doesn't fall far from the idea of macroscope, that was proposed in developing an energy-based system theory for ecology (Odum and Odum, 1994). However, prior to defining such a systemic approach, a revision should start from the key concepts. In fact, only clear and univocal definitions can lead to clear quantifications. If the objective is 'sustainability', what is sustainability should be clarified in order to identify how quantitative indicators of sustainability can be shaped.

Many issues, pertinent to sustainability, are discussed every day, starting from renewable energy, circular economy, climate change or ongoing environmental and social conflicts (Meira et al., 2022). Governments and international bodies promise national and international actions to address these issues. Considering that the definition of sustainability deals with the needs of humans, how these present and future needs could be quantified? With respect to the definition of sustainable development, what is a 'need' and how can it be quantified? In fact, what a need is should be defined in an univocal way to guarantee the univocity of a quantification method. Instead, it becomes clear that the definition of sustainability is non-univocal.

A recent investigation among sustainability scholars led to the emergence of four distinct areas under which sustainability was labelled (Aminpour et al., 2020): Environmental concerns, Common understanding, neo-Malthusian environmentalism and Sustainability as well-being. These four perspectives can be summarized in the

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<sup>12</sup> UN, SDG 12: <https://sdgs.un.org/goals/goal12>

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following ways: (1) Sustainability and unsustainability are a matter of environmental degradation, energy sources and their consumption, being the consequence of different interacting physical phenomena; (2) Sustainability is the multi-scale effect of interdependent economic, social and environmental development, being dependent on intergenerational equity; (3) Sustainability is contrasted by technologies, that have a predominant de-humanizing impact, which should be opposed by no-growth economy paradigms, promoting ethical values and superior social goals, questioning the validity of growth as a societal goal, while considering the harmonization of social and economic objectives with ecological management as a more suitable approach; (4) Sustainability is the effect of a management producing a stable availability of natural and human-made resources to guarantee a stable well-being of present and future generations. Other researchers tried to develop a new understanding of sustainability in the context of the Anthropocene. Starting from post-humanist and new-materialist perspectives, disrupting the traditional binary approach, being typical of western philosophy, theorizing thing-power and using art-based research, considering system thinking and other theories, like quantum mechanics, from a not-always-correct and acceptable common-sense perspective, scholars proposed to develop new subjectivities as the means for decentring the human and to move from anthropocentrism toward ecocentrism (Jeong et al., 2018). Other scholars stressed the relevance of indigenous concepts and values, which should be included into the definition of sustainability (Virtanen et al., 2020): context-based relationality, community-based governance, education, language, quality of life and health, and communal recognition of certain nonhumans as life-givers. Considering the multi-faceted nature of sustainability research, a study proved that there is a general tendency to concentrate the attention on the environmental dimension of sustainability, especially in relation to ecosystems, natural resources, environmental protection and conservation (Salas-Zapata et al., 2018). Finally, Feminist Ecological Economics reject the concept of sustainability within the framework of sustainable development due to its focus on GDP as the main measure of well-being, which excludes a proper consideration of reproduction and care work. This vision completely changes the relationships between human beings and the biosphere compared to that mainly focused on production and consumption (Martinez Alvarez and Barca, 2023).

Plurality is inherent to sustainability studies. Researchers and organizations continuously reshape the definition of sustainability, depending on their perspectives and motivations. This plurality is reflected in the top and lowest ten keywords used in scientific papers in combination with 'sustainability' and 'sustainable' (Lima and Partidario, 2020). The used words span from 'environment', 'social' and 'economic' to 'wicked', 'interdependence' and 'interconnection'. This ambiguous plurality of concepts and keywords mirrors the fragmentation of knowledge, the multiplicity and, sometimes, arbitrariness of interpretations, as well as the contrasting paradigms in sustainability studies. This suggests that sustainability is a wicked problem, being time and space (context) specific, without simple or unique solutions and involving actors with multiple perspectives. Thus, all the evidence points to the need of "questioning old perspectives and developing new ones" (Ramos et al., 2020). This questioning and research of new horizons should start from the very beginning, including the definition of sustainability.

