Mediterranean University of Reggio Calabria

Doctorate in Agricultural, Food and Environmental Sciences and Technologies,

curriculum Agricultural Economics and Politics,

XXXVIII cycle - Scientific Disciplinary Sector AGR/01

"PARADIGMATIC STANCES AND METHODOLOGICAL ISSUES IN SOCIAL LIFE CYCLE ASSESSMENT.

COMPARISON OF TWO DIFFERENT METHODOLOGICAL PROPOSALS APPLIED TO AGRICULTURAL PRODUCTS."

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Supervisor: Dr. Alfio Strano

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"What gets measured, gets managed"

(Attributed to William Thomson, 1883)

"Not everything that can be counted counts,

and not everything that counts can be counted"

(Attributed to William Bruce Cameron, 1963)

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ABSTRACT

The purpose of present thesis is twofold. Firstly, it aims offering an explanation about the diversity of methodological approaches proposed until today for SLCA, tracking down its roots in the cultural and scientific heritage of social sciences, especially sociology and management sciences. This will help to shift the current methodological debate in SLCA to an epistemological level, through a critical review about the underlying paradigms have been applied in SLCA literature until now. Secondly, the research will highlight the possible consequences of different paradigmatic stances in sLCA by means of the application of two different methodological proposals set up from opposite paradigms (post-positivism and interpretivism) and compared in terms of research process and typology of insights.

The thesis moves from the assumption that the diversity of positions in philosophy of science and the multiparadigmatic character of sociology and management research have had repercussions on SLCA since its beginnings, even if not in an explicit way. The concept of sustainability and sustainable development in scientific literature have been reviewed, as well as the principal concepts of social sustainability and inherent practical issues. Likewise, the same concept of social sustainability has been analysed through a critical review of scientific peer-reviewed literature on SLCA. Then, an analysis of which disciplinary fields are linked to SLCA and for which reason has been conducted. A digression on the philosophy of science and the criteria of knowledge validation introduces the description of two main families of paradigms of sociology and management research, namely post-positivism and interpretivism. A second critical review has been conducted to investigate which scientific paradigms have been applied in SLCA studies from 1996 to September 2015. Three quarters of the scientific papers published until now in SLCA can be ascribed to the group of interpretivism-oriented paradigms, and only the remaining quarter can be ascribed to post-positivist ones. This data deserve some attention, because since the beginnings of SLCA methodologies, most of the scholars involved claimed for application of the same assessment perspective of eLCA (post-positivist) to social impacts. .

Then, two different methodologies are set up starting from opposite paradigms and applied to the same case study, i.e. citrus growing in Calabria region (South Italy), an agricultural sector important for the regional economy (Calabria is the second producer of citrus at national level), but also well-known for social urgencies. Finally, the two paradigmatic approaches, in which the two methodological proposals are framed, are compared highlighting the main features and the different significance of results obtained.

In the light of the reflections carried out, it is arguable that it is of utmost importance in this pre-scientific phase of SLCA development, to be aware of which paradigms are underlying the work

of the scholars. Indeed, the simple methodological debate should be put forward, and should be aware of the multilayered nature of social phenomena and the multiparadigmatic characteristics of social and management sciences.

ACRONYMS

AoP: Area of Protection

CLAM: Comité de liaison de l'agrumiculture de la Méditerranée

COM: Common Market Organization

CS: province of Cosenza

CSR: corporate social responsibility

CZ: province of Catanzaro

IRR: Internal Rate of Return

LCA or eLCA: (environmental) life cycle assessment

LCAA: life cycle attribute assessment

LCC: life cycle costing

LCM: life cycle management

LCSA: life cycle sustainability assessment

LCT: life cycle thinking

LCWE: life cycle working environment

NPV: Net Present Value

PRF: psychosocial risk factors

RC: province of Reggio Calabria

SAM: subcategory assessment method

SD: sustainable development

SHDB: social hotspot database

SLCA: social life cycle assessment

UUA: Utilised Agricultural Area

WCED: World Commission on Environment and Development

1. INTRODUCTION

1.1 Topic of the research and motivations

As sustainability issues became an urgency in the last decades, the scientific research shift most of its attention to the gravity and breadth of human impacts on earth's carrying capacity, in terms of depletion of natural resources and pollution, but also to the social and economic consequences of anthropic activities. In this sense, 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 conceived to evaluate the potential impacts generated during the whole life cycle (from "cradle" to "grave") of a product or service, and to orientate, in a sustainability perspective, the production of goods and services, and therefore help decision-making processes, e.g. for public policies or management modes within organizations (Horne 2009). The innovation to which LCT tools contributed is attributable to broaden focus of the assessment - the whole life cycle - aimed at avoiding burden shifts among phases. This typology of evaluations found acceptance and agreement by scholars, practitioners, academics, companies and the general public.

Under this theoretical framework, three principal tools were set up, namely:

- Life Cycle Assessment (LCA or eLCA), the first tool to be developed, is devoted to the quantification of environmental impacts through cause-effects relationships (pathways) that link material and energy inventory to categories of impact (e.g. damages on human health, ecosystems, resources depletion) by means of software for impacts characterization. The methodology is standardised by ISO (2006a, 2006b) norms 14040-14044 and organized in four main steps: goal and scope definition, inventory analysis, impacts assessment and interpretation of results.

- Life Cycle Costing (LCC), has been set up to account all expenditures of the product or service under assessment from its conception and fabrication until the end of its useful life.

- Social Life Cycle Assessment (SLCA) is the latest tool developed under this conceptual framework and is devoted to the assessment of all kind of impacts generated by the life cycle and affecting people. The methodology is not standardized, there is no consensus about the evaluation process, nor a unique definition exist for SLCA and social impacts. This led to a plethora of methodological proposals that can differ in many points, such as the perspective of the

assessment, the source of impacts, what is worth to be assessed (the “impact categories” as called in the vocabulary of eLCA), and even the definition itself of SLCA.

1.2 Research questions and objectives

The objective of the present thesis is twofold. First, is to furnish an explanation of the reason why SLCA is struggling to gather consensus around a unique methodological process, much longer than eLCA and LCC. In particular, it will be investigated if the methodological diversity that characterised SLCA literature has been influenced by the scientific and cultural heritage of the disciplines assumed to be linked to SLCA, i.e. social sciences. Indeed, the object of evaluation of SLCA are social impacts (social phenomena), that are also the object of study of sociology; furthermore, LCT tools are devoted to the support of decision-making process in management practices. Both sociology and management research have the epistemological characteristics of social sciences to which they belong to, i.e. they are multiparadigmatic disciplines. While the post-positivism philosophy dominates in scientific research of natural sciences (named also “hard sciences”, in contrast to humanist disciplines called “soft sciences”), in the history of social sciences is difficult to recognise a dominant paradigm, shared by all scientists. In particular, in sociology and management science, many worldviews (paradigms) could be held, social phenomena are multi-layered events and, as a consequence, social and management researches are heteroclite. Two main opposite paradigmatic positions are both possible in these disciplines: a post-positivist paradigm (as it is common in the study of natural phenomena), and an interpretivist paradigm. They differ in terms of ontology, epistemology and methodological procedures, but both are valuable and suitable in social studies.

Secondly, the thesis seeks to answer the question if different paradigms can coexist in SLCA. To this aim, two methodological proposals have been set up starting from opposite paradigms (post-positivism and interpretivism) to compare the different research process features, and the possible use of the different typology of results has been discussed. Indeed, to promote the development of SLCA as mature discipline, there is a need to shift the methodological debate to an epistemological level. LCT tools have been developed in the technical and academic *milieu* of eLCA, and that most of its practitioners and scholars are usually engineers, chemists, physicians, led to frame and shape the assessment methodology of social impacts in the same way it has been done for environmental impacts in eLCA.

1.3 The context and the case study

The field chosen for the application of the case study are agricultural products. Firstly, because it is the primary sector of economy and, secondly, there is a growing awareness that farm activities induce significant impacts (economic, environmental and social ones) on several typologies of actors. In particular, the two methodologies will be applied to the life cycle of citrus growing in Calabria region (South Italy). Permanent crops are the most important cultivations in Calabria (46% of the total area used for cultivation, compared to the 18% of the national level) and, among them, olive groves cover the most ground, followed by citrus orchards. In terms of average standard production value, citrus growing shows the best economic performance compared to other agricultural sectors, with the highest value registered by farms of Catanzaro province, and the lowest by the farms in the province of Reggio Calabria. Among citrus products, clementine growing represents about 60% of national production, confirming the importance of this product at regional and national level. However, citrus growing in Calabria is also well known for issues of social concern, particularly in relation to seasonal workers engaged in the harvesting period, that live in poor and unhealthy conditions due to low wages; local communities are impacted too by their presence concentrated in few towns.

1.4 Structure of research

The second chapter will analyse the meanings and concepts of sustainable development and sustainability, and social sustainability in particular: the definition of this concept still remains vague and evaluation practices often lacks of scientific bases. Then, some of most well known tools for social issues evaluations are presented, with a special focus on the development of SLCA among the other assessment tools of LCT and the theories of sustainability applied in SLCA scientific literature.

The third chapter discuss which are the disciplines linked to SLCA and their roots in the different research paradigms of social and management research. In particular, some recalls to the philosophy of science are made, as well as to the different criteria of knowledge validation of the main paradigms of sociology and management science. Ontological, epistemological and methodological differences between post-positivism and interpretivism are described.

The fourth chapter proposes a shift of the methodological debate in SLCA at an epistemological level through a critical review of which paradigms have been applied in SLCA studies by scholars and which have been the methodological consequences.

In the fifth chapter, the two methodologies from opposite paradigms will be presented and applied to the same case study. In particular, the first one will concern an “impact pathway methodology” (post-positivist paradigm) and will assess the health consequences of psychosocial risk factors on workers. The second one will concern the construction of a Social Impact Matrix (interpretivist paradigm) to assess a wider variety of impact categories according to the preferences of stakeholders affected.

Finally, in the sixth chapter, the two research processes will be compared to highlight the main differences attributable to the paradigmatic stances. Some reflections will be made about the values and meanings brought by the different methodologies, as well as a discussion about which questions could be answered and to whom these answers could concern.

2. SOCIAL SUSTAINABILITY: THE VAGUENESS OF A WIDESPREAD CONCEPT

2.1 Introduction

Sustainability concerns are 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). At the same time, renowned 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).

First felt as an environmental problem principally, sustainability topics slowly move toward human well-being and societies. A matter of concern later confirmed in the much-quoted Brundtland Report (WCED 1987) and during the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, whose declaration affirmed, in its first principle, the centrality of human beings in the concerns for Sustainable Development (SD) (UNEP 1992).

As sustainability issues became an urgency in the last decades, the scientific research shift most of its attention to the gravity and breadth of human impacts on earth's carrying capacity, in terms of depletion of natural resources, pollution but also in terms of social and economic consequences. In this sense, 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.

2.2 Meanings and concepts of "sustainable development" and "sustainability"

The themes of sustainability recalled the attention of scientists and politicians especially since the end of sixties. However, according to Wiersum (1995) and Kuhlman and Farrington (2010), the term is much older, dating back to the XVIII century, when it was used to describe practices of forestry harvesting respecting what the forest yields in new growth (Wilderer, 2007).

The rapid economic development after the Second World War increased exponentially the consumption of resources and, therefore, the pollution impacts on nature. In these years, environmentalist movements arose, giving birth to environmentalist associations like the WWF (World Wide Fund) and Green Peace. In 1970, the Earth Day was established, when twenty millions of people in USA conducted a march calling for the protection of environment and nature

conservation. Two years after, Meadows et al. (1972) published the well-known essay entitled "The Limits to Growth", in which the authors affirmed that the growth, in whatever socio-economic system, cannot be infinite as it is based on the use of scarce resource. The essay showed the results of a computer simulation calculating the economic and population growth of that time and the amount of available resources on earth: the limits of the carrying capacity of the planet would have been reached in 100 years. According to Meadows et al. (1972), among the categories of necessary goods to sustain life on earth, the first is represented by all the physical necessities that support all biological and industrial activities, included the ecological systems. The second one is represented by social necessities, because also factors as peace and social stability, education and employment are necessary for growth. This puts into light how social concerns have been felt important in sustainability issues.

In 1972, the report of United Nations Conference on the Human Environment (UN, 1972), held in Stockholm, stressed the nature of relationship between man and the environment, affirming that "both aspects of man's environment, the natural and the manmade, are essential to his well-being and to the enjoyment of basic human rights - even the right to life itself" (UN, 1972:3). Moreover, in the first principle the report declare the importance of the quality of the environment to permit a life of dignity and well-being and the responsibility to protect and improve it for the future generations.

The same concern was expressed years later in the so-called Brundtland Report, whose SD definition became a milestone (De Luca et al., 2015a), defined as the "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987:24). This is the most diffused and widely accepted definition of SD, probably because of its broad meaning and vagueness, which makes it well adaptable to many contexts and foster many interpretations. The Report did not furnish any prescriptive or binding condition to be satisfied to achieve sustainability, but it recognised that it was necessary fighting poverty (which is not just economic) and preserving the environment (which is not just biophysical) at the same time, because both were likely to fail if not addressed together (Gibson, 2006).

In 1992, the United Nations Conference on Environment and Development held in Rio de Janeiro, produced the renowned Rio Declaration (UNCED, 1992) which, in its first principle, highlighted the centrality of human beings in the concerns of SD as they deserve a healthy and productive life in harmony with natural environment. In the same declaration, the third principle reiterated the need to guarantee "the right to development" of present and future generation.

As it can be noticed, since the beginnings two concepts are emphasised in sustainability concerns:

- the reciprocal relationships of man and nature, whose existences are interconnected (the quality of the environment should be preserved for human well-being itself),
- the long-term aspect: if the focus is on the future generations, it means that sustainability is not time-limited, it should be forever.

However, as it will be illustrated in the paragraph that follows, at practical level these two conditions are easily disregarded.

Sustainability and SD are more and more central themes in academic research, as well as in the most diverse disciplinary fields. However, until now there is no consensus on a specific definition of these trendy terms. First of all, these terms are often considered synonyms and used interchangeably (Lovren, 2015; Waas et al., 2015). Other times, sustainability is intended as the objective of SD, or, at the contrary, the prerequisite to achieve this last.

Several conceptions of sustainability have been elaborated, one of the most academically recognized classification is the definition of "weak sustainability" and "strong sustainability" (Hartwick, 1977; Solow, 1986). The first one (weak sustainability) can be considered an extension to neoclassical welfare economics, and assumes that natural capital and man-made (artificial) capital are perfectly substitutable and both can equally sustain human well-being. In this sense, sustainability means maintaining the availability and the total value of the aggregate stock of capitals, and even the exploitation of non-renewable resources is justified in exchange for machineries, roads, ports and other artificial capitals (Neumayer, 2010). Technological progress can provide those necessary solutions to compensate environmental problems derived from the exploitation of resources to produce goods and services (Ekins, 2000). SS foster a different perception of the substitutability of artificial for natural capital, which is intended strongly limited by the inherent characteristics of the environment, such as the irreversibility, uncertainty and those critical elements that provide a unique contribution to human well-being (Ekins, 2000). As a consequence, different sorts of capitals are not perfect substitutes but at least complementary, and four procedures are necessary to support operationally strong sustainability, according to Costanza and Daly (1992):

- Limiting human activities within the limits of the carrying capacity of the earth, defined as the capacity of the environment and ecosystems to maintain a population, i.e. to furnish the essential resources;
- increasing the efficiency of technological progress rather than volumes of productions;
- respecting the maximum sustainable yields of renewable natural capital, preventing the extinction of general stocks;

- Exploiting non-renewable natural capital should be done at a rate equal to the creation of renewable substitute.

Daly (2014) stressed the importance to distinguish growth from development, intending the first as the quantitative physical increase by accretion, and the second one as the qualitative improvement in design, technologies and ethical priorities. His conception of sustainability concerns the cessation of growth (meaning exploitation of physical stocks and flows), not of development (i.e. welfare) in favour of a steady state economy, a development without growth, a "sustainability in the sense of longevity with sufficiency" (Daly, 2014:ix).

Another interesting conception of sustainability is grounded in the vision of the bioeconomics (Georgescu-Roegen, 1970, 1971), that is the economic theory based on the biophysical limit of growth applied to a closed thermodynamic context as it is the earth. This theory considers that an indefinite growth is impossible in a limited world, and the only sustainable behaviour is to reduce productions and consumptions, i.e. degrowth (Latouche, 2010). In this sense, SD is a pleonasm and an oxymoron, because development cannot be sustainable itself, if intended as "sacrificing populations and their concrete, local well-being on the altar of an abstract, deterritorialized well-being" (Latouche, 2010:31).

A further concept frequently associated to sustainability is resilience, introduced by Holling (1973) in the field of ecology, intended as the capacity of a system to respond to perturbations, i.e. the capacity of reacting and return to previous state. The resilience is measured as the degree of disturbance that can be absorbed before that the system change its structure, as well as those variables and processes necessary to its vitality. More in details, it "determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist" (Holling, 1973:17). In recent years, the "resilience thinking" was discovered to indicate "a framework that emphasizes dynamics and interdependencies across time, space and domains" (Darnhofer et al., 2010:195) to offers a vision of sustainability not based on equilibrium and not reduced to a steady state that needs to be achieved (Darnhofer et al., 2010).

More recently, Capra (2002) presented a "systemic" vision of life that integrates the biological, cognitive, and social dimensions of life into a new conception of sustainability. The author recognizes in nature and all living beings the same characteristics of "living systems", meaning that every single member is strictly interdependent on the others and the whole system. His reflection moved from the mechanistic worldview by Newton and Descartes that revealed to be less and less appropriate to understand the world and societies; the new perspective he proposed

is a systemic view of life based on relationships among the psychological, biological, cultural and societal dimensions, which together constitute the "web" (Capra, 1996)

However, since many decades, the most applied concept of sustainability is based on the well-known approach of the "Three Pillars" (TP), i.e. three separated dimensions: economic viability, social equity and ecologic integrity. Assumed by the most as the catchphrase of the Rio Conference (UNCED, 1992) and the Brundtland Report (WCED, 1987), it is widely accepted by policy makers, part of many soft law documents and promoted within business management of companies (Bosselmann, 2008). It is also called "Triple Bottom Line" (TBL) approach (thereinafter TP and TBL are considered synonyms), especially in the management and accounting fields (Elkington, 1997). This term was coined in the middle nineties by Elkington (1997), an expert of Corporate Social Responsibility (CSR) (European Commission 2001), to respond to the needs of companies of accounting their social, environmental and economic performances and to report their results to customers, investors and other stakeholders (Manetti, 2006). Actually, the number of dimensions used in this kind of performance measures is not fixed: some assessments include also culture (Hawkes 2001), governance, education, stakeholder participation, etc. A TBL approach entails for businesses incorporating additional information to be communicated to stakeholders; the reported information should be periodically verified, and if the sustainability goals are not met, companies should conveniently correct processes or procedures. It is not surprising that the TBL approach raised in the managerial and corporate field: separating the supposed three dimensions of sustainability allows adapting accounting practices to necessities. This separation allows overcoming the difficulties of an inter- and trans-disciplinary accounting: integrating different typology of expertise and knowledge from more disciplines at the same time is very difficult because each one has its different methods for data gathering and analysis. The TBL approach allows businesses easily communicating positive impacts and demonstrating its commitments towards sustainability and transparency, reassuring stakeholders that accounting is taken to a higher level.

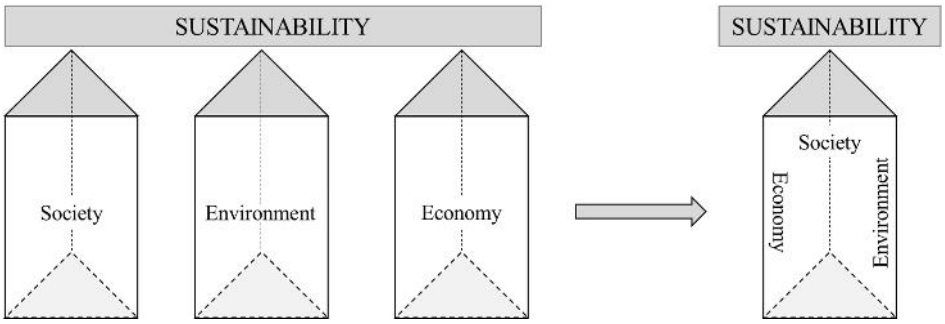
However, according to Feschet et al. (2016), many critics have been moved to this "three-dimensional" vision of sustainability. Assessment methodologies based on TBL "encourage an emphasis on balancing and making trade-offs, which may often be necessary but which should always be the last resort, not the assumed task, in sustainability assessment" (Gibson, 2006:259).

Regardless of the number of pillars, the lack of consideration of the interrelationships among the (supposed) dimensions of sustainability is principal weakness. The vision of conflicts instead of complementarities among them led to consider sustainability as a concern of balance instead of a mutual support (Gibson, 2006). This practise entails that there is a conflict among assessment

goals, as it would not be possible reaching economic viability without damaging the environment (Feschet et al., 2016). Furthermore, TBL entails too much relativity, the choice of indicators is not univocal, neither regulated by specific norms; there is scepticism among businesses about the effectiveness of such investments, and among consumers too, about the reliability of provided information. A further critic moved to TBL/TP approaches is that they try to shape sustainability in the language of businesses instead of adapting businesses to its requirements.

Ikerd (1997, 2007, 2012) proposed an economics of sustainability that considers society and natural environment inside the same boundaries of a new sustainable paradigm, where economy stands for its original meaning "oikonomia", i.e. the management of households. Within this theory, ecological, social and economic dimensions are considered as inseparable and all human beings are interdependent.

Figure 1 - Comparison of three pillars approach with an holistic perspective

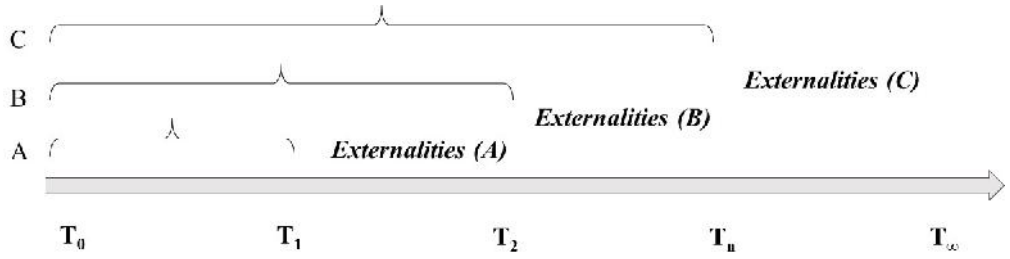


The decision maker is not separated from society and the natural environment, and externalities (environmental impacts, but also social and economic ones) do not exist as "externalities" because they are considered inside the boundaries of the system, in a long-run perspective. If this vision is accepted, sustainability can no longer be considered by its separated dimensions (three, four or whatever) but should be considered as a unique pillar, where society, economy and environment are just interchangeable lenses through which look at the same reality (Feschet et al., 2016). This reflection recalls the issue of sustainability assessment of which time horizon should be considered. According to Stoffle et al. (2013), future impacts on people and nature should be considered taking into account the length of time of analysis, the cultural value of the resource assessed, the resilience of the resource, which kind problem is to be solved (at local or higher level). However, actually, practical constraints are the principal criteria to shapes the assessment procedures. Figure 2 shows the possible perspectives of different time horizons: the shorter is this "sustainability dead line", the greater is the possibility to do not consider externalities (now

understood as long run consequences) on each dimension and different actors (Feschet et al., 2016); likewise, the more extended is the time horizon, more externalities become included in the system.

Concluding, sustainability and SD are controversial concepts, there is no consensus on a unique definition, on their relationship, neither on a scientific theory of SD (Zuindeau 1995; Feschet et al., 2016). Some authors consider sustainability to be the aim of SD (Diesendorf, 2000); in other cases it is the contrary, being sustainability the *condicio sine qua non* a sustainable development would be impossible (Sartori et al., 2014). Univocally accepted definitions of both terms do not exist, rather different definition are adapted to each context depending on the needs, because "there are conceptual, political and ethical dilemmas in recasting development activities as sustainable" (Springett, 2013:75).

Figure 2 - Representation of different time horizon in sustainability evaluations and associated externalities



Source: Feschet et al. (2016). A, B, C = evaluation frameworks; T= time horizons.

According to Feschet et al. (2016), the different approaches that have been proposed to assess sustainability can be grouped in the compensatory approaches (e.g. three pillars or TBL approaches) and the conditional approaches (e.g. the systemic view).

From a theoretical point of view, a "Sustainability Science" has not yet achieved maturity, as it is rather in a pre-science phase (or pre-paradigmatic stage, in a Kuhnian sense), indeed few references can be found on its epistemological foundations and many questions remain open (Rios Osorio et al., 2009; Sala et al. 2013a). The difficulty lay in the integration of different disciplines to understand at the same time material and energy cycles, dynamics and properties of networks, systems evolution, interrelationships and future consequences of present actions (Castellani and Sala, 2009). Indeed, few scientific references can be found on an epistemology that would enable to determine a metatheoretical structure for sustainability science (Rios Osorio et al., 2009)

According to Vazquez-Brust et al. (2014), sustainability science should overcome the fragmentation of disciplines and approaches towards the integration of issues of collaboration and innovation, producing knowledge on the complex interaction between systems and their role in affecting planetary sustainability. Furthermore, the authors affirm that sustainability science research should be based on five tasks:

- aiming to advance understanding of complex issues while at the same time providing support to policy decision;

- finding solutions that take into account differ typology of factors;

- problems should be identified and solved in appropriate spatial and temporal scales;

- providing a perspective that pay attention to the whole and to complex interrelationships among parts (biosphere, economic and market systems, human social system, etc.);

- integrating the views from a wide range of scientific disciplines (and their inherent epistemologies), in an interdisciplinary and worldwide accepted approach (Vazquez-Brust et al., 2014).

However, there is an urgent need, in different fields and disciplines, for implementing assessment tools to develop cleaner productions, eco-efficient process, social responsible products, and foster sustainable consumption.

2.3 Social sustainability from theory to practice: evaluation issues, methods and norms

2.3.1 The definition of social sustainability in literature

It does not exist a consensus on a definition of social sustainability. However, the attempt of defining what "social sustainability" is, entails that it exists a "non-social sustainability", i.e. that a TP or TBL approach is implicitly acknowledged. Among all dimensions, social sustainability has been often overlooked and it is still "the most conceptually elusive pillar in SD discourse" (Murphy, 2012:15). While the discourse on the concept of sustainability and SD has gained relevance in many fields of research and policies, the social dimension is quite neglected or given a lower priority compared to other dimensions, or undertheorized and oversimplified (Partridge, 2014).

According to Colantonio (2009), the concept of social sustainability is lacking consensus because the concept has been and is being approached from diverging perspectives and through different

criteria that are discipline-specific and hinder the achievement of a general definition. Moreover, the context to which a definition of social sustainability is applied, influence the choice of the different aspects under study, such as in the case of buildings construction, urban planning, teaching, rural development, technological processes, product design, policy making, and so on.

The vagueness around the meaning and objectives of social sustainability is mainly due to the lack of a sociological theory in its conception (Murphy, 2012). Making a univocal and comprehensive collection of the meanings and aspects of social sustainability is quite difficult: there is a plethora of definitions (Table 1) and the interpretation are often context bounded (Weingaertner and Moberg, 2011); moreover, the greatest difficulty concerns catching the interconnections among different aspects (dimensions) and classing them in a taxonomic (consequential) order. Differences are mainly due to the variety of objectives, contexts, time boundaries, and the perspective and object of assessment in the case of assessment practices, which can concern projects, policies, products or services, a community or a group of people, etc. (Weingaertner and Moberg, 2011).

