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Can social research paradigms justify the diversity of approaches to social Life Cycle Assessment?

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Abstract

Purpose The present paper aims to offer an explanation for the diversity of methodological approaches proposed up to the present for social Life Cycle Assessment (sLCA), tracking down its roots in the cultural and scientific heritage of social sciences and especially management sciences. A second aim is to shift the current debate on methodologies to an epistemological level, presenting the first results of an ongoing critical review about which underlying paradigms have been applied in sLCA literature.

Methods This paper moves from the hypothesis that the diversity of positions in philosophy of science and the 'multiparadigmatic' character of social sciences have had repercussions on sLCA literature since its beginnings, probably in an unconscious manner. Therefore, a discriminating reflection on the scientific and disciplinary inheritance that can represent the roots of sLCA has been conducted. The philosophy of science and the role of different research paradigms in social sciences have been deepened to provide an overview of the main elements of a paradigm (in terms of ontology, epistemology, and methodology). Finally, a brief but critical review of 131 selected scientific contributions on sLCA has been conducted to highlight which paradigms have been applied in sLCA studies.

Results and discussion Recognising that boundaries between paradigms are subtle and that researchers are rarely conscious of which paradigm underpins their works, a distinction between the interpretivist and post-positivist approaches used by the studies has been carried out on the basis of a text analysis conducted by identifying the main 'literal' criteria. From an initial population of 209 studies, we excluded those concerning reviews of sLCA literature and those with selected criteria that were insufficient to catch the epistemological viewpoint of the authors. Among the remaining papers (133), 73% has been ascribed to the group of interpretivism-oriented paradigms, and only 24% could be ascribed to the post-positivist one; the remaining 3% is represented by studies with both characteristics. This data deserves some attention because, since the beginnings of sLCA methodologies, most sLCA publications explicitly suggest having the same underlying perspectives as environmental Life Cycle Assessment (eLCA).

Conclusions In light of the reflections carried out, we argue that it is important, before going into methodological questioning issues, to be aware of which paradigm is underlying. Indeed, in this phase of sLCA development, scholars should go beyond the simple methodological debate and recognise the 'multi-layered' nature of social phenomena and the multiparadigmatic characteristics of social and management sciences.

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Keywords Research paradigms, sLCA, social sciences, literature review, interpretivism, post-positivism, epistemology

1 Introduction

Sustainability concerns have been under the attention of scholars since the early seventies, when milestone references were published, such as the well-known essay entitled 'The Limits to Growth' (Meadows et al. 1972). Many world conferences stressed the importance of paying attention to economic and social development to improve the quality of life, such as the United Nations Conference on the Human Environment held in Stockholm in 1972 (United Nations 1972), the much-quoted Brundtland Report (WCED 1987), and the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 (UNEP 1992).

Several methodologies and techniques were set up to answer the need for evaluating and measuring impacts within many contexts, like scientific and technical projects, policies planning, supply chains improvement, consumption patterns, manufacturing processes, provision of services, and many others.

Among these, Life Cycle Thinking (LCT) methodologies were developed to evaluate the potential impacts generated during all phases of the life cycle (from 'cradle' to 'grave') of a product or service, and therefore support decision-making processes towards more sustainable public policies or management modes within organizations (Horne 2009). The so-called life cycle-based approaches fit into sustainability discourses as tools that help to enlarge the focus of analysis and exhort to see the broad sizes of a problem, considering a wide range of components linked to the object under assessment from different perspectives according to the scope of the analysis (De Luca et al. 2015a).

The first LCT method that reached a methodological consensus is the *environmental* Life Cycle Assessment (LCA or eLCA), aimed at evaluating the environmental impacts, and today standardized by specific norms (ISO 2006a; 2006b). Life Cycle Costing (LCC) was developed to focus on the costs generated during the life cycle.

Social Life Cycle Assessment (sLCA) is the latest tool in chronological order; it has been developed to evaluate social impacts, but it is still not well defined, and its process of development is particularly long and difficult. From its beginnings, a plethora of different methodologies and impact assessment methods have been proposed, paying attention to the most diverse aspects, e.g. the social performances (O'Brien et al. 1996; Weidema 2006; Norris 2006; UNEP-SETAC 2009; Martìnez-Blanco et al. 2014; Bouzid and Padilla 2014; Adami Mattioda et al. 2015), the presence of hot spots (Benoît-Norris et al. 2012), the consequences of a change in life cycle (Feschet et al. 2013; Bocoum et al. 2015), the externalities (Swarr 2009), and the participation of stakeholders (Mathé 2014; De Luca et al. 2015b). Even the definition of social impacts has been interpreted in many different ways, considered by some authors as synonyms of performances, effects, or consequences.

The fact that sLCA has been developed in the technical and academic *milieu* of eLCA, and that most of its practitioners and scholars are usually engineers, chemists, and physicians, led to frame and shape the

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assessment methodology of social impacts in the same way it has been done for environmental impacts in eLCA (Iofrida 2016). However, since the beginning, some of the typical elements and procedures of eLCA were difficult to transfer into the analyses of social impacts; this is the case, for example, of the Functional Unit (FU), the system boundary settings, the choice of cut-off criteria, and the attribution of impacts to the functioning of the life cycle (mostly attributed to companies' behaviour).

It is doubtless that the inherent nature of the impacts under assessment are different in sLCA than they are in eLCA, as these methodologies have their roots in different fields of study and disciplines (O'Brien et al. 1996); environmental impacts are the objects of study in natural sciences (such as biology, chemistry, physics, etc.), while social impacts and decision-making processes concern people, actions, and social phenomena that are *multilayered* (Cupchik 2001; Corbetta 2003).

Actually, the application of the methodological rules of natural sciences to the study of social phenomena has been a central research question since sociology emerged as an independent discipline (Durkheim 1895; Comte 1988); but, when the human dimension, the context, and the interactions among actors become significant, the narrow rules of natural sciences are difficult to follow (Avenier and Gavard-Perret 2012). These different ways of doing research have been declined in many contexts, taking the names of quantitative versus qualitative, hard science versus soft science, deductive versus inductive, and relativism versus realism (Phoenix et al. 2013).

The same difficulty appeared in translating the uses of eLCA to sLCA, the epistemological differences of which have been mentioned by some authors, such as O'Brien and colleagues (1996), Jørgensen and colleagues (2010), Reitinger and colleagues (2011), Sala and colleagues (2013a, 2013b), Baumann and colleagues (2013), Arvidsson and colleagues (2015), and deepened by Iofrida and colleagues (2014) and Iofrida (2016).

When a research process is undertaken, every methodological choice is based on a scientific paradigm, which represents 'the basic belief system or worldview that guides the investigator' (Guba and Lincoln 1994:105). The term paradigm is not new in social research (Bailey 2007), and Kuhn (1962) notoriously used it to denote 'normal science' when a set of theoretical beliefs and methodological techniques are shared by the scientific community.

The present paper proposes a reflection on the repercussions of sLCA literature on the epistemological eclecticism of social sciences. Therefore, the first aim of this research is to offer an explanation for the diversity of methodological approaches proposed to this day for sLCA, tracking down its roots in the cultural and scientific heritage of sociology and management sciences. A second aim is to shift the current debate on methodologies to an epistemological level, presenting the first results of a brief critical review about which underlying paradigms have been applied in sLCA literature.

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2 The reasons for the methodological diversity in sLCA

2.1 The scientific and disciplinary roots of sLCA: Sociology and management sciences

To highlight which are the scientific and disciplinary roots of to sLCA, a comparison is made with its environmental peer in Figure 1. Both eLCA and sLCA are useful tools for management practices towards more sustainable activities, e.g. as tools for Life Cycle Management (LCM), a flexible, integrated framework of concepts, techniques, and procedures to manage the life cycle of goods or services, reducing negative impacts and avoiding burden shifts (Seadon 2010). Inside this framework, sLCA and eLCA can be defined as *engineering* tools devoted to analysing and evaluating the effects caused by changes in the life cycle of a product or service. Indeed, LCT tools were created and improved by engineers, and among them today, eLCA is one of the most widely applied tools in the scientific and industrial contexts to evaluate environmental impacts of products and services (Finnveden et al. 2009; Frostell 2013). Even if they are still in a *pre-scientific* stage of their development (in a *kuhnian* sense), LCT tools cannot be considered to be tools to accompany decision making in management practices and policies (Heiskanen 2002).