Based on the multiple visions of sustainability, it is obvious that devising a unified sustainability metrics would be impossible. The attention, then, has to be moved to the narrative purpose of indicators, which cannot support a univocal identification of target goals, distance-to-target when applied to a specific socio-cultural context (Renn et al., 2020). In fact, to convert raw data into clear and transparent information contents, besides an appropriate choices of indicators, narratives are indispensable (Liu et al., 2018). The narratives chosen to drive a transition toward a more sustainable and just lifestyle should be comprehensible to all, as well as supported by shared social norms of recognized value and also supported by indicators able to provide a transparent quantification of target

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and distance-to-targets. The relevance of such a connection between indicators and narrative was already recognized by those who developed the Multiple-Scale Integrated Assessments of Societal Metabolism (MuSIASEM) methodology (Maldonado et al., 2019). Finally, attention should be paid to potential incoherencies in the narratives supported by the chosen indicators (Liu et al., 2017).

Despite the plurality of sustainability definitions, perspectives and narratives, several scholars have tried to develop indicators to quantify sustainability under different aspects (see also chapter 10 in this volume). Moving from the definition of sustainability to its quantification, this chapter will try to summarize an up-to-date knowledge on these indicators, based on a bibliometric analysis. In parallel, considering indicators as instruments supporting the visualization of alternative desirable sustainable futures, alternative envisioning instruments will be also discussed. The next section will highlight the methods used to perform the proposed bibliometric analysis. Then, results will be detailed, followed by a discussion and a brief conclusive paragraph.

## 11.2 Method

A bibliometric analysis was performed in relation to published research or review articles dealing with sustainability indicators. In particular, data were retrieved from Scopus (Sc) and Web of Science (WoS) databases, using "sustainability indicator" as search keyword. No time limitation was given for the search. The analysis included only research and review articles, published in peer-reviewed journals.

The research on Sc produced 4390 works, from which 3358 research or review papers were selected. In the case of WoS database, from a starting number of 679 works, 574 articles were identified. The bibliographic and bibliometric data were downloaded as files in \*.ris format, including the names of the authors, the article titles, the basic article data (journal, year, volume, issue and pages), the abstract and keywords, the references as well as the number of citations. Successively, the data files were merged into a unique file, removing the duplicates. Then, 13 incomplete bibliographic files were removed, reaching a total of 3414 works.

Following the same selection criteria, parallel searches were performed using the following keywords: "environmental sustainability" AND "indicator"; "economic sustainability" AND "indicator"; "social sustainability" AND "indicator"; "cultural sustainability" AND "indicator". The purpose of this research was to map the published peer-reviewed indexed works dealing with the implementation and application of indicators to different sustainability pillars. A total of 3907 works were selected, with the following subdivision: 2579 (environmental sustainability), 601 (economic sustainability), 678 (social sustainability), 49 (cultural sustainability).

SciMAT and VOS viewer open-source software were used to perform a bibliometric analysis and to derive the author and keyword landscapes (i.e., to assess the association strength among authors working within the selected bibliographical database) (Cobo et al., 2012; van Eck and Waltman, 2010).

## 11.3 Results

### 11.3.1 Sustainability indicators

Table 11.1 contains the subdivision of publications with respect to different 5-years interval periods (1985-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2009, 2010-2014, 2015-2019, 2020-2023). Results indicate that the literature on sustainability indicators started in the same period of the Brundtland Commission (1987). Since then, a growing number of works was published.

Table 11.1 Number of scientific publications on sustainability indicators subdivided per years period

Years period	Number of publications
1985-1989	1
1990-1994	2
1995-1999	76
2000-2004	150
2005-2009	298
2010-2014	569
2015-2019	1024
2020-2023	1289

Table 11.2 indicates the top fifty authors, who published peer reviewed works (i.e., research or review articles) on sustainability indicators. The table also indicates the number of published works on this topic for each author. The number of published works per author could indicate that either the bibliographic search was not able to fully capture the number of authors' contributions to the literature on sustainability indicators or that the number of authors' contributions to this topic remains limited. In fact, 10 works out of a total number of 3414 would correspond to a maximum contribution percentage of 0.29% per author.