As it is shown in Table 1, there is a wide range of definitions of social sustainability available in literature. Despite the variety of their contents, it is possible to find some points in common. According to Magis and Shinn (2009), although the construct of social sustainability is still at a formative stage, it has roots in in a rich and mature tradition of research on well-being and quality of life. Indeed, the first point in common with most of the social sustainability definitions is the requirement of the basic needs fulfilment, considered as universal principles: human well-being, equity, democracy. They entail the satisfaction of physiological needs such as access to food and water, housing, health and security, which ensure a minimal acceptable level of well-being and which are universally acknowledged as basic human rights (Magis and Shinn, 2009). As quoted by the same authors, Prescott-Allen (2001) too defines social well-being as the fulfilment of basic needs, but also the exercise of political, economic, and social freedoms.

In this sense, Sen (2000) proposed the concepts of freedom and human capabilities as primary objectives and means of the quality of life (Nussbaum and Sen, 1993) and development. He affirmed that development requires the removal of major sources of “unfreedom”, such as poverty, hunger, tyranny, social deprivation and repressions, poor economic opportunities, which impede people to live with dignity and develop as human being.

Sen (2000) also affirmed that freedom is central to the process of development for two distinct reasons, the evaluative and the effectiveness one. First, the progress should be assessed in terms people’s freedom enhanced; secondly, the achievement of development is strictly dependent on free acting of people.

Table 1 – Definitions of social sustainability from scientific literature

Definition of social sustainability	Reference
A strong definition of social sustainability must rest on the basic values of equity and democracy, the latter meant as the effective appropriation of all human rights – political, civil, economic, social and cultural – by all people	Sachs (1999:27)
Social sustainability for a city is defines as development (and/or growth) that is compatible with harmonious evolution of civil society, fostering an environment conducive to the compatible cohabitation of culturally and socially diverse groups while at the same time encouraging social integration, with improvements in the quality of life for all segments of the population	Stren and Polèse (2000:15-16)
"a socially sustainable system must achieve fairness in distribution and opportunity, adequate provision of social services, including health and education, gender equity, and political accountability and participation"	Harris and Goodwin (2001:xxix)
Social equity, the fulfilment of basic health and educational needs, and participatory democracy are crucial elements of development, and are interrelated with environmental sustainability.	Harris (2003:2)
Social sustainability occurs when the formal and informal processes, systems, structures and relationships actively support the capacity of current and future generations to create healthy and liveable communities. Socially sustainable communities are equitable, diverse, connected and democratic and provide a good quality of life.	McKenzie (2004:18)
Social sustainability is a quality of societies. It signifies the nature-society relationships, mediated by work, as well as relationships within the society. Social sustainability is given, if work within a society and the related institutional arrangements • satisfy an extended set of human needs • are shaped in a way that nature and its reproductive capabilities are preserved over a long period of time and the normative claims of social justice, human dignity and participation are fulfilled.	Littig and Grießler (2005)
Social sustainability – which requires that the cohesion of society and its ability to work towards common goals be maintained. Individual needs, such as those for health and well-being, nutrition, shelter, education and cultural expression should be met.	Larsson (2008:14)
Social aspect of sustainability should be understood as both (a) the processes that generate social health and well-being now and in the future, and (b) those social institutions that facilitate environmental and economic sustainability now and for the future.	Dillard et al. (2009:4)
Human well-being, equity, democratic government, and democratic civil society are central constituents of social sustainability.	Magis and Shinn (2009:16)
Social sustainability concerns how individuals, communities and societies live with each other and set out to achieve the objectives of development models, which they have chosen for themselves taking also into account the physical boundaries of their places and planet earth as a whole. At a more operational level, social sustainability stems from actions in key thematic areas encompassing the social realm of individuals and societies, ranging from capacity building and skills development to environmental and spatial inequalities.	Colantonio and Dixon (2011:24)
Equity, Awareness for sustainability, Participation, Social cohesion	Murphy (2012)
The notion of social sustainability implies that the prerequisite for long-term social stability and development is social justice, a condition of equity and fairness conducive to an optimal quality of life for the diverse range of social categories.	Shafer (2013:19)
The main principles or components of social sustainability that emerge are as follows: quality of life (or well-being), equity or social justice (which in turn encompasses the goals of inclusion and access), a "futures focus," and democratic and participatory governance,	Partridge (2014:6181-6182)

Among the literature about quality of life, Nussbaum and Sen (1993) describe human life as a combination of various doings and beings, called functionings, which can vary from elementary

needs (nutrition, health) to more complex one such as preserving human dignity, participation, respect, etc. The capabilities are the alternatives of functionings and their combinations that a person can choose; i.e., they correspond "to the freedom that a person has to lead one kind of life or another" (Nussbaum and Sen, 1993:3).

Veenhofen (2006) acknowledged that different words are used to describe the quality of human life (i.e. social sustainability): the most used are "quality of life" and "well-being", and in some schools of thought the terms "happiness" and "welfare" are also used; but these terminologies do not have unambiguous or consensual meanings and their comprehensiveness can vary among authors. For this reason, the author distinguished four qualities of life according to objective and subjective stances (i.e. actual and potential) and external (the environment) and internal qualities (the individual); as a result, the four qualities are "livability" of environment, life-ability of the person, utility of life, appreciation of life.

From these theoretical bases, each approach to social sustainability gives importance to one or another aspect, leading to many different objectives and means.

Finally, an interesting review of social sustainability concepts by Littig and Grießler (2005) evidenced that the difficulty in conceptualising social sustainability is also due to the lack of a clear differentiation between its analytical, normative, and political aspects, which can find different prioritization among scholars. According to these authors, the principal reason probably lays in the broad and multi-faceted connotation of the word "social", which can have at the same time an analytical and a normative meaning (this aspect will be further discussed in chapter three). According to the analytical principle, the development has essential natural prerequisites (inseparably connected to natural phenomena such as reproduction); it is necessary to investigate scientifically the structures and processes that occurs in society, as well as social processes which shapes a society's interactions and relationships with nature.

Social sustainability is also a normative concept, according to the three normative social principles declared during the Rio Conference (UNCED, 1992) and universally accepted: the right to a decent life, social justice and participation of all stakeholders during this and the next generations. And finally, it is also a political concept because sustainability political strategies are expected to respond to stakeholder needs and desiderata, as well as policy-making itself should incorporate social sustainability indicators.

Concluding, philosophers do not agree on a univocal definition of social sustainability (or well-being, quality of life, etc.) and in measurement practices "we see comparisons of apples and pears" (Veenhoven, 2006:74) and many different aspects are put into light. This is also due because the selection of indicators often is not founded in theory but rather in the plausibility of

practical issues and current political agendas (Littig and Grießler, 2005) and the rhetoric of an encompassing and holistic approach crumbles when put into practice (Veenhoven, 2006).

On the other side, according to Colantonio (2009), traditional social sustainability themes such as employment and poverty alleviation are increasingly been replaced by wider holistic but less measurable concepts such as happiness and well-being sustainability debate, adding complexity to the analysis of social sustainability, especially at practical level.

2.3.2 Practical issues

According to the review by Littig and Grießler (2005) about social sustainability concepts in the international arena, the selection of indicators frequently has no roots in theoretical underpinnings but rather in a practical understanding and concrete issues. This is probably due to the lack of consensus on a univocal concept of social sustainability; often these concepts remain implicit and remain concealed behind a random choice of common socio-political indicators

Many approaches for the evaluation of social impacts have been set up in different disciplinary fields, according to the object of evaluation, such as projects, policies, goods, etc; some - non exhaustive - examples are given in Table 2, while Table 3 describes some examples of social impacts on companies' stakeholders, according to Bebbington and Dillard (2009).

Social Impact Assessment (SIA) has a consolidated scientific tradition as a methodology to analyse, monitor and manage social consequences of projects, interventions, policies, and in particular assesses social changes in positive and negative terms; particular attention is paid to participatory processes and to interconnections with economic and environmental issues (Vanclay, 2003).

Health Impact Assessment (HIA) is a multidisciplinary process aimed at the sole assessment of health consequences in different sectors taking into account qualitative and quantitative issues; like in SIA, participatory approaches are a key concern: opinions and needs of affected actors are taken into consideration, and cooperation between agencies is recommended (Lock, 2000). As well as in SIA (Vanclay, 2003), HIA produces useful suggestions for decision-making processes in domains where this methodology is applied (Quigley and Taylor, 2004).

Corporate Social Responsibility (CSR) is a widely used method for the assessment of social impacts deriving from the activities of an organisation. More in details, the aim of CSR application by companies is to integrate environmental, social, ethical, human rights and consumer concerns in business operations, in close coordination with stakeholders, with two principal aims: to enhance the creation of shared value for owners, shareholders and society in

general, and to identify and reduce possible negative impacts on people (European Commission, 2011). Great attention is especially paid to human rights and labour conditions. The European Commission (2011) invited all enterprises with more than 1,000 employees to integrate in their business policies at least one of the formalised CSR set of principles, such as the standardised norms SA8000, the ISO 26000 on Social Responsibility, AA1000, or some principle-based frameworks such as the UN Global Compact or the OECD Guidelines for Multinational Enterprises.

Table 2 - Examples of methodologies for the assessment of social impacts

Object of study	Methodologies or approaches	Examples of main references
Projects, programmes, policies	Social Impact Assessment	Vanclay (2002, 2003)
	Health Impact Assessment	Quigley and Taylor (2004); Lock (2000)
Organisations	Corporate Social Responsibility	European Commission (2011)
Communities	Participatory Action Research	Boyle (2012)
	Household resilience approach	Alinovi et al. (2009)
Rural Communities	Participatory Rural Appraisal	Chambers (1994)
Society	Human Development Paradigm	Edewor (2014)
	Human Scale Development	Max-Neef (1991)
Products and services	Social LCA	O'Brien et al. (1996); UNEP-SETAC (2009); Jørgensen et al. (2008, 2009); Feschet et al. (2013)

Concerning the assessment of social impacts on communities, Participatory Action Research (PAR) is usually applied to services to community; this methodology aimed at empowering and enabling people belonging to a community who are affected by the issues studied, in order to plan and implement positive changes (Boyle, 2012). In a similar perspective, but considering changes suffered by households, Alinovi et al. (2009) applied the household resilience approach to evaluate the resilience to food insecurity of low-income households: taking as example the concept of resilience from ecology science, the persistence of a state in dynamic and perturbed systems is analysed in socio-economic terms (Levin et al., 1998).

Table 3 - Examples of social impacts of business activities

Company's stakeholders	Examples of interactions/impacts
Employees (individually and collectively via unions)	Employment terms and conditions (including job security, pay, fairness of employment practices, and freedom of association)
	Union recognition and interactions
	Training and job development opportunities
	Engagement of employees in management of the firm
Suppliers (via supply chain impact)	Fair payment and terms of engagement with suppliers
	Issues concerning human rights abuses in supply chains, including, for example, slavery and the implications that arise from purchasing goods that may fuel conflict (such as conflict diamonds).
	A special case of supply chain issues concerning interactions with host governments (with issues of bribery, corruption, and aiding human rights abuses)
Communities	Health impacts that arise from living near a production facility
	Displacement of communities in order to accommodate activities (the extraction industry is an area where this comes to the fore, as does infrastructure projects that require population movement)
	Socioeconomic impacts that arise when an organization leaves a location (taking employment opportunities with it)
	Community-based activities (including philanthropy) that an organization undertakes
	Where community is defined as a country, relationships with nation-states (in terms of lobbying) also could come within the scope of this category, as do political donations
Consumers	Product safety
	Responsible advertising (especially of products such as tobacco and alcohol)
	Collateral damage that arises from consumption of products produced (this notion arises in the context of armaments, violent movies/games,

Source: Bebbington and Dillard (2009:158)

Participatory Rural Appraisal (PRA) represents a family of approaches and methods to foster people participation in sharing knowledge and analysing their living conditions, to plan and act improvements. This approach has its roots in applied anthropology, as well as rural sociology and agricultural systems management (Chambers, 1994). PRA entails not only assessment practices, but also planning and implementation.

Applied in a wider sense to the overall society, Human Development Paradigm (HDP) attempts to operationalise Sen's capabilities approach (Fukuda-Parr, 2011; Edewor, 2014) while Human Scale Development (HSD) approach is focused on the satisfaction of fundamental human needs, the growth of self-reliance, the relationships of people with nature and technology, on the coexistence of global processes with local activity (Max-Neef et al., 1986).

Finally, in the last decades, Life Cycle Thinking (LCT) (Heiskanen, 2002) gained consensus as conceptual model for what concerns the evaluation of goods/services production and consumption all along the whole life cycle, from planning to disposal. Its methodological framework, the Life Cycle Management (LCM), offers many methodologies to assess impacts of products and processes: Life Cycle Assessment (LCA or eLCA), to evaluate environmental impacts (ISO 2006a, 2006b) and Life Cycle Costing (LCC) for economic ones (Hunkeler et al., 2008); recently the Social Life Cycle Assessment (SLCA) has been developed to focus especially on social impacts. The innovative characteristic, that should distinguish this tool from others, stays in the life cycle perspective, aimed at avoid burden shifts among phases. More details about the evolution of SLCA are given in the following paragraph.

2.4 The "life cycle" perspective: SLCA

2.4.1 The assessment of social impacts in the conceptual framework of Life Cycle Thinking (LCT)

Life Cycle Thinking (LCT) methodologies were conceived to evaluate the potential impacts generated during the life cycle (from "cradle" to "grave") of a product or service, and to orientate in a sustainable perspective the production of goods and services, and therefore accompany decision-making processes, e.g. for public policies or management modes within organizations (Horne, 2009). Life cycle-based approaches are claimed to fit into sustainability discourses as tools that help to broaden the focus of analysis enlarging the boundaries of the system under assessment (De Luca et al. 2015b); however they were conceived as separated tools to conduct stand-alone assessment of different king of impacts (environmental, economic, and social ones).

The first LCT method developed was the environmental Life Cycle Assessment (LCA or eLCA), aimed at evaluating the environmental impacts, today standardized by specific norms (ISO 2006a, 2006b). Later, Life Cycle Costing (LCC) was developed to focus on the costs generated during the life cycle. These methodologies have also gained a practical consensus in life cycle based product management approaches (Sonneman and Valdivia, 2014).

Social Life Cycle Assessment (SLCA) is the latest tool in chronological order; it has been conceived to evaluate social impacts, but it is still not well defined and its process of development is being particularly long and difficult. From its beginnings, many different methodologies have been proposed, whose objectives payed more attention to the most diverse aspects, such as:

- the social performances (UNEP-SETAC, 2009; Martìnez-Blanco et al., 2014; Bouzid and Padilla, 2014; 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), externalities (Swarr, 2009);

- the participation of stakeholders (Mathé, 2014; De Luca et al., 2015b).

The fact that SLCA has been conceived in the engineering milieu of eLCA (Weidema, 2006), led to frame and shape the assessment of social impacts in the same way it has been done for environmental impacts in eLCA. However, it is doubtless that the inherent nature of the impacts under assessment are different in SLCA from eLCA, as these methodologies have their roots in different fields of study and disciplines (O'Brien et al., 1996). Social phenomena are the object of study of sociology, that not only has a variety of methodological approaches to research, but also it is considered a multiparadigmatic science (Corbetta, 2003), in which more worldviews can be hold. According to Iofrida et al. (2014), this implicitly had consequences in SLCA too (see chapter 3), and this is the reason why scholars have set up many different methodological proposals.

Even in the definition of SLCA there is no consensus; indeed it has been defined at the same time as a:

- methodology (Jørgensen et al., 2008),
- systematic process (Benoît et al. 2010),
- framework (Benoît Norris, 2012)
- technique (Benoît Norris et al., 2012a; Ramirez et al., 2014),
- technology (Fan et al., 2015),
- method - not a technique - (Macombe et al., 2011),
- phenomenon (Benoît Norris and Reverét, 2015).

In SLCA literature, it is difficult to outline a general common procedure for the assessment of social impacts. Following De Luca et al. (2015b), the different methodologies can be distinguished according to which are recognised as sources of social impacts, e.g. the very nature of processes, actors' behaviours, variations of capitals, stakeholders' desiderata.

The "impact pathway methodology" follows the same epistemological approach of LCA. Weidema (2006) and Norris (2006) published the first seminal works, and then deepened and improved by Feschet et al. (2013), Macombe et al. (2013) and Bocoum et al. (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 (or part of them) that can be explained by cause-effect relationships. The principal aim of this methodology is to allow formulating expectancies and to provide generalizable findings.

UNEP-SETAC (2009) published the Guidelines for SLCA to furnish a practical framework, and few years later the so-called Methodological sheets (UNEP-SETAC, 2013). The Guidelines boosted the publishing on SLCA themes, especially applicative works. In the guidelines it is suggested to follow the same general structure of eLCA (ISO, 2006a; 2006b), i.e. the four phases of "goal and scope", "life cycle inventory", "life cycle impact assessment", "interpretation of results". The assessment framework in the Guidelines is mainly inspired to the above-mentioned Corporate Social Responsibility (CSR), therefore, the applications published according to this framework mostly paid attention to the social performances of companies in terms of companies' behaviours.

The "capabilities approach" has been proposed by Reitinger et al. (2011) and, based on the work by Sen (2000, 2005), it considers the kind of capabilities (set of alternative lives) that people can freely chose; here the philosophical perspective of assessment is oriented toward what is important in peoples' lives. Garrabé and Feschet (2013) furtherly 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 influence on the production and accumulation of people's capacities.

Finally, some approaches have put more attention on what is important for stakeholders (intended as those actors interested by the functioning of the life cycle) and how to involve them in the assessment (Mathé, 2014; De Luca et al., 2015a).

2.4.2 The most recurring concepts of social sustainability in SLCA studies

To analyse the most agreed concepts of social sustainability in scientific SLCA literature, a brief review were conducted on papers published from the year 1996 until September 2015. They were gathered by means of dedicated on-line databases and engine research, i.e. Scopus, Web of Science, ScienceDirect, Google Scholar, Google Books, the mobile phone application Scholar Droid, and dedicated social networks such as *Academia* and *ResearchGate*. This research was conducted with the help of specific keywords (within article title, topic, abstract, keywords), and Boolean operators (AND, OR) and proximity operators (N/n, W/n) when possible. As an example, main keywords used were *social life cycle assessment*, *social LCA*, *SLCA*, *S-LCA*, and *social*

impact, social consequence, social performance, social evaluation, social sustainability, social assessment in association with *life cycle*.

From a former population of about two hundred works, reports, dissertations, non-indexed conference proceedings and non-indexed books, even if interesting, were considered "grey literature" and therefore excluded. As a result, the final selection included 87 scientific works from peer-reviewed scientific journals, as well as indexed book chapters and conference proceedings. The paper selected are all about SLCA alone or in association with other assessment methodologies (such as papers about the combination of SLCA with other evaluation methodologies), while those about Life Cycle Sustainability Assessment (LCSA) - even if they presented a separated application of SLCA - were discarded. In case of papers about a whole assessment of sustainability in a broad sense, only papers that presented SLCA in keywords section were included in the selection.

Among the paper selected, 87.5% mentions sustainability issues and 20% the social dimension of sustainability; however, few of them explicitly state which concept or theory of social sustainability underpins the study, and besides, poor description of the concept is furnished. Indeed, the concept remains implicit or is taken for granted, and most of the authors prefer to deal directly with the practical issue of the assessment.

Most of the papers have in common the citation of well-known references, such as the Brundtland Report (WCED, 1987) and the Rio Conference (UNCED, 1992).

Some authors refers to SLCA as the transposition of concepts and values borrowed from Social Impact Assessment (SIA) (7% of papers gathered) and Corporate Social Responsibility (CSR) to the life cycle perspective. According to Vanclay (2003:2), SIA "includes the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions". This definition has been translated in SLCA, for example, by Macombe et al. (2011, 2013) arguing that the functioning of a life cycle entails a change process that delivers effects that, into a certain context, are perceived by actors. An example of this interpretation can be found in the impact pathway methodology by Feschet et al. (2013), who applied the Preston curve to analyse the effects of a life cycle change (banana production in Cameroon). When the assessment do not address the changes caused by a life cycle, but rather consist in gathering attributional aspects, Parent et al. (2010) suggest referring to them as social "performances" instead of impacts.

Many other papers (30%) refers to CSR, stressing the importance of businesses behaviour in the production of social impacts, and saw in SLCA a practical tool for CSR mainstream. Even in

SLCA guidelines, UNEP-SETAC (2009) considered SLCA allowing to associate company level information with processes in a life cycle system, as well as an instrument for reporting and communication.

Concerning the reference to some form of conceptual frame or theoretical basis, most of the papers analysed explicitly refers to the three pillars of sustainability (21.5%) and to the TBL approach (11%), meaning that it is acknowledged that social sustainability exists as a separated dimension of sustainability and therefore can be stand-alone assessed. However, in 18% of the papers it is affirmed that the inclusion of social aspects in life cycle tools is a step towards a more holistic understanding of sustainability.

A few of them (6%) quote Sen's capabilities approach, but only Reitinger et al. (2011) tried to put it into practice, and other authors that were not included in this selection (e.g. Garrabé and Feschet, 2013).

Concerning the three pillars approach, O'Brien et al. (1996) described SLCA as a tool to assess the "third area" of sustainability, i.e. the social and political processes. Hunkeler (2006) transposed the three pillars concept into SLCA affirming the necessity to use the same functional unit (FU) and system boundary for every pillar.

Even if interrelations among supposed pillars are acknowledged to be the inherent characteristics of sustainability (Hutchins and Sutherland, 2008), few efforts have been made to put into assessment practice this holistic view. Except Feschet et al. (2013) and Bocoum (2015) that applied an economic relationship to assess impacts on population health, other works conducted separated assessment, and then compared results.

Most of the papers (41%) refers to social sustainability as "well-being", confirming the statement by Fan et al. (2015) that the first step of SLCA is to define what it is. But, how is well-being defined in SLCA literature? How authors chose its sub-dimensions - if existing - (named also damage categories, sub-categories, intended as components of social sustainability) to which refer impacts?

Answering these questions, we found similarities with the above-mentioned classification by Littig and Grießler (2005). Social sustainability in SLCA literature can assume at the same time:

- a normative meaning: many authors chose worldwide consensus documents regarding social issues, concerning universal rights such as freedom, decent life conditions, access to essential resources, education. The most quoted documents are ILO principles declaration (ILO, 2007), the Universal Declaration on Human Rights (UN, 2012) (see Dreyer et al., 2006);

- a political meaning: some authors chose their categories of impacts referring to the specific case of the context where the assessment is conducted (e.g., business companies, local communities); often they choose impact categories according to the relevance or values given by stakeholders (Mathé, 2014);
- an analytical meaning: few authors chose impact categories to be assessed according to what is quantifiable and causally linked to the functioning of a product/service life cycle (see Lagarde and Macombe, 2013; Neugebauer et al., 2014; Bocoum et al., 2015).
- Consequently, there is a certain variety in the choice of what counts or should be assessed to evaluate a life cycle in terms of social sustainability.
- In Table 4 some examples of the most recurring assessment categories are given: well-being is the most recurrent definition of social sustainability, human health is the most paid attention aspect, and the workers are the most considered group of affected actors.

Table 4 – Examples of definitions of social sustainability and their sub-dimensions in SLCA literature

Social sustainability	Impact categories or sub-dimensions	Reference
Autonomy *Well-being* *Freedom and fairness.*	Life, knowledge and aesthetic experience, work and play, friendship, self-integration, self-expression, transcendence and fairness itself	Reitinger et al. (2011)
Human life *Well-being*	Life and longevity, Health, Autonomy, Safety security and tranquillity, Equal opportunities, Participation and influence	Weidema (2006)
Human rights *Working conditions* *Socio-economic repercussions*	Child labour, Discrimination, Freedom of association and collective bargaining, Working hours, Minimum income, fair income recognised, employment relationships and fulfilment of legal social benefits, physical working conditions (health, security, working equipment), psychological working conditions, education	Aparcana and Salhofer (2013a; 2013b)
Social well-being *Social justice*	Fair wage, level of education	Neugebauer et al. (2014)
Freedom of choice among alternative lives	Variation of five sort of capitals: human, technical, financial, social and institutional capitals	Garrabé et al. (2014)
Social well-being	Land-use, employment, workplace health & safety. Resource utilisation values, amenity and traffic, water management, community health and safety, land values, community identity, investment and profitability uncertainty, soil erosion and compacting, food security, subsidence, amenity and community health.	Weldegiorgis and Franks (2014)
Human well-being in terms of health	Changes in economic activity generated by the functioning of a product chain that cause changes in health status of the population	Feschet et al. (2013)

The principal quoted references (about 60% of the papers) for the choice of impact categories were UNEP/SETAC (2009) Guidelines and their methodological sheets (UNEP-SETAC, 2013), that proposed five groups of stakeholders, and for each of them categories of impact (31 in total) and 189 examples of relevant indicators. Among the groups of stakeholders (workers, local communities, society, consumers and value chain actors), the workers are the most assessed group among studies applying UNEP-SETAC framework.

2.5 Conclusions

In the light of these reflections, the application of the life cycle perspective in sustainability assessment practices is certainly ad advancement toward more comprehensive and holistic evaluations, allowing overtaking common one-dimensional and sectorial analyses.

However, many assessment issues are still remaining unsolved.

According to Feschet et al. (2016), most of SLCA scholars affirm that SLCA is a useful decision support system towards sustainability. Nevertheless, the same authors rarely put into discussion which theoretical bases support their assessment practices and, even more, the choice of the object of assessment, and relative indicators, appears discretionary and quite random.

Probably SLCA reflects the lack of a consensual and clear theoretical concept of social sustainability that can be viewed from different perspective as a normative, political and analytical concept (Littig and Grießler, 2005). It is also true that SLCA has roots in different disciplines, each having different epistemological bases (Iofrida et al., 2014).

These aspects will be further discussed in the following chapter.

3. LOOKING FOR THE THEORETICAL ROOTS OF SLCA: THE RESEARCH PARADIGMS OF SOCIOLOGY AND MANAGEMENT SCIENCES.

3.1 Introduction

Social Life Cycle Assessment (SLCA) is the latest tool in chronological order; it has been conceived to evaluate social impacts, but it is still not well defined and its process of development is being particularly long and difficult. From its beginnings, many different methodologies have been proposed, paying attention to the most diverse aspects, e.g. the social performances (UNEP-SETAC, 2009; Martìnez-Blanco et al., 2014; Bouzid and Padilla, 2014; 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), externalities (Swarr, 2009) and recently, the participation of stakeholders (Mathé, 2014; De Luca et al., 2015b).

The fact that SLCA has been conceived in the engineering milieu of eLCA, and that most of its practitioners and scholars are usually engineers, chemists, physicians, led to frame and shape the assessment methodology of social impacts in the same way it has been done for environmental impacts in eLCA. It is doubtless that the inherent nature of the impacts under assessment are different in SLCA from eLCA, as these methodologies have their roots in different fields of study and disciplines (O'Brien et al. 1996). The difficulty of translating the uses of eLCA to SLCA has been clearly argued by Macombe and Loeillet (2013), stressing that while in eLCA an inventory of physical flows allows a measurement or estimation without ambiguity, this is not easily possible in the social domain, when facing many immaterial flows.