While eLCA evaluates environmental impacts that are the objects of the assessments of disciplines, such as biology, chemistry, physics, etc., that belong to the realm of natural sciences, sLCA evaluates social impacts, which are the objects of the study of sociology and, with management science, belong to the realm of human and social sciences. The substantial difference between these two domains resides in the possible ways of seeing the world, i.e. the scientific paradigms guiding their typical research processes. The concept of a paradigm is crucial to understanding how the two domains can differ in terms of basic epistemological premises, research questions and hypotheses, methods for data gathering and analysis, ways of presenting research insights, and broader issues about causality and generalizability (Phoenix et al. 2013).

Figure 1 Disciplinary and scientific fields related to sLCA and eLCA

Positivism-oriented paradigms dominate – and are well accepted – in natural sciences (Tacconi 1998); but, in the history of social sciences, it is difficult to recognize one dominant paradigm, and many worldviews can be held (Corbetta 2003; Bailey 2007; Ritzer 2010) because of their epistemological eclecticism.

As discussed above, sLCA evaluates social impacts, i.e. the consequences of the functioning of a life cycle on people (Macombe et al. 2013). Before sLCA was proposed, other academic fields addressed the evaluation of social impacts, e.g. Social Impact Assessment (SIA) for projects and programmes (Freudenburg 1986; Becker and Vanclay 2003), Corporate Social Responsibility (CSR) for organizations and companies (EC 2001), the Participatory Rural Appraisal (PRA) for rural communities (Chambers 1994), and the Human Scale Development for societies (Max-Neef 1991). The originality sLCA brought is the life cycle perspective. Most of the sLCA literature transposed the definitions of social impacts from CSR and SIA into this new perspective.

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144 The social phenomena that sLCA aspires to observe and measure, as well as their causes, manifestations,
145 effects, and their reciprocal relationships are the subject matters of the study of sociology, which has been
146 surrounded by an important epistemological debate since its beginnings. The wider, long-standing
147 controversy in sociology was about to what extent or in which way sociology is a science. In the Nineteenth
148 Century, Comte (1988) introduced positivism and coined the term 'sociology' with the aim of systematizing
149 the study of social phenomena with the same rigor as natural sciences. In fact, the central tenet of the
150 philosophy of Saint-Simon, Comte, and Spencer was that social phenomena must be treated as natural ones
151 (Comte 1988), and that sociology would provide general laws similar to those found in Newtonian physics
152 or Darwinian biology (Abercrombie 2006). Indeed, for a long time, natural sciences had been the only ones
153 that deserved the mention of 'science', and their typical rigorous methods based on observation, empirical
154 testing, and hypothetic-deductive models were the only 'scientific methods'. After the positivist
155 philosophy, many scholars (e.g. Marx 1845; Weber 1922; 1947; Boltanski and Thévenot 1991)
156 acknowledged that when the human dimension, the context, and the interactions between a researcher and
157 his/her object of research become relevant, the narrow rules of natural sciences become difficult if not
158 impossible to follow (Avenier and Gavard-Perret 2012). Today, the positivist philosophy has been replaced
159 by a more moderate position (post-positivism), even in the natural sciences, while many epistemological
160 positions are possible in social studies, taking different names according to the disciplinary background
161 (constructionism, interpretivism, phenomenology, functionalism, grounded theory, etc.).
162 From an academic and scientific point of view, 'the management sciences are the youngest of the social
163 sciences' (David et al. 2013:15). In fact, even if their practical and professional legitimacy are doubtless, it
164 is only recently that they have gained the mention of sciences, due to the lack of clear expression in scientific
165 terms until today (David et al. 2013). The epistemological eclecticism of management science has several
166 reasons also due to the influence of natural and engineering sciences. Firstly, it is the object of analysis
167 because every human activity takes place in a physical environment, especially in the case of a production
168 process, where organisations have to deal with natural phenomena and their laws. Secondly, engineering
169 science has the role of providing information to organisations/companies about how to obtain demanded
170 effects and results. Indeed, insights from life cycle studies can support decision-making processes toward
171 sustainability-oriented management through the adoption of *reengineering* practices (Hammer and Champy
172 1993), both at a private and public level, for territorial policies, resources management, reducing impacts,
173 increasing quality, and enhancing effectiveness. This is confirmed in many sLCA studies (among others,
174 Lehman et al. 2011; Traverso et al. 2012; Neugebauer et al. 2015; De Luca et al. 2015a; 2015b), stressing
175 the role of supporting management practices toward sustainability at different levels: operative decisions,
176 strategic decisions, and communication purposes. Addressing social issues in management practices has
177 also become a normative and political urgency in the last decades, especially under the pressure of NGOs,
178 groups of interest for specific social issues, and, nevertheless, increasingly conscious consumers.

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Assessing impacts and informing about the results has become an inescapable priority for business leaders at the worldwide level, a necessity, and sometimes a high-stake obligation (Porter and Kramer 2006; Galbreath 2006; Friedman 2007). The variety of stakeholders and deciders (consumers, customers, suppliers, communities, etc.) entails a diversity of interests and desiderata; environmental requirements, economic purposes, and social expectations sometimes appear to be mutually exclusive or conflicting. In this case, the participation of stakeholders and the application of weighting tools could be useful (e.g. through multicriteria analysis tools). The conciliation of different perspectives through participation can be found also in sLCA literature (see, for example, Manik et al. 2013; Mathé 2014; and De Luca et al. 2015b).

Management science is a complex multidisciplinary field concerning decision-making, representation, and legitimacy (David et al. 2013); multiple paradigms coexist, many theories are applied, and different techniques are developed (Tinker and Lowe 1982; Whitley 1984; Johnson and Duberley 2000; Bertrand and Fransoo 2002; Easterby-Smith et al. 2012; Allard-Poesi and Perret 2014). Indeed, a purely positivist paradigm is inadequate in management sciences, especially when working as management consultants (Gummesson 2000). As in other social sciences, the concept of paradigms exerts a great influence in business and management research (Shepherd and Challenger 2013), and there is a wide literature about the diversity of paradigms and epistemological approaches applicable in management research and practices (Velmuradova 2003; Dumez 2010; Sułkowski 2010; Maurand-Valet 2010; Raut and Veer 2014). Therefore, it is crucial for a researcher to answer the epistemological question of his/her research.

Transposing these reflections to social impacts investigated from a life cycle perspective, it is possible to ascribe sLCA to the disciplinary field of management sciences, and, likewise, sLCA can be considered an engineering tool to help organisations make decisions on how to organise their processes according to the social impacts of their products or services.

2.2 Recalling the main scientific paradigms

During the Twentieth Century, a great debate interested academia around one of the most important problems of the philosophy of science, i.e. the problem of finding a criterion that differentiates science from non-science. Among the most influential philosophers, Kuhn refuted the traditional conception of the sciences as a cumulative and linear progression of new acquisitions (Corbetta 2003) and introduced the concepts of paradigm and 'normal science' to describe the period in which scientists adhere to the same paradigm, i.e. the shared set of philosophical background and methodological tools that enable scientists to solve their research issues, the so-called 'puzzle-solving' (Kuhn 1962). When the paradigm is no longer able to solve research issues, the crisis conducts to a scientific revolution, and the existing paradigm is replaced by another one (Bird 2013). Therefore, for Kuhn, scientific knowledge progresses through paradigm shifts. During a period of normal science, there are no debates over the fundamental tenets of a paradigm; but, when anomalies – in the current theories – reach a certain critical mass and a new paradigm emerges, a crisis occurs and leads to a paradigm shift. However, Kuhn also claimed there to be an