Table 11.2 Top fifty authors and number of published peer-reviewed works (research or review articles) on sustainability indicators

Author [Surname, N.]	Number of Documents
Morse, S.	10
Zhang, J.	10
Chowdhury, H.	9
Chowdhury, T.	9
Bastianoni, S.	9
Azapagic, A.	9
Li, X.	9
Li, H.	9
Onat, N.C.	9
Sait, S.M.	8

Author [Surname, N.]	Number of Documents
Ruiz-Mercado, G.J.	8
Liu, G.	8
Liu, Z.	8
Spangenberg, J.H.	8
Dale, V.H.	8
Li, M.	8
Veleva, V.	8
Pulselli, F.M.	8

Based on the authors' list contained in the analysed bibliographical record, the authors' landscape was produced (Figure 11.1). This graphical representation indicates the association strength among these authors in relation to the input bibliographical record. Consequently, this association map refers to the connection among identified authors with respect to the search topic. Then, eleven relevant authors clusters were identified, that are reproduced in different colours in the figure.

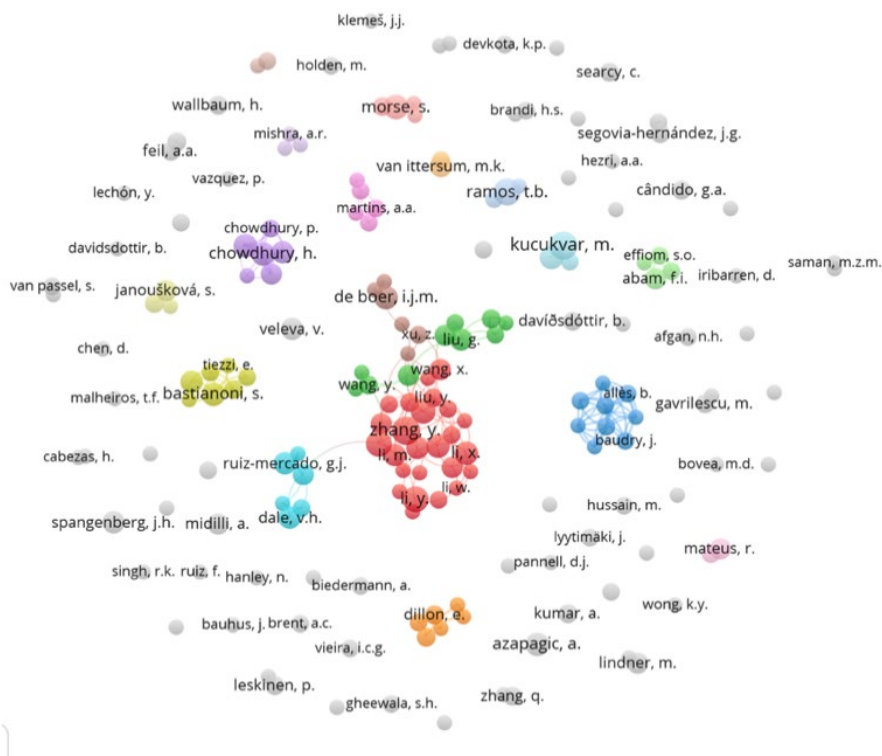


Figure 11.1 Authors landscape, produced through VOSviewer software, displaying the connection among Authors, who published at least one peer-reviewed document (i.e., research or review article) dealing with sustainability indicators

The list of the top ten journals that published works on sustainability indicators is reported in Table 11.3, indicating also the number of documents, displaying that the top three journals, that published works on sustainability indicators currently are Sustainability (MDPI), Journal of Cleaner Production (Elsevier) and Ecological Indicators (Elsevier).

Table 11.3 Top ten authors and number of published peer-reviewed works (research or review article) on sustainability indicators

Journal Name	Number of documents
Sustainability (Switzerland)	290
Journal of Cleaner Production	190
Ecological Indicators	126
Environment, Development and Sustainability	47
Ecological Economics	45
Sustainable Development	38
Journal of Environmental Management	35
Renewable and Sustainable Energy Reviews	35
WIT Transactions on Ecology and the Environment	34
International Journal of Sustainable Development and World Ecology	32

The top ten keywords used in the publications captured by the bibliographic research, indicating also the number of documents in which the keywords appear, is reported in **Table 11.4**. Then, considering the keywords, a landscape of co-occurrence strength was produced using VOSviewer. The obtained landscape is reproduced in **Figure 11.2**.