Social impacts are the object of study of social research and sociology in particular; they concern people (individuals and societies, behaviours and perceptions) and complex phenomena whose intrinsic mechanisms are not always verifiable or reproducible as it is for the most of natural phenomena. From a sociological point of view, "social phenomena are multilayered events" (Cupchik, 2001:7) and their study can be approached in many different ways by sociologists, depending on their point of view. The same concept of social impacts, and what is considered the object of study of sociology, can vary according to the paradigm or philosophical underpinnings of the researcher.

Moreover, LCT tools have been conceived to serve as management tools to decrease footprints and help to analyse and manage in a more sustainable way production and consumption of goods and services. Managing in a life cycle perspective is intended by scholars as crucial to understand and prevent burden shifting, either between different kinds of impacts, different supply chain

stages, or different stakeholders that may occur because of management decisions (Pelletier, 2015).

When a research process is undertaken, every methodological choice is based (more or less explicitly) 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 indicate as "normal science" when a set of theoretical beliefs and methodological techniques are shared by the scientific community.

Positivism-oriented paradigms dominate - and are well accepted - in the so-called "hard sciences" (Tacconi, 1998), but in the history of social sciences it is difficult to recognize one dominant paradigm. Indeed, social research is considered *multiparadigmatic* (Corbetta, 2003; Bailey, 2007; Ritzer, 2010), more worldviews can be hold simultaneously (Batty 2008) because even opposite paradigms are no longer considered irreconcilable (Niglas, 2010).

Management and accounting, both belonging to the wider field of social sciences (Riahi-Belkaoui, 1996; David, 2013), are at the centre of the same epistemological debate too, as proven by a wide literature on this subject (see for example: van Gigch, 2003; Sułkowski, 2010; David et al., 2013; Thiétart, et al., 2014; Raut and Veer, 2014)

According to Guba and Lincoln (1994:105) "questions of method are secondary to questions of paradigm, […], not only in choices of method but in ontologically and epistemologically fundamental ways". Therefore, the aim of the present chapter is to examine the disciplinary fields to which SLCA belongs and the possible paradigms that underpins social research both in sociology and management science, to which SLCA is supposed to be ascribed. This will allow, in the next chapter, to recognize the repercussions of alternative positions in philosophy of science and the multiparadigmatic character of social sciences have had on SLCA literature.

3.2 The disciplinary fields of SLCA

SLCA was defined within the Life Cycle Management (LCM) framework that is a flexible, integrated framework of concepts, techniques and procedures to manage the life cycle of goods or services. Its principal aim is to reduce the impacts associated with a product/service life cycle and to improve its effects avoiding burden shifts; it incorporates science tools with societal ones and helps to understand which could be the drivers for improvement (Seadon, 2010).

Inside this framework and, interpreting Macombe et al. (2013), SLCA can be defined as an engineering tool devoted to analyse and evaluate the social effects caused by changes in the life cycle of a product or service. Indeed, eLCA and the other LCT tools were created and improved

in an engineering *milieu* (Weidema, 2006), and today, among them, eLCA is one of the most widely applied tool in scientific and industrial contexts to evaluate environmental impacts of product and services (Frostell, 2013).

The influence of natural sciences and engineering science in management is due for a twofold reason. Firstly, it is a reason of object of analysis, because every human activity has an impact on the natural environment in terms of resource use and emissions of wastes, especially in the case of a production process, therefore organisations have to deal with natural phenomena and their laws and consider them in their management practices. In this sense, engineering sciences provide organisations information about how to manage to obtain demanded effects and results. For example, results from life cycle studies can be functional to support decision-makers in management and *reengineering* practices, being this last the rethinking and redesigning of a business process (either at public level, e.g. of territorial policies or resources management) to achieve improvements by reducing impacts, increasing quality, enhancing effectiveness (Hammer and Champy, 1993). Secondly, their influence is due to epistemological rationales and methodological reasons in scientific research, as it will be better explained in the next paragraphs.

As represented in Fig. 3, SLCA can be considered an analytical tool for management practices. Indeed, many scholars affirmed that companies and actors that are interested in knowing the social impacts of products life cycle and address their management practices can find a solution within SLCA, as well as through CSR in terms of responsibility, SIA for projects and initiatives, and other social accountability tools. The most recurring slogan is “what gets measured, gets managed” (attributed to William Thomson, 1883).

Since its beginnings, some scholars have seen in SLCA a transposition of CSR in a life cycle perspective; however, CSR focuses on behaviours and is a company-centred tool while what assessed by SLCA are not always attributable to a single company, and impacts that come from the very nature of life cycle processes are also included. In this sense, SLCA can be applied to a wider range of management issues, such as supply chains, regional and national policies, districts, besides companies and businesses. In this pre-scientific stage of their development, LCT tools and SLCA above all, cannot be considered certain and definite decision support systems (DSS), but at least as tools to accompany decision making in management practices.

Addressing social issues has become a normative and political urgency in the last decades, especially under the pressure of NGOs, groups of interest for specific social issues and, nevertheless, increasingly conscious consumers. In this sense, companies has increased their engagement in practices of impacts evaluation and sustainability accounting, guiding their management choice in consequence of results and objectives.

According to Porter and Kramer (2006), assessing impacts and informing about results has become an inescapable priority for business leaders at worldwide level, a necessity and sometimes a high-stake obligation. In particular, they describe four prevailing justifications for social accounting (CSR in particular), i.e. the moral obligation, sustainability, license to operate, and reputation. Businesses have the moral obligation to achieve their commercial success honouring ethical values and respecting people's moral stakes and natural environment. Sustainability is the highest worldwide concern, and companies should take into account their consequences on this generation and on future ones. The licence to operate recalls the fact that companies needs tacit or explicit permission from governments, communities and other stakeholders to do business. In addition, concerns of reputations often guide the engagement of companies towards social responsibility practices to improve the image, strengthen their brand, raise the value of products and reach new markets.

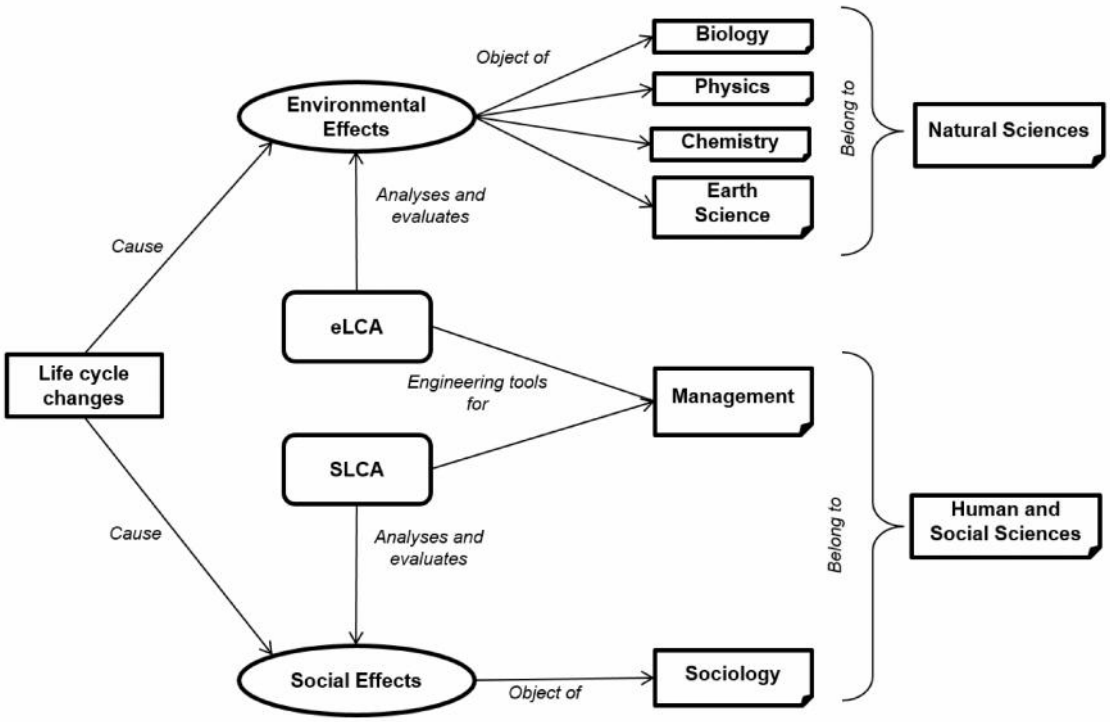
Friedman (1970), with his provocative "shareholder theory" affirmed that businesses do not have social responsibility in the sense of having the obligation to pursue social aims (increase employment, protect the environment, sustain consumers' health); their responsibility are to the people that own the company (shareholders) and is to make the most profit possible. In this theory, pursuing social aims, instead of profit increase, would mean spending other's money on manager's personal political goals. In Friedman's view, the discussions of the "social responsibilities of business" are notable for their analytical looseness and lack of rigor: businesses cannot have any responsibility, only people have. Moreover, maximising profits would allow all stockholders, customers, or employees to spend separately their own money on the particular actions they wished to do (Friedman, 1970). In his perspective, the only reason for companies to pursue social aims is to increase profits, by responding to social pressures and take competitive advantages, within the legal boundaries.

However, this is a short-term vision. According to Galbreath (2006), there are other three visions: the altruistic, the reciprocal, and the citizenship strategies. The altruistic strategy acknowledge an interwoven relationship between firms and communities; the firm is understood as a member of the community to which it shall positively contribute in the form of philanthropy and, normally, these contributions consist in a surplus profit distributed according to social needs and moral precepts (Galbreath, 2006). The reciprocal strategy try to overcome the contrast between economic purposes and social expectations of society, i.e. benefitting society while preserving economic profitability of the firm. It is a proactive strategy toward social responsibility, going beyond minimum legal requirements, that in the long run could be economic benefits for society. Finally, citizenship strategy has a broader scope: the variety of stakeholders (consumers, customers, suppliers, communities, etc.) entails a diversity of interests and expectations. The

strategy seeks to balance competing demands satisfying the more possible needs. Sometimes these expectations are mutually exclusively, in this case a categorization of stakeholders and weighting practices could be useful (e.g. trough multicriteria analysis tools).

For this reasons, SLCA has a strongly related to sociology and management sciences, because it has been conceived to analyse social phenomena and serves to accompany management choices (Fig. 3).

Fig. 3 - Disciplinary and scientific fields related to SLCA and eLCA



From an academic point of view, "the management sciences are the youngest of the social sciences" (David et al. 2013:15). In fact, even if their practical and professional legitimacy is doubtless, it is only recently that they have gained the mention of sciences, due to the lack of clear expression in scientific terms until today (David et al. 2013). It is a very complex disciplinary field, and "a science whose object is neither a type of organisation, nor a type of phenomenon, nor a series of facts, but rather, a class of issues that constitute all collective action: decision-making, rationalisation, representation, legitimacy, co-operation, prescription, etc." (David et al. 2013:16). Following Thiétart et al. (2014), management science is also an unlimited domain of questions, which differ according to:

- their subject: a study of content, the analysis of a process;

- their aims: description, explanation, prediction, the establishment of norms;

- the approach adopted: the construction of a new theory, testing propositions, classification, the advancement of new concepts, the representation of experiences.

Moreover, being management science a relatively new science, multiple paradigms coexists, many theories are applied and different techniques are developed; this versatility of management research is considered both a disability and an asset, leading to the paradox of being a living social subject in which the practical experience of the people involved gives it legitimacy (Thiétart et al. 2014).

As in other social sciences, the concept of paradigms continue to exert a great influence in business and management research (Shepherd and Challenger, 2013). There is a wide literature about the diversity of paradigms and epistemological approaches applicable in management research. For example, Velmuradova (2003), Dumez (2010), Sułkowski (2010) Maurand-Valet (2010) affirm that in management science very often two or three epistemological paradigms are considered opposing: positivism on one side and interpretivism and constructivism (somehow considered synonyms) on the other side. However, it is also acknowledged that a perfect separation do not resist to analysis, they are not completely distant; furthermore, it is suitable to combine different approaches.

According to Raut and Veer (2014) the diversity of different epistemological arrangements entails distinct ways of engaging with management and doing management research. A distinguishing characteristic of management research is that it is involved in both the world of theory and the world of practice (Raut and Veer, 2014), exactly as it is for SLCA.

It is crucial, in management research, to answer the epistemological question and help the positioning of researcher “in search of knowledge” (Velmuradova, 2003).

Allard-Poesi and Perret (2014) gave also an explanation of the complexity of management science, highlighting three main frameworks of reference that influence the epistemological debate, namely *natural sciences*, *engineering sciences*, and *human and social sciences*.

Natural sciences (mathematics, physics, chemistry, etc.) have always been consensually dominated by positivism-oriented philosophies, mainly characterised by quantitative methodologies devoted to the explanation and prediction of phenomena, experimental approach, and empirical validation according to a deductive principle. For a long time, the disciplines of natural sciences have been considered the only ones that deserved the mention of “science” and their typical methods, based on observation and the empirical test of hypotheses to deduce theories, the only “scientific methods”.

As already mentioned, their influence in management science is due both for a reason of object (e.g. when dealing for different reason with the use or management of natural resources) and for reason of methodology. This last occurs for example when the aim of the research is looking for causal laws, the research approach is shaped on natural sciences methods and is wanted to be valid, reliable and operational; observation is independent and objective, value-free and the guiding theory can be tested (Johnson and Duberley 2000). Positivist methods are based on the assumption that true answers can be found and the job of the researcher is to formulate hypothesis and then seek data to confirm or discard them. Experimental and quasi-experimental methods are preferred for their clarity, transparency and repeatability, while surveys for data gathering are structured to find patterns and causal relations with a detached viewpoint, such as factual, inferential and exploratory surveys (Easterby-Smith et al. 2012).

According to Avenier and Gavard-Perret (2012), management sciences, or at least that part of management sciences whose object of analysis fits well in quantification methods frameworks, can develop easily in the model of natural sciences. Moreover, being this last the most influent model of science of all time, is quite unavoidable a strong influence in human and social sciences too, and among these, management sciences (Avenier and Gavard-Perret 2012).

When the human dimension, the context, the interactions between researcher and his object of research become relevant, the narrow rules of natural sciences become difficult if not impossible to follow (Avenier and Gavard-Perret 2012). Because of the central role of tools, technologies, devises and the creation of artificial stuff to support management, many researchers highlighted the strong influences of engineering sciences in the epistemology and methodologies of management science (Allard-Poesi and Perret 2014). Likewise, SLCA can be considered an engineering tool to help organisations taking decisions on how to organise their processes according to the social impacts of their product or services.

Some authors (Avenier and Gavard-Perret 2012) prefer to define it "science of the artificial" according to Simon (1996) studies, who affirmed that social organisations (such as enterprises, administrations and associations) could be considered artefacts[1]. This kind of conceptualisation start from the assertion that all elements of the environment show evidences of human artifice; likewise, organisations are intentionally shaped by humans to give them attributes and functions in a particular context, with specific purposes according to particular constraints (Avenier and Gavard-Perret 2012). Allard-Poesi and Perret (2014) affirm that claiming for an identity of

[1] Actually, Simon (1996) affirmed that the science of artificial is linked to "science of engineering", that is different from "engineering science", being the former not concerned with necessities but with contingencies and conception.

management science in the framework of engineering science signify, above all, the willingness to separate them from natural sciences: the complex nature of management and the human and social dimensions that govern the construction of "managerial artefacts", lead the engineering researcher to join concepts inherited from social sciences frameworks.

Indeed, the objects of assessment of SLCA are social impacts, i.e. the consequences, on people, of the functioning of a life cycle (Macombe et al. 2013), even if in SLCA literature this concept is not consensual, neither well defined. These social phenomena, - that SLCA pretends to observe and measure - their causes, manifestations and effects and their reciprocal relationships are the subject matter of study of sociology. As it will be discussed in the next paragraphs, social sciences have been interested by an important epistemological debate since their beginnings.

And if it is acknowledgeable that, like the other life cycle tools, SLCA concerns the support of decision-making processes in the management of organizations, supply chains, productive sectors, politics, and that it entails the study of social phenomena, then it is influenced by the intrinsic characteristics of social and management sciences, and an in-depth analysis of these latter is needed.

3.3 The philosophy of science and the criteria of knowledge validation

Epistemology is a branch of philosophy that studies the theories of knowledge; sometimes considered a synonym of philosophy of science, it has also been defined by Piaget (1967) as the study of the process of valid knowledge constitution (Avenier and Gavard-Perret 2012), or "the study of the nature of knowledge and justification" (Schwadt 2001:71). The epistemology inquiring consists in answering three main questions: what is knowledge, how it is elaborated, how to justify its validity (Avenier and Gavard-Perret 2012). Every researcher should be aware of what is his epistemological position to which the research is ascribed, because it shapes the research practices and gives different values and justification to the knowledge elaborated and different representations of the phenomena under study (Avenier and Gavard-Perret 2012). Even more, identifying the relationship between the epistemological basis of a research and the methodologies applied is critical to provide meaningfulness to results; however, very often this connection is not clearly stated (Darlaston-Jones 2007)

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 criteria of demarcation of science from non-science (e.g., the concepts of verifiability, falsifiability, normal science and paradigm shift, etc.);

- in terms of logical processes through which knowledge is reached (deduction and rationalism vs induction and empiricism) (Avenier and Gavard-Perret 2012);

- in terms of reciprocal position of social sciences versus natural sciences (monist and dualist position) (Boudon et al. 1995);

- in terms of paradigms (Guba and Lincoln 1994; Avenier and Gavard-Perret 2012).

During the twentieth century a great debate interested academia around one of the most important problem of philosophy of science, i.e. the problem of finding a criterion that demarcates science from non-science (Akinci 2004). Karl R. Popper and Thomas S. Kuhn were two of the most influential philosophers and their works are considered up to now milestone references. Karl Popper (1962) strongly criticised inductivism as logical process, in favour of deductive methods, and he rejected the demarcation criterion of verifiability (confirmability) defended by logical positivists at that time. He affirmed that the way scientific knowledge processes is by conjectures that are then controlled by refutations and critical tests; therefore, "only by purely deductive reasoning is it possible for us to discover what our theories imply, and thus to criticize them effectively" (Popper 1962:51). This means that it is not possible to affirm that a theory is definitively true, but, to be scientifically reliable, a theory (or a hypothesis) should be "falsifiable", i.e. should have the potential to be refuted by some possible observation and to test the limits of its validity (Fuller, 2003). In Popper's view, the work of scientists consists in producing theories and testing them: only falsifiable theories are considered scientific; theories are not fully correct per se but, if not falsified, they can be accepted as true (Popper, 2002). Thomas Kuhn refuted the traditional conception of the sciences as a cumulative and linear progression of new acquisitions (Corbetta, 2003). He shared with Popper the opposition to the traditional verifiability conception about the idea that single findings and discoveries would be added to current body of knowledge in the same way as bricks are placed one on top of another in the construction of a building (Corbetta, 2003). However, on the other hand, he criticized Popper's principle of falsification, introducing the concept of "normal science" to describe the period in which scientists adhere to the same paradigm. Kuhn intended the paradigm as 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[2]. During a period of normal science, there are no debates over 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. Therefore, the principal difference with Popper's philosophy is that for Kuhn scientific theories and hypothesis are not always open to criticism and revision, but there are periods in which theories and methodologies are shared and constant. However, Kuhn also claimed for the "incommensurability" between different paradigms (Bird 2013), conception that has been criticized and overtaken today by many authors, especially the supporters of mixed-methods research (see Tashakkori and Teddlie, 2010). Lakatos, trying to reconcile the ideas of Kuhn and Popper, preferred to use the term "research programmes" instead of paradigms, but shared the idea that it could exist more than one research programme per field of research, and that they could be competing (Lakatos, 1978). Research programmes are composed by two main elements: a "hard core", i.e. a set of basic ideas and methods strictly inherent the programme, and a "protective belt", represented by auxiliary hypothesis, links to applications; it is the competition between research programmes that ensure the rationality and the progress in science (Lakatos, 1978).

According to Avenier and Gavard-Perret (2012), two principal schools of thoughts went through the history of sciences. The first one, rationalism, considered analytical reasoning the basis of scientific knowledge: scientific knowledge is reached through deduction, starting from "the general" to concrete conclusions, "the particular". The second one is empiricism, based on the validation of a hypothesis, through experience and experimentations repeated several times, so from particular cases to a general rule through an inductive process.

According to Boudon et al. (1995), the epistemological debate can be resumed in three main philosophical positions: the monist, the dualist, and the mixed positions. The monist position acknowledges that there are no differences between social sciences and natural sciences, and so the former must follow the same objectives and methods of the latter (scientific-experimental), as a requisite to obtain the title of "science" (Goeben and Rustemeyer, 1994; Boudon, et al. 1995) because "science is science regardless of its domain of applicability" (Hands, 1993:41). This vision can be associated to the positivist paradigm (in spite of the diversity of "models" in this last), that will be better presented in the next paragraphs. The dualist position, diffused since the

[2] This point of view has been revisited by Funtowicz and Ravetz (1993), arguing that it also exists a "post-normal" science, complementary to normal science (Tacconi 1998). The core principle of their concept of post-normal science is that uncertainty and ignorance are unavoidable, even in scientific practices, so researchers must manage them (Tacconi 1998).

19th century, affirms that natural sciences, human and social sciences must be considered as different (Boudon et al., 1995), because the scientific methodology should be shaped according to the object of study of each discipline (Goeben and Rustemeyer, 1994).

Dualists share the principal belief, firstly proposed by sociologists like W. Windelband, H. Rickert and W. Dilthey, that social sciences have nothing in common with natural sciences, because the objective of the former ones is to determine the *sense* (of behaviours, movements, and social phenomena in general) and therefore, their central tenet is not objectivity as in natural sciences (Boudon et al., 1995).

Finally, the mixed position is not an eclectic position or a compromise, but moves from the critics to the other positions; it has been embraced by M. Weber and G. Simmel, who affirmed that social sciences should look for valid and objective explanations of social phenomena and that the validity of a sociological theory should be measured with the same criteria of natural sciences, but also that determining the sense of social actor's action is essential in every sociological analysis (Boudon et al., 1995).

Finally, following a further school of thoughts, scientific research can find its references into beliefs and visions shared by a scientific community, the set of concepts of knowledge called paradigms (Avenier and Gavard-Perret, 2012), which represent "the basic belief system or worldview that guides the investigator" (Guba and Lincoln, 1994:105). Kuhn (1962) gave notoriety to the term paradigm with his book *The Structure of Scientific Revolutions*, where he intended it as the shared set of philosophical background and methodological tools that enable scientists to solve their research issues. Despite the critics received by Kuhn, the concept of paradigm still remain up-to-date and preserve its centrality in the meta-research debate of social sciences and management sciences (Darlastone-Jones, 2007; Phoenix et al., 2013; David et al., 2013; Thiétart et al., 2014).

According to Leavy (2014), scientific research is characterized by interconnected elements ascribable to three dimensions: philosophy, praxis and ethics. The philosophical dimension concerns the paradigm that guide and shape the research; the practical dimension concerns the doing of research, such as theories, approaches, methodologies and the genre of research; ethics bridges the philosophical basis and the praxis of the research determining how people (participants or the public) are - eventually - engaged with, informed or protected (Leavy, 2014).

The paradigm, in turn, consists of three elements: the researcher's conception about the nature of reality (ontology), the relation between the knower and what is under study (epistemology), and how the researcher can find out knowledge (methodology) (Guba, 1990; Guba and Lincoln, 1994; Mertens, 2007). Some of the most applied definitions are reported in Table 5. These elements are

strongly interrelated, and together guide the design, planning and implementation of the research (Carter and Little, 2007), as it is graphically represented in Figure 4.

Before analysing these elements, some key concepts need to be clarified. Very 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 kind of paradigms (Wagner et al., 2014), with an explicit reference to the methodologies that are commonly associated to each typology.

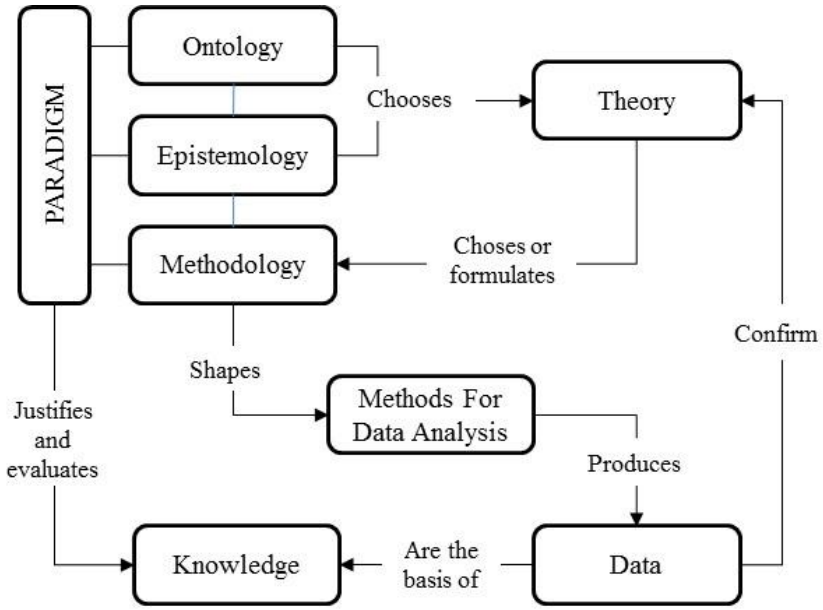
Table 5 - Definitions of the main elements of a paradigm

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)
	Ontology reveals what is the nature of the "knowable" and what is the nature of reality.	Guba (1990)
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)
	It represents the relationship between the inquirer and the known.	Denzin and Lincoln (2005)
Methodology	"We can think of methodology as a theoretical bridge that connects the research problem with the research method".	Hesse-Biber (2010:11)
	Methodology is the result of "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)

Actually, many authors (among others: Guba and Lincoln 1994; David et al. 2013) argue that these terms should be devoted to describe type 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 they are not sufficient to justify and outline the typology of research.

Concerning the elements that compose the paradigm (Guba and Lincoln 1994; Carter and Little 2007; Iofrida et al. 2014), the ontology questions the nature of social reality from a philosophical point of view and influences the selection of research topics, the formulation of research questions, and guides the epistemological position of the research (Hesse-Biber and Leavy 2011). Epistemology concerns the relationship between the researcher (the knower) and the aim of the research, that is to reach knowledge (Phoenix et al. 2013) upon a topic and ponders about the nature of this last (Guba 1990; Allard-Poesi and Perret 2014). The ontological and epistemological positions guide the choice of the theory that guide and justify the research, or that need to be demonstrated and/or confirmed by data.

Fig. 4 - Relationship between paradigms and methods



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

The methodology is the formalization of the epistemological position into practices, and shapes methods design for data gathering and analysis. Corbetta called “the delicate phase of operationalization” (Corbetta, 2003:4) the bridge between theory and practice, the passage from hypotheses to concepts, indicators and variables. The methods produce data, which bring the information that will constitute the knowledge and confirm the theory.

According to Creswell (2013), in studies that apply quantitative methods, theories are tested as explanation to research questions; in studies that apply qualitative methods the theory can be generated as final result, or it can be used as the basis (a lens) that shapes research questions.

3.4 Main families of paradigms in social and management sciences: post-positivism and interpretivism

While the positivist philosophies have dominated scientific research (Tacconi, 1998) and up to now it is the dominant paradigm in natural science (named also "hard sciences", in contrast to humanist disciplines called "soft sciences"), in the history of sociology is difficult to recognise a dominant paradigm, shared by all sociologists (Iofrida et al., 2014). 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 *heteroclite* (Boudon, 1997), also because "social phenomena are multilayered events as is the inquiring mind of the social scientist" (Cupchik, 2001:7).

The relationship between researcher and object of research is one of the crucial discourses in the epistemological debate of social research.