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215 'incommensurability' between different paradigms (Bird 2013), a conception that has been criticized and
216 overtaken today by many authors, especially the supporters of mixed-methods research (Tashakkori and
217 Teddlie 2010).
218 Scientific research can find its references turned into beliefs and visions shared by a scientific
219 community, the set of concepts of knowledge called paradigms (Avenier and Gavard-Perret 2012), which
220 represent 'the basic belief system or worldview that guides the investigator' (Guba and Lincoln 1994:105).
221 Kuhn (1962) gave notoriety to the term paradigm with his book, *The Structure of Scientific Revolutions*,
222 where he intended it to be the shared set of philosophical background and methodological tools that enable
223 scientists to solve their research issues. Despite the criticism received by Kuhn, the concept of paradigm
224 still remains up-to-date and preserves its centrality in the meta-research debate of social sciences and
225 management sciences (Darlaston-Jones 2007; Phoenix et al. 2013; David et al. 2013; Thiétart et al. 2014).
226 A paradigm consists of three elements: the researcher's conception about the nature of reality
227 (ontology), the relation between the knower and what is under study (epistemology), and how the researcher
228 can find out knowledge (methodology) (Guba 1990; Guba and Lincoln 1994; Mertens 2007). Some of the
229 most applied definitions of these elements are presented in Table 1.
230
231 Table 1 Definitions of the main elements of a paradigm
232
233 The ontology questions the nature of social reality from a philosophical point of view and influences
234 the selection of research topics, the formulation of research questions, and guides the epistemological
235 position of the research (Guba and Lincoln 1994; Carter and Little 2007; Hesse-Biber and Leavy 2011;
236 Iofrida et al. 2014). Epistemology is a branch of philosophy that studies the theories of knowledge and
237 sometimes is considered a synonym of the philosophy of science. It has also been defined by Piaget (1967)
238 as the study of the process of valid knowledge constitution, or 'the study of the nature of knowledge and
239 justification' (Schwandt 2001:71). Epistemology concerns the relationship between the researcher and the
240 aim of the research, that is to reach knowledge (Phoenix et al. 2013) upon a topic and ponder about the
241 nature of this last (Guba 1990; Allard-Poesi and Perret 2014). Every researcher should be aware of the
242 epistemological position to which the research is ascribed because it shapes the research practices and gives
243 different values and justifications to the knowledge elaborated and different representations of the
244 phenomena under study (Avenier and Gavard-Perret 2012). Furthermore, identifying the relationship
245 between the epistemological basis of research and the methodologies applied is critical to the provision of
246 meaningfulness to the results; however, very often this connection is not clearly stated (Darlaston-Jones
247 2007). The ontological and epistemological positions guide the choice of the theory that guides and justifies
248 the research, or that needs to be demonstrated and/or confirmed by the data.
249 The methodology is the formalization of the epistemological position into practices, and it shapes
250 methods design for data gathering and analysis. Corbetta called 'the delicate phase of operationalization'

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(2003:4) the bridge between theory and practice, the passage from hypotheses to concepts, indicators, and variables. The methods produce data, which brings the information that will constitute the knowledge and confirm the theory.

The epistemological debate in the history of social sciences can be represented in many ways, i.e. through different schemes but with interconnected meanings:

- in terms of the criteria of demarcation of science from non-science (e.g. the concepts of verifiability, falsifiability, normal science, paradigm shift, etc.);
- in terms of the logical processes through which knowledge is reached (deduction and rationalism versus induction and empiricism) (Avenier and Gavard-Perret 2012);
- in terms of the reciprocal position of social sciences versus natural sciences (monist and dualist positions) (Boudon et al. 1995);
- in terms of paradigms (Guba and Lincoln 1994; Avenier and Gavard-Perret 2012).

The paradigm elements are strongly interrelated and together guide the design, planning, and implementation of the research (Carter and Little 2007), as it is graphically shown in Figure 2.

Figure 2 Relationship between paradigms and methods

Source: Carter and Little (2007:1317), modified.

2.3 Differences and methodological implications of positivism- and interpretivism-oriented paradigms

Before analysing which paradigms underpinned sLCA studies, we will first herein present the most relevant differences between the two main families of paradigms, namely positivism- and interpretivism-oriented paradigms, each of them claiming opposite criteria of research processes and knowledge validation.

The positivism-oriented philosophies have guided scientific research (Tacconi 1998), and up to now they have been the dominant paradigms in natural science. In the history of sociology, it is difficult to recognise a dominant paradigm that is shared by all sociologists. Moreover, in sociology, more worldviews could be held simultaneously (Batty 2008; Tashakkori and Teddlie 2010), especially when paradigms can be complementary or at least not exclusive of one another (Batty 2008). This is the main reason why sociology is considered a multiparadigmatic science (Ritzer 1975; Corbetta 2003; Batty 2008), and its production is defined as heteroclite (Boudon 1997); this is also because 'social phenomena are multilayered events as is the inquiring mind of the social scientist' (Cupchik 2001:7).

Actually, a wide number of paradigms exist, but, as the lines between paradigms are often very fine, Table 2 reports two principal families of paradigms (with just two examples of each) that can be considered the opposite poles toward which almost all paradigms tend.

The ontology of pure positivism has been defined as 'naïve realism' because it only recognises the existence of one objective reality that is patterned and perfectly predictable and controllable; the role of

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science is to discover the very nature of reality and explain how it works (Guba 1990; Guba and Lincoln 1994). From an epistemological point of view, the researcher is fully separated from the object of the study (dualism), and the aim of research is to explain reality through its laws and cause-effects relationships. Only replicable and verifiable findings are considered true. The methodologies considered relevant are those quantitative, experimental, and deductive, whose results and findings are generalizable and therefore detached from their contexts and value free. Quality criteria mainly consists of the external (and objective) validity as well as the verifiability and repeatability of methods.

The post-positivist paradigm emerged at the beginnings of the Twentieth Century from some critical reflections and amendments of positivism (Guba and Lincoln 1994). The ontological stance is critical realism (to be distinguished from the 'naïve realism' of positivism), i.e. it exists only as one objective reality, but it is just probabilistically apprehendable, the perspective is non-reductionist, and the observation is theory-laden. A perfect dualism between researcher and the object of research is not possible, and multiple perspectives can be undertaken. From an epistemological point of view, a full explanation of reality is not possible because the undeniable influence of contexts and replicated findings are probably true. The methodologies most applied are mainly quantitative and experimental, as it was in the pure positivist paradigm, but the scientific community plays an important role in validation. Statistical analysis is the most used methodology to measure the above-mentioned probability.

In terms of methodological elements, some key concepts need to be clarified. Quite often the terms 'qualitative' and 'quantitative' are (misleadingly) used to identify typologies of research (e.g. Merton et al. 1979; Goodwin and Goodwin 1996; Corbetta 2003; Creswell 2013) or even kinds of paradigms (Wagner et al. 2014), with an explicit reference to the methodologies that are commonly associated with each typology.

Actually, many authors (among others, Guba and Lincoln 1994; and David et al. 2013) argue that these terms should be devoted to describing types of methods instead of typologies of research, especially because, according to Guba and Lincoln (1994), both quantitative and qualitative methods may be used within every research paradigm. This entails that questions of method are secondary and that they are not sufficient to justify and outline the typology of research.

Table 2 Examples of paradigms in social and management sciences.

Concerning the quality criteria in post-positivism, there are similarities with positivism in terms of rigor, staying in the search for internal validity (the most possible correspondences of findings with reality), and external validity (in the sense of generalization, reliability, and objectivity) (Guba and Lincoln 1994).

Interpretivism paradigms diffused during the second half of the Twentieth Century with the impulse of philosophers such as Weber (1922) and Dilthey (1883). According to this school of thought, reality cannot be explained but can be understood and described. Many paradigms can be ascribed to the interpretivism

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family of paradigms, e.g. constructivism and critical theory, while some others are rather between both positivism and interpretivism, such as the grounded theory formulated by Glaser and Strauss (2006). However, for the purpose of this paper, we want to focus on the main differences between the opposite visions.

The ontologies of constructivist and interpretivist researchers are similar; the view of reality is relativist and subjective because the social world is considered to be continually constructed and interpreted through the actors' perceptions. This entails that researchers are not separated from the object of research' on the contrary, they are strongly involved, in the sense that they influence and are influenced by what they study. At the epistemological level, reality cannot be fully explained because it is continually constructed or interpreted by actors; it can be understood through descriptive processes and dialogue.

From a methodological point of view, qualitative methods are the most applied, as they are the most appropriate to gather values, perceptions, purposes, people's experiences, and context specificities (which are less relevant in positivism-oriented paradigms). In statistical analyses, purposive and multi-purposive sampling (i.e. two forms of non-probability sampling) are preferred as criteria of significance; the aim is to catch all existing relevant varieties of the phenomenon (saturation) (Jansen 2010) instead of the proportionality or the stratification criteria mostly used in positivism-oriented paradigms. Concerning the interpretivist paradigm in particular, hermeneutics and dialectics play a fundamental role (Guba and Lincoln 1994). The stakeholders' involvement, in terms of experience (constructivism) and perceptions (interpretivism) gathered, plays an important role as validation and a source of information (data gathering).

The quality criteria of interpretivism-oriented paradigms are similar and are fundamentally based on the intersubjective agreement and consensus reached through dialogue, conversation, and construction (Phoenix et al. 2013).

As a result, the aims of the two families of paradigms can be very different in terms of research processed, objectives, and results obtained. Interpretivism-oriented paradigms are devoted to the in-depth examination of the values and significances of social phenomena, while positivism-oriented ones strive to be value-free and look for objectivity and generalisability.

Very often, quantitative methodologies have been univocally associated with positivism-oriented paradigms, and qualitative methodologies to interpretivism-oriented ones, coming to a misleading debate on 'quantitative research' versus 'qualitative research'. Even if it is true that a tendency in this sense exists, the methodological choice alone is not sufficient to identify a paradigm or a typology of research, as it is rather in the way results are used that the epistemological position is revealed.

