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The Role of Life Cycle Tools in Environmental Management System: The Italian Experience

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Abstract: Pollution prevention and sustainable development are the key goals in modern strategic business and many companies worldwide adopt environmental standards to demonstrate their commitment in improving environmental performances. Environmental management system and ISO 14001 certification are the milestones, but new life cycle tools are emerging to obtain environmental improvement beyond the gates of business. This new perspective is undoubtedly challenging, involving the entire supply chain: are companies ready to adopt it? The research tries to answer this question focusing on Italian companies certified ISO 14001: through a national survey, the paper verifies (H.1) if Italian companies are ready to adopt life cycle tools (as life cycle assessment, carbon footprint, water footprint, ecodesign, and environmental labels), (H.2) rather than other improvement projects (H.3) as well as the interest in these tools depends on maturity of EMSs. The results underline that most companies want to improve their organizational and environmental performance, however only few companies are willing to adopt life cycle tools; the greater maturity of EMS seems to favor the greater interest in the life cycle approach. In conclusion, the paper highlights the role of scientists and practitioners in demonstrating to companies the importance of LC tools to obtain better organizational and business performance.

Key words: ISO 14001; life cycle thinking; life cycle assessment; Italian companies; survey
JEL codes: Q, Q5, Q56

1. Introduction

Since the 1980s the concerns linked to the consequences of irresponsible industrial practices have led international community to adopt sustainability as the only way for development (UN, 1987). Among scientists a lively debate concerning corporate sustainability has determined multiple epistemological and theoretical paradigms (Vildåsen et al., 2017), while in the meantime the attention to environmental problems has grown in consumers, pushing companies to introduce the sustainability as strategic variable in their business (Lasiyono, 2020). To support the growing needs of sustainable management in many sectors around the world, the standards and guidelines have gradually multiplied (Toniolo et al., 2019/b).

To respond to increasing pressure of legislation and market of environmental issues, many organizations have adopted voluntary requirements to reduce environmental impacts (Ren et al., 2019) and demonstrate to external stakeholders their environmental responsibility (Hoeckstra & Wiedmann, 2014), mainly through the adoption of

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environmental management system (EMS). To support this trend, the most widespread tool is ISO 14001, that leads to strategic management of environmental issues achieving market recognition (Ni, 2018).

Recent revision of ISO 14001 standard, published in September 2015, among others introduces an important new requirement: the life cycle approach (ISO, 2015). In this new perspective, environmental improvement must be defined by considering the products and services not only in a single phase of their life, for example production or supply, but throughout their entire life cycle, as named "from cradle to grave" (Mazzi, 2020/b). Environmental impacts associated with each activity are dynamically considered, from raw materials extraction to processing materials and semi-finished products, and to assembling components, continuing with distribution and use, up to recovery/recycling and disposal (Bjørn et al., 2018).

The most important methodology for applying the life cycle approach is Life Cycle Assessment (LCA), which quantifies the impacts on all the environmental categories throughout the life cycle stages, from cradle to grave. The same life cycle approach is then taken up by other tools which observe particular categories of environmental impact: Carbon Footprint (CF), Water Footprint (WF), Eco-Design (ED) and Environmental Labeling (EL) (Mazzi, 2020/b). Even if with distinguishing features, all these footprints allow to obtain overall environmental improvement through actions that reduce the environmental impacts and avoid transferring consequences to other life cycle phases (Hellweg & Milà I Canals, 2014). You can name them "life cycle tools" (LC tools): they are spreading a lot all over the world, many companies in many industrial sectors choose them both as management tools — to improve environmental performance of products and processes — and marketing tools — to support external communication.

In Italy the adoption of LC tools is still a niche market that seems to interest a few particularly proactive companies (Mazzi, 2016/a). On the other hand, the new requirement of ISO 14001 conducts organizations to evaluate and manage significant environmental aspects by going beyond their own territorial, temporal and functional "gates", to take charge of the environmental impacts that may occur along the supply chain (Koberg and Longoni, 2019). Really the new life cycle perspective is a challenge for the EMS: it changes the decision-making boundaries of business strategies, inevitably tying them to strategies of the other players in supply chain (Giannakis & Papadopoulos, 2016). Are companies ready to adopt the new perspective? The paper intends to answer this question by analyzing the point of view of Italian companies certified ISO 14001 and verifying their interest in adopting LC tools to improve their EMS.