For example, Durkheim (1895, 1898) affirmed that the subject matter for sociology are "social facts", i.e. manners of acting, thinking and feelings, external to the individual but realized through individuals. Social facts are structured rules that explain how society operates, and the society is considered a *sui generis* reality, in the sense that it cannot be reduced to its composing parts (Carls, 2012). Coming from a positivist vision, durkheimian scholars approach the study of social facts as they were "things", i.e. rejecting any subjectivity preconceptions or attachment to what they are investigating in favour of the research of causality laws in human behaviours (Carls, 2012). However, Durkheim considered himself a cultural relativist (1895, 1898), in the sense that every type of society has a self-referential morality, not valid for every place and time: each culture has its own legitimate truths (mythological truths, or "representations"), different from scientific representations that are instead independent from the cultural context and subjected to validation and control (Durkheim, 1895; Miller, 1994; Carls, 2012). Differently form Durkheim, the methodological foundations of Weber's (1978) sociology included social actions and their effects imbedded in their meanings (individual, plural, theoretically constructed), which is considered to be the basis of intentions and motivations, i.e. the complex system of subjective meanings (Larsen, 2009). Indeed, in a Weberian perspective, sociology is the science of

interpretive understanding of social action and causal explanation of its course and consequences; individual choices and motivations are at the core of sociology. Decades after the works of Durkheim and Weber, and in accordance with his concept of "category" (Durkheim, 1912), Boltanski and Thévenot (1991) used the term "conventions" to indicate evaluation criteria whose legitimacy stay in the general acceptance by a society; these evaluation criteria are not values, but arbitrary and artificial agreements and guiding references (Borghi and Vitale, 2007). In this case, the objects of sociological research are the processes of categorization and the creation of conventions.

A wide number of paradigm exists but, as the lines between paradigms are often very fine, Table 6 reports two principal families of paradigms (with just two examples of for each of them) that can be considered the opposite poles to which almost all paradigms tend.

In the 19th century, the French philosopher A. Comte introduced positivism and coined the term "sociology" with the aim to systematize the study social phenomena with the same rigor of natural sciences; in facts, the central tenet of its philosophy was that natural phenomena must be treated as natural ones.

The ontology of the pure positivism has been defined "naïve realism", because it exists only one objective reality that is patterned and perfectly predictable and controllable; the role of 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, deductive, whose results and findings are generalizable, and so detached from their contexts and value free. Quality criteria mainly consists in the external (and objective) validity and the verifiability and repeatability of methods.

The post-positivist paradigm emerged at the beginnings of the 20th century from some critical reflections and amendments of positivism. According to the main supporters of this paradigm[3], the ontological stance is critical realism (to be distinguished from the "naïve realism" of positivism), i.e. it exists only one objective reality, but it is just probabilistically apprehendable, the perspective is non-reductionist and 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, the fully explanation of reality is not possible because of

[3] See also Carnap (1966) for logical positivism.

the undeniable influence of contexts and replicated findings are probably true. The methodologies most applied are mainly quantitative and experimental as it was in pure positivist paradigm, but the scientific community plays an important role of validation. Statistical analysis is the most used methodology to measure the above-mentioned probability.

Table 6 - 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.	

Source: Guba 1990; Guba and Lincoln (1994); Girod-Séville and Perret (1999); McKenzie and Knipe (2006); Lincoln et al. (2011); Hesse-Biber and Leavy (2011); Levers (2013); Phoenix et al. (2013); Iofrida et al. (2014).

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 correspondence 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 20th century, with the impulse of philosophers such as M. Weber and W. Dilthey. According with this school of thoughts, reality cannot be explained but understood and described. Many paradigms can be ascribed to this family of paradigms, such as phenomenology, ethnography, critical theory, while some others are rather

between both positivism and interpretivism (such as grounded theory by Glaser and Strauss, 2006); however, for the purpose of this thesis, the focus is on the main differences between opposite visions.

The ontology of constructivist and interpretivist researchers is similar: the vision of reality is relativist and subjective, because the social world is considered continually being constructed and interpreted through actors' perceptions. This entail 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 experiences and context specificities (that are less relevant in positivism-oriented paradigms). In statistical analyses, purposive and multipurposive sampling (i.e. two forms of non-probability sampling) is 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). Stakeholders involvement, in terms of experience (constructivism) and perceptions (interpretivism) gathered, plays an important role of validation and source of information (data gathering).

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 process, objectives, results obtained. Interpretivism-oriented paradigms are devoted to the in-depth examination of the values and significances of social phenomena, while positivism-oriented ones are almost value-free and look for objectivity and generalisability.

Very often, quantitative methodologies have been univocally associated to positivism-oriented paradigms, and qualitative methodologies to interpretivism-oriented one, bringing 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.

3.5 Conclusions

The chapter highlighted which disciplines are related to SLCA, i.e. sociology and management science. Both had in common the dominance of two principal families of paradigms: post-positivism and interpretivism. For each of them, the possible epistemological foundations have been explored in depth, as well as a brief digression on philosophy of science and the problem of validation criteria of knowledge.

In the light of these considerations, in the next chapter, a critical review of scientific literature on SLCA will enable to retrace which epistemological positions have been applied and to hypothesize which consequences they had at practical level.

The question of paradigms is very up-to-day and still discussed by many different scholars from sociological and management disciplines.

4. A LACK OF CONSENSUS: SHIFTING THE METHODOLOGICAL DEBATE TO AN EPISTEMOLOGICAL LEVEL

4.1 Introduction

Following the considerations made about the disciplinary roots of SLCA in social and management research, the aim of the present chapter is to highlight which paradigms have been applied until now in SLCA literature and with which methodological consequences.

Actually this was briefly suggested by Jørgensen et al. (2010); they mentioned, in a footnote, the question of the use of different paradigms in social sciences and the importance of explaining the tenets and assumption upon which a research is built.

Reintinger et al. (2011) applied a philosophical perspective putting into discussion 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" (Reitinger et al. 2011:381).

Sala et al. (2013a, 2013b) went farther, questioning the epistemological foundations of life cycle tools (therefore, including SLCA), their role into the emerging discipline of sustainability science, and which should be the criteria for acknowledging scientific robustness.

Finally, agreeing with Arvidsson et al. (2015), social science and economics should be considered to strengthen the scientific solidity of topics (or impact categories, areas of protection) under assessment in sLCA and their respective indicators.

It has been affirmed by many authors that SLCA should assess social impacts of life cycles in the same way eLCA do it for environmental ones. However, as discussed in the previous chapters, social impacts are of different nature from environmental ones and many epistemological positions are possible, leading to a wide range of assessment methodologies.

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 it should also be acknowledged that it is not necessarily the same case in sLCA proposals, as it will be discussed in the next paragraphs.

To highlight which paradigms have been applied in SLCA studies, a brief but *critical* review[4] has been conducted. As already affirmed, boundaries between paradigms are subtle and rarely researchers explicitly affirm which is the paradigm they are undertaking in their studies (Iofrida et al., 2014); moreover, many times researcher are not aware of it, or take it for granted. Given this difficulty, the present critical review does not necessarily reflect the real authors' opinion; it is rather an interpretation according to some topical criteria.

4.2 Scientific paradigms in SLCA literature. A critical review

4.2.1 Review method

Studies on SLCA has been gathered with the help of on line scientific databases and engine research, i.e. Scopus, Web of Science, ScienceDirect, Google Scholar, Google Books, the mobile phone application Scholar Droid, and dedicated social networks such as Academia and ResearchGate. This search was conducted with the help of specific keywords (within article title, topic, abstract, keywords), and Boolean operators (AND, OR). The following keywords were used to identify potentially useful articles: "social life cycle assessment", "social LCA", "SLCA", "S-LCA", as well as "social impact", "social consequence", "social performance", "social evaluation", "social sustainability", and "social assessment" in association with the term "life cycle".

All scientific literature about the assessment (and synonyms) of social impacts in a life cycle perspective, or that addressed social impacts evaluation as part of a broader sustainability assessment (as it is the case of LCSA - life cycle sustainability assessment) were included. Each publication has been scrutinized according the relevance of the title, abstract and keywords; when not sufficient, a speed-reading and a search for topical sentences has been done.

From the first population of 209 works, *grey literature* was excluded, i.e. non-indexed conference proceedings, articles and books, as well as theses and dissertations, readers, project reports, articles on national journals. Papers that did not concern any methodological proposal (neither theoretical, nor applicative), as well as short papers (e.g. editorial letters, long abstracts etc.) and reviews, were discarded due to the scarcity of elements for classification.

[4] For an exhaustive description of reviews typologies, see Grant and Booth (2009).

As a result, 78 scientific works have been selected, and a classification matrix has been developed, to order all studies according to the following entries:

- *identifiers*: author names, year of publication, title, source;

- *typology of literature*: journal article, book chapter, conference proceeding;

- *field of application or study*: typology of product/service or general aim of the paper;

- *methodologies applied*: SLCA (alone or in combination with other assessment tools), LCSA, LCAA (life cycle attribute assessment) and others;

- *impact assessment methodology*: pathways methodologies, UNEP-SETAC guidelines, participative methods, capabilities/capacities approach, multicriterial decision analysis, etc.;

- *research paradigm applied*: post-positivist, interpretivist, or both.

Among these criteria, impact assessment methodology is a question of utmost importance in life cycle oriented tools, and the principal source of diversity in sLCA proposals too (Parent et al. 2010); therefore, it has been the core criterion to classify the literature gathered. However, as the methodological features alone are 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.

The most diffused impact assessment methodologies can be summarized in four main groups in SLCA, according to Zamagni et al. (2016). A first group is represented by those inspired to UNEP-SETAC (2009, 2013) guidelines and methodological sheets. A second group concerns the Social HotSpot Database (SHDB) created by the non-profit organization New Earth. A third group concerns the "social impact pathways" (Weidema 2006, Feschet et al. 2013, Neugebauer et al. 2014, Bocoum et al. 2015), and finally the fourth one is represented the "capacities/capabilities approach" (Reitinger et al. 2011, Garrabé and Feschet, 2013, Feschet 2014).

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, local community. Society, consumers and value chain actors are considered the main affected actors 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 generic and specific analysis. The list of indicators is not exhaustive, and the choice is left to the intention of the researchers/practitioners. Most of them are static indicators that allow to describe 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 in aggregating results of sub-categories within each impact category for each stakeholder group, and type II based on 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 to UNEP-SETAC approach apply the first type. 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, the predominance of static indicators.

SHDB is the first database created for SLCA, it enable to conduct social risk assessment at sector or country level, by means of an Input-Output model derived from GTAP (Global Trade Analysis Project) database (Benoît Norris et al. 2012a, 2012b). The SHDB covers 22 social themes (e.g. gender equity, child labour, armed conflicts, and many others inspired to UNEP-SETAC guidelines) that can be aggregated per productive sector or country. More than 200 publicly available data sources have been integrated into the database (e.g. WHO, ILO). It received some critics due to arbitrariness and subjectivity embedded in its risk assessment criteria (Rugani et al. 2014). Each risk flow is given a score and, for this reason, papers that applied this methodology have been classified in the interpretivism-oriented group.

The "impact pathway methodology" follows the same epistemological approach of LCA. Weidema (2006) and Norris (2006) published the first seminal works, then followed by the works of Feschet et al. (2013), Macombe et al. (2013), Neugebauer et al. (2014), Bocoum et al. (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 on actors' quality of life and to provide generalizable findings. 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 et al. (2011) and, referring to the works by Sen (2000), 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 toward what is important in peoples' lives. Garrabé and Feschet (2013) furtherly 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 relationships 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 following assessment grid (Tab. 7) has been used to check the presence (or not) of some topical elements according to paradigm discourse exposed in the previous section.

Table 7 - 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	☐
Total:		*Total:*	

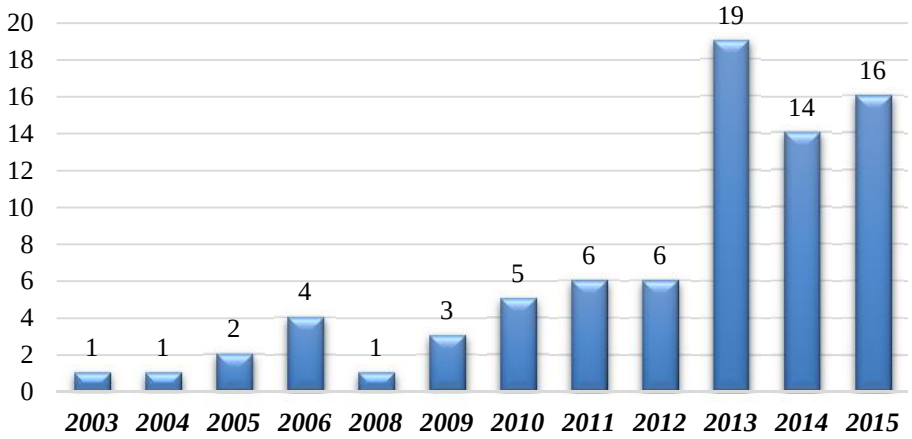
Concerning the left column (post-positivism-oriented papers), if causal variable are deterministically accounted, then research/practitioner is detached from the object of assessment, he/she does not personally intervene in the assessment process, then findings are generalizable and applicable to other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

Regarding the right column (intepretivism-oriented papers), if the choice of indicators and impact categories is at discretion of the researcher/practitioner or entails the participation of stakeholders, relativism dominates and the reality is intended as subjective and shaped by actors' perception. The use of static indicators are useful to describe and understand a current situation or compare more scenarios, however 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 evaluations focused on companies responsibilities at a specific temporal moment.

4.2.2 Review results

The studies gathered and selected (78) have been published from 2003 to July 2015, with a peak in 2013 of 19 publications (Fig. 5). While, if grey literature were included in the selection of contributions, the peak would be in 2014 with 41 publications, probably due to the publication of the Methodological sheets by UNEP-SETAC in 2013 (Iofrida et al., 2016).

Figure 5 – Scientific SLCA contributions per publication year

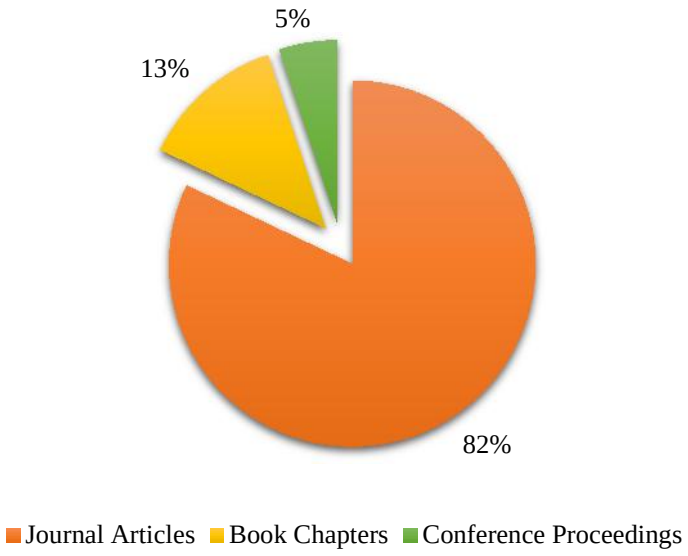


As represented in Figure 6, articles on international scientific journals represent the 82%, followed by book chapters (13%), and indexed conference proceedings (5%).

Most of the articles are published on the International Journal of Life Cycle Assessment (60%), followed by the Journal of Cleaner Production (10%), Sustainability (7%) and the Journal of Industrial Ecology (4%) (Fig. 7).

For the reasons above explained, papers have been classified, firstly, according to the impact assessment methodology, both in case of applicative studies and methodological proposals or discussions. Very often, the impact assessment methodologies are not explicit; this is the reason why the evaluation grid (Tab. 7) was applied in a second step, in search of total amount of topical elements enabling to ascribe the studies to the interpretivist or post-positivist group.

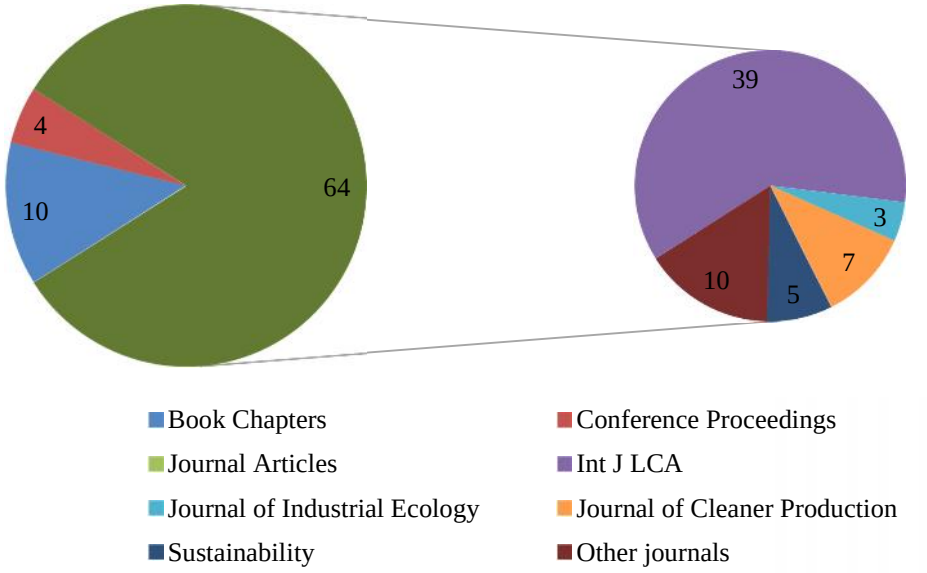
Figure 6 - Literature typologies distribution



Indeed, the only presence neither of quantitative or qualitative indicators, nor of a certain impact assessment methodology, is not sufficient to characterise a research paradigm. Just 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 has this datum on some typology of actors in a certain period of time, nor how changes in life cycle would improve or worsen life cycle social impacts. Moreover, even if in several studies some cause-effect relationships are accounted, some relativism persists in the choice of impact categories or impacts. The principal sources considered are insights from a literature review, personal expertise of scholars or panels of independent experts, stakeholders opinions gathered trough qualitative

methods (e.g. interviews, questionnaires, documents analyses), the importance given by companies or who commissioned the assessment. Indeed, about 25% of studies affirms to have conducted a literature review to select the most relevant issues or indicators to be assessed, or to confirm their importance in the chosen field of study.

Figure 7 - Literature typology (number) and main sources

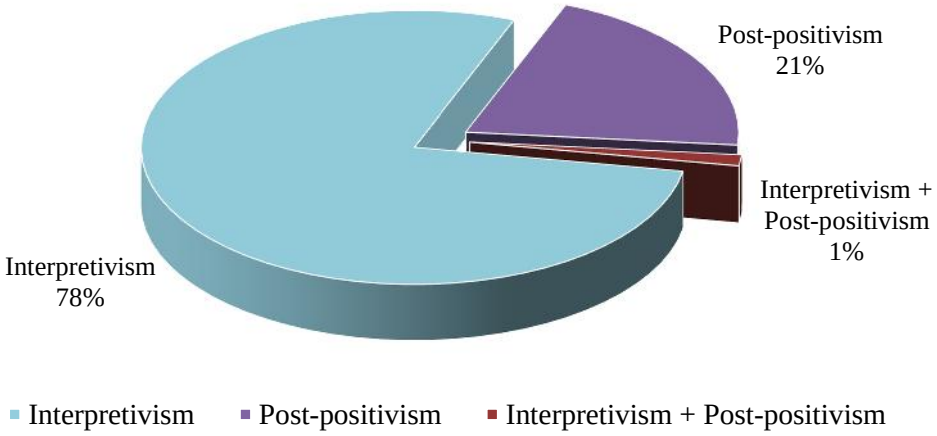


Concerning this last, the most recurrent fields of study to which sLCA has been applied are agricultural, forestry and food products (about 20% of studies), followed by industrial and technological products (19%), energy production, waste management and others. According to Revéret et al. (2015), one of the reason could be that there has been a growing awareness that farm activities induce significant impacts (economic, environmental and social) on several typologies of actors, especially workers and local communities.

Annex 1 reports the results and details of the classification here summarised in Fig. 8.

About 78% of the selected studies can be ascribed to the group of interpretivism-oriented paradigms, and only the 21% can be ascribed to the post-positivism one. These data deserve some attention, because since the beginnings of sLCA methodologies, most of the scholars supported the idea that the same assessment perspective of eLCA should be applied to social impacts (Hunkeler 2006; Chhipi-Shrestha et al. 2015).

Figure 8 - Results of classification according to the critical review



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.). Advocacy for stakeholders' involvement, participation, and public acceptability at different level of the methodology were common characteristics of these studies. The principal focuses of the assessment methodologies of this group were social values, actors or companies' behaviour, and context specificities. Among these papers, the most recurrent methodology to choose indicators were literature review (about previous sLCA studies or others), recurring to international or national norms on socio-economic issues or to stakeholders involvement. Researcher (scholars, practitioner) directly and strongly intervened in the research process, influencing the methodological choices. As an example, quoting Revéret et al. (2015:40): "Our assessment methodology thus relies not only on this literature, but also on our expertise in this field".

Often, the list of indicators is randomly chosen and these last are applied to conduct attributional or static assessment such as "number of employees" or "percentage of women employed" do not furnish explanations about the consequences of these data, but describe a current situation or enabled to highlight differences between two or more scenarios. However, this typology of studies allowed conducting more holistic assessments and covering a wide range of social dimensions. This allowed, in turn, furnishing more complete information about the social performance of the systems under assessment.

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 health via economic causal relationships, as it is the case of Weidema (2006), Feschet et al. (2013), Bocoum et al. (2015), Chang et al. (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 paper has been classified as both interpretivism and post-positivim oriented (representing 1% of studies). It was the case of the study by Norris (2006) that proposed the application of a "simplified empirical relationship to characterize the complex pathways from product life cycles' economic activity to health in the aggregate" (Norris, 2006:97) taking also into account context-specific attributes.

4.3 Conclusions: strength and weaknesses of paradigms and methodological consequences for SLCA

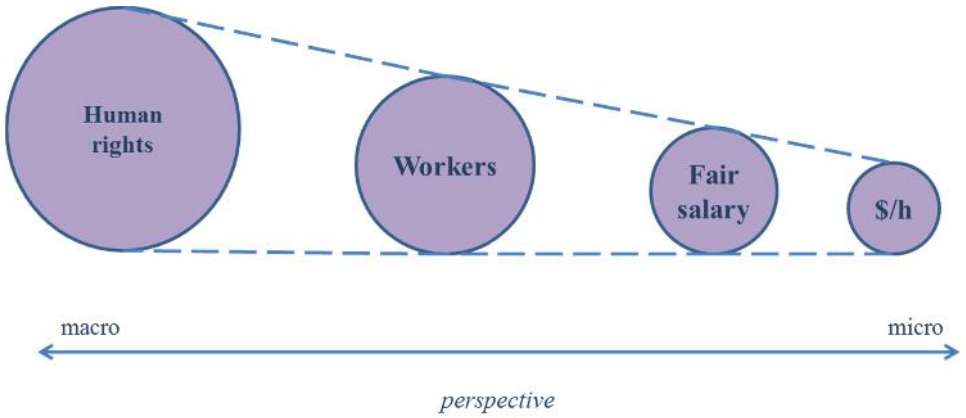
In the light of the previous reflections, it is arguable that it is important, before going into methodological questioning issues, to be aware of which paradigm is underlying the research process. There is consensus about considering sLCA and the other life cycle assessment methodologies as management tools towards more sustainable patterns as mentioned in about 60% of studies gathered. Furthermore, 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.

Many scholars clearly affirm that SLCA should address social impacts as eLCA does for environmental ones and this also implicit in studies addressing LCSA. At the same time, it became evident that the two methodologies are not perfectly overlapping, because "the process related nature of indicators used within the three methods LCA, LCC and SLCA show tremendous differences" (Neugebauer et al., 2015:167).

Reviewing the selected studies, two principal differences emerged in terms of impact assessment. Papers belonging to the interpretivism-oriented group provided a broad assessment of several impact categories, furnishing a complete description of a situation at a certain moment in certain time. Very often, they involved stakeholders at different points of the research process, such as the choice of what is worth assessing (impact categories), the choice of the most relevant indicators, or scoring tasks to discriminate the importance of results. They often took into account the experience of privileged witnesses, as well as the expertise of local actors, thus performing a more coherent context-based assessment.

However, as represented in Figure 9 on the example of what suggested by UNEP-SETAC (2009), and the most assessed impacts in literature, often there is no relationship between the Area of Protection (AoP), impact category, subcategory and indicator (dotted lines stays for no relationship). Or rather, it is affirmed - or taken for granted - that a relationship exists, but it is not quantified nor demonstrated. As a result, social issues are represented according to a micro or macro perspective, but it is not possible to explain how changes in life cycle would have effects in terms of final social impacts.

Figure 9 - Example of a descriptive assessment

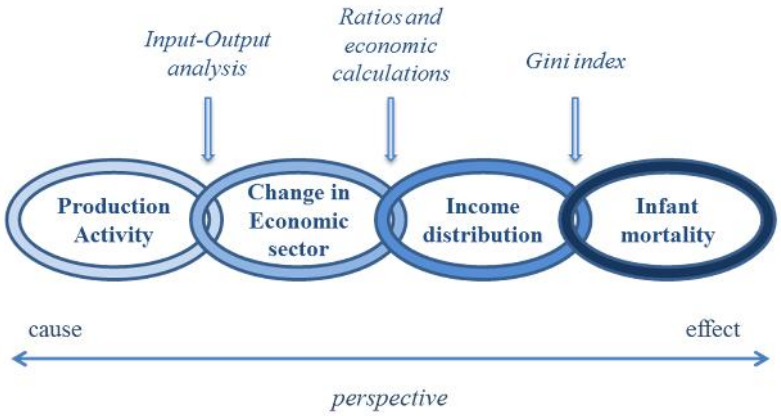


In this sense, some authors discussed the UNEP-SETAC (2009) indicator "child labor": the mere existence of child labor says little about whether there are negative or positive impacts on children and society (Jørgensen et al. 2010). Likewise, it can be considered something that eschews supply chains if the alternative is education, but not if the alternative is prostitution or unemployment (Clift 2013).

Papers belonging to the post-positism oriented group, provided a smaller range of impact categories, focusing only on few social aspects, but furnished explanations of the cause-effect relationships between inventory data and impacts. This could allow predicting which changes would be suitable in life cycle management to obtain more sustainable results and impacts. Figure 10 provides a graphical representation on the example of the work by Bocoum et al. (2015). Each element of the chain is linked to the next one through a quantifiable relationship, and the posture of the researcher, in this kind of assessment, is detached from the object of assessment (cfr. Tab. 6).

In this pre-scientific phase of SLCA development, the methodological debate about indicators and impact assessment, that led to a plethora of case studies and methodological proposal, should take into account this diversity and questioning the theoretical and epistemological bases. The "SLCA infancy" (Dong and Ng, 2015) should end, it is about time to face a further phase. Being aware that there is still so much to do to reach a methodological standardization, an attitude of modesty should be maintained in current SLCA research (Macombe and Loeillet 2013). Likewise, looking outside the literature boundaries of SLCA (e.g. social and management reesearch) could help to deal with the multilayered feature of social phenomena and the multiparadigmatic characteristics of sociology and management sciences. This issue was already highlighted by O'Brien et al. (1996), Jørgensen et al. (2010) and Iofrida et al. (2014) but found little response among current SLCA studies.

Figure 10 - Example of a cause-effect explanation



This awareness should focus on answering some fundamental questions: how and why indicators are chosen? Which theoretical basis underpins the assessment process? Which are the objective of the study and who is concerned by results?