Table 11.4 Top ten keywords and number of documents (research or review article) on sustainability indicators in which the keyword appears

Keyword	Number of documents
Sustainability	1686
Sustainable-Development	1597
Sustainability-Indicators	1440
Decision-Making	397
Environmental-Protection	358
Sustainability-Assessment	318
Indicators	268
Environmental-Impact	260
Environmental-Indicator	202
Life-Cycle	190



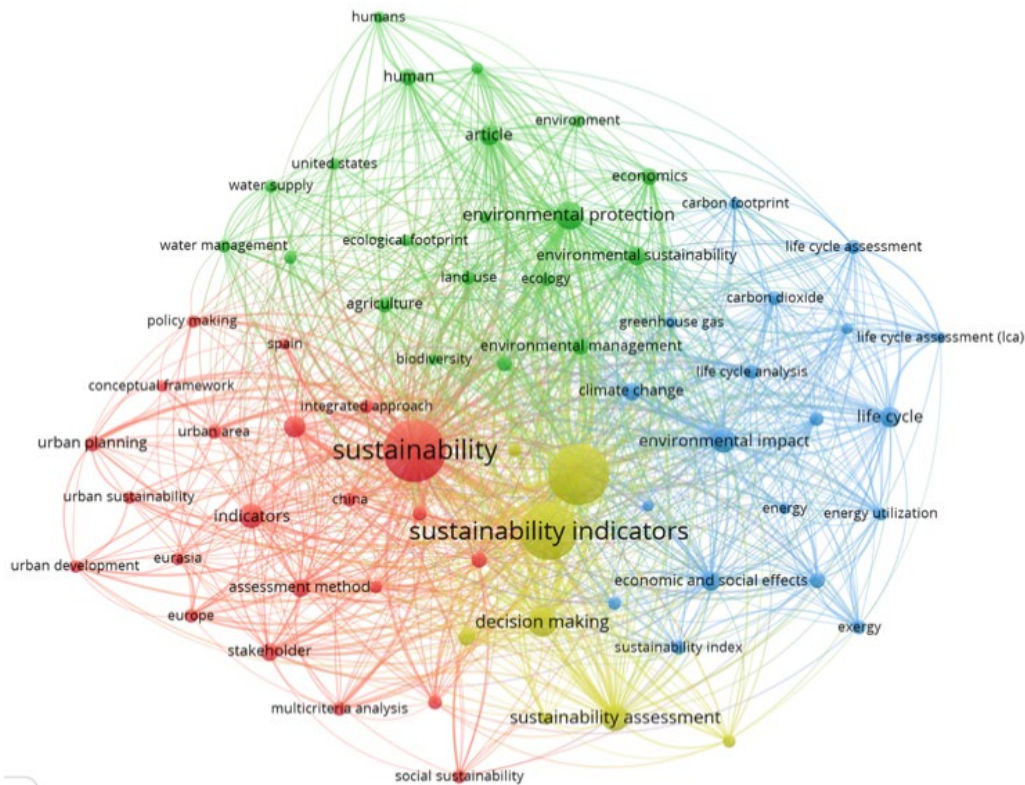


Figure 11.2 Keywords landscape, produced through VOSviewer software, displaying the connection among keywords used at least in one peer-reviewed document (i.e., research or review article) dealing with sustainability indicators

According to the **Figure 11.2**, in agreement with **Table 11.3**, the top 2 keywords, visible as larger circles, are “sustainability” and “sustainability indicators”. Then, four co-occurrence areas are identified in the map with different colours. The area in red pertains to the application of sustainability indicators for urban studies. The area in yellow identifies the application of sustainability indicators for decision making. The area in blue connects the use of sustainability indicators with LCA and similar approaches, mainly focused on the accounting of resources (i.e., materials and energy) flows and the assessment of potential impacts through environmental accounting practices. Finally, the area in green mainly identifies the application of sustainability indicators to land use and water use, as well as their correlation with footprint indicators.

### 11.3.2 Specific sustainability indicators

A second round of bibliometric research and analysis considered the application of sustainability indicators to specific sustainability pillars. With this in mind, together with the three traditional pillars (i.e., environmental, economic and social sustainability), cultural sustainability was included (Meireis and Rippl, 2018).