The paper is structured as follows. Section 2 reports a literature overview about EMS and LC tools, and the knowledge gaps related their relationship. In section 3 the research questions and hypotheses are formulated and the survey is presented. Section 4 summarizes and discusses the research results to verify the validity of research hypotheses. Section 5 concludes the paper, with final considerations and implications for scientists, practitioners and companies.

2. Literature Review

2.1 Environmental Management Systems

The so-called "neoclassical" approach that considers the environment as a negative externality and focuses on the environment in terms of compliance with regulatory requirements is considered to be outdated (Bhat, 1998; Bithas, 2011; Novak, 2019). To gain increase of market credibility, many organizations around the world have adopted voluntary environmental commitments (Wijethilake, 2017). The EMS, standardized by ISO 14001, is the

most widespread tool to improve the environmental performances of organizations (ISO, 2019); thanks to its applicability in all economic sectors, it represents the best-known environmental label on the market (Ni, 2018). Approved by International Organization for Standardization (ISO) in 1996 and revised in 2004 and again in 2015, ISO 14001 supports organizations in the implementation and maintenance of an EMS, defining a list of requirements through which any organization, of any size and any sector, can develop a systematic approach to improve environmental performance, coherently and consistently with its specific context (ISO, 2015).

The key concept of ISO 14001 is the voluntary implementation of a systematic approach to reduce environmental impacts and control significant environmental aspects, with an ongoing commitment to improve the overall environmental performance, through a virtuous circle with a preventive and proactive approach (Mazzi, 2020/a). The choice of many organizations around the world is to achieve certification of EMS, as official recognition by accredited body, to gain increase of stakeholders' transparency and community's legitimacy. In this frame, Italy occupies a leader position, as numerosity of certified organizations in Europe and in the world (ISO, 2019).

There is a consensus among scholars to recognize a positive relationship between the adoption of EMS and several business advantages for companies: EMS and business competitiveness generally are mutually and positively correlated. The main positive effects determined by ISO 14001 certification are improvement of resource management, process control, environmental accountability and supply chain cooperation (Mazzi, 2020/a). On the other hand, some characteristics of companies can support or limit the benefits associated to EMS: the main "moderator factors" are the complexity of firms and the maturity of sustainable commitment (see also Mazzi et al., 2016/b; Antonioli & Mazzanti, 2018). Recent papers underline the relevance of new fields associated to the EMS: the green supply chain management (Tseng et al., 2019) and the circular economy perspective (Kalmikova et al., 2018), connected to each other by the life cycle approach.

Concerning the requirement of continuous improvement, the ISO 14001 stimulates organizations to set increasingly challenging improvement objectives: they can concern strategic, organizational and operational interventions and must be measurable (Campos, 2012). The main objectives adopted by companies to improve EMS are related the environmental efficiency, through energy saving and environmental costs accounting, environmental performance evaluation and communication and integration of EMS with other management systems (as quality and health & safety) (see also Alrazi et al., 2015; Bernardo et al., 2015). On the other hand, in the recent revision of ISO 14001, companies with certified EMS are encouraged to adopt the new perspective of life cycle, in order to obtain overall and actual environmental improvement, avoiding organizational or operational changes that shift the environmental burden to other activities (Acquaye et al., 2018). The life cycle approach includes also considerations about the quantification of possible environmental improvements among all the players along the supply chain, so as to intervene in those activities where it is environmentally convenient or promising (EC, 2003).

2.2 Life Cycle Tools

The life cycle perspective offers a comprehensive analysis, leading to solutions for reducing impacts in an absolute and not relative way. A product's life cycle can begin with the extraction of raw materials from natural resources and the energy generation. Materials and energy are then part of production, packaging, distribution, use, maintenance, and recovery, recycling or final disposal. In each life cycle stage there is the potential to reduce resource consumption and improve the product's performance (Bjørn et al., 2018a).