The present thesis do not want to promote one or another paradigm or approach in SLCA, but the aim is to promote a shift of the methodological debate towards an epistemological level. As above explained, and as represented in Table 8, each paradigms family has its strengths and weaknesses. Both relativism and objectivism (cfr. chapter 3) can be suitable for social impacts evaluations, but the choice should be done in accordance to the purposes of the studies and with the awareness that results can differ in terms of significance.

Thus, it is possible to confirm what affirmed by Baumann et al. (2013:2), that "a coherent discussion about the social values and ethical and ideological positions that underlie the indicators of social impacts is missing".

Table 8 - 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
	Poor in values	In-depth investigation
	Affordable and quick	Comprehensive understanding
Weaknesses	Reductionism	Context-bound
	Objective	Subjective
	Simplification	Long and costly
	Superficial	Weak in generalizability

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

5. COMPARISON OF TWO SLCA METHODOLOGIES MOVING FROM OPPOSITE SCIENTIFIC PARADIGMS

5.1 Introduction

The present chapter proposes two different methodologies for the assessment of social impacts – from a life cycle perspective -, applied to the same field of study. They will move from opposite paradigms (post-positivism and interpretivism). The aim is to compare the two research processes, from epistemological postures and relative assumptions, to methodological proposal and methods put into practice.

Unquestionably, agriculture plays a critical role in the local development and the backbone of the economy of every country. Citriculture has a great importance among fruit production: citruses are the most produced and exported fruit after bananas. For this reason, it has been chosen as field of study to apply the two methodologies.

The first part of the chapter is dedicated to the description of the world scenario of citrus production and consumption, supported by international statistic data, and to the case of citrus growing in Calabria region (South of Italy). Here citriculture has an important economic role (e.g. bergamot for the production of essential oils) but it is also well known for social problems, linked to less profitable varieties.

In the second part of the chapter, the two methodologies are presented, the material and methods applied and insights obtained. In particular, the post-positivist methodology will evaluate two citrus growing scenarios in terms of effects of psychosocial risk factors on workers' health. The second one, starting from interpretivist stances, assesses nine productive scenarios of clementine, i.e. three typologies of farming practices (organic, integrated, and conventional) in the three main productive areas in Calabria. This last is part of a research conducted in 2013 and already published (cfr. De Luca et al., 2013b).

Finally, the conclusions will comment the results and introduce the discussion of chapter 6 about the comparison, in details, of the two research processes.

The reader should be advised that the two methodological proposals must be intended as exercises and procedural examples of possible further developments. Results are still far from offering a concrete solution to social problems of citriculture in Calabria, so they should be interpreted with caution, especially because SLCA is in a pre-science phase and is an immature methodology, without neither epistemological nor methodological consensus.

5.2 Field of application: citrus growing in Calabria region

5.2.1 Characteristics of world citriculture at a glance

Citruses represent the the most important fruit production in the world after bananas and plantains, with a produciton of 123 millions of tonnes in 2009-2010, that represents 21% of the overall fruit production at global level (Jacquemond et al., 2013). The principal destination of the production is for self-consumption (Tab. 9) and the trade volumes of citruses for fresh consumption increased of 120% in 30 years (1970-2010) (Tab. 10). The first producer of citruses is the Asian continent, followed by Southern and Central America, the Mediterranean countries, and Northern America. However, Mediterranean countries are currently the first exporter of citruses for fresh consumption, thanks to favourable pedoclimatic conditions, a privileged phytosanitary environment and local expertise.

Table 9 – Destination of citruses and evolution (millions of tons)

	1970-1972	**2009-2011**	**Evolution (%)**
Self-consumption and losses	25.8	71.6	178
Transformation	11	26.8	145
Export fresh citruses	5.7	13.1	131
Total production	*42.4*	*111.5*	*163*

Source: Jacquemond et al. (2013:150)

Table 10 – International trade volumes of citruses for fresh consumption (millions of tons)

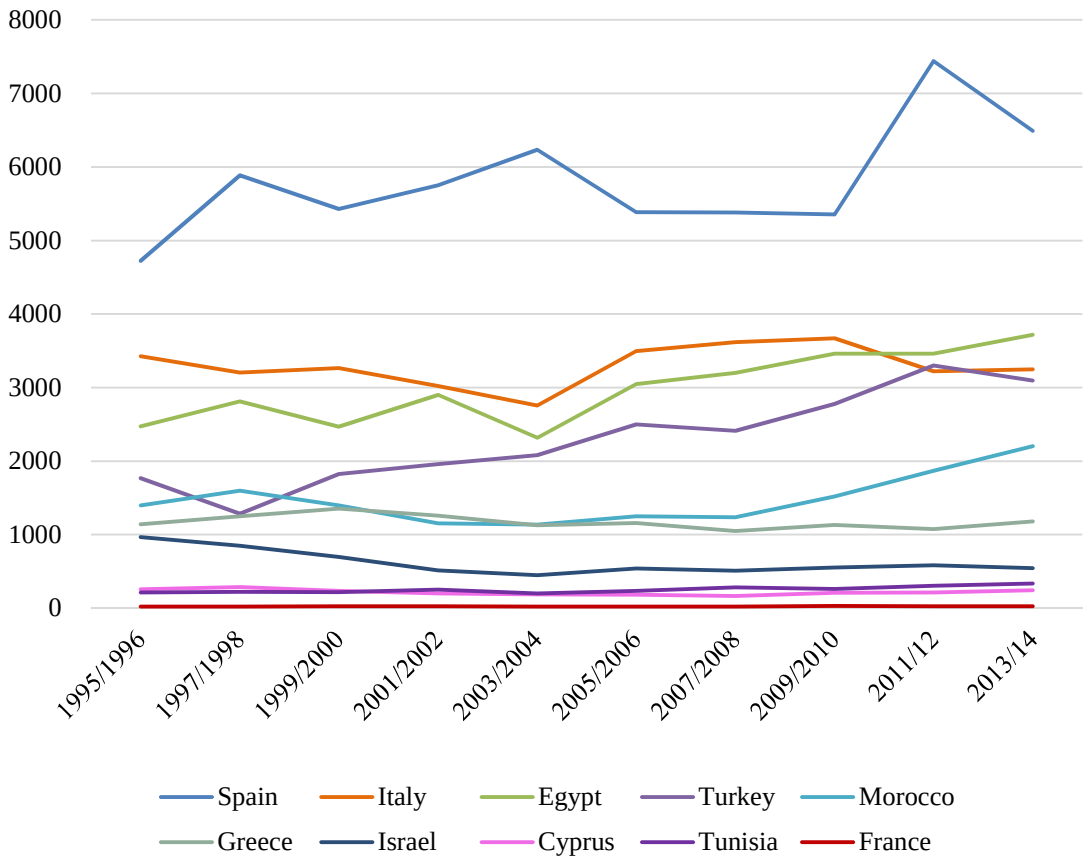
	1970	**2010**	**Evolution (%) 1970-2010**
Oranges	3.9	5.7	47
Lemons	0.7	1.6	121
Pomelo	0.4	0.8	99
Small citruses	0.5	4.1	677
Total	*5.5*	*12.2*	*120*

Source: Jacquemond et al. (2013:153)

Among Mediterranean countries, Spain is the principal producer representing the 31% of the total production of CLAM[5] countries in 2013-2014; in the period 1995-2014, Spain, Egypt, Turkey and Morocco increased their volumes, while Italian production slightly decreased (Figure 11).

Spain is also the principal exporter of citrus fruits and with an overall positive trend in the period from 1994/1995 to 2009/2010, outperforming all the other countries (Fig.12); Italy surpassed Israel exports after years 1999/2000, remaining up to now the third exporter among Mediterranean countries.

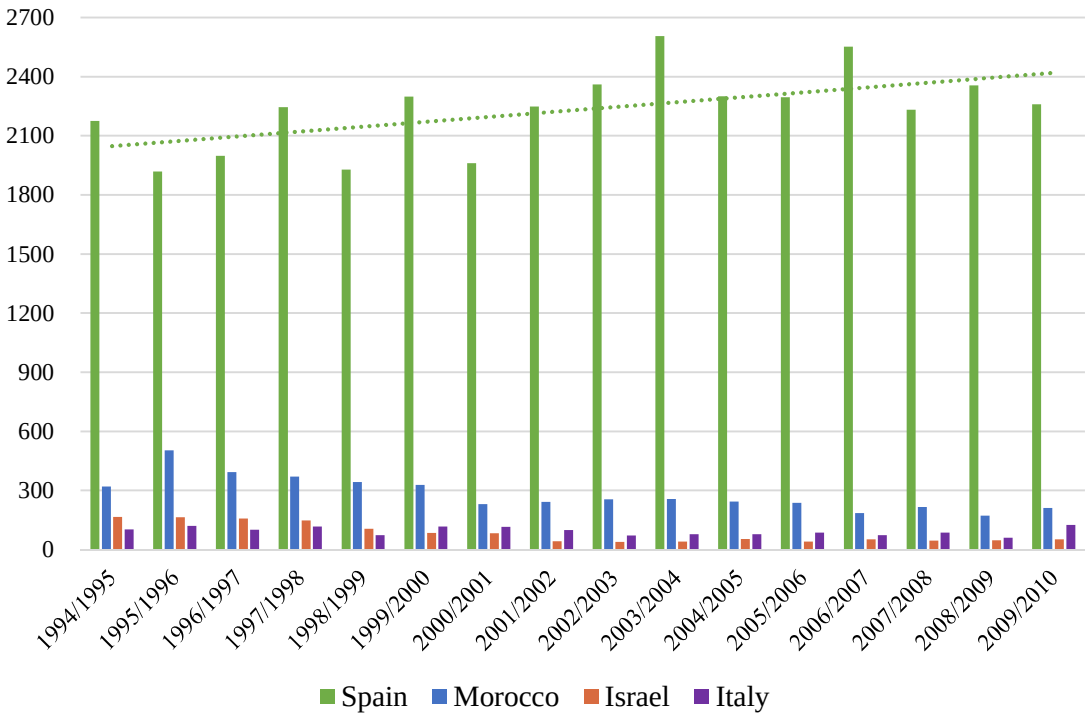
Figure 11 – Trends of citrus production in Mediterranean area (thousands of tons)



Source: CLAM statistics, courtesy of CIRAD Montpellier

[5] CLAM stays for "*Comité de liaison de l'agrumiculture de la Méditerranée*", an international committee created to establish a liaison between professional producers, industrial and commercial organizations of Mediterranean citriculture. Ten countries are members: France, Italy, Spain, Egypt, Turkey, Morocco, Greece, Israel, Cyprus, and Tunisia.

Figure 12 – Principal exports from Mediterranean countries (thousands of tons)



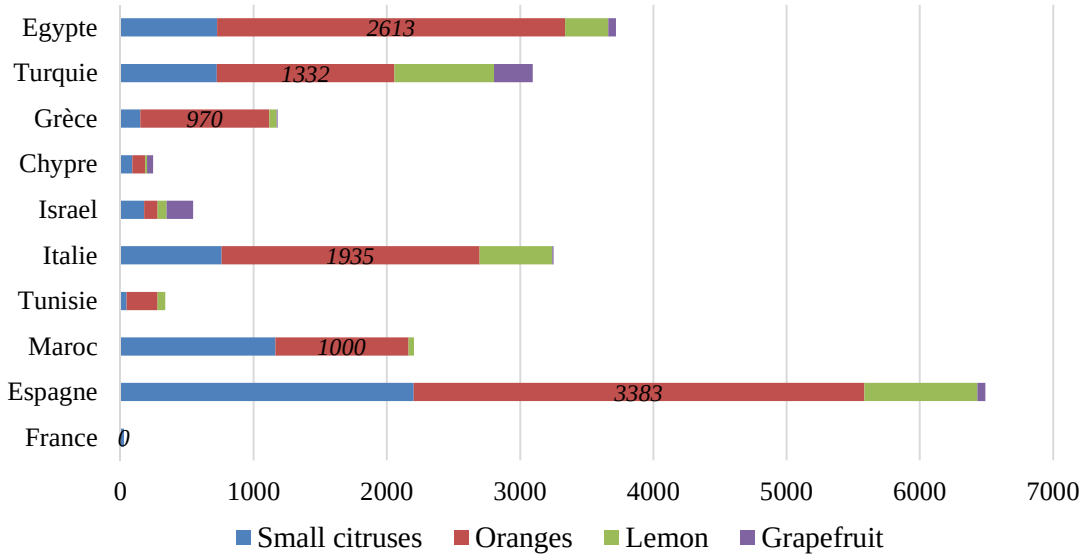
Source: CLAM statistics, courtesy of CIRAD Montpellier

Oranges are the most produced citrus fruit, representing, in 2009-2010, about 68% of the worldwide production, followed by 21.7% of small citruses (clementine, bergamot, kumquat, mandarin, etc.), lemons and limes (14.3%) and others (Jacquemond et al. 2013).

Likewise, the same ranking can be found in the Mediterranean area, with small differences: in 2013/2014, oranges represented 55% of citrus production, while small citruses 29%, with Spain as principal producer, followed by Egypt and Italy (Figure 13).

Different countries are specialised in some sector. Central and Southern America dominate the industrial processing of citrus, in particular for the production of juices; Mediterranean countries are leaders in the market of citrus for fresh consumption; Asian production is mostly destined to self-consumption. In average, 60% of the world citrus production is used for self-consumption, 30% is destined to industrial processing and only 10% arrive to the international markets.

Figure 13 - Characteristics of Mediterranean citriculture in 2013/2014 (thousands of tons)



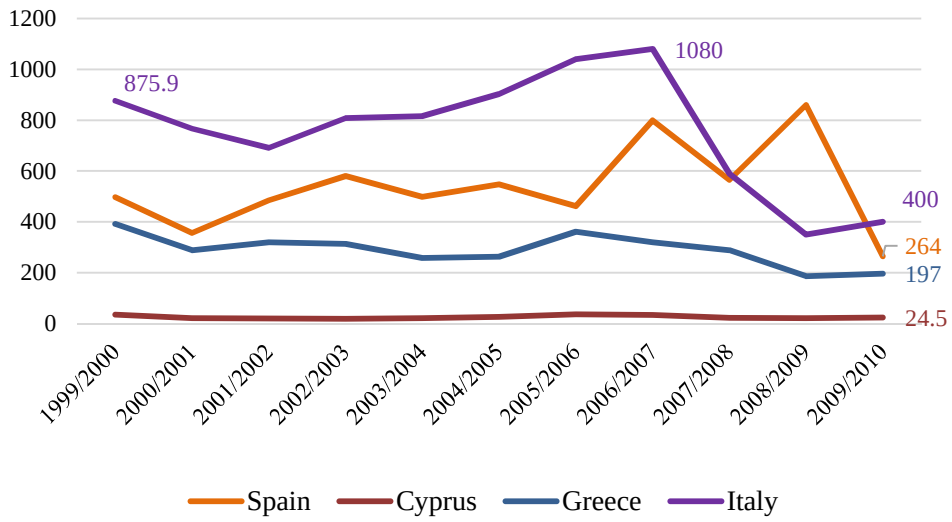
Source: CLAM statistics, courtesy of CIRAD Montpellier

Among small citruses, clementine is the most diffused product in all CLAM countries, except Egypt, Cyprus, and Israel, with a total Mediterranean production that passed from 1,090 thousands of tons in 1994/1995, to 1,620 in 2011/2012. However, in relative terms, clementine passed from representing 70% of small citruses production to 58% during the same period, in favour of an increase of minor citruses (mandarins and others, excluding clementine and satsuma). Indeed, these latter were interested by a production of 262.5 thousands of tons in 1994/1995 (17% of total small citruses production) to 879.2 in 2011/2012 (31% of all small citruses). According to Jacquemond et al. (2013), the production of small citruses is concentred into two principal areas that together represent more than 80% of total world harvesting, i.e. the Asian continent (60%) and the Mediterranean area (22%), with Spain as principal producer and exporter.

Concerning the production of oranges for industrial transformation, Italy is the first producer among Mediterranean countries, with an average production of 756 millions of tons during the period 1999-2010; but a strong decrease occurred after 2007 (Fig. 14), reducing the differences against the other countries, but still remaining the first country at the end of the period observed.

In terms of proportions, Italy destined in average 38% of oranges production to industry during the above-mentioned period, with a peak in the years 2006/2007 of 1,080 thousands of tons, against 30% of Greece, 32% of Cyprus and 18% of Spain (average percentage in the same period).

Figure 14 - Oranges for industrial processing (thousands of tons)



Source: CLAM statistics, courtesy of CIRAD Montpellier

After 2007, some changes occurred in European agricultural policies, due to the reform of the Common Market Organization (COM) of fruit and vegetables (Reg. EC n. 1182/2007), especially concerning processing aids granted to producers, that have been abolished (decoupled) and integrated into the single payment scheme. In particular, Italy chose to directly put into effect the reform, without gradual application process, and this caused a decrease of surfaces dedicated to citriculture at national level (Scuderi, 2008).

5.2.2 Citriculture in Calabria region

Citriculture is an important resource of Italian economy, representing 3% of national agricultural Gross Saleable Production (GSP) (Scuderi, 2008). According to the last agricultural census by ISTAT (2012), the overall surfaces cultivated with citrus fruits are approx. 128,921.07 hectares in 2010, mostly concentrated in the South, especially Sicily (as first national producer) and Calabria, that together represent 82% of national citrus production. More in detail, Sicily is the principal producer of oranges and lemons (65% and 89% of national production, respectively), while Calabria is the first producer of clementines (60% of national production) and small citruses (61% of national production, especially bergamot and cedars). In the period between the last two agricultural census (2000-2010), ISTAT (2012) highlighted a general decrease, in Italy, of the surfaces cultivated with citrus fruits (-3%), while the tendency has been the opposite in Calabria,

where the regional citriculture surface increased a 10%, with a peak of 24% in the province of Cosenza.

Table 11 - Citriculture surfaces and farms in the five Calabrian provinces (2010)

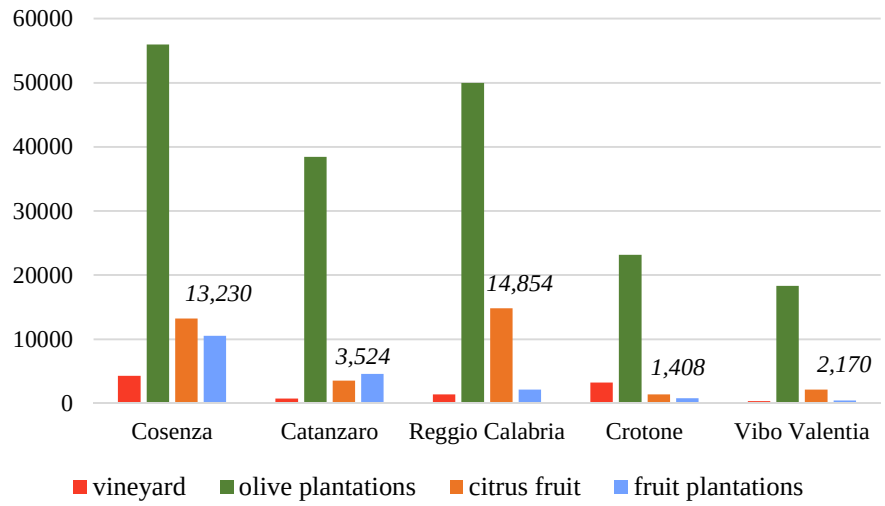
	Total citruses	Orange	Clementine and hybrids	Other citruses	Mandarin	Lemon
Surfaces (ha)						
Italy	128,921.1	79,551	20,916.3	4,548.3	8,481	15,424.5
Calabria	35,185.3	16,257.74	12,530.83	2,792.27	2,984.77	619.69
Cosenza	13,229.77	3,269.89	8,664.31	253.36	695.39	346.82
Catanzaro	3,523.52	1,982.44	853.06	231.45	402.97	53.6
Reggio C.	14,853.71	8,801.53	2,224.84	2,134.98	1,505.9	186.46
Crotone	1,408.33	1,036.19	153	50.69	161.49	6.96
Vibo V.	2,169.97	1,167.69	635.62	121.79	219.02	25.85
Farms (n.)						
Italy	79,589	57,724	12,996	5,308	15,083	19,389
Calabria	20,974	14,148	6,002	2,158	3,823	1,354
Cosenza	6,987	3,321	3,889	373	1,037	663
Catanzaro	1,552	1,317	266	102	487	74
Reggio C.	10,306	7,711	1,493	1,525	1,827	459
Crotone	862	758	63	64	159	32
Vibo V.	1,267	1,041	291	94	313	126

Source: data elaboration according to ISTAT (2012)

Actually, in Calabria most of agricultural surfaces is occupied by olive growing (Fig. 15) that, with 55,955 hectares, represents the most cultivated crop and interest 34% of UUA (Utilised Agricultural Area). Among permanent crops, citrus growing is the second most important in terms of surface, accounting for 35,185.3 hectares in 2010 (ISTAT, 2012). Furthermore, 9,005 ha (about 25% of citrus growing areas) are conducted according to standards of organic farming practices (De Luca et al., 2014).

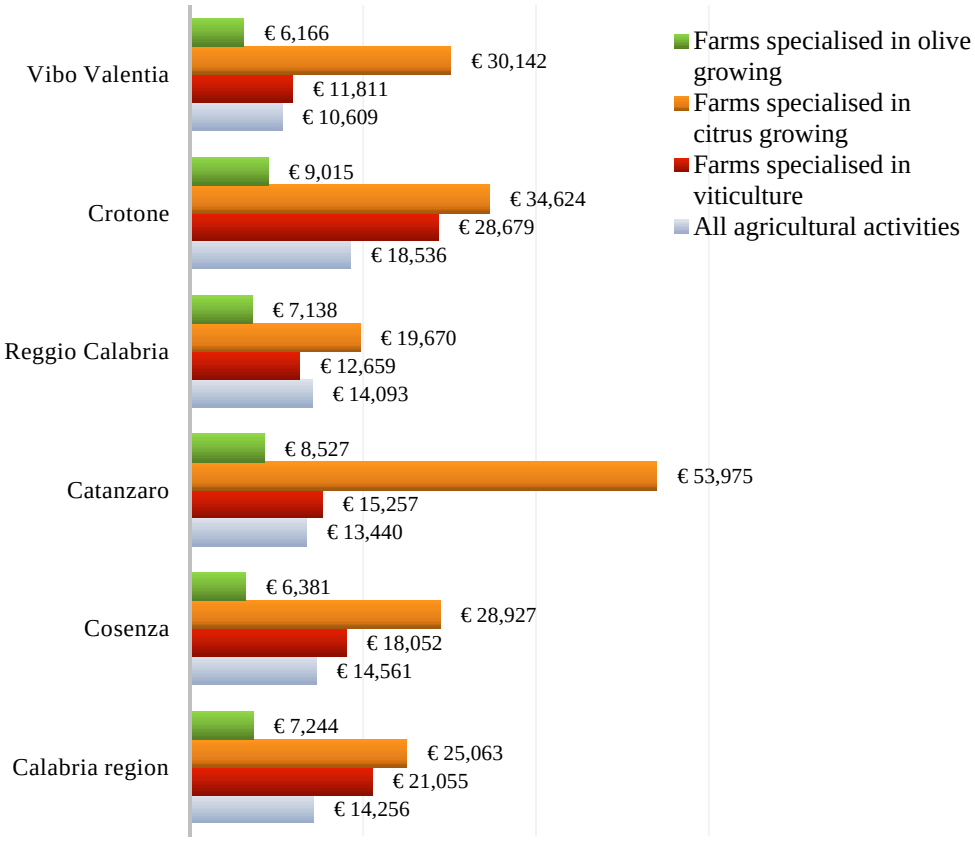
However, in terms of average standard production (Fig. 16), expressed in € $farm^{-1}$ $year^{-1}$ and calculated as the total value of standard productions divided per the number of farms, citrus growing shows the best economic performance compared to other agricultural sectors (ISTAT, 2012). The highest value is registered by the farms in the province of Catanzaro, and the lowest by the farms in the province of Reggio Calabria (Fig. 16). On the land used for citrus growing, 12,530.8 hectare clementine and hybrids are grown, which represents about 60% of national production (ISTAT, 2012), reaffirming the importance of this product at regional and national level (Tab. 11).

Figure 15 - Permanent crops in Calabrian provinces (2010)



Source: data elaboration according to ISTAT (2012)

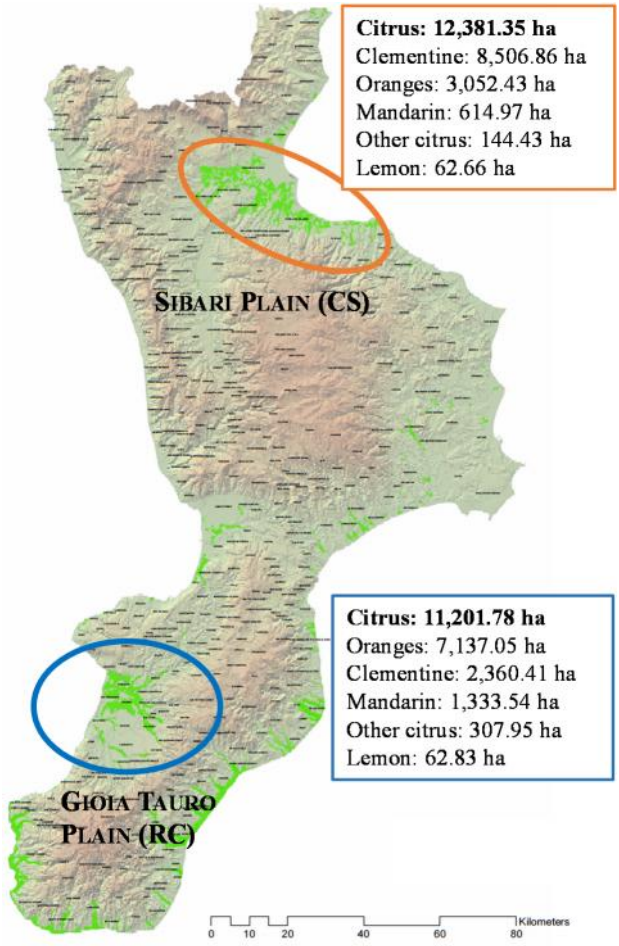
Figure 16 - Average standard production (€ farm^{-1} year^{-1})



Source: data elaboration according to ISTAT (2012)

As previously outlined in Table 11 and represented in Fig. 17, citriculture is concentrated in flat areas near the coast, in the provinces of Cosenza and Reggio Calabria, both in terms of hectares and number of farms.

Figure 17 – Main areas of citrus growing in Calabria (2010)



Source: data elaboration according to ISTAT (2012)

In Sibari Plain's citriculture, in the province of Cosenza (CS) about 12,381.35 hectares are dedicated to citrus growing. The area is specialised in the production of clementine: about 70% of the regional production is concentrated there, and most of the clementine productions (795.4 in Calabria) are labelled with the Protected Geographical Indication (PGI), as disciplinated by the Commission Regulation (CE) n. 2325/97 (De Luca et al., 2014).

Gioia Tauro Plain's surface, in the province of Reggio Calabria (RC), is occupied by 11,201.778 hectares of citrus growing; here, citriculture is specialised in oranges, half of which was destined

to industrial processing for the production of juices until the last decade (De Blasi and De Boni, 2001).