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3 In search of the hidden paradigms in sLCA

3.1 Review methodology

In light of the previous considerations, this study hypothesizes that the main reason for the methodological diversity that characterized sLCA proposals until now has its roots in the underlying paradigms, inherent in every research process (Iofrida et al. 2014). Jørgensen et al. (2010) mentioned, in a footnote, the question of the use of different paradigms in social sciences and the importance of explaining the tenets and assumptions upon which research is built. A philosophical perspective was also applied by Reitinger and colleagues (2011), who reflected upon the choice of Areas of Protection (AoP) and impact categories (a terminology borrowed from eLCA) and stressed the importance of the disclosure of one's presumptions, as researchers 'have tendency to investigate ethical or social issues with our pre-conceived values' (2011:381). Sala and colleagues (2013a, 2013b) went farther, questioning the epistemological foundations of life cycle tools (therefore including sLCA), their role in the emerging discipline of sustainability science, and which should be the criteria for acknowledging scientific robustness. Finally, in agreement with Arvidsson and colleagues (2015), social science and economics should be considered to strengthen the scientific solidity of topics (or impact categories and areas of protection) under assessment in sLCA and their respective indicators.

As discussed in the previous paragraphs, although eLCA and sLCA are both management tools, the latter can be assessed by many epistemological positions, leading to a wide range of assessment methodologies due to the different nature of environmental and social impacts.

Furthermore, if a post-positivist orientation is assumed to be suitable in eLCA because of the application of quantitative methods, modelling, and statistical analyses and the search for cause-effect relationships to predict long-term effects, then we should also acknowledge that it is not necessarily the same case in sLCA proposals, as will be discussed in the results.

To highlight which paradigms have been applied in sLCA studies, a critical review has been conducted. Boundaries between paradigms are subtle, and rarely do researchers explicitly affirm which paradigm they are undertaking in their studies (Iofrida et al. 2014); moreover, many times, researchers are not aware of it or take it for granted. Given this difficulty, the present critical review does not necessarily reflect the actual opinion of authors' studies under scrutiny; it is our own interpretation.

Grant and Booth (2009) described many typologies of literature reviews; among them, the critical review is defined as an in-depth literature research with a critical evaluation of the main contents, analysing significant concepts and identifying the most significant differences, while a systematic review serves the purpose of methodically search, appraise and synthetize research evidences. However, the application of systematic reviews in a field such as social sciences and humanities risks to have drawbacks and a hermeneutic framework would be more appropriate: hermeneutics concerns the process of creation of interpretive understanding (Boell and Cecez-Kecmanovic 2010). Due to the delicate topics of this study, it

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394 is our opinion that a critical and hermeneutical review is the most appropriate approach to understand other
395 researchers' meanings, purposes and actions. Conceived in the Nineteenth Century to recognize the original
396 meaning of texts (Schleiermacher 1998; Dilthey 2002), then challenged during the Twentieth Century
397 (Heidegger 1996; Gadamer 1976), today hermeneutics can be understood as an iterative process for
398 interpreting and understanding questions and meanings of texts (Boell and Cecez-Kecmanovic 2014).
399 The methodology applied for this review can be ascribed, therefore, to the family of interpretivist
400 paradigms. By means of integrated top-down deductive and bottom-up inductive processes, using both
401 confirmatory and exploratory research questions (Teddlie and Tashakkori 2010), a qualitative content
402 analysis has been conducted to obtain an in-depth understanding of the motivations, representations and
403 research actions in the studies analysed, and then to ascribe each study to a paradigm group. This typology
404 of non-standardized and non-codified method borrows the document analysis that belongs to the qualitative
405 social research methods described by Bailey (2007). Papers' contents have been critically analysed by
406 means of literal criteria (Table 4) selected according to the main ontological, epistemological and
407 methodological claims of opposite families of paradigms (see Table 2). Table 3 provides an overview of
408 the critical and hermeneutic methodology. Two main phases guide the review steps: the first one is about
409 searching and acquisition of studies, and the second about analysis and interpretation; the reading is the key
410 activity that develops understanding (Boell and Cecez-Kecmanovic 2010, 2014).
411
412 Table 3 Critical and hermeneutic review methodology
413
414 All studies on sLCA published from the year 1996 until July 2015 (scientific and grey literature) have
415 been gathered with the help of online scientific databases and engine research, i.e. Scopus, Web of Science,
416 ScienceDirect, Mendely, Google Scholar, Google Books, the mobile phone application Scholar Droid, and
417 dedicated social networks such as Academia.edu and ResearchGate. This research was conducted with the
418 help of specific keywords (within article titles, topics, abstracts, and keywords), Boolean operators (AND,
419 OR), and proximity operators (N/n, W/n), when possible.
420 The following keywords were used to identify potentially useful articles: social life cycle assessment,
421 social LCA, SLCA, S-LCA, as well as social impact, social consequence, social performance, social
422 evaluation, social sustainability, and social assessment in association with the term 'life cycle'.
423 The papers selected are all about sLCA alone or in association with other assessment methodologies,
424 while those about Life Cycle Sustainability Assessment (LCSA) were included only when presenting a
425 separate application of sLCA. In case of papers about a whole assessment of sustainability in a broad sense,
426 only those papers that included sLCA in the keywords section were included in the selection. Publications
427 have been scrutinized according to the relevance of the title, abstract, and keywords; when not sufficient, a
428 speed-reading and a search for topical sentences has been done.

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From the first population of 209 works gathered, articles from national journals, bachelor's and master's theses, project reports, and books without publishing identifiers (ISSN or ISBN) were discarded.

Papers that did not concern any methodological proposal (neither at a theoretical level nor at an applicative one) and reviews were discarded due to the scarcity of elements for classification.

For the reason of pertinence, the selection included some grey literature such as the proceedings of specific conferences dedicated to the topic of sLCA (such as the International Seminars on sLCA) - when available - and doctoral theses because they are reviewed by an academic committee.

As a result, a selection of scientific works have been gathered, and a classification matrix has been developed (Supplementary Material) to order all studies according to the following entries:

- identifiers: author names, year of publication, title, source, doi, or website;
- typology of literature: journal article, book chapter, conference proceeding, or PhD thesis;
- typology of study: theoretical dissertation, methodological proposal, case study, review, or editorial letter;
- research paradigm applied: positivism- or interpretivism-oriented;
- methodologies applied: only sLCA or the same in combination with other assessment tools;
- field of application, if any: agriculture, industry, waste management, services, etc.;
- impact assessment methodology: pathways methodologies, UNEP-SETAC guidelines, participative methods, capabilities/capacities approach, multicriteria decision analysis, etc.

Impact assessment methodology is a question of utmost importance in life-cycle-oriented tools, and this is particularly even more significant in the diversity of sLCA proposals (Parent et al. 2010); therefore, it has been the core criterion to classify the literature gathered, too. However, as the methodological level alone is not sufficient to disclose which paradigm is underlying the research (Iofrida et al. 2014), an assessment grid has been set up to check and verify the presence of topical elements that helped to attribute papers to one or another family of paradigms (Table 4).

Concerning the most diffused impact assessment methodologies, according to Zamagni and colleagues (2016), we can recognize three main groups in sLCA (Fig. 3). The first group is represented by those inspired by UNEP-SETAC (2009; 2013) guidelines and methodological sheets (including also the Social HotSpot Database [SHDB]); the second group concerns the 'social impact pathways' (Weidema 2006; Feschet et al. 2013; Neugebauer et al. 2014; Bocoum et al. 2015). The third group is represented by the 'capacities/capabilities approach' (Reitinger et al. 2011; Garrabé and Feschet, 2013; Feschet 2014). Further information on the state of developments in sLCA have been already provided by many scholars in the last years. Since the real goal of this paper is to explore the reasons of sLCA methods, more details on different sLCA methods can be found in Macombe and colleagues (2013), Wu and colleagues (2014), Arvidsson and colleagues (2015), Chhipi-Shrestha and colleagues (2015), Fan and colleagues (2015), Arcese and colleagues (2016), Petti and colleagues (2016).