The most important tool of the life cycle approach is Life Cycle Assessment (LCA): it is the methodology to quantify and analyze environmental impacts associated with the life cycle of products, services and processes. Standardized by the ISO 14040 and ISO 14044 (ISO, 2006a/b), LCA is mainly used to identify strategies for environmental improvement without burden shifting and to compare different products, processes and activities (Hellweg & Milà I Canals, 2014).

In recent years, partial LCAs have emerged to transmit the environmental impacts associated with a product in a simpler way by focusing on single environmental categories. The environmental footprints, strongly requested by the market, are defined as metrics used to report LCA results addressing an environmental topic defined by the interest of society. Recent standards published by ISO concern the quantification and communication of specific environmental footprints: they are based on the same methodology, same data models and same impact assessment methods but usually focused on specific environmental aspects (Hoekstra & Wiedmann, 2014). Carbon Footprint (CF), regulated by ISO 14067 (ISO, 2018), addresses the issue of climate change by quantifying the potential impacts associated to the Green House Gas emissions associated to activities included in the life cycle of products (Scipioni et al., 2012). Water Footprints (WF), standardized by ISO 14046 (ISO, 2014), quantifies the impacts of product on water resources considering both the quantity of water use and its degradation (Mazzi et al., 2014). Eco Design (ED), standardized by ISO 14006 (ISO, 2020), systematically incorporates environmental considerations into the design of products/services and support the adoption of life cycle environmental performance as additional requirement in design process (Marcelino-Sádaba et al., 2015). Environmental Labels (ELs), regulated by ISO 14025 (ISO, 2006/c) and additional Program Operators' procedures, support organizations to use in market communication the environmental performance of products or services obtained by verified LCA studies (Ibáñez-Forésa et al., 2016).

3. Research Design

3.1 Research Goal and Hypotheses

The research aims to investigate the role of LC tools in EMS, focusing on the point of view of companies with ISO 14001 certification. Given that Italy plays a leading role as number of ISO 14001 certifications, the opinion of Italian organizations is relevant in the research goal. The research question becomes: are Italian companies with EMS interested in adopting LC tools?

From literature overview main issues emerge to define the research scope. Organizations with an EMS certified ISO 14001 must pursue objectives of environmental improvement and adopt a life cycle approach. Therefore, the potential alternative for Italian companies to realize the continuous improvement is the adoption of LC tools rather than other "no-life cycle" projects. On the other hand, the propensity to adopt LC tools or other improvement projects may depend on business characteristics such as the maturity of EMS.

Three hypotheses are formulated to answer the research question:

- H.1: Italian companies certified ISO 14001 are interested in adopting life cycle tools;
- H.2 Italian companies certified ISO 14001 are interested in adopting other improvement projects;
- H.3: the interest of Italian companies certified ISO 14001 in adopting life cycle tools and other improvement projects depends on maturity of EMS.

3.2 Design of Survey

The opinion of Italian companies certified ISO 14001 was collected through a survey. All types of the Italian

ISO 14001 certified companies, in different industrial and services sectors were involved in the survey. Italian organizations to be interviewed were selected through the national database of Italian organizations certified with ISO 14001, managed by Accredia, the Italian accreditation body.

To verify the research hypotheses, companies were asked to express their interest in enhancing the EMS by using:

- the LC tools: LCA, CF, WF, ED, and ELs;
- and/or the improvement projects: environmental cost analysis, environmental performance evaluation, energy efficiency, integration of management systems, environmental communication.

The business characteristic adopted to distinguish the maturity of EMS was the year of obtaining the ISO 14001 certification.

The opinion of Italian companies about the above issues were investigated through a questionnaire addressed to the environmental managers (as EMS manager), coherently with other similar surveys (e.g., Liu et al., 2016; Mazzi et al., 2016/a). The questionnaire was distributed in electronic form via e-mail, along with a cover letter explaining the purpose of the survey. The anonymous answers were collected through an automatic online database (Google Forms®).

4. Results

4.1 Type of Responding Companies

The survey involved about 5,000 Italian organizations and the respondent companies were 452, with response rate about 9%.

The main distinguishing characteristics of the respondent companies are summarized in Table 1. Small-Medium Enterprises (SMEs) are more than 80% of responding companies. Both companies with a more recent certification and companies certified for many years are well represented in the sample. Then, the year of ISO 14001 certification is significant variable, that can be used to test hypothesis H.3.