European agricultural policies have always had repercussions on Calabrian agriculture, due also to the dependency of the sector by communitarian grants and funds. In the end of sixties, COMs were created to regulate and orientate the market of fruits and vegetables (Reg. EEC n. 159/66), and the first so-called "Citruses Plan[6]", funded by European Community (Reg. EEC n. 2511/69), entered into force. The aim of these interventions, both at European and national level, was to furnish a temporary help to the structural modernization and the conversion of old cultivars in favour of new ones according to markets fluctuation, as well as grants for industrial processing, opening of markets, fall of the phytosanitary barriers, agreements with non-EU countries, etc. However, according to Scuderi (2008), the situation evolved differently from the initial purposes: the helps programmed passed from being temporality to permanent and, since then, citriculture - and above all the Calabrian one - received a huge amount of economic resources. These have been devoted to the improvement of farming techniques to increase the yield to detriment of quality, having also the assurance of the industrial way out (or at least, the set-aside procedures); this perverse mechanism ensured fair incomes to farmers without assuming market risks (Scuderi, 2008).

As formerly mentioned in par. 5.2.1, the European reform of the Common Market Organization (COM) of fruit and vegetables (Reg. EC n. 1182/2007) has been suddenly put into force without any transition period. This entailed a reduction of citrus production that have been 2,691.2 thousands of tons in 2008/2009, i.e. 926,000 tons less than the previous year, of which 856,000 tons of oranges (92%) (Source: CLAM data, courtesy of CIRAD Montpellier); moreover, a decrease occurred in the number of Producers Associations (PA) that once gathered the product both for fresh consumption and for processing, thus guaranteeing the existence of an end market.

This led to a further worsening of an already weak Calabrian citriculture and its supply chain. Indeed, according to the study by De Blasi and De Boni (2001), the structure of the citrus-growing already in the early 2000 lacked of profitability and competitiveness of the products, oriented more to quantity than quality (more in Calabria than in Sicily) which was intensified by the low-level of bargaining power available to producers when dealing with the processing industries.

[6] The "Citruses Plans" are Italian programming documents of mid-term period promoted by the Ministry of Agricultural, Food and Forestry Policies, funded by the European Union, aimed at boosting innovation and re-organization of national citriculture.

Moreover, in Calabria, the changes introduced by the reform worsened an already delicate social situation. Since decades, there are many well-known social issues linked to the Calabrian agriculture, especially concerning the harvesting task and the involvement of foreign illegal workers. When the economic effectiveness of a productive system decrease, often the solution assumed is cutting the costs, and labour is the first cost item accounted. This migration phenomenon has been the subject of many local and national reports (CNEL, 2002; Medici senza Frontiere, 2008; Cicerchia and Pallara, 2009; Osservatorio Placido Rizzotto, 2012; Dedalus, 2012). Two principal typologies of migration flows interests the region: foreign migrants that come for the first time from their countries of origin (principally Sub-Saharan Africa); and foreign migrants that travel all around the country according to different harvesting periods (e.g. they stay in Apulia during summer for tomatoes harvesting) and return to Calabria for citrus harvesting during the winter season. Seasonal migration is concentrated to the main citrus growing areas, the Plain of Sibari (CS) and the Plain of Gioia Tauro (RC) in particular. Following the report by Osservatorio Placido Rizzotto (2012), the main social issues concerning migrants are working and housing exploitation, irregular labour employment, fraud and deceit for non-paid wages and outstanding labour contracts, illegal recruitment of day labourers, requisition of documents.

According to grey literature on the theme, and interviews to privileged witnesses conducted in 2014, in the only Plain of Gioia Tauro, in the town of Rosarno and surroundings, arrive every year more than 3,000 migrants to be employed in citrus harvest. Not always the supply of work meet the demand. The presence of such a massive number of people that live in poor condition due to low wages (often clandestine and so, without access to many social services) impacts local population and sometimes creates tensions as it has been the case of Rosarno revolt in January 2010 , when an increased immigration unfortunately coincided with a decreased citrus production (Paciola, 2012).

5.3 A post-positivist perspective. An impact pathway methodology: psychosocial risks

5.3.1 Post-positivist stances of the impact pathway methodology.

According to critical review implemented in chapter 4, few SLCA studies developed and applied impact pathways as impact assessment methodology until now (among others: Feschet et al., 2013; Bocoum et al., 2015).

According to the characteristics of the impact pathway methodology described in the previous chapters (3 and 4), the ontological posture that will be assumed for this first methodology is

critical realism, with reality considered unique and objective, but not perfectly apprehendable, patterned and predictable. From an epistemological point of view, the researcher will approaches the study in a detached and rational way, i.e. without entering with personal beliefs into the research process. However, differently from the pure positivism paradigm, a perfect detachment will be not possible and some procedural choices will be at discretion of the researcher.

Indeed, the methodology will look for cause-effects relationships validated by statistical criteria from previous empirical studies that previously provided a generalizable explanation of causes by their effect (induction), and whose results are verifiable, confirmable and refutable (Velmuradova, 2003). Statistical relationships will be used to provide the impact pathway that link the product life cycle to possible social impacts in a quantifiable and probabilistic way.

Results will be generalizable to other contexts of evaluation.

The aim of this methodological proposal is to furnish a tool to accompany management decision processing in agricultural systems, demonstrating which effects - in terms of health - could have the productive phase of citrus life cycle on workers, namely seasonal workers, temporary workers, entrepreneur farmers.

Health and well-being of workers throughout their working lives is fundamental concern and a prerequisite to achieving the Europe 2020 employment objectives in the EU (Eurofound and EU-OSHA, 2014).

According to the statistics of the Italian national institution for assurance for working injuries INAIL (2012), in average, every year 6% of Italian workers are interested by accidents linked to working conditions (all sectors). This entailed an expense, in 2012, equal to 3.6% of Gross Domestic Product (GDP), and in particular 35 billion of Euro for reimbursement of accidents and about 6.8 billion for reimbursement of professional diseases (Bartoli, 2014).

According to INAIL (2015), in 2010-2014 period, 176,690 accidents (denounced and reimbursed) happened in the agricultural sector (2% of them in Calabria); among injuries occurred in 2014 in Calabria during working tasks (all sectors), 14% were in agriculture.

Moreover, labour wages represents for farmers more than 50% of overall costs, so it is understandable how healthy working conditions could be important for agricultural economy.

5.3.2 Material and methods: Psychosocial Risk Factors (PRF) impact pathway

The present methodology is inspired to the work by Gasnier (2012) and Silveri et al. (2014) about the anticipation of psychosocial factors effects in SLCA. It is still at a first phase of development,

so the reader should be aware that many place for improvements remain, and results should be read assuming a cautionary posture.

Even if healthy working conditions are of utmost important in European and world policies, and central challenge in management processes, there is not a univocal definition of PRF.

According to Amiri et al. (2015:69), “Psychosocial risks factors are elements that impact employees psychological responses to work and work conditions, potentially causing psychological health problems”.

For this study the definition by Cox and Griffith (1995) and Cox et al. (2000) is taken into account; these authors defined PRF as those aspects and characteristics of work planning and management that can potentially lead to physical or psychological damages.

Eurofound and EU-OSHA (2014) affirmed that psychosocial risks are among the most challenging risk factors to manage at workplace. They can lead to poor health and well-being, with associations that can differ in strength and outcomes. Many studies can be found in literature that quantify these associations for a wide range of PRF and working conditions and many health problems (among others: Karasek, 1979; Siegrist, 1996; Krause, 1997, Bovenzi, 2010; Lahelma et al., 2012; Ng et al., 2015).

The present impact pathway methodology is applied to two citrus growing scenarios: the agricultural life cycle phases of oranges for industries and of clementine for fresh consumption in two fictitious farms of Gioia Tauro Plain (RC), with the same agricultural surface (3 ha), duration (40 years), and farming typology (conventional, not organic).

Average data have been considered for both farms according to grey literature on Calabrian citriculture, internal databases from previous studies on the same sector (Strano et al., 2013); data have been triangulated with results from direct surveys to representative farms of the area. The choice of these two scenarios is based on the real current situation of Calabrian citriculture: due to the decrease of helps to transformation and the strong concurrence of non-EU countries (Brazil above all), oranges for industry are declining in favour of cultivars of quality for fresh consumption. The methodology (Fig. 18) is divided into the following steps:

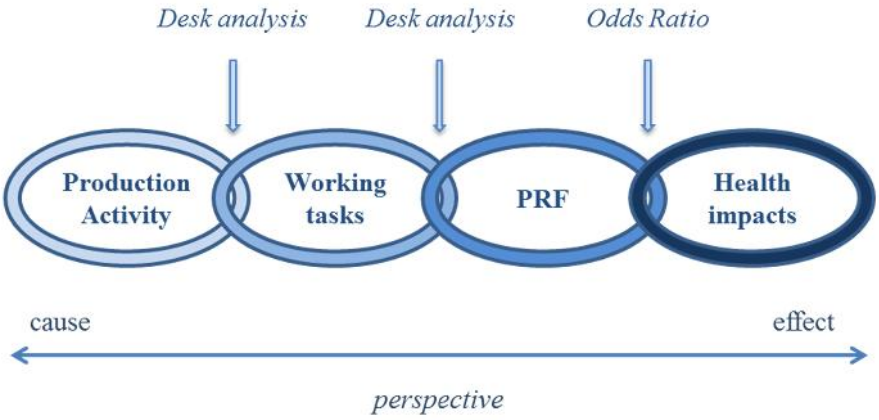
1. An inventory analysis of working hours needs for each task (pruning, harvesting, phytoyatric treatments, etc.) and for each agricultural phases, classifying the typology of work (manual, mechanical, etc.).

2. A literature review of studies about the association of particular working conditions that entail the exposure to psychosocial risk factors. Each statistical association is classified according to its intensity.

3. The construction of a PSR Matrix (Annex 2), where every working conditions occurring in the scenarios are linked, through the previous statistical relationship, to a physical or psychosocial disease.

4. The assessment of social impact through the quantification of working hours that potentially expose workers to one or more disease, physical or psychological.

Figure 18 - PRF impact pathway methodology



5.3.3 Results of PRF impact pathway

The first phase (inventory) started with the definition of each cultural phase, namely: Plantation (y_0), Growing Phase (y_{1-4}), Increasing Production (y_{5-8}), Constant Production (y_{9-32}), Decreasing Production (y_{33-40}), Disposal (y_{40}). The study of agronomic literature, and surveys with representative farms, allowed to build the inventories, i.e. 12 technical templates completed (six per scenario), each of them reporting working tasks specific for each phase, such as:

- Characteristics of the orchard, e.g. planting density (6x5 m for industrial oranges; 5x4 for clementine), number of plants (1,000 orange trees; 1,500 clementine trees), that are constant for all phases; average yield (300 q of oranges in constant production phase; 350 q of clementine), duration of the phase, residual biomass per year;

- Fertilization and soil management, e.g. spreading fertilizers (N, P, K), harrowing, etc.

- Pruning, i.e. shaping intervention or wood cutting, biomass removal (charge, transportation and discharge);

- Irrigation, i.e. watering and maintenance of installations;

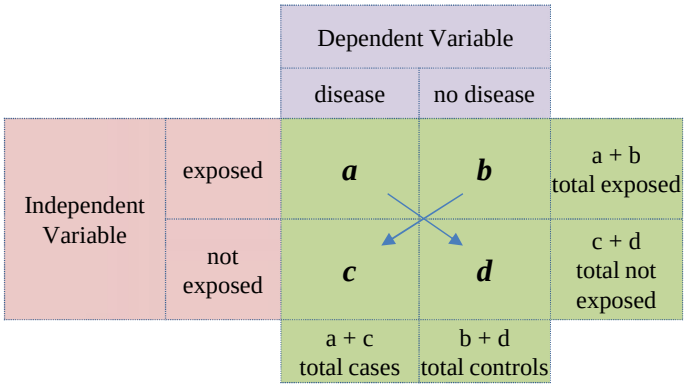
- Pest and disease control, e.g. spraying of fungicides, insecticides;

- Harvesting, i.e. manual harvest, crates charge and discharge, transportation;

- Organization and management, e.g. organization of tasks, intellectual work, bureaucracy, agronomic consultancy

In the second phase a literature research has been conducted to gather scientific studies about the association between working (physical) conditions and health diseases. Most of the studies were retrieved from medical scientific journals. In particular, the research were focused on those papers quantifying the correlations in terms of odds ratio (Fig. 19).

Figure 19 - Statistical measure of association intensity: odds ratio



Source: Bottarelli and Ostanello (2011)

The odds ratio is a statistical measure of the intensity of association between two variables, can be expressed, in the case of people exposed to risk factors of disease, as the ratio between odds of exposure in sick people (a/b) and odds of exposure in healthy people (c/d), or as the following formula:

eq (1)
$$\text{ODDS RATIO} = \frac{a \times d}{b \times c}$$

It represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure (Szumilas, 2010). As affirmed by Bottarelli and Ostanello (2011), it is a retrospective analysis of a phenomenon, non-dimensional value, and it can assume values between 0 and + ∞. A value of 1 indicates that there is no association between disease and exposure, while values < 1 indicate a negative association (the risk factor can protect from disease). The higher the value, the stronger the association between

exposure and outcome. However, to validate the consistency of a cause-effect relationship, a statistical significance test should be conducted. Furthermore, odds ratio is not a *per se* measure of risk because it refers to the probability of having already a disease; but, if it is assumed that the average duration of a disease is the same in exposed and non-exposed, then the odds ratio is a good measure of relative risk (Bottarelli and Ostanello, 2011).

All odds ratios gathered from the literature search that explained relations between working conditions of the two scenarios and some typology of disease have been used to build and complete the PRF Matrix in Annex 2. Few studies referred to agricultural working situations, so for this study it has been assumed that they were transferrable to the case study; furthermore, as the study is about a comparison of two scenarios, if there is a margin of error, it is repeated in both scenarios. As an example, according to the study of Bovenzi and Betta (1994), tractor drivers exposed to vibrations and certain postures, are exposed to the risk of sciatic pain with an odds ratio of 3.9 (16-25 driving years). Odds ratios have been classified according to Bottarelli and Ostanello (2011) as showed in Table 12.

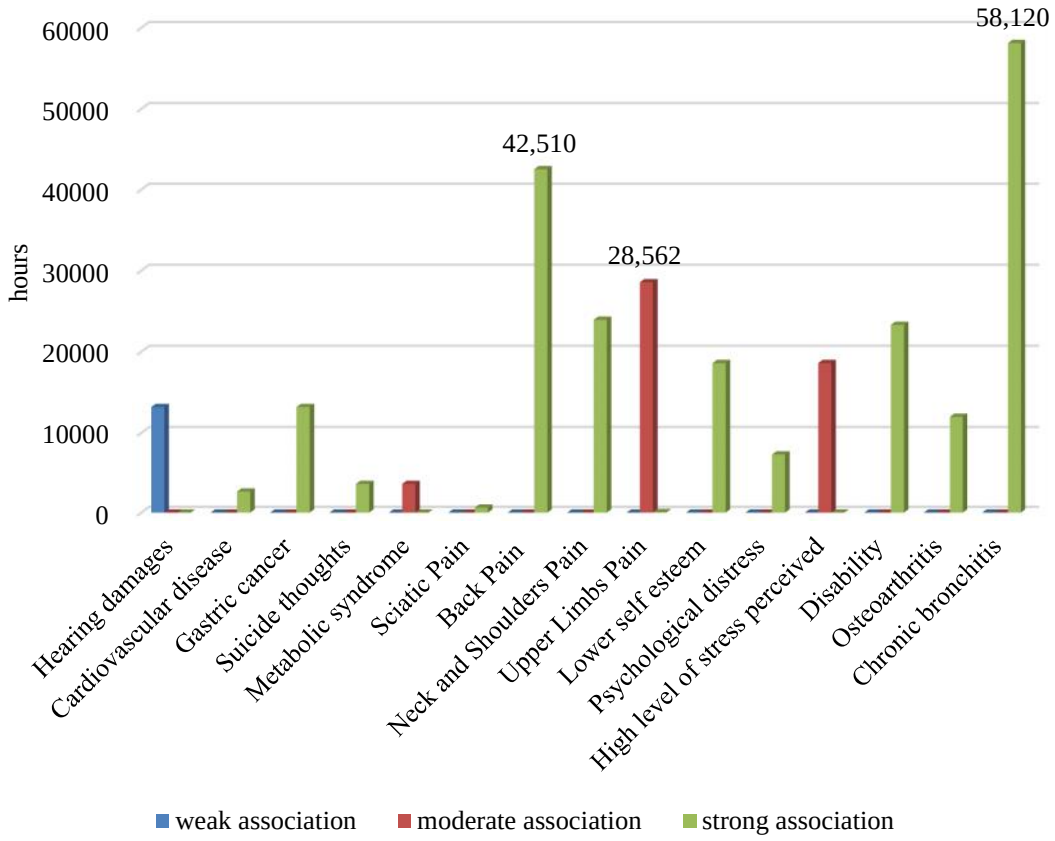
Table 12 - Odds ratios classification

Negative association	No association	Weak	Moderate	Strong	Very strong
0<OR<1	OR=1	1<OR<1,3	1,3<OR<1,7	1,7<OR<8	OR>8

Finally, total hours per each working conditions have been grouped; when a situation exposed contemporary to more PRF, it has been accounted twice, per each risk factor. The study did not take into account interactions between more PRF, because no reference pertinent were found. But it would be an interesting further development of the research. Social impacts have been quantified and characterised according to Tab. 12.

Results showed that the agricultural phases of industrial oranges life cycle (Fig. 20) entails 58,120 hours of work with exposure to the risk of chronic bronchitis (strong association), 42,510 hours of work exposing to risk of back pain (strong association), and 28,562 hours of work exposing to risk of upper limbs pain (moderate association).

Figure 20 - PRF impact pathway assessment of industrial oranges life cycle

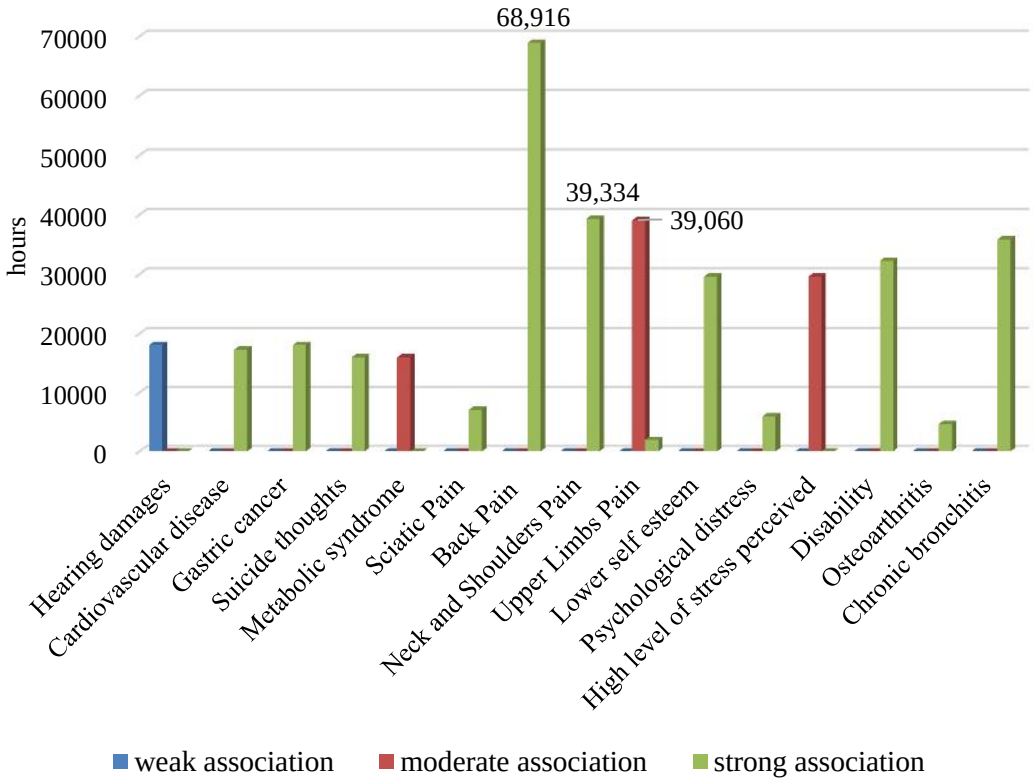


As represented in Figure 21, the agricultural phase of clementine life cycle entails 68,916 hours of working tasks exposing to the risk of back pain (strong association), and the risk of neck and shoulders pain (39,334 hours with strong association) and upper limbs pain (39,060 hours with moderate association).

Probably the reason of the difference of results is to, among others, to the different duration of harvesting, that is longer in clementine orchard: workers have to pay attention to do not damage fruits that are destined to fresh consumption, so the exterior aspect must be preserved.

Further developments are necessary to better define the methodology. A deeper research of more psychosocial risks and odds ratio relevant to agriculture would be an asset.

Figure 21 - PRF impact pathway assessment of clementine life cycle



5.4 An interpretivist perspective. Stakeholders and experts participation to develop a Social Impact Matrix (SIM)

5.4.1 Interpretivist stances

The present methodological proposal[7] has been based on an interpretivist paradigm, so it is assumed that subject /researcher) and object (research) are dependent and that knowledge can be constructed through the participation of relevant actors; and from positivism-oriented assumptions, e.g. that reality can be explained, but not totally, and that the scientific community plays an important role. Many procedural choices have been at discretion of the researcher or those actors whose perception were considered important by the researcher. Indeed, more realities

[7] A second version of this work has been published on the journal Integrated Environmental Assessment and Management (cfr. De Luca et al., 2015b)

can exist in the perceptions of stakeholders, and this study want to take them into account, to interpret and understand the social realities of the system under study.

The methodology is mainly hermeneutical and recurred to the use of many qualitative and multicriterial methods from social research. The aim is to verify the interpretivist realism paradigm as an epistemological option for developing SLCA, fulfilling requirements for: (i) completeness, assessing a wider variety of impacts; (ii) coherence, by involving local experts; (iii) legitimacy, by involving local actors and stakeholders as active subject in an iterative and inclusive process and not as passive receivers.

According to the literature review conducted, the resort to different methods chosen for their relevance to each step is quite new in the field of SLCA.

Multi-Criteria Decision Analysis (MCDA) served a two-fold purpose. Firstly, it allowed carrying out of a joint assessment of different analyses results. Secondly, it permitted to directly incorporate the preferences of different interest groups or stakeholders, thus providing useful information that could be of great utility, for example, to increase the likelihood of political actions based on new contextual knowledge. Recently, MCDA and participatory approaches have been applied to LCA studies (Recchia et al., 2011; Bachmann, 2012; Castellini et al., 2012; De Felice et al., 2013; Malloy et al., 2013; Mathé, 2014; Yue et al., 2014). However, the use of these methodologies for the purpose of integrating different LCT results remains a little explored field.

Thus, in an attempt to increase knowledge in this area, the objective of this paper is to propose an approach that combines S-LCA with tools derived from qualitative and operational research. More specifically, this study aims to implement participatory and multicriterial tools in an S-LCA application by integrating, simultaneously, environmental and economic indicators gathered from LCA and LCC analyses conducted in the same territorial context (Strano et al., 2013; Gulisano et al., 2013). This study focused on citrus growing in the three main cultivated areas, allowing for the comparison of different (organic, integrated and conventional) agricultural practices in the three main province of production.

5.4.2 Material and methods

The first step of the methodological framework combined territorial analyses, literature review and focus groups (Bloor et al., 2001; Stewart et al., 2007; Kamberelis and Dimitriadis, 2013); the focus groups were structured to involve a specific target-group of local experts in the process of choosing impact categories, subcategories, and indicators.

The second step concerns the inventory analysis and the fulfilment of a Social Impact Matrix (SIM), in which data collected from both primary and secondary sources were elaborated for each clementine-growing scenario. Environmental and economic data were taken from the results of previous LCA and LCC analysis of the same case study (Strano et al., 2013).

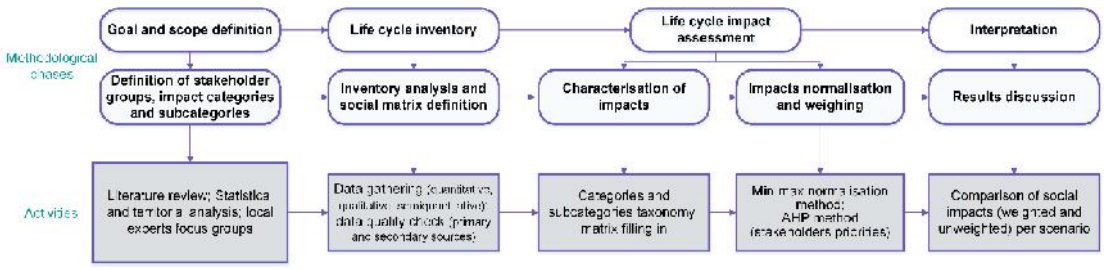
The third step, the life cycle impact assessment, was carried out through three sub-steps, which will be described in more detail in the next sub-paragraph. For the purposes of this assessment, the Analytic Hierarchy Process (AHP) (Saaty, 1990) was applied as a multicriterial tool to involve affected actors (hereinafter "stakeholders") in the evaluation of the relative importance of each impact category and subcategory, and allowed to mix qualitative and quantitative data. The forth step consisted in the interpretation of results.

Participation played a key role to make the assessment legitimate and adherent to reality.

The methodological framework is represented in Figure 22, structured according to the example of the standardised environmental-LCA steps (ISO 2006a; 2006b).

With regard to the first step, a territorial analysis and a literature review constituted the basic information upon which the focus group has been structured. The territorial analysis consisted of both desk and field research: at desk level, it consisted in analysing the current official statistics and the specific grey literature (e.g. dissertations and technical reports) relevant to the contexts under study; at field level, it was carried out through semi-structured questionnaires and face-to-face interviews with farmers and privileged actors. The literature review allowed us to compile a list of those social domains that were likely to be significant for our assessment.

Figure 22 - Interpretivist methodological scheme



Source : De Luca et al. (2015b:385)

Focus groups (Bloor et al., 2001; Stewart et al., 2007; Kamberelis and Dimitriadis, 2013) were used in this study as a qualitative technique to involve local experts (researchers) with experience in agricultural domains, rural economics and local development. The result of this first step was the identification of stakeholder groups, which were chosen among those recommended by UNEP-SETAC (2013): "Workers" directly involved in clementine-growing farms, "Local Communities", i.e. the inhabitants of municipalities where farms were located, and "Society", i.e. all those individuals not included in the previous groups. For each of them, the focus groups allowed the selection of the most relevant categories, subcategories and indicators, assembled in a taxonomic order. The second step consisted of inventory analysis and the construction of a Social Impacts Matrix (SIM) framework (Fig. 23).

Figure 23 – Participative Social Impact Matrix (SIM)

Source: De Luca et al. (2015b:386)

Direct and proxy indicators measurements were developed in accordance with the suggestions of local experts, and data were gathered from primary and secondary sources, namely the above mentioned semi-structured questionnaires and direct interviews conducted at the farms, as well as official statistics and literature (see example Tab. 13). Results from previous LCA and LCC

studies (Strano et al., 2013; Gulisano et al., 2013; De Luca et al., 2013) conducted in the same areas, sector and period of time have been used to measure some of the indicators of the environmental and economic impact categories in the SIM, in order to establish a framework for a holistic interpretation of social issues, as well as to attempt an integration of different life cycle analyses.

The third step of this methodological proposal consisted of three sub-steps: (i) the characterisation of impacts, i.e. the completion of a social impacts matrix using the inventory data, previously checked in terms of quality and significance; (ii) the specification of indicators' direction - quantitative and qualitative indicators have been minimised or maximised, according to their negative or positive meaning; (iii) impacts normalisation and weighting.