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Figure 3 Main impact assessment methods applied in sLCA literature

UNEP-SETAC (2009; 2013) guidelines and methodological sheets proposed a general approach based on a set of stakeholder groups and possible impact categories, subcategories, and indicators. Workers, the local community, society, consumers, and value chain actors are considered the main actors affected by the functioning of a life cycle. Examples of impact categories are given (human rights, working conditions, cultural heritage, etc.) as well as a total list of 189 indicators to conduct both a generic and a specific analysis. The list of indicators is not exhaustive, and the choice is left up to the intention of the researchers/practitioners. Most of them are static indicators that allow the description of a current status (attributive assessment) or the performance of a company (or other actors responsible for the life cycle). However, the guidelines propose two characterization models: type I that consists of aggregating results of sub-categories within each impact category for each stakeholder group and type II that is based on the causal relationship between sub-categories and inventory indicators. As affirmed in the same guidelines, type II is not well developed; indeed, all sLCA studies inspired by the UNEP-SETAC approach apply the first type therefore, their major difficulties is to identify systematically the most significant issues and stakeholders (Wu et al., 2014). This kind of approach has been ascribed to the group of interpretivism-oriented paradigms for all the above-mentioned reasons: the discretional choice of indicators, the lack of causal relationships, and the predominance of static indicators.

The 'impact pathway methodology' follows the same epistemological approach as eLCA. Weidema (2006) and Norris (2006) published the first seminal works, then they were followed by the works of Feschet and colleagues (2013), Macombe and colleagues (2013), Neugebauer and colleagues (2014), and Bocoum and colleagues (2015). The core principles of this methodology are that social impacts are considered consequences of a change in the life cycle of a product, and these consequences are phenomena felt by affected actors that can be explained by quantifiable cause-effect relationships. The principal aim of this methodology is to allow formulating expectancies, i.e. predicting the consequences to the actors' quality of life and providing generalizable findings. So, the major challenge in this approach is to carefully recognize the impact pathways, i.e. as much as possible fitting with the real causal relationships (Wu et al., 2014). For these reasons, the papers applying these methodologies have been ascribed to the group of post-positivism paradigms.

The 'capacities/capabilities approach' has been proposed by Reitinger and colleagues (2011), and, referring to the works by Sen (2000; 2005), it proposed an impact assessment based on the kind of capabilities (set of alternative lives) that people can freely chose; here, the philosophical perspective of assessment is oriented towards what is important in peoples' lives. Garrabé and Feschet (2013) further developed this approach with the so-called 'capacities SLCA', based on the measurement of variations of capital stocks (human, technical, financial, social, and institutional capitals) – caused by the life cycle of a product – and their consequences on the production and accumulation of people's capacities. Here again, a cause-effect

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relationship is at the core of the assessment methodology; for this reason, papers based on this approach have been classified into the post-positivist group. As the only impact assessment methodology is not sufficient to classify the papers, and to corroborate the classification into the two paradigm groups, the assessment grid in Table 4 has been used to check the presence (or absence) of some topical elements according to the paradigm discourse exposed in the previous section.

Table 4 Assessment grid for the critical review of sLCA literature

Concerning the left column (post-positivism-oriented papers), if causal variables are deterministically accounted, then the researcher/practitioner is detached from the object of assessment, he/she does not personally intervene in the assessment process, and the findings are generalizable and applicable to other contexts. Dynamic indicators allow status changes to be caught and therefore to predict future consequences for people.

Regarding the right column (interpretivism-oriented papers), if the choice of indicators and impact categories is at the discretion of the researcher/practitioner or entails the participation of stakeholders, relativism dominates, and the reality is intended to be subjective and shaped by the actors' perception. The use of static indicators is useful to describe and understand a current situation or compare more scenarios; however, it says little about how consequences and causes are linked together and how much impact can be attributed to the nature of the life cycle. Most of this kind of evaluation focuses on companies' responsibilities at a specific temporal moment.

3.2. Results

The studies gathered and selected (133) were published from 2003 to July 2015, with a peak in 2014 of 41 publications (Fig. 4), probably due to the publication of the methodological sheets by UNEP-SETAC (2013).

Figure 4 Number of sLCA publications per year

Articles in international scientific journals represent 58%, mainly published in the International Journal of LCA (52% of journal articles), the Journal of Cleaner Production (12%), Sustainability (9%), and the Journal of Industrial Ecology (5%). The remaining publications are represented by conference proceedings (25%), book chapters (12%), books (3%), and PhD theses (2%).

As explained in the previous section, papers have been classified according to the impact assessment methodology, both in cases of applicative studies and methodological proposals or discussions. Quite often, the impact assessment methodologies are not explicit; this is the reason for which the assessment grid (Tab. 4) was applied in the search of topical elements enabling the studies to be ascribed to the interpretivist or post-positivist group. Indeed, as explained in Section 2, the presence of quantitative or qualitative indicators

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alone is not sufficient to characterize a research paradigm. As an example, the loss of time per ton of steel due to injuries (Weldegiorgis and Franks 2014) is certainly a quantitative indicator; it can describe the situation of the productive sector according to national statistics based on past data. However, it does not say which durable consequences this has on a typology of actors in a certain period of time or how changes in the life cycle would improve or worsen the social impacts.

Moreover, even if some cause-effect relationships are accounted in several studies, some relativism persists in the choice of impact categories or impacts; the principal reasons adduced are insights from a literature review, the importance given by companies or those who commissioned the assessment, or stakeholders considered important or affected. Indeed, about 25% of studies affirms to have conducted a literature review to select the most relevant issues to be assessed or to confirm their importance in their chosen field of study.

Concerning the last, the most recurrent fields of study to which sLCA has been applied are agricultural, forestry, and food products (16% of studies), followed by energy production, industrial and technological products, and others. One of the reasons adduced is that there has been a growing awareness that farm activities induce significant impacts (economic, environmental, and social) on several typologies of actors (Revéret et al. 2015).

As represented in Fig. 5, about 73% of the selected studies can be ascribed to the group of interpretivism-oriented paradigms, and only 24% can be ascribed to the post-positivism ones. This data deserves some attention because, since the beginning of sLCA methodologies, most of the scholars supported the application of the same assessment perspective as eLCA to social impacts (Hunkeler 2006; Chhipi-Shrestha et al. 2015). Most of the papers ascribed to the interpretivism-oriented group applied the UNEP-SETAC (2009; 2013) approach, and in particular, the 'type I' impacts assessment, followed by the SHDB and other methodologies (risk assessments, monetary assessments, etc.).

Figure 5 Paradigms applied in sLCA literature

Advocacy for stakeholders' involvement, participation, and public acceptability at different levels of the methodology were common characteristics of these studies. The principal focus of the assessment methodologies were social values, actors or companies' behaviour, and context specificities. Among these papers, the most recurrent methodology for choosing indicators were literature review (about previous sLCA studies or others), recurring to international national norms on socio-economic issues, or stakeholders' involvement. Too often, the list of indicators is not justified at all, and these last are applied to conduct attributional or static assessments such as 'number of employees' or 'percentage of women employed'; they do not furnish explanations about the consequences of these data but describe a current situation or highlight differences between two or more scenarios. However, this typology of studies allowed

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more holistic assessments to be conducted, a wide range of social dimensions to be covered, and more complete information about the social performance of the systems under assessment to be furnished.

In the studies ascribed to the group of post-positivism-oriented paradigms, the key arguments referred to impact pathways, cause-effect relationships, and causal chains. Some of them assessed consequences on people's health via economic causal relationships, as it is the case of Weidema (2006), Feschet and colleagues (2013), Bocoum and colleagues (2015), and Chang and colleagues (2015). These studies are in accordance with the (post-positivist) eLCA framework; however, as this kind of impact assessment is not yet well developed, few pathways are available, and evaluations are limited to a certain range of impact categories.

Finally, a third group has been classified as both interpretivism and post-positivism-oriented (3% of studies). Studies belonging to this group applied cause-effect relationships assessment as well as mixed methods or risk characterization factors, but often the choice of impact categories or indicator has been made in accordance with the preferences of stakeholders or with some theoretical framework, e.g. the theory of justice (Macombe 2014).

3.3 Discussion

In light of the previous reflections, we argue that it is important, before going into methodological questioning issues, to be aware of which paradigm is underlying. There is consensus about considering sLCA and the other life cycle assessment methodologies to be management tools toward more sustainable patterns, as mentioned in about 61% of the studies gathered. In addition, it is doubtless that sLCA addresses social impacts, which are a concern of sociology. This entails that the epistemological eclecticism of these disciplines (management and sociology) is reflected in sLCA literature.

In this *pre-scientific* phase of sLCA development (in a *Kuhnian* sense), the methodological debate about indicators and impact assessment, which led to a plethora of case studies and methodological proposals, should take into account this diversity and question the theoretical and epistemological bases.

We are no longer in sLCA infancy, so it is time to face a further phase. To do this, an attitude of modesty should be maintained in current sLCA research (Macombe and Loeillet 2013), and looking outside the literature boundaries of sLCA could help in dealing with the multilayered feature of social phenomena and the multiparadigmatic characteristics of sociology and management sciences. This issue was already highlighted, for example, by O'Brien and colleagues (1996), Jorgensen and colleagues (2010), Iofrida and colleagues (2014, 2016) Sala and colleagues (2013a, 2013b), Baumann and colleagues (2013) and Arvidsson and colleagues (2015), but little response was found among the sLCA studies.