Table 1 Characteristics of Respondent Companies

	Size of companies		Year of certification ISO 14001				
	SMEs	Big enterprises	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015	2016 - 2018
N. of organizations	366	86	14	106	115	159	58
% of organizations	81.0%	19.0%	3.1%	23.5%	25.4%	35.2%	12.8%

4.2 Interest in Adopting Life Cycle Tools

To verify the hypothesis H.1, answers collected by respondent companies related their interest in adopting LC tools were analyzed, and results are reported in figure 1. About a quarter of firms declares to be a goal at least one of the LC tools. The greater interest is in the LCA, followed by ELs. Few companies show interest in CF, WF and ED. On the other hand, a small group of companies says he has already adopted the LC tools, especially LCA and CF: they are pioneering firms on these issues.

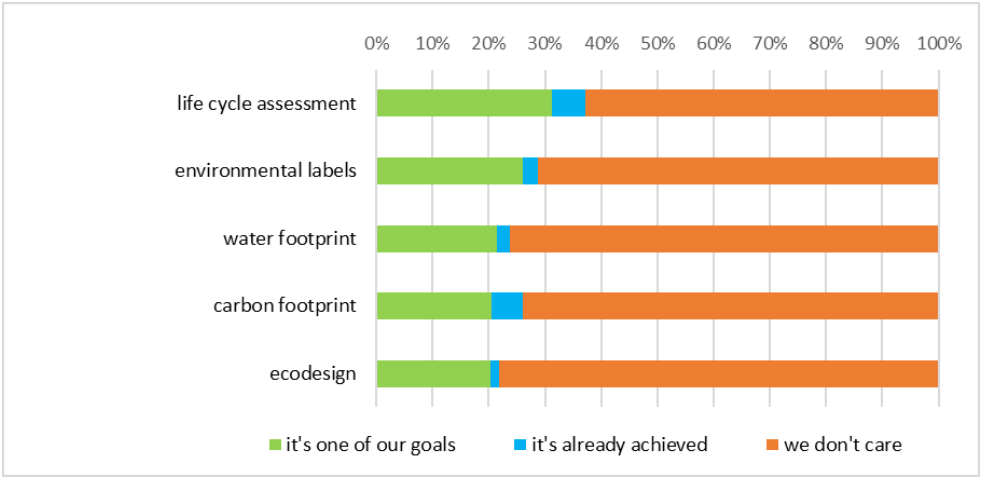

Figure 1 Interest of Italian Companies in Adopting LC Tools

4.3 Interest in Adopting Other Improvement Projects

To verify the hypothesis H.2, answers collected by respondent companies related their interest in adopting other improvement projects were analyzed, and results are reported in Figure 2. More than 50% of companies intend to develop the proposed projects and many companies have already adopted them. The integration with other management systems is undoubtedly important, and environmental cost analysis and environmental performance evaluation are very interesting projects for Italian companies.