Concerning (iii), impacts have been homogenised through a min-max normalisation function (Han et al., 2011) that has allowed for the conversion of heterogeneous data in a-dimensional indices, comprised between 0 (minimum value of the indicator investigated) and 1 (maximum value):

$$v' = \frac{v - \min_A}{\max_A - \min_A}$$

eq (2)

Normalisation allowed the comparison between indicators of different nature (see example in Table 13), establishing a first ranking among scenarios in terms of (unweighted) social performances. Contrary to environmental assessment in LCA, in this study a higher score represents more socially sustainable performances and impacts.

Categories and sub-categories have been weighted using the Analytic Hierarchy Process (AHP), a multicriteria method developed by Saaty (1980). The first phase of the AHP, i.e. the creation of a hierarchical structure through the decomposition of the decisional problem into levels and sub-levels (Calabrò et al., 2005), coincided with the structuring of the social impact matrix. The second AHP phase consisted in pairwise comparison at each level: stakeholders, divided in three groups, were interviewed to compare each sub-category and category of impact. Each element of the AHP priority matrix has been normalised and a consistency ratio (CR) of the pairwise comparison matrix (Saaty, 1990; Pineda-Henson et al., 2008) has been calculated to discard answers with CR > 10%.

The AHP allowed the transformation of qualitative judgements into quantitative elements (the weighting of each subcategory), and, therefore, the synthesis of stakeholder priorities. Before starting the weighting process, subcategories with more than one indicator or categories with more

than one subcategory, were summed them by column and then normalised by row in order to maintain the rankings among scenarios (otherwise, categories with more indicators would have been more important than others).

Table 13 – Example (detail) of participative SIM data completion (CS scenarios)

							CS		
Stakeholders groups	Categories	Sub categories	Indicators	Sources and data significance		Unit of Measurement	O	I	C
Society	Contribution to economic development	Economic efficiency	Net Present Value (from LCC)	+	Strano et al. 2013	Quant: euro/ha	126,154.6	66,640	107,592
		Contribution to occupation	Permanent Work Estimation	+	Elaborations on primary data	Quant: n/ha	0.33	0.42	0.38
	Environmental impacts	Risorse naturali	Water depletion (from LCA)	-	Strano et al., 2013	Quant: m^3	1,450.4	1,453	1,448.2
		Ecosistemi	Carbon footprint (from LCA)	-	Strano et al., 2013	Quant: CO_2 eq	92,801	91,723	101,951
		Salute umana	Climate change human health (LCA)	-	Strano et al., 2013	Quant: Recipe Endpoint single score	2,903	5,820	8,154
Local Communities	Notoriety	Reputation of local area linked to working conditions	Episodes of serious workers exploitation	-	Osservatorio Placido Rizzotto (2012), agriculture, municipalities or districts	Qualit: YES-NO (1-0)	0	0	0
			Episodes of indecent working conditions	-		Qualit: YES-NO (1-0)	1	1	1
			Presence of epicentres of zones at risk	-		Quant: n/area	4	4	4

Normalised data were then multiplied for each set of local weights (one per area considered), allowing for a second ranking among scenarios in terms of (locally) weighted social impacts. Finally, a single set of weights has been calculated (at regional level, from AHP) and a third (regional) ranking has been obtained. The fourth step of the methodology consisted in the interpretation of results.

5.4.3 Results of the participative SIM methodology

A system boundary “from cradle to gate” (i.e. from planting to harvesting, at farm level) was chosen according to parallel studies that were developed using the same data to assess economic

and environmental sustainability (Strano et al., 2013; Gulisano et al., 2013; De Luca et al., 2014). The main reason behind this choice was the fact that the study focussed on the agricultural phase.

One hectare of clementine orchard was chosen as a functional unit (FU) to which indicators, when possible, have been referred. The three main agricultural areas were selected (Sibari Plain in the province of Cosenza, Lamezia Terme Plain in the province of Catanzaro, and Gioia Tauro Plain in the province of Reggio Calabria), and three principal techniques of cultivation were considered; in this way we identified nine production scenarios (CS_C, CS_I, CS_O; CZ_C, CZ_I, CZ_O; RC_C, RC_I, RC_O; where: C stands for Conventional, I for Integrated and O for Organic; CS stands for Cosenza, CZ for Catanzaro, and RC for Reggio Calabria).

According to UNEP-SETAC (2013), three main groups of affected actors have been identified, as follows:

- "*Workers*", understood as actors directly involved in the production of clementine citruses;
- "*Local community*", designating actors living in the same territory where clementine orchards are located, who are somehow affected in their role of users of local resources (material and immaterial ones);
- "*Society*", designating actors indirectly affected in terms of quality of the environment and economic development in a broad sense, living far (>30 km) from the territories where clementine orchards are located.

For each stakeholder group, the experts involved in the focus group elicited a value tree of categories, subcategories and indicators; as a result, the SIM has a tree-based architecture.

Experts found that "Workers" in agricultural domains are mostly concerned in terms of the following categories of impact:

- *Health and safety*, due to the risk that workers undertake, especially during field operations such as pruning, driving machines and phytoiatric treatments. This category has been assessed in terms of the number of complaints of injury and occupational disease during the last three years of available data (2010-2012) in the citrus sector. Data per province for the citrus sector were retrieved from the Italian national insurance provider for work-related accidents (INAIL, 2013) database, and then related to the number of hectares of land used for clementine production through a proportional relation. Data showed the best performance in "CZ" scenarios, where no complaints for injuries were registered, while, with regard to diseases, the only examples were found in "RC" scenarios.

- *Fairness of working conditions*, because statistics on irregular work show that it occurs with the highest rate in Calabria (30%), with an increase of up to 53% in the agricultural work sector for

the year 2002 (ISTAT, 2004). Two main issues were considered relevant by the experts in the assessment of impacts on this category: illegal work and risk of immigrants mistreatment. The former is estimated by calculating the difference between the working needs of a one hectare orchard and the amount of employees regularly contracted by interviewed farmers, expressed in working days per hectare per year. The latter is assessed through two qualitative indicators, i.e. the presence of episodes of serious worker exploitation and of indecent working conditions, and a quantitative one, i.e. the number of areas with a high incidence of exploitation of illegal immigrants; in both cases, data were retrieved from grey literature (Osservatorio Placido Rizzotto, 2012).

- *Equal opportunities*, chosen by experts as a topic of high concern in agricultural domains, where foreigners and women are often the objects of episodes of discrimination. These were assessed as the percentage difference of daily wages, based on data gathered directly through questionnaires.

Concerning the stakeholders belonging to "Local communities", three categories of impact were considered by the experts to be relevant:

- *Access to material resources*, measured according to soil and water quality at local level, and calculated as the percentage of hectares situated on nitrate-contaminated soils and on contaminated aquifers, both of which were retrieved by comparing different database of the Regional Agency for Agricultural Development and Services in Calabria (ARSSA, 2002a, 2002b). In fact, agricultural activities are considered one of the main sources of pollution, due to tillage and the use of fertilisers and pesticides.

- *Use of immaterial resources and technologies*, assessed in terms of the percentage of farms - or percentage of hectares of farms - that use information technologies, have Internet access and have recourse to local knowledge (such as expert advice and customisation of technical tools).

- *Area reputation*, assessed according to the contribution of clementine production to the (positive or negative) reputation of the area they belong to, in terms of quality of products (percentage of farms producing "Clementine of Calabria" Protected Geographical Indication) and working conditions (with reference to the same indicators used for "working conditions").

Finally, in order to assess impacts on members of "Society" in a broad sense, experts selected two categories that met the broader consensus among the authors reviewed, i.e. *environmental quality*, and *economic development*. In order to assess the first category - *environmental quality* - data from an LCA conducted on the same case study and scenarios (Strano et al., 2013; Gulisano et al., 2013) were re-elaborated, converting its results into "ReCiPe endpoint single scores" in order to assess the damages on the three typical areas of protection, i.e. *natural resources*, *ecosystems*

and human health. The reason for this choice resides in the broad boundaries of the damage categories in LCA, according to which it makes sense to consider the whole society as an affected actor. The second category - *contribution to economic development* - has been assessed as:

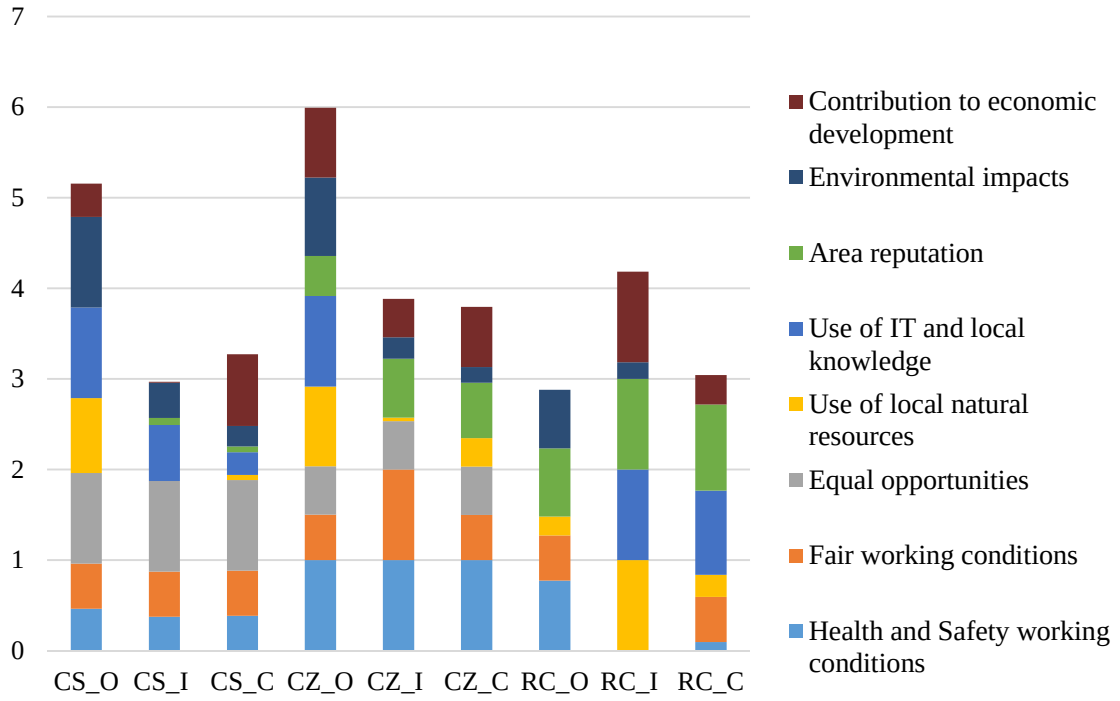
- *Economic efficiency*, on the basis of NPV (Net Present Value) and IRR (Internal Rate of Return) results from an LCC assessment conducted in the same, above-mentioned studies (Strano et al., 2013; Gulisano et al., 2013). These parameters take into account the economic and financial trends of investment during the whole life cycle. A discounting rate of 1.8% has been applied, due to the low risk and long-lasting nature of agricultural investments. The economic trends do not allow for the estimation of a reliable average inflation rate during the overall period considered, therefore a coefficient has been employed that is not inflation-adjusted, in order to reduce the degree of uncertainty in the results.

- *Estimated employment impact*, assessed through proxy indicators elaborated on data gathered through farmers questionnaires: "Estimated Permanent Work" (EPW) and "Estimated Temporary Work" (ETW) were both calculated as the number of employees per hectare, and the "Estimated Stability Work" (ESW) index was calculated as the relation between the two ($ETW \cdot EPW^{-1}$). In almost all cases, employment shows a tendency toward instability, due to the concentration of labour in few periods (e.g. harvesting season), with the highest relations registered in Sibari Plain (CS). The data from the Gioa Tauro Plain (RC), showing an opposite tendency, is also meaningful, with an ESW< 1 that reveals the use of irregular (undeclared) temporary labour.

- *Estimated evasion of social security contribution payments* was assessed through a proxy indicator elaborated from primary data and based upon the difference between the average labour requirements of a hectare of clementine orchard, and the labour force declared by interviewees, expressed in working days per hectare. The highest results were registered in Gioia Tauro Plain, especially in the conventional and organic sectors (respectively 31.66 and 46.57 days ha^{-1}).

As above mentioned, normalization allowed the comparison between indicators of different nature, thus offering a first ranking among scenarios in terms of (unweighted) social performances. Impacts dimensions, expressed in "unweighted social points", are the result of minimised negative data and maximised positive data, and, therefore a higher score represents a more socially sustainable performance. Figure 24 shows that "CZ_O" is the best scenario, followed by "CS_O" and "RC_I". In most scenarios, "Health and safety conditions at work" - here interpreted as a low incidence of diseases and accidents - contributed strongly to social-friendly performances, followed by "Use of IT and local knowledge" and "Equal opportunities". "RC_O" is the worst scenario, mainly due to the lack of equal opportunities, IT and local knowledge, and the poor contribution made to economic development.

Figure 24 - Unweighted social impacts, per area, per growing system



AHP results showed small differences in terms of rankings, except for a few of them such as "Environmental impacts", which is the most important impact category for actors from Gioia Tauro Plain (RC), while in the other areas (CS and CZ) "Health and safety conditions at work" are seen as more relevant (Figures 25, 26, 27).

Figure 25 – Categories weights from CS stakeholders preferences

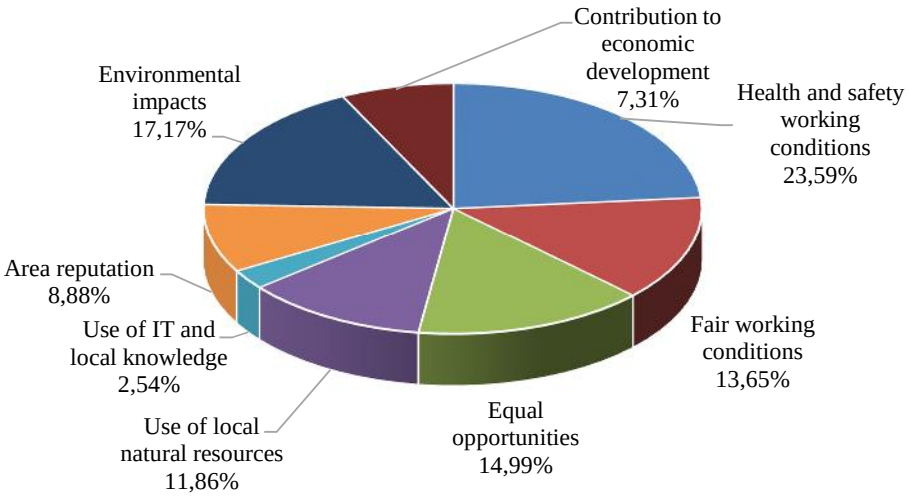


Figure 26 – Categories weights from RC stakeholders preferences

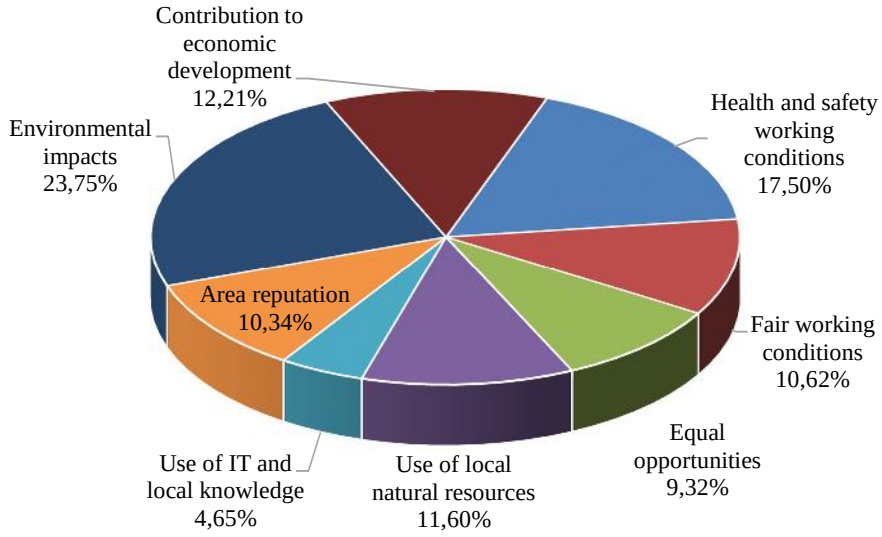


Figure 27 – Categories weights from CZ stakeholders preferences

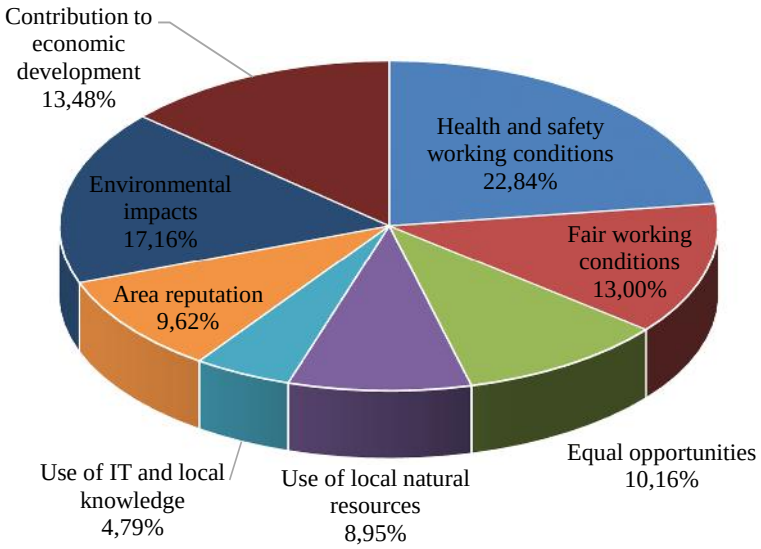


Figure 28 represents a second ranking, considering three sets of local weights. It shows few differences in terms of ranking among scenarios. Indeed “CZ_O” and “CS_O” are once again the best scenarios, but they are followed here by “CZ_I”. Concerning impact categories, “Health and safety conditions at work” is the best performing category, followed by “Environmental impacts” and “Equal opportunities”.

Figure 28 – Social impacts with local weights, per area, per growing system

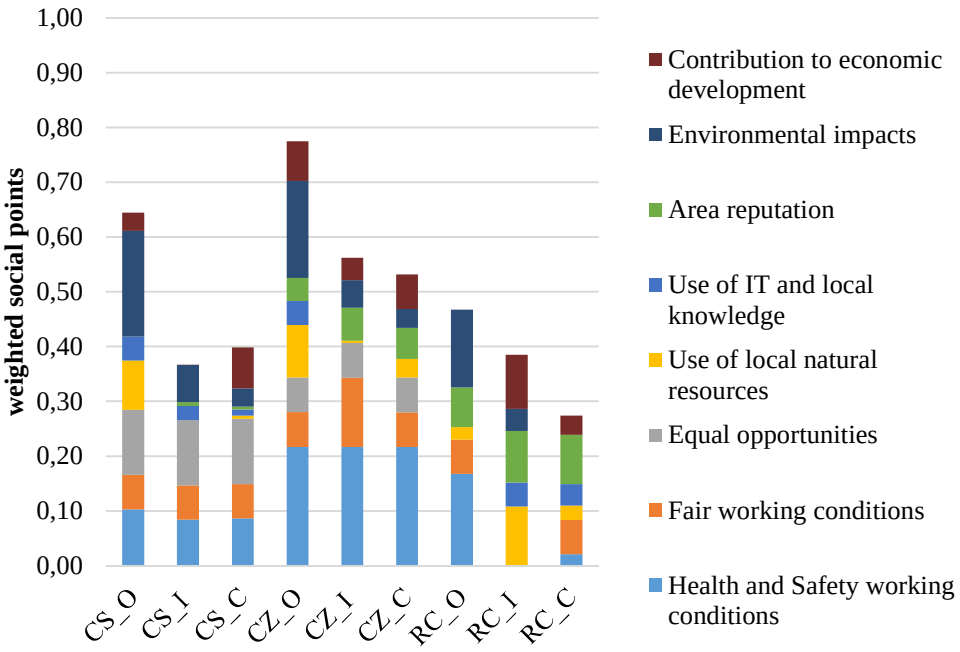
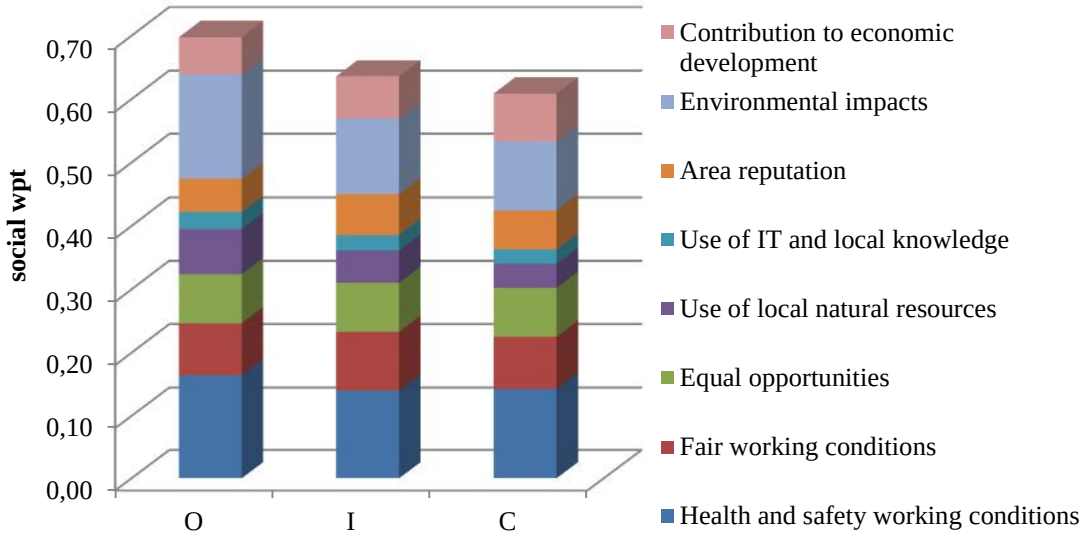


Figure 29 illustrates a further overall ranking elaborated from a unique set of weights (regional preferences). Results show that the organic growing scenario (O) is the most socially sustainable, with a difference of 8.8% compared to integrated growing scenario (I) and 12.74% compared to the conventional one.

Figure 29 – Social impacts with regional weights, per growing system



5.5 Conclusions

The two methodologies have been very different in terms of research procedures, epistemological assumptions, and methodological choices. Furthermore, they furnished different typologies of results that can have different usefulness according to the context they are applied.

Far from favouring one or another methodology or paradigm, in the next chapter the main difference will be discussed, and reflections for the future of SLCA development are proposed.

6. DISCUSSION AND CONCLUSIONS

6.1 Considerations comparing the two methodological proposals for SLCA

The first methodology applied in this study, i.e. the PRF impact pathway framed in the realm of post-positivism paradigms, allowed to quantify the cause-effect relationship between citrus life cycle and psychosocial impacts on affected workers. It allowed assessing objectively the differences between two productive scenarios, and the methodology is generalizable and applicable to other contexts. It is limited to only a group of affected actors (workers), but it would be possible to extend the study to other stakeholders. The principal strength stays in the possibility of predicting the consequences of managerial or structural changes in the life cycle. Decision makers can find in the PRF matrix a valuable instrument to support decision, both at farm level and in the context of policy making. Furthermore, this methodology is in line with the current state of the art of environmental Life Cycle Assessment, based on cause-effect relationships between inventories of matter and energy flows and impact categories. Many scholars advocated for the development and improvement of LCSA, intended as the harmonisation of eLCA, LCC and SLCA. The impact pathway methodologies well serve this aim of unification, being framed in the same paradigmatic perspective.

The interpretivism-oriented SLCA methodology (participative SIM) applied in this study mixed quali-quantitative techniques and multicriteria analysis tools allowing the recognition of local specificities by involving local experts and affected stakeholders. Despite its local character, the entire methodological framework could be adapted to other agricultural processes and to further supply chain phases, but system boundaries and the choice of impact categories should be revised and adapted to the new context. The value added of this methodology stays in the legitimacy given by stakeholder participation and their opinions that have been used to assess impacts. Furthermore, negative and positive impacts have been taken into account, and assessment practice that have been poorly applied until now in SLCA studies. The paradigmatic perspective underpinning the methodology is in line with the state of the art of SLCA literature, as demonstrated in the critical review of chapter 4.

Concerning the research phases, Table 14 compares the two methodological proposals. As it shows, differences can be outlined since the beginning of the research processes, i.e. in the paradigm choice. The research questions have different meaning: the first looks for explanation (*Erklären*, typical of nomothetic sciences), the second for comprehension (*Verstehen*, typical of

idiographic sciences[8]) of social impacts; the same dichotomy can be found between the two main families of paradigm of sociology and management science.

Table 14 – Comparison of research processes of the two methodologies

PRF impact pathway	*Research phases*	*Participative SLCA*
Post-positivism. Realist and objective posture.	1. Paradigm choice	Interpretivism. Relativist and subjective posture.
Which are the real social impacts caused by the functioning of citrus life cycle? Which changes should be made to improve it?	2. Formulation of research question	How assessing social impacts on a wide range of actors affected (positively and negatively) by citrus growing? What is worthwhile protecting and for who? Who is responsible for what? Which typology of farming practice is more socially sustainable?
A transformation is occurring in Calabria citriculture: oranges for industry are disappearing in favour of quality products, e.g. clementine.	3. Choice of case study and planning	Clementine is the most renowned citricultural product from Calabria. Three main areas of production (CS, RC, CZ) and three typologies of farming practices (O, I, C).
Review of scientific literature. Data triangulation with few interviews to privileged actors.	4. Data collection	Review of grey and scientific literature, databases consultation, direct surveys and interviews.
Data gathering, classification and calculation.	5. Data analysis and impact assessment	Data gathering, normalization, and weighting according to stakeholder preferences, calculation.
The risk of Back Pain is stronger in clementine growing, but chronic bronchitis is weaker. Management changes would improve working conditions and reduce the exposure to risk of health troubles.	6. Interpretation and use of results	Organic farming practices are socially preferable. Environmental impacts and working conditions are the greatest concern among local actors.

The choice of case studies are similar, because based on available information and knowledge about the actual situation of Calabria citriculture; the same sources have been used, i.e. literature and statistics (e.g. ISTAT, 1012; INAIL, 2013).

[8] The terms *Erklären* and *Verstehen* comes from the discussions inside the German historicism, but have been used in many sociological debate contexts.

Data collection, at the contrary, has been very different. In the first case, it was limited to literature review among medical journals, and triangulation served to select and verify the pertinence of the PRF chosen to the case study. In the second methodology, it has been a long and costly process in terms of time and costs. Many displacements were necessary for interviews that also took time according to the typology of actor interviewed: for example, foreigners (and relative problems of communication), or actors that have no information about citriculture issues. Also data gathering from available database was a quite long task, due to the differences of levels among them and relative adjustments needed (e.g. local vs regional data). This entailed also the construction of proxy indicators to adapt data to the case study.

Data analysis and impact assessment took the same efforts in terms of time, just a bit longer in the second case due to the calculation and application of stakeholders' preferences.

In these two last points of research process (phase 4 and 5 in Tab. 14) the posture of the researcher was different. In the second methodology, the intervention onto the analysis and the assessment was stronger and the personal expertise on the field of application was necessarily involved. On the other side, it was a personally enriching experience, and it showed how it is necessary to inform actors about research topics and findings and to cooperate and listen to them: at the end, they are the final addressees of research, not only academics.