**Table 11.5** reports the number of peer-reviewed research or review articles published in different time periods, starting from 1990-1994 to 2020-2023. Each column of the table indicates the number of published articles with respect to their focus (i.e., environmental, economic, social or cultural sustainability). The results show that the first published work concentrated on economic sustainability. The literature on environmental sustainability emerged later, together with the studies on social sustainability. However, the attention prevalently concentrated on the environmental dimension. The studies on cultural sustainability started to appear later, in the period 2005-2009. All the focus areas display a growing trend of published works.

Table 11.5 Number of peer-reviewed published documents (research or review article) dealing with environmental, economic, social or cultural sustainability, classified according to seven years periods (1990-1994, 1995-1999, 2000-2004, 2005-2009, 2010-2014, 2015-2019, 2020-2023)

Year period	Environmental sustainability	Economic sustainability	Social sustainability	Cultural sustainability
	<i>Number of documents</i>			
1990-1994	0	1	0	0
1995-1999	17	2	8	0
2000-2004	64	6	14	0
2005-2009	136	25	33	1
2010-2014	348	71	62	9
2015-2019	741	203	175	15
2020-2023	1273	370	309	24

The **Figure 11.3** reports the same results in the form of histograms.

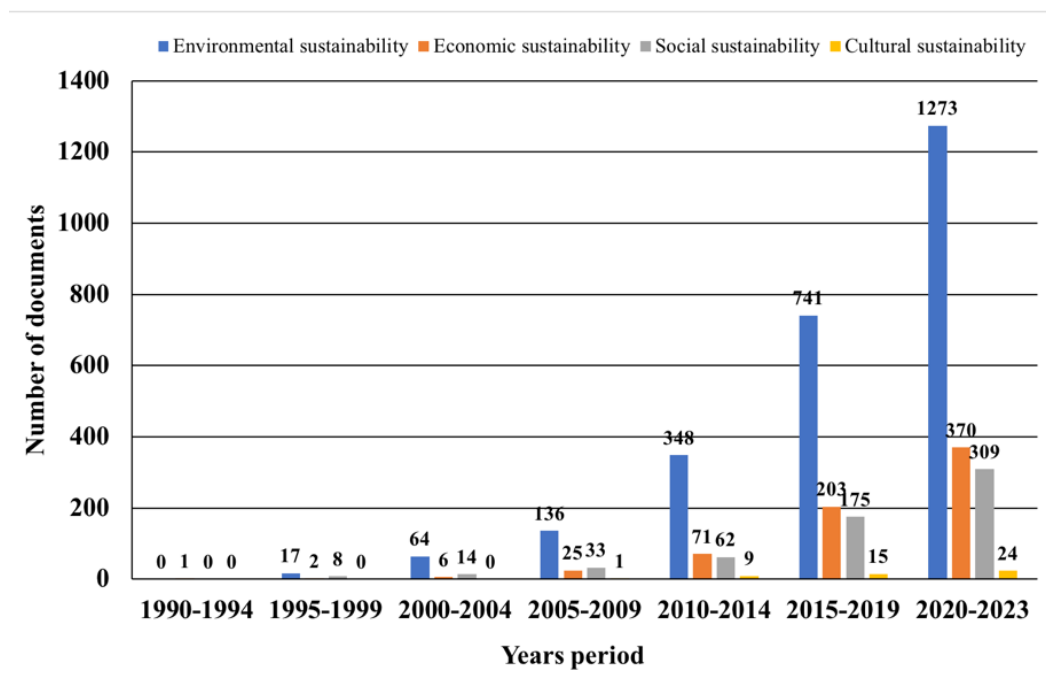


Figure 11.3 Number of documents (i.e., research or review article), grouped according to different years periods, dealing with environmental sustainability indicators

**Table 11.6** identifies the top ten keywords and the corresponding number of documents of works dealing with environmental sustainability indicators. With this respect the identified top three keywords used in these works were “environmental sustainability”, “sustainable development” and “sustainability”. Other keywords include the dimensions of environmental impact, protection and management, as well as the life cycle assessment.