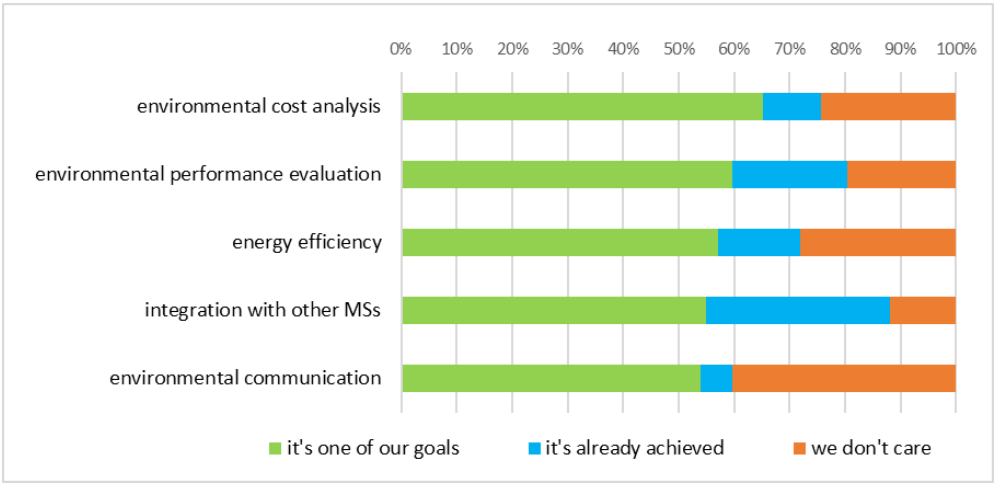

Figure 2 Interest of Italian Companies in Adopting Other Improvement Projects

4.4 Correlation Between EMS Maturity and Interest in LC Tools and Other Improvement Projects

To test the hypothesis H.3, answers related companies that have showed interest in LC tools rather than other improvement projects, were analyzed in the base of maturity of EMS. The criterion used to group the companies' opinion is the year in which companies have obtained ISO 14001 certification, as indicated in Table 1.

Figure 3 shows the % of companies interested in adopting LC tools, grouped per year of certification. The trend of each group is represented by colored lines, while the average trend of all companies interested in LC tools is represented by the grey bar. The distribution is rather homogeneous among the groups of companies, although distinctive features emerge. The interest in LCA and ED is higher among companies with mature EMS (certified

for over 15 years), while the interest in all LC tools is lower for companies with recent certification (certified for less than 10 years).

Figure 4 shows the percentage of companies interested in other improvement projects, grouped per year of certification. The trend of each group is represented by colored lines, while the average trend is represented by the grey bar. Companies with mature EMS show a greater interest in all the projects; recently certified companies show a greater interest than the average in integration of management systems.

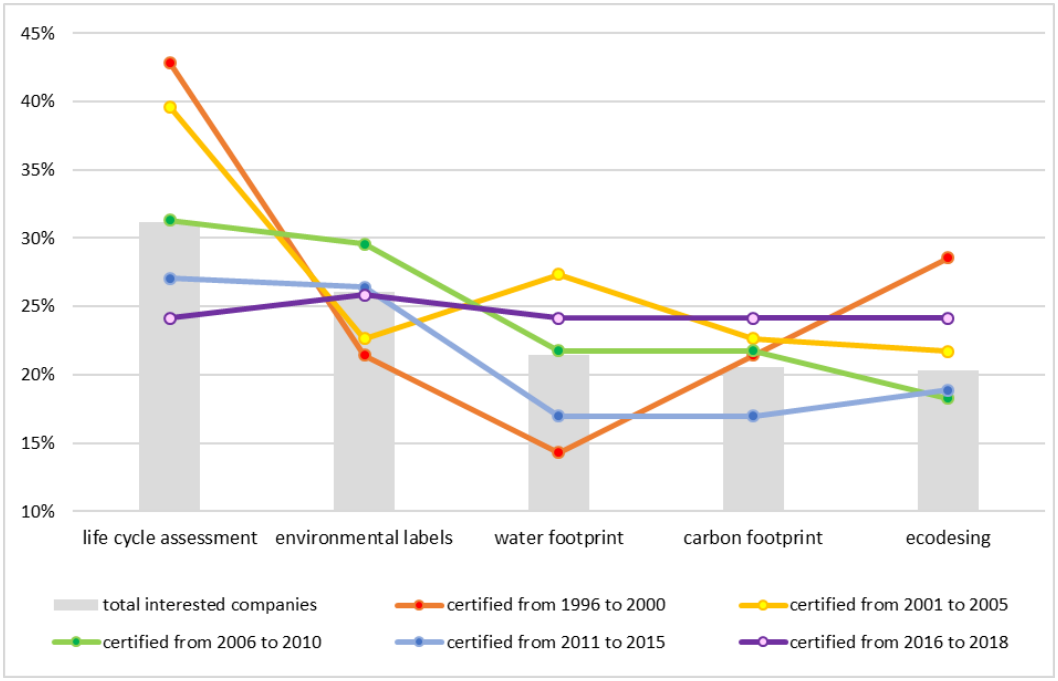

Figure 3 Percentage of Italian Companies Interested in Adopting LC Tools Grouped Per Year of Certification