The interpretation of results served different aims, as different were the starting questions. The first methodology focused only on a typology of actor, i.e. workers, but allowed to predict the effects of life cycle changes, such as the disappearing of industrial oranges citriculture in favour of clementine citrus growing. The second methodology furnished a wide description of different typologies of social impacts (or rather "performances" according to Parent et al., 2010) and different actors. Furthermore, results from previous available LCA and LCC studies have been used for some indicators in the same methodological framework. However, it is not totally possible to predict which effects would occur by means of life cycle changes.

According to the analysis of paradigms in SLCA conducted in chapter 4, in Table 15 the characteristics of each impact assessment are checked. Comparing them, and according to what discussed until now, it is possible to find the same strength and weaknesses of each family of paradigm in the two methodological proposal (cfr. Tab. 8)

In both methodologies, the choice of impact categories (or health diseases in the first methodology) influenced the results. Maybe results would be different if considering more categories or different issues. As already said, there is many place for further developments and improvements.

Table 15 – Comparison of the two impact assessment methodologies

PRF matrix	*Yes* ▫ *No* ✗	*Participative SIM*	*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 behaviour 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 behaviours	▫
Effects prediction, modelling, quantification as priority task to be assumed	▫	Qualitative scoring, social acceptance	▫
The study can be based on the same inventory data used for LCA and LCC	▫	Qualitative and quali-quantitative indicators are preferred	▫
All impacts can 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	▫
Total:		*Total:*	

6.2 Conclusions

The aim of thesis was not just to compare results, but to compare the research processes that led to the development of each methodology.

The first aim of the thesis was to demonstrate that the methodological diversity that characterised SLCA literature is due to the influences of the scientific and cultural heritage of the disciplines assumed to be linked to SLCA, i.e. social sciences. Secondly, the thesis tried to answer the

question if different paradigms can coexist in SLCA. Finally, the general aim was to push the academic debate from a methodological level towards an epistemological one, that has been lacking until now in SLCA.

Although the concern of "social sustainability" is widely perceived as an urgency by the most, in chapter two we have seen the great diversity of concepts that interest not only the definition of "social sustainability" but, first of all, the concepts themselves of "sustainability" and "sustainable development". Likewise, a brief review of social sustainability assessment has been exposed: the difficulty to translate theories in practices is common to all disciplines.

In chapter three, the disciplinary roots of SLCA have been tracked down into sociology and management science, and the multiparadigmatic characteristics of both have been outlined, describing the main difference of the two opposite possible paradigmatic positions (post-positivism and interpretivism).

In chapter four, SLCA has been critically reviewed in search of which family of paradimgs were mostly applied. Results provided an interesting information: 82% of selected studies applied an interpretivist perspective. However, many scholars affirmed that SLCA should address social impacts evalutation in the same way eLCA does for environmental ones (i.e., in a post-positivism prerspective).

In chapter 5, two methodologies have been proposed starting from opposite paradigmatic perspectives. Both provided interesting results that, however, differ in terms of validity and usability. The two research processes have been compared at the beginning of the current chapter (chap. 6).

Coming back to the research questions, the methodological diversity of SLCA literature can find a justification in the multiparadigmatic characteristics of sociology and management science, in which SLCA is rooted. That there is place in SLCA for different paradigms, it is an empirical evidence, as showed in the critical review. They have been already applied both. What remains to be discussed in SLCA academia, is about the awareness that the paradigmatic stance matters when social impacts are assessed. The present thesis wants to be a first contribution to this.

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Zamagni A, Buttol P, Porta PL, Buonamici R, Masoni P, Guinée J, Heijungs R, Ekvall T, Bersani R, Bienkowska A, Pretato U (2008) Critical review of the current research needs and limitations related to ISO-LCA practice. Technical Report of CALCAS project. Available at: http://www.calcasproject.net

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ANNEXES

Annex 1 – Review references

Anne 2 – PRF matrix

Annex 1 - Review references

N.	Author	Year	Title	Publication source	Literature typology	Field of application or study	Methodologies	Impact Assessment methodology (applied or proposed)	Paradigms family
1	Albrecht S, Brandstetter P, Beck T, Fullana-i-Palmer P, Grönman K, Baitz M, Deimling S, Sandilands J, Fischer M	2013	An extended life cycle analysis of packaging systems for fruit and vegetable transport in Europe	Int J LCA 18(8):1549-1567	JA	Packaging	LCA + LCC + Life Cycle Working Environment	GaBi software and database	i
2	Andrews E, Lesage P, Benoît C, Parent J, Norris G, Revéret JP	2009	Life Cycle Attribute Assessment. Case Study of Quebec Greenhouse Tomatoes	Journal of Industrial Ecology 13(4):565-578	JA	Greenhouse tomatoes	Life Cycle Attribute Assessment	Attribute LCA; labour hour satellite matrix	i
3	Aparcana S, Salhofer S	2013a	Development of a social impact assessment methodology for recycling systems in low-income countries.	Int J LCA 18(5):1106-1115	JA	Waste: recycling systems	SLCA	UNEP-SETAC guidelines + interviews + score system	i
4	Aparcana S, Salhofer S	2013b	Application of a methodology for the social life cycle assessment of recycling systems in low income countries: three Peruvian case studies	Int J LCA 18(5):1116-1128	JA	Waste: recycling systems	SLCA	UNEP-SETAC guidelines + stakeholders interview + score system	i
5	Arcese G, Di Pietro L, Guglielmetti Mugion R	2015	Social Life Cycle Assessment Application: Stakeholder Implication in the Cultural Heritage Sector	In: Muthu SS (eds), Social Life Cycle Assessment, Springer Singapore, pp 115-146	BC	Cultural heritage sector	SLCA	UNEP-SETAC guidelines, SAM + consistency scoring	i
6	Arcese G, Lucchetti MC, Martucci O	2015	Social Life Cycle Assessment in a Managerial Perspective: An Integrative Approach for Business Strategy	In: Muthu SS (eds), Social Life Cycle Assessment, Springer Singapore, pp 227-252	BC	Business management	SLCA	UNEP-SETAC guidelines	i
7	Arcese G, Lucchetti MC, Merli R	2013	Social Life Cycle Assessment as a Management Tool: Methodology for Application in Tourism	Sustainability 5:3275-3287	JA	Tourism services	SLCA	UNEP-SETAC guidelines	i
8	Arvidsson R, Baumann H, Hildenbrand J	2015	On the scientific justification of the use of working hours, child labour and property rights in social life cycle assessment: three topical reviews	Int J LCA 20(2):161-173	JA	SLCA development	SLCA	Pathway	pp
9	Baumann H, Arvidsson R, Tong H, Wang Y	2013	Does the Production of an Airbag Injure more People than the Airbag Saves in Traffic? Opting for an Empirically Based Approach to Social Life Cycle Assessment	Journal of Industrial Ecology 17(4):517-527	JA	Airbags	SLCA	Disability-adjusted life years (DALY)	pp
10	Benoît C, Norris GA, Valdivia S, Ciroth A, Moberg A, Bos U, Prakash S, Ugaya C, Beck T	2010	The guidelines for social life cycle assessment of products: just in time!	Int J LCA 15(2):156-163	JA	SLCA development	SLCA	UNEP-SETAC guidelines	i
11	Benoît Norris C	2012	Social Life Cycle Assessment: A Technique Providing a New Wealth of Information to Inform Sustainability-Related Decision Making	In: Curran M.A. (Ed), Life Cycle Assessment Handbook, Wiley, pp.433-450.	BC	SLCA development	SLCA	UNEP-SETAC guidelines	i
12	Benoît Norris C	2014	Data for social LCA	Int J LCA 19(2):261-265	JA	SLCA development	SLCA	UNEP-SETAC guidelines	i
13	Benoît Norris C, Aulisio D, Norris GA, Hallisey-Kepka C, Overakker S, Vickery Niederman G	2011	A social Hotspot Database for Acquiring Greater Visibility in Product Supply Chains: Overview and Application to Orange Juice	In: Finkbeiner M (ed) Towards Life Cycle Sustainability Management, pp. 53-62, Springer	BC	Orange juice	SLCA	SHDB	i
14	Benoît Norris C, Aulisio Cavan D, Norris GA	2012a	Identifying Social Impacts in Product Supply Chains: Overview and Application of the Social Hotspot Database	Sustainability 4(9):1946-1965	JA	Strawberry yogurt	SLCA	Social Hotspot Database	i
15	Benoît Norris C, Aulisio Cavan D, Norris GA	2012b	Working with the Social Hotspots Database - Methodology and Findings from 7 Social Scoping Assessments	In: Dornfeld DA, Linke BS (Eds) Leveraging Technology for a Sustainable World. Proceedings of the 19th CIRP Conference on Life Cycle Engineering, Berkeley, USA, May 23-25 (pp. 581-586). Springer.	CP	Shampoo supply chain	SLCA	Social Hotspot Database	i
16	Benoît Norris C, Norris GA, Aulisio D	2014	Efficient Assessment of Social Hotspots in the Supply Chains of 100 Product Categories Using the Social Hotspots Database	Sustainability 6(10):6973-6984	JA	100 product categories	SLCA	Social Hotspot Database	i
17	Benoît Norris C, Revéret JP	2015	Partial Organization and Social LCA Development: The Creation and Expansion of an Epistemic Community	In: Muthu SS (eds), Social Life Cycle Assessment, Springer Singapore, pp 199-226	BC	SLCA development	SLCA	UNEP-SETAC guidelines, Social Hotspot Database	i
18	Benoît Norris C, Vickery-Niederman G, Valdivia S, Franze J, Traverso M, Ciroth A, Mazijn B	2011	Introducing the UNEP/SETAC methodological sheets for subcategories of social LCA	Int J LCA 16(7):682-690	JA	SLCA development	SLCA	UNEP-SETAC guidelines	i
19	Bocoum I, Macombe C, Revéret JP	2015	Anticipating impacts on health based on changes in income inequality caused by life cycles	Int J LCA 20(3):405-417	JA	Income inequality and health	SLCA	Wilkinson Pathway	pp
20	Bork CAS, Junior DJDB, Gomez JDO	2015	Social Life Cycle Assessment of three Companies of the furniture sector.	Procedia CIRP 29: 150-155	CP	Furniture for buildings construction	SLCA	UNEP-SETAC guidelines	i
21	Bouzid A, Padilla M	2014	Analysis of social performance of the industrial tomatoes food chain in Algeria	NEW MEDIT N. 1/2014, pp. 60-65	JA	Tomatoes	SLCA	UNEP-SETAC guidelines	i
22	Chang Y-J, Sproesser G, Neugebauer S, Wolf K, Scheumann R, Pittner A, Rethmeier M, Finkbeiner M	2015	Environmental and Social Life Cycle Assessment of Welding Technologies	Procedia CIRP 26:293-298	CP	Welding technology	LCA + SLCA	Fair salary and health risks	pp
23	De Luca AI, Iofrida N, Strano A, Falcone G, Gulisano G	2015b	Social Life Cycle Assessment and participatory approaches: a methodological proposal applied to citrus farming in Southern Italy	Int Env Assesst and Manag 11(3):383396	JA	Clementine	SLCA	UNEP-SETAC guidelines + participatory approach	i
24	Dong YH, Ng ST	2015	A social life cycle assessment model for building construction in Hong Kong	Int J LCA 20(8):1166-1180	JA	Buildings	SLCA	UNEP-SETAC guidelines	i
25	Dreyer LC, Hauschild MZ, Schierbeck J	2006	A Framework for Social Life Cycle Impact Assessment	Int J LCA 11(2):88-97	JA	SLCA development	SLCA	Scorecard multicriteria indicator model	i
26	Dreyer LC, Hauschild MZ, Schierbeck J	2010a	Characterisation of social impacts in LCA Part 1: Development of indicators for labour rights	Int J LCA 15(3):247-259	JA	SLCA development	SLCA	social risk assessment	i
27	Dreyer LC, Hauschild MZ, Schierbeck J	2010b	Characterisation of social impacts in LCA. Part 2: implementation in six company case studies	Int J LCA 15(4):385-402	JA	Industry	SLCA	social risk assessment	i
28	Ekener-Petersen E, Finnveden G	2013	Potential hotspots identified by social LCA—part 1: a case study of a laptop computer	Int J LCA 18(1):127-143	JA	Laptop computer	SLCA	UNEP-SETAC guidelines, Social Hotspot Database	i
29	Ekener-Petersen E, Höglund J, Finnveden G	2014	Screening potential social impacts of fossil fuels and biofuels for vehicles	Energy Policy 73:416-426	JA	Fossil and biological fuels	SLCA	UNEP-SETAC guidelines, Social Hotspot Database	i

30	Ekener-Petersen E, Moberg Å	2013	Potential hotspots identified by social LCA-Part 2: Reflections on a study of a complex product	Int J LCA 18(1):144-154	JA	Laptop computer	SLCA	UNEP-SETAC guidelines, Social Hotspot Database	i
31	Feschet P, Macombe C, Garrabé M, Loeillet D, Rolo Saez A, Benhmad F	2013	Social impact assessment in LCA using the Preston pathway. The case of banana industry in Cameroon	Int J LCA 18(2):490-503	JA	Bananas	SLCA	Preston Pathway	pp
32	Foolmaun RK, Ramjeeawon T	2013a	Life cycle sustainability assessments (LCSA) of four disposal scenarios for used polyethylene terephthalate (PET) bottles in Mauritius	Environment, Development and Sustainability 15(3):783-806	JA	Waste	LCSA	UNEP-SETAC guidelines	i
33	Foolmaun RK, Ramjeeawon T	2013b	Comparative life cycle assessment and social life cycle assessment of used polyethylene terephthalate (PET) bottles in Mauritius	Int J LCA 18(1):155-171	JA	Waste	LCA + SLCA	UNEP-SETAC guidelines	i
34	Franze J, Ciroth A	2011	A comparison of cut roses from Ecuador and the Netherlands	Int J LCA 16(4):366-379	JA	Roses	SLCA	UNEP-SETAC guidelines	i
35	Gauthier C	2005	Measuring Corporate Social and Environmental Performance: The Extended Life-Cycle Assessment	Journal of Business Ethics 59(1): 199-206	JA	Business strategy and management	"Extended" LCA	Systematic assessment of social criteria in extended LCA	i
36	Hauschild MZ, Dreyer LC, Jørgensen A	2008	Assessing social impacts in a life cycle perspective - Lessons learned	CIRP Annals - Manufacturing Technology 57(1):21-24	JA	SLCA development	SLCA	Companies behavior	i
37	Heller MC, Keoleian GA	2003	Assessing the sustainability of the US food system: a life cycle perspective	Agricultural Systems 76(3):1007-1041	JA	Food systems	LCSA	Attibutive assessment through static indicators	i
38	Hosseinijou SA, Mansour S, Shirazi MA	2014	Social life cycle assessment for material selection: a case study of building materials	Int J LCA 19(3):620-645	JA	Building materials	SLCA	UNEP-SETAC guidelines	i
39	Hsu C-W, Wang S-W, Hu A	2013	Development of a New Methodology for Impact Assessment of SLCA	In: Nee AYC, Song B, Ong S-K, (Eds) Re-engineering Manufacturing for Sustainability. Proceedings of the 20th CIRP International Conference on Life Cycle Engineering, Singapore 17-19 April, 2013. pp. 469-473	CP	SLCA development	SLCA	UNEP-SETAC guidelines and Performance Reference points	i
40	Hu M, Kleijn R, Bozhilova-Kisheva KP, Di Maio F	2013	An approach to LCSA: the case of concrete recycling	Int J LCA 18(9):1793-1803	JA	Recycling	LCSA	UNEP-SETAC guidelines	i
41	Hunkeler D	2006	Societal LCA methodology and case study.	Int J LCA 11(6):371-382	JA	Detergents	SLCA	Geographically specific midpoint based	pp
42	Jørgensen A	2013	Social LCA - a way ahead?	Int J LCA 18(2):296-299	JA	SLCA development	SLCA	Pathway	pp
43	Jørgensen A, Finkbeiner M, Jørgensen MS, Hauschild MZ	2010	Defining the baseline in social life cycle assessment	Int J LCA 15(4):376-384	JA	SLCA development	SLCA	Pathway	pp
44	Jørgensen A, Hauschild MZ, Jørgensen MS, Wangel A	2009	Relevance and feasibility of social life cycle assessment from a company perspective	Int J LCA 14(3):204-214	JA	Company	SLCA	interviews	i
45	Jørgensen A, Lai LC, Hauschild MZ	2010	Assessing the validity of impact pathways for child labour and well-being in social life cycle assessment	Int J LCA 15(1):5-16	JA	Child labour	SLCA	Pathway	pp
46	Kruse SA, Flysjö A, Kasperczyk N, Scholz AJ	2009	Socioeconomic indicators as a complement to life cycle assessment—an application to salmon production systems.	Int J LCA 14(1):8-18	JA	Salmon	Socio-economic LCA	Attributive and descriptive assessment	i
47	Lagarde V, Macombe C	2012	Designing the social life cycle of products from the systematic competitive model	Int J LCA 18(1):172-184	JA	System boundaries definition	SLCA	Systematic Competitive Model	pp
48	Lehmann A, Russi D, Bala A, Finkbeiner M, Fullana-i-Palmer P	2011	Integration of Social Aspects in Decision Support, Based on Life Cycle Thinking	Sustainability 3(4):562-577	JA	Water management and packaging waste	SLCA	UNEP-SETAC guidelines + literature	i
49	Lehmann A, Zschieschang E, Traverso M, Finkbeiner M, Schebek	2013	Social aspects for sustainability assessment of technologies - challenges for social life cycle assessment (SLCA)	Int J LCA 18(8):1581-1592	JA	Technologies	SLCA	UNEP-SETAC guidelines	i
50	Macombe C, Leskinen P, Feschet P, Antikainen R	2013	Social life cycle assessment of biodiesel production at three levels: a literature review and development needs	Journal of Cleaner Production 52(1):205-216	JA	Energy	SLCA	Pathway	pp
51	Manik Y, Leahy J, Halog A	2013	Social life cycle assessment of palm oil biodiesel: a case study in Jambi Province of Indonesia	Int J LCA 18(7):1386-1392	JA	Energy	SLCA	UNEP-SETAC guidelines	i
52	Martínez-Blanco J, Lehman A, Munoz P, Antòn A, Traverso M, Rieradevall J, Finkbeiner M	2014	Application challenges for the social Life Cycle Assessment of fertilizers within life cycle sustainability assessment	Journal of Cleaner Production 69 34-48	JA	Fertilizers	LCSA	UNEP-SETAC guidelines	i
53	Mathé S	2014	Integrating participatory approaches into social life cycle assessment: the SLCA participatory approach	Int J LCA 19(8):1506-1514	JA	Fisheries	Participatory SLCA	Participatory approach	i
54	Musaazi MK, Mechtenberg AR, Nakibuule J, Sensenig R, Miyingo E, Makanda JV, Hakimian A, Eckelman MJ	2015	Quantification of social equity in life cycle assessment for increased sustainable production of sanitary products in Uganda	Journal of Cleaner Production 96 569-579	JA	Sanitary pads	LCA + SLCA	Pathway	pp
55	Nemarumane TM, Mbohwa C	2015	Social Life Cycle Assessment in the South African Sugar Industry: Issues and Views	In: Muthu SS (eds), Social Life Cycle Assessment, Springer Singapore, pp 71-113	BC	Sugar cane	SLCA	UNEP-SETAC guidelines	i
56	Neugebauer S, Martinez-Blanco J, Scheumann R, Finkbeiner M	2015	Enhancing the practical implementation of life cycle sustainability assessment. Proposal of a Tiered approach	Journal of Cleaner Production 102:165-176	JA	SLCA development	LCSA	UNEP-SETAC guidelines + Tiered approach	i
57	Neugebauer S, Traverso M, Scheumann R, Chang Y-J, Wolf K, Finkbeiner M	2014	Impact Pathways to Address Social Well-Being and Social Justice in SLCA-Fair Wage and Level of Education	Sustainability 6(8):4839-4857	JA	SLCA development	SLCA	Pathway	pp
58	Norris GA	2006	Social Impacts in Product Life Cycles - Towards Life Cycle Attribute Assessment.	Int J LCA 11: 97-104	JA	SLCA development	SLCA	Pathway + Life Cycle Attribute Assessment	pp + i
59	Ramirez SPK, Petti L, Haberland NT, Ugaya CML	2014	Subcategory assessment method for social life cycle assessment. Part 1: methodological framework	Int J LCA 19(8):1515-1523	JA	SLCA development	SLCA	SAM	i
60	Ramirez SPK, Petti L, Ugaya CML	2014	Subcategory assessment method for social LCA: A first application on the wine sector	In: Salomone R, Saija G (eds):Pathways to environmental sustainability: Methodologies and experiences. Springer	BC	Wine	SLCA	SAM	i
61	Reitinger C, Dumke M, Barosevcic M, Hillerbrand R	2011	A conceptual framework for impact assessment within SLCA	Int J LCA 16(4):380-388	JA	SLCA development	SLCA	Capabilities approach	i
62	Revéret JP, Couture JM, Parent J	2015	Socioeconomic LCA of Milk Production in Canada	In: Muthu SS (eds), Social Life Cycle Assessment, Springer Singapore, pp 25-69	BC	Milk	SLCA	UNEP-SETAC guidelines + SHDB	i

63	Rugani B., Benedetto E, Igos E, Quinti G, Declich A, Feudo F	2014	Towards prospective life cycle sustainability analysis: exploring complementarities between social and environmental life cycle assessments for the case of Luxembourg's energy system	Materiaux & Techniques 102, 605 (2014)	JA	Energy	LCA + SLCA	SHDB	i
64	Sandin G, Peters G, Pilgård A, Svanström M, Westin M	2011	Integrating Sustainability Considerations into Product Development: A Practical Tool for Prioritising Social Sustainability Indicators and Experiences from Real Case Application	In: Finkbeiner M (ed) Towards Life Cycle Sustainability Management, pp. 3-14, Springer	BC	SLCA development	SLCA	UNEP-SETAC guidelines	i
65	Santoyo-Castelazo E, Azapagic A	2014	Sustainability assessment of energy systems: integrating environmental, economic and social aspects	Journal of Cleaner Production 80:119-138	JA	Energy	Sustainability assessment	Social interpretation LCA indicators	i
66	Schmidt I, Meurer M, Saling P, Reuter W, Kicherer A, Gensch C-O	2004	Managing Sustainability of Products and Processes with the Socio-Eco-Efficiency Analysis by BASF	Greener Management International 45:79-94	JA	Energy	Socio-eco-efficiency	SEEBalance	i
67	Smith J, Barling D	2014	Social impacts and life cycle assessment: proposals for methodological development for SMEs in the European food and drink sector	Int J LCA 19(4):944-949	JA	Food and drink	SLCA	Qualitative bottom-up and top down approach	i
68	Traverso M, Asdrubali F, Francia A, Finkbeiner M	2012	Towards Life Cycle Sustainability assessment: an implementation to photovoltaic modules	Int J LCA 17(8):1068-1079	JA	Energy	LCSA	UNEP-SETAC guidelines + LCSA dashboard	i
69	Traverso M, Finkbeiner M	2012	Life Cycle Sustainability Dashboard	Journal of Industrial Ecology 16(5):680-688	JA	Natural hard floor coverings	LCSA	UNEP-SETAC guidelines	i
70	Umair S, Björklund A, Ekener-Petersen E	2015	Social Life Cycle Inventory and Impact Assessment of Informal Recycling of Electronic ICT Waste in Pakistan	Resources, Conservation and Recycling 95 46-57	JA	Waste	SLCA	UNEP-SETAC guidelines	i
71	Valdivia S, Ugaya CML, Hildenbrand J, Traverso M, Mazijn B, Sonnemann G	2013	A UNEP/SETAC approach towards a life cycle sustainability assessment - our contribution to Rio+20	Int J LCA 18(9):1673-1685	JA	Marble	LCSA	UNEP-SETAC guidelines	i
72	Vavra J, Munzarova S, Bednarikova M	2015	Assessment of Social Impacts of Chemical and Food Products in the Czech Republic	In: Muthu SS (eds), Social Life Cycle Assessment, Springer Singapore, pp 147-197	BC	Chemical and food products	SLCA	UNEP-SETAC guidelines and qualitative weighting	i
73	Vinyes E, Oliver-Solà J, Ugaya C, Rieradevall J, Gasol CM	2013	Application of LCSA to used cooking oil waste management.	Int J LCA 18(2):445-455.	JA	Waste	LCSA	general indicators	i
74	Weidema BP	2005	ISO 14044 also Applies to Social LCA	Int J LCA 10(6):381-381	JA	SLCA development	SLCA	Two-layer SLCA method	pp
75	Weidema BP	2006	The integration of Economic and Social Aspects in Life Cycle Impact Assessment	Int J LCA 11:89-96	JA	SLCA development	SLCA	Pathway	pp
76	Weldegiorgis FS, Franks DM	2014	Social dimensions of energy supply alternatives in steelmaking: comparison of biomass and coal production scenarios in Australia	Journal of Cleaner Production 84:281-288	JA	Energy	SLCA	UNEP-SETAC guidelines	i
77	Wilhelm M, Hutchins, Mars C, Benoit Norris C	2015	An overview of social impacts and their corresponding improvement implications: a mobile phone case study	Journal of Cleaner Production 102:302-315	JA	Mobile phones	SLCA	SHDB	i
78	Wu SR, Chen J, Apul D, Fan P, Yan Y, Fan Y, Zhou P	2015	Causality in social life cycle impact assessment (SLCIA)	Int J LCA 20(9):1312-1323	JA	SLCA development	SLCA	Pathway	pp

Legend: JA (Journal Article); CP (Conference Proceedings); BC (Book Chapter); pp (post-positivism); i (interpretivism).

Annex 2 - PRF Matrix

	Hearing damages	Cardiovascular disease	Gastric cancer	Suicide thoughts	Metabolic syndrome	Musculoskeletal Disorders MSDs				Lower self esteem	Psychological distress	High level of stress perceived	Disability	Osteoarthritis	Chronic bronchitis
Psychosocial risk factors						**Sciatic Pain**	**Back Pain**	**Neck and Shoulders**	**Upper Limbs**						
Noise									1.58 (Stock et al., 2006)						
Total Boby Vibrations (tractor driving)						3.9 (Bovenzi and Betta, 1994)	1.83 (Bovenzi and Betta, 1994)	2.07 (Stock et al., 2006)							
Vibration manual tools (chain saw)									2.44 (Stock et al., 2006)						
High physical demand							4.4 (Raeisi et al. 2014)	2.1 (Stock et al. 2006)	1.66 men (Stock et al.)				2.02 (Lahelma, 2012)		
Temporary employment							2.00 (Domenighetti et al., 1999)			2.9 (Domenighetti et al., 1999)		1.6 (Domenighetti et al., 1999)			
Outdoor working environment															1.77 (Kotaniemi et al., 2003)
Heavy manual labour														2.8 (Zarz and Larkin, 2011)	
Citrus chemicals exposure	1.19 (Crawford et al., 2008)		2.88 (Mills and Yang. 2006)												
Long working hours >8 to 9 hours/day				1.38 (Yoon et al., 2015)	1.66 (Kobayashi et al., 2012)										
Long working hours >9 to 10 hours/day				2.01 (Yoon et al., 2015)	1.48 (Kobayashi et al., 2012)										
Long working hours >10 hours/day				2.01 (Yoon et al., 2015)	2.32 (Kobayashi et al., 2012)										
Work pressure		3.45 (Siegrist ,1996)													
Effort-reward imbalance		6.15 (Siegrist, 1996)													
High psychological demand (quantity of work, intellectual requirements, time constraints)											2.04 (Bourbonnais, 1996)				