Table 11.6 Top ten keywords and number of documents (research or review article) on environmental sustainability indicators in which the keyword appears

Keyword	Number of documents
Environmental-Sustainability	1362
Sustainable-Development	1143
Sustainability	1143
Article	624
Environmental-Impact	411
Human	308
Environmental-Management	257
Environmental-Protection	255
Life-Cycle-Assessment	239
Decision-Making	231

**Table 11.7** identifies the top ten keywords and the corresponding number of documents of works dealing with economic sustainability indicators. With this respect the identified top three keywords used in these works were “sustainability”, “sustainable development” and “economic sustainability”. Together with economic sustainability, however, the environmental dimension still appears to be relevant.

Table 11.7 Top ten keywords and number of documents (research or review article) on economic sustainability indicators in which the keyword appears

Keyword	Number of documents
Sustainability	234
Sustainable-Development	220
Economic-Sustainability	184
Environmental-Sustainability	76
Economic-Analysis	47
Article	42
Sustainability-Indicators	39
Environmental-Impact	36
Social-Sustainability	36
Economic-And-Social-Effects	34

**Table 11.8** identifies the top ten keywords and the corresponding number of documents of works dealing with social sustainability indicators. With this respect the identified top three keywords used in these works were “sustainability”, “social sustainability” and “sustainable development”. Together with the social dimension of sustainability, the economic and environmental dimensions, together with LCA appear to be still relevant.

Table 2 Top ten keywords and number of documents (research or review article) on social sustainability indicators in which the keyword appears

Keyword	Number of documents
Sustainability	319
Social-Sustainability	294
Sustainable-Development	280
Decision-Making	73
Environmental-Sustainability	71
Economic-And-Social-Effects	61
Sustainability-Indicators	60
Indicators	55
Life-Cycle	49
Sustainability-Assessment	43

**Table 11.9** identifies the top ten keywords and the corresponding number of documents of works dealing with economic sustainability indicators. With this respect the identified top three keywords used in these works were “sustainability”, “sustainable development” and “cultural sustainability”. Surprisingly, in the case of cultural sustainability, there is “bioenergy” as unusual keyword together with China, indicating that most of the studies on this topic might have considered China as main geographic area for the quantification of cultural sustainability indicators.

Table 3.9 Top ten keywords and number of documents (research or review article) on cultural sustainability indicators in which the keyword appears

Keyword	Number of documents
Sustainability	22
Sustainable-Development	16
Cultural-Sustainability	13
Sustainability-Assessment	6
Indicators	5
Bioenergy	5
China	4
Sustainability-Indicators	4
Cultural-Heritage	4
Culture	4

## 11.4 Discussion

Results of the bibliometric analysis show that the studies on sustainability indicators are growing, paralleled by studies which concentrated their quantification efforts on different sustainability pillars (i.e., environmental, economic, social or cultural). These indicators, as proven by the keywords occurrence and as confirmed by the

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literature, are mainly aimed at decision-making, environmental protection, and sustainability assessment. In particular, indicators are meant to produce or support a representation and cannot be seen separately from their narrative purpose, which is a policy instrument, that shouldn't be disentangled from social justice (Astleithner and Hamedinger, 2003; Fredericks, 2012). With this respect, the scientific knowledge derived from indicators and the evolution in the process of political norm creation, that stem from the definition and the application of sustainability indicators, should be properly acknowledged (Rametsteiner et al., 2011). Consequently, policy-makers and scientists with different disciplinary background should contribute in a process of knowledge co-creation. In parallel, policy-makers, representing different policy domains, should contribute to the same process, adjusting also the defined indicators according to changing political and social norms. In the case of a transition toward just circular economy models and behaviours, the definition and application of sustainability indicators should evolve, supported by recommendations, policies and incentives, to encourage the adoption of just circular economy solutions in real industrial processes, without neglecting environmental and economic well-being, as well as the need of diffused social benefits (Ngan et al., 2019).

Quantitative indicators are one of the tools that can be used to support an environmentally-, economically- and socially-sustainable transition, supporting the implementation of policies to adopt just circular economy solutions. In parallel, there are other ways that can be used to support the transition toward more sustainable lifestyles through the generation of narratives.

First, there are qualitative sustainability indicators. **Figure 11.4** represents the number of published works, in different years periods, dealing with this type of indicators. The research domain of qualitative sustainability indicators is quite recent, since the first published articles appeared in 2016. A peak of published works was recorded in year 2021. This year corresponds to one year after the COVID-19 pandemics, when it was more difficult to collect field quantitative data, but when it was still possible to collect qualitative data through online questionnaires. Obviously, from a deeper analysis, we might expect a biased geographic or socio-economic production of results, associated to the possibility of being online or connected to the world wide web. However, these biases still require to be assessed.