This awareness would help answer some of the following fundamental questions. How and why are indicators chosen? Which theoretical basis underpins the assessment process? It is not our desire to promote one or another paradigm or approach in sLCA; the aim is to shift the methodological debate towards an epistemological level.

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As represented in Table 5, each paradigm orientation has its strengths and weaknesses. Both relativism and objectivism (cfr. Section 2), features of interpretivism and post-positivism respectively, can be suitable for social impact evaluations, but the choice should be made in accordance with the purposes of the studies, the researcher's position, and with the awareness that results can differ in terms of significance. The strengths of the post-positivist paradigms mainly stay in the generalizability of value-free results and in their research processes that are more unbiased, quick, and affordable (with exceptions). On the other side, their analytical modelling of reality is over-simplified and reductionist, often valid only in *coeteris paribus* conditions, and focused on few specific aspects. Interpretivism-oriented paradigms allow a comprehensive understanding of meanings and values as perceived by actors, and subjectivity and holistic approaches are their core strengths; but this also means that they are context-bound and poorly generalizable, as well as having long and costly research processes (Iofrida 2016). Objectivism (realism) and subjectivism (relativism) can be considered strengths and weaknesses at the same time. For example, relativism is the most significant characteristic of interpretivist approaches - many realities exist, and the idea of a certain and absolute knowledge is rejected - but it would be considered a bias and an inaccuracy from a post-positivist stance (Yeganeh and Su 2005).

Table 5 Main characteristics of sLCA studies according to the paradigm applied

This study confirms what was already affirmed by Baumann and colleagues (2013:2), that 'a coherent discussion about the social values and ethical and ideological positions that underlie the indicators of social impacts is missing'.

4. Conclusions

SLCA was conceived to evaluate social impacts from a life cycle perspective, but it is not yet well defined (a standardized or univocal methodology does not exist), and its process of development is long and difficult; indeed, many different approaches and methodologies have been proposed that pay attention to the most diverse aspects. SLCA has been conceptualized in an engineering milieu, as it is the main field of study of eLCA scholars and practitioners. However, the inherent nature of the impacts under assessment are different in sLCA from eLCA, as the latter was conceived to analyse environmental impacts (the object of study of natural sciences) and the former to analyse social impacts (the object of study of social sciences). The disciplinary and scientific inheritance of sLCA has been argued and tracked down into sociology and management sciences. The epistemological characteristics of both disciplines have been argued as well as the role of scientific paradigms in research processes in the translation from theory to practice.

Post-positivism is the dominant paradigm in the natural sciences, while sociology is epistemologically eclectic, because many worldviews can be held. Among these, two main families of scientific paradigms, post-positivism and interpretivism, have been outlined in depth.

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643 Moving from a reflection upon the repercussions of this multiparadigmatic characteristic of social
644 sciences on sLCA literature, the aim of this research was to shift the current methodological debate to an
645 epistemological level through a critical review that attempted to classify sLCA scientific literature
646 according to the above-mentioned families of social research paradigms.
647 Studies on sLCA were gathered by means of the most acknowledged online academic databases and
648 scientific literature search engines, using specific parameters of significance.
649 Each publication has been analysed and classified according to the assessment methodology applied
650 and a critical text analysis with literal criteria allowed ascribing each of them to the post-positivist or
651 interpretivist family of paradigms.
652 The results showed that about 70% of the selected studies can be ascribed to the group of interpretivism-
653 oriented paradigms, and only 24% can be ascribed to the post-positivism ones. These data deserve some
654 attention because, since the beginning of sLCA methodologies, most of the scholars supported the
655 application of the same assessment perspective as eLCA to social impacts. Studies ascribed to the
656 interpretivist group, principally, applied qualitative and static indicators and advocated for stakeholder
657 participation, social values, behaviour of the actors or companies, and were more context-bound compared
658 to the second group. Studies belonging to the group of post-positivism-oriented paradigms mainly referred
659 to impact pathways, cause-effect relationships, and quantifiable consequences; they applied mainly
660 quantitative methods supported by mathematical/statistical relationships.
661 In conclusion, this paper attempts to provide a contribution for the advancement of sLCA development
662 by pointing out that, urgently, a reinforcement of the theoretical bases of sLCA is needed, with more
663 attention given to the epistemological discourse. Coming back to the title of this paper, 'Can social research
664 paradigms justify the diversity of approaches in sLCA?' we can answer affirmatively, and we highlight that
665 this awareness can foster the insights of future works on sLCA.
666
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933 Table 1 Definitions of the main elements of a paradigm

Research element	Definitions	References
Paradigm	"Paradigms are universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners".	Kuhn (1970:viii)
	"A research paradigm is a perspective about research held by a community of researchers that is based on a set of shared assumptions, concepts, values, and practices".	Johnson and Christensen (2014:31)
	"A paradigm is a fundamental image of the subject matter within a science. It serves to define what should be studied, what questions should be asked, how they should be asked, and what rules should be followed in interpreting the answers obtained".	Ritzer (1975:7)
Ontology	"A philosophical standpoint onto the research process that asks such questions as, What is the nature of reality? Ontologies are theories on the nature of being and existence"	Hesse-Biber (2010:126)
	"Ontology raises basic questions about the nature of reality and the nature of the human being in the world".	Denzin and Lincoln (2005:183)
	"The ontological question is: What is the nature of the "knowable"? Or, what is the nature of reality?".	Guba (1990:18)
Epistemology	"A philosophical standpoint onto the research process that asks such questions as, What can we know and who can know? A researcher's epistemology encompasses her/his standpoint on the nature of knowledge and learning".	Hesse-Biber (2010:126)
	"Epistemology asks: How do I know the world? What is the relationship between the inquirer and the known?"	Denzin and Lincoln (2005:183)
Methodology	"We can think of methodology as a theoretical bridge that connects the research problem with the research method".	Hesse-Biber (2010:11)
	"The delicate passage from theory to empirical research, from hypotheses to concepts, indicators and variables; in other words, to the question of so-called 'operationalization' ".	Corbetta (2003:2)

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936 Table 2 Examples of paradigms in social and management sciences.

Families of paradigms	*Positivism-oriented*		*Interpretivism-oriented*	
Examples of paradigms	*Positivism*	*Post-positivism*	*Constructivism*	*Interpretivism*
Ontology: *What is reality?*	Naïve realism. It exists only one objective reality, apprehendable, patterned and predictable.	Critical realism. It exists only one objective reality, but it is probabilistically apprehendable.	Relativism. Subject and object are dependent. The real essence of the reality cannot be known. Reality is constructed and interpreted trough perceptions.	
Epistemology: *How do you know?*	Dualism researcher-research. Replicable findings are "true". Reality can be explained.	Dualism is not possible. Replicated findings are "probably" true. The fully explanation of reality is impossible.	Knowledge is constructed. Reality can be constructed.	Knowledge is interpreted. Reality can be understood and described.
Methodologies: *How do you find it out?*	Experimental, deductive, nomothetic. Purely quantitative. Verifiable relationship cause-effect.	Experimental. Mainly quantitative methods, manipulative. Scientific Community plays a role of validation. Statistical analysis. Probability sampling.	Mainly qualitative methods. Purposive and multipurpose sampling. Stakeholders' experience.	Hermeneutical, dialectical. Mainly qualitative methods. Stakeholders' perceptions.
Goodness or quality criteria.	External validity, verifiable data through repeatable methods.	Statistical confidence level and objectivity in data produced.	Intersubjective agreement and reasoning reached through dialogue, shared conversation and construction.	