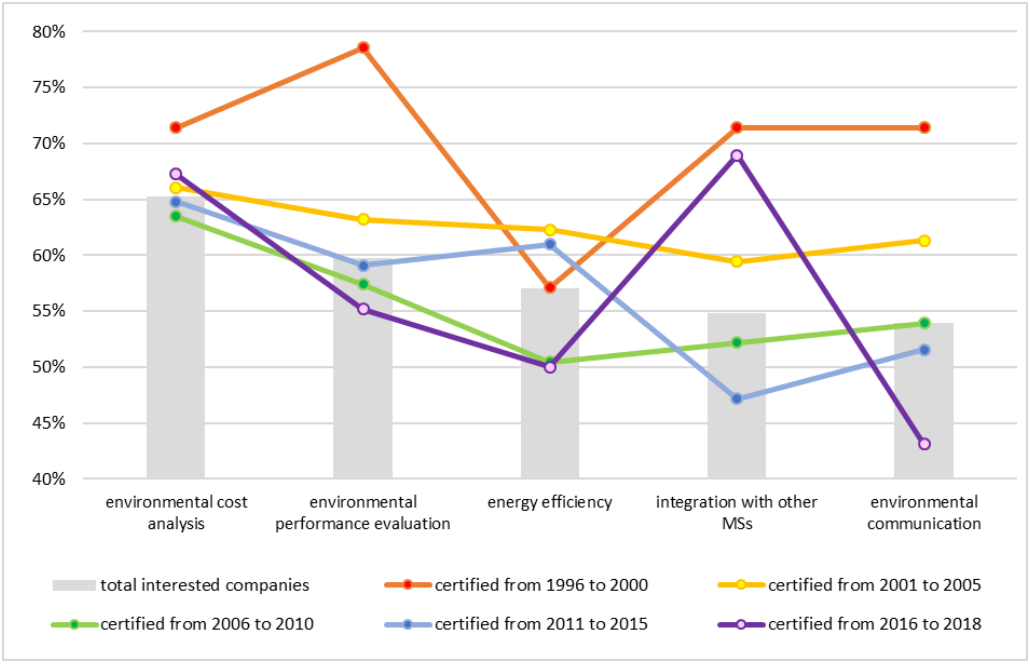

Figure 4 Percentage of Italian Companies Interested in Other Improvement Projects Grouped Per Year of Certification

5. Conclusions

The EMS is certainly an important tool for improving environmental performances. Once certified, organizations may feel the need to adopt other improvement projects: the "new generation" of environmental tools, having life cycle perspective, obtain increasing interest in several industrial sectors. However, many organizations are still struggling to adopt LC tools, due to the difficulty of application or lack of knowledge of their potential. Through a national survey conducted in Italy, environmental managers of Italian companies certified ISO 14001 are interviewed to verify their interest in adopting LC tools rather than other project to improve the EMS.

On the basis of the results presented, it is possible to express an evaluation regarding the research hypotheses initially formulated.

Hypothesis H.1 is partially confirmed: in Italy, ISO 14001 certified companies interested in adopting life cycle tools are a minority.

Hypothesis H.2 is fully confirmed: in Italy, ISO 14001 certified companies are very interested in adopting organizational and performance improvement projects.

Hypothesis H.3 is partially confirmed: in Italy, companies with mature EMS have shown greater interest in life cycle assessment and eco-design and all other improvement projects; companies with young EMS show less interest in LC tools and high interest in all other improvement projects.

These results lead to conclusive considerations, which can guide the scientific community and the business.

Italian companies are still quite far from using LC tools, which in turn still seem to be aimed at a market niche. Companies that look towards a collaborative supply chain are also driven by the maturity of EMS and are particularly interested in the LCA. At the same time, companies with young EMS have a limited interest in all LC tools. All other improvement projects are attracting widespread interest among Italian companies, even with younger EMS.

The greater interest in traditional improvement projects compared to LC tools testifies that the managerial and business advantage associated with life cycle thinking is not yet evident among Italian entrepreneurs. The scientific community is called upon to demonstrate more effectively the usefulness of life cycle approach for competitiveness of companies, so that more often practitioners can approach LC tools and the use of LC tools becomes more familiar among EMS managers.

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