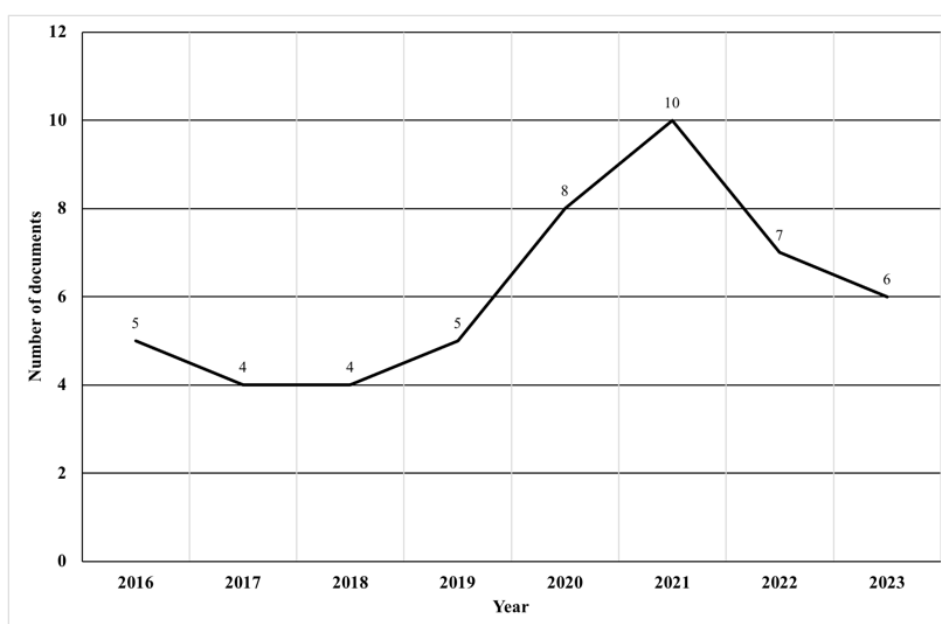


Figure 11.4 Number of documents (i.e., research or review article), grouped according to different periods, dealing with qualitative environmental sustainability indicators

Other non-quantitative ways, that could either generate visions of desirable sustainable futures or support a better understanding of more sustainable and just lifestyles, connected to the pre-industrial epoch, derive from humanities. Archaeology and history, in fact, could provide a documental and material evidence, that, in integration with existing knowledge, could support decision-making in different sectors, such as agriculture (Alciati and Casazza, 2018; de Vingo et al., 2019; Guttmann-Bond, 2010; LeFebvre et al., 2022). Alternatively, art-based research, as first person science paralleling traditional ("third-person") hard sciences, serves as alternative reflective and enquiry approaches, that, starting from a non-normative perspective, can support the identification of appropriate actions, as well as the motivation to pursue specific sustainability goals (Liu et al., 2021). This is why different artistic and performing languages were used as enquiry instruments in the context of sustainability studies (Casazza et al., 2017; Casazza and Gioppo, 2020; Muhr, 2020). Thus, alternative ways, spanning from qualitative indicators to art-based research approaches, can serve as instruments or methods, that can support, in integration with qualitative approaches, the envisioning of transition roadmaps toward more sustainable and just lifestyles.

## 11.5 Conclusions

As shown in this contribution, the number of studies investigating alternative or complementary approaches to quantify the sustainability or certain sustainability dimensions, is growing. These quantification approaches exist, despite the lack of univocity in the definition of sustainability. This is why alternative envisioning methods, including works rooted on humanities and art-based research serve as an alternative, used also to overcome the prevalently-normative approach, used in the context of management actions and policy-making. Thus, this contribution indicates that hybrid approaches could be used, in the future, to engage with citizens and stakeholders through a balanced integration of creative reflective inquiry and normative pathways to support a transition toward more sustainable and just lifestyles assuring in this way a plurality of discourses in circular economy transition beyond the mainstream one.

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PDF ISBN: 9791256001446  
DOI: 10.5281/zenodo.10958884

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The JUST2CE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003491

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