937 Source: Guba 1990; Guba and Lincoln (1994); Girod-Séville and Perret (1999); Cupchik (2001); McKenzie and Knipe (2006); Lincoln
938 et al. (2011); Hesse-Biber and Leavy (2011); Levers (2013); Phoenix et al. (2013); Iofrida et al. (2014).
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941 Table 3 Critical and hermeneutic review methodology

Phases	*Review steps*	*Implementation*	*Results*
Search and acquisition	Searching	Application of keywords and Boolean operators to scientific literature databases	First group of potentially relevant papers
	Sorting and selecting	Screening and download of papers meeting the criteria	Selection of a defined set of pertinent papers
	Matrix construction	Definition of literal criteria according to post-positivism and interpretivism	Construction of an evaluation matrix
Analysis and interpretation	Critical and hermeneutic evaluation	Reading and scoping applying the literal criteria according to post-positivism and interpretivism	Matrix completion
	Interpretation of results	Discussion about results	Insights

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944 Table 4 Assessment grid for the critical review of sLCA literature

Post-positivism-oriented papers	*Yes ✓ No ✗*	*Interpretivism-oriented papers*	*Yes ✓ No ✗*
Dynamic indexes/indicators to assess a status change	☐	Static indexes/indicators compared to international standards or national laws	☐
Cause-effect relationships and causal chain	☐	Participation, stakeholders involvement through qualitative methods	☐
Direct relation between process flows and impact pathways	☐	Choice of impact category according to the claims of interest groups, public acceptability, actors opinions	☐
Social impacts are intended in the same way as environmental ones in eLCA	☐	Companies behavior regarding international norms on social issues	☐
The researcher do not need to have a direct contact with affected actors, research process is not influenced by personal opinions	☐	The researcher is directly involved in the research process, as the principal responsible of procedural and category assessment choice	☐
Access to national and international databases and statistical hypothesis testing	☐	Direct contact with affected actors (interviews, surveys)	☐
Deterministic account of life cycle causal variables	☐	Social values, actor meanings and companies behavior	☐
Effects prediction, modelling, quantification as priority task to be assumed	☐	Qualitative scoring, social acceptance	☐
The study is based on the same inventory data used for LCA and LCC	☐	Qualitative and quali-quantitative indicators are preferred	☐
All impacts must be quantitatively linked to a functional unit	☐	Company performances and behaviors are considered the principal source of impacts	☐
Social consequences on people lives due to a life cycle change	☐	The context specificities have strong repercussions on the assessment results	☐
The importance of generalizations and universal laws is emphasized	☐	Findings can assume a different meaning according to the context	☐
Results allow to predict a future situation	☐	Results allow to describe a current state or based on historical data	☐
Long term consequences are accounted	☐	Short term assessments	☐

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947 Table 5 Main characteristics of sLCA studies according to the paradigm applied

	Post-positivism-oriented paradigms	*Interpretivism-oriented paradigms*
Strengths	Context free	Rich in meaning and values
	Generalizable	Holistic
	Value free	In-depth investigation
	Affordable and quick	Comprehensive understanding
	Objective	Relativist
Weaknesses	Poor in values	Weak in predictability
	Reductionist	Context-bound
	Over-simplified	Long and costly
	Superficial	Weak in generalizability

Source: our elaboration on Guba and Lincoln (1994),Yeganeh and Su (2005), Phoenix et al. (2013), Iofrida (2016)

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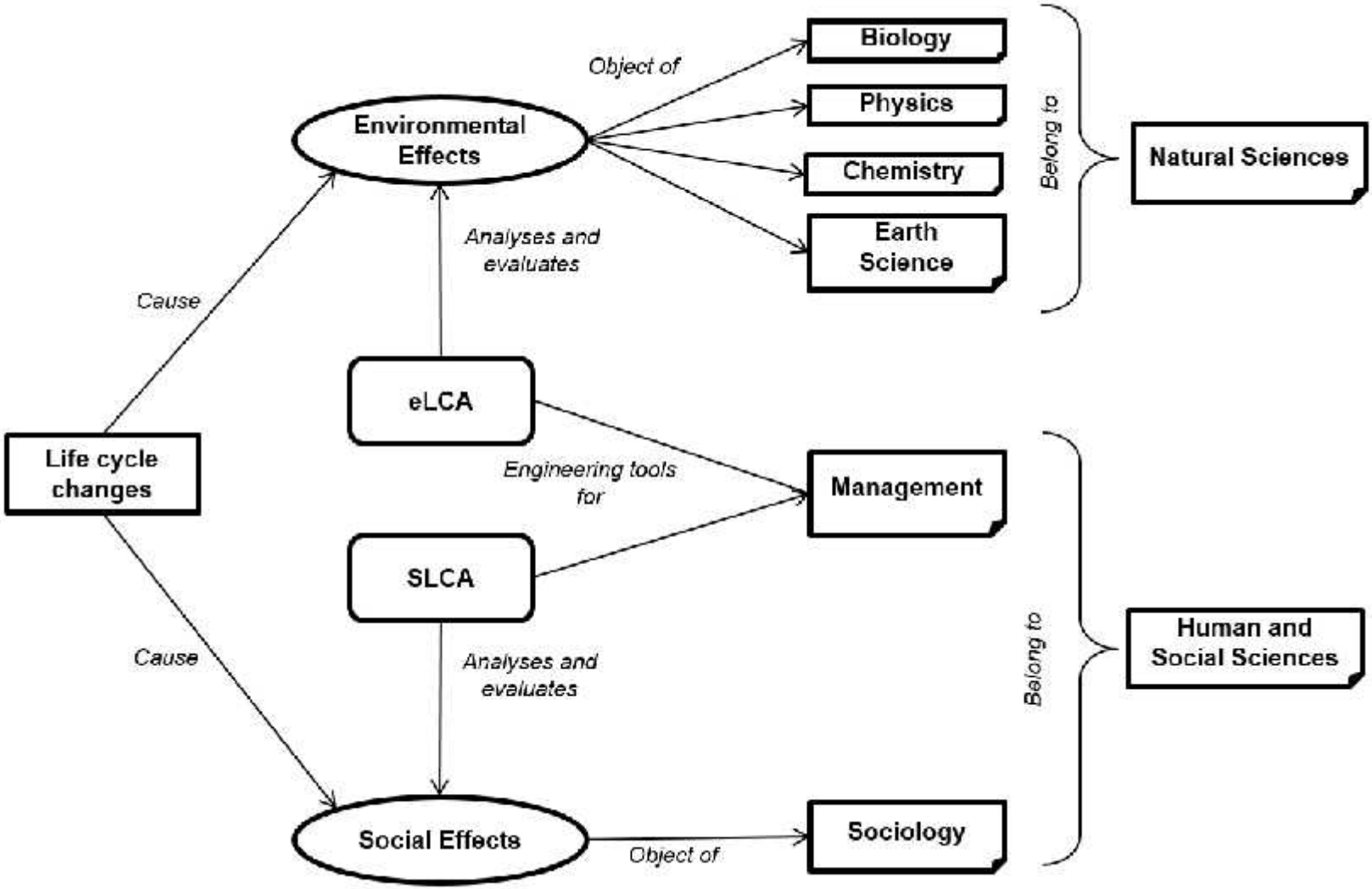
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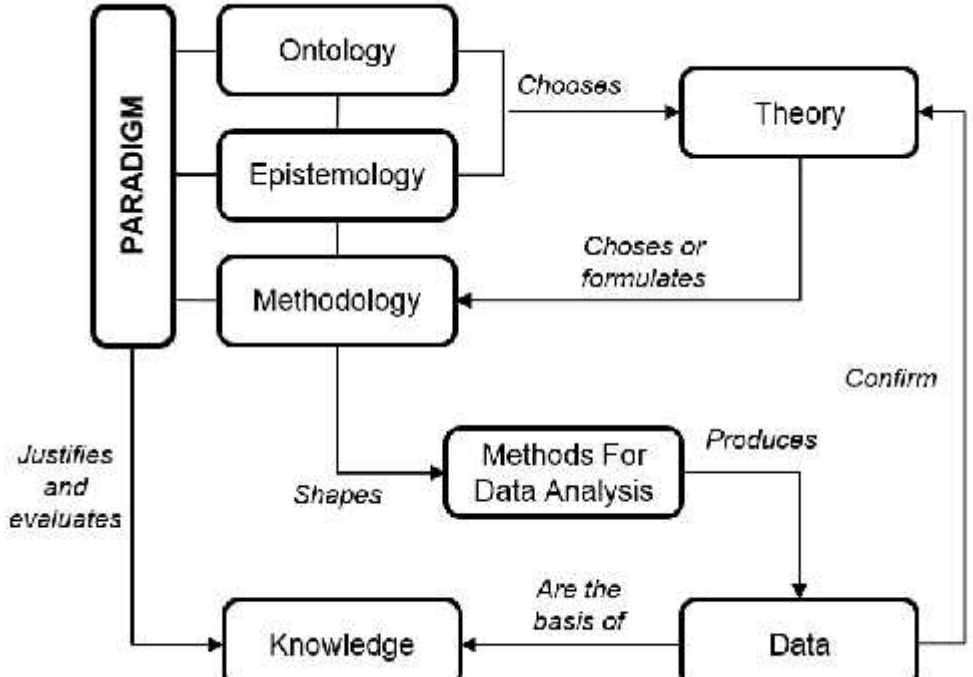
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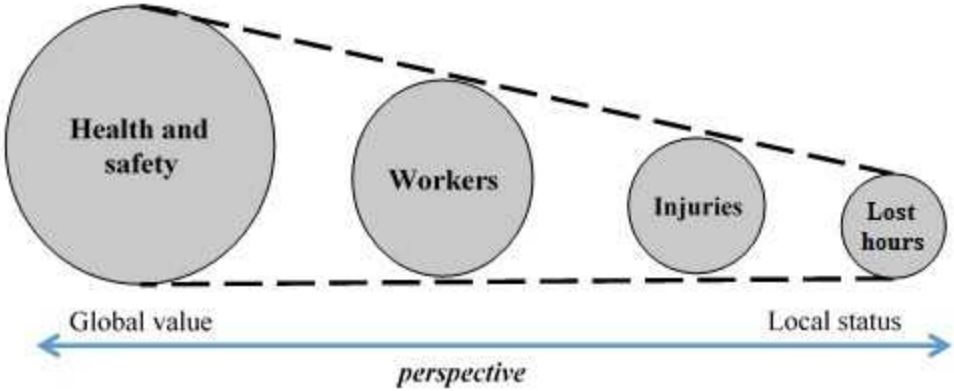
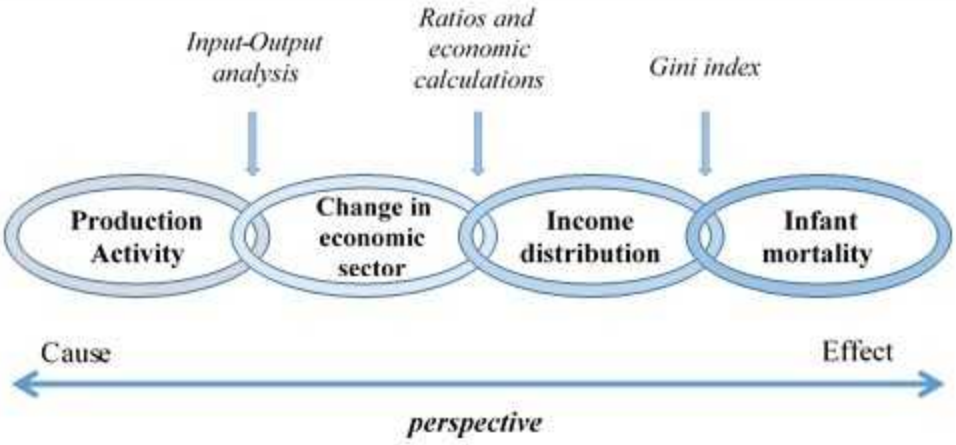


UNEP-SETAC approach

Main characteristics:
- 5 stakeholder groups
- Static indicators
- Categories from international laws
- Performances, "snapshot" of a status
- Similar to CSR
- Type I impact characterisation

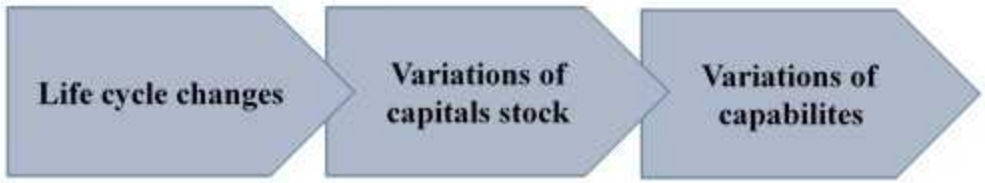
Source: authors' own elaboration based on Weldegiorgis and Franks (2014)



Social impact PATHWAYS

Main characteristics:
- Consequences
- Quantification of cause-effect relationships
- Similar to eLCA's epistemology
- Formulation of expectancies

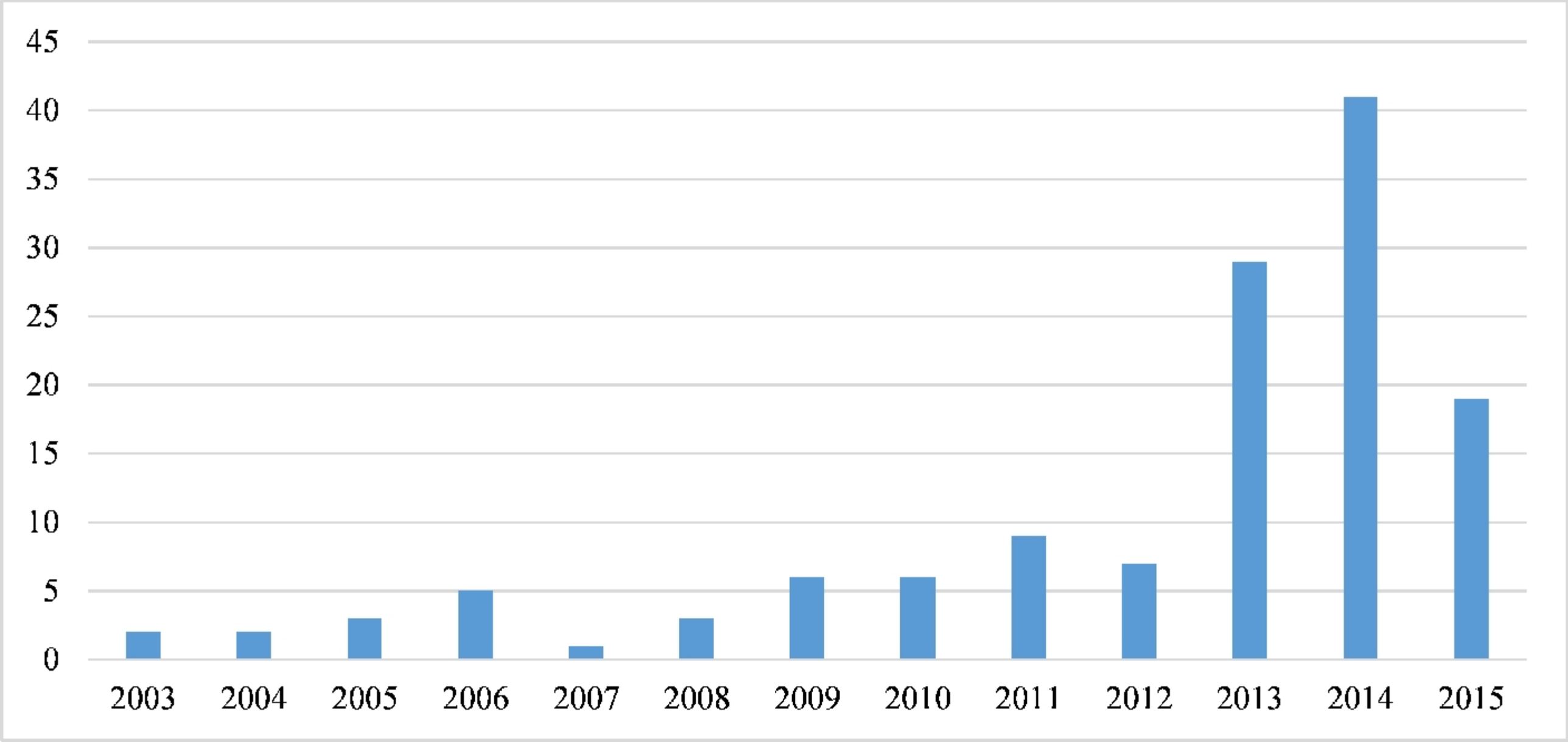
Source: authors' own elaboration based on Bocoum et al. (2015)



CAPACITIES and capabilities approach

Main characteristics:
- Capabilities people can freely chose
- Consequences of variation of capital stocks

Source: authors' own elaboration based on Garrabé et al. (2014)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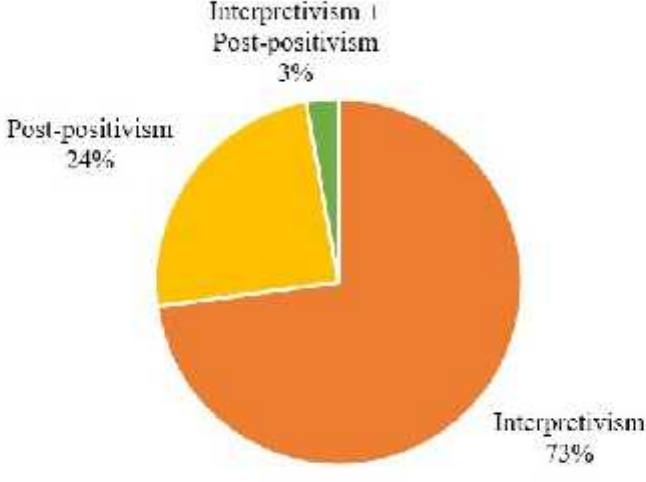
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