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# The combination of an Environmental Management System and Life Cycle Assessment at the territorial level

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ABSTRACT

A framework to include a Life Cycle Assessment in the significance evaluation of the environmental aspects of an Environmental Management System has been studied for some industrial sectors, but there is a literature gap at the territorial level, where the indirect impact assessment is crucial. To overcome this criticality, our research proposes the Life Cycle Assessment as a framework to assess environmental aspects of public administration within an Environmental Management System applied at the territorial level. This research is structured in two parts: the design of a new methodological framework and the pilot application for an Italian municipality. The methodological framework designed supports Initial Environmental Analysis at the territorial level thanks to the results derived from the impact assessment phase. The pilot application in an Italian municipality EMAS registered demonstrates the applicability of the framework and its effectiveness in evaluating the environmental impact assessment for direct and indirect aspects. Through the discussion of the results, we underline the growing knowledge derived by this research in terms of the reproducibility and consistency of the criteria to define the significance of the direct and indirect environmental aspects for a local public administration.



## 1. Introduction

In the last three decades, the topic of environmental responsibility has affected policymakers and markets. Many countries around the world have developed different environmental policy instruments, such as regulatory tools (command and control regulations), economic instruments (taxes and tradable permits), and voluntary actions (environmental certifications, reporting and labelling) (Barde, 1995; Phan and Baird, 2015; Vatn, 2015). At the same time, the organizations have made efforts to develop cleaner production technologies and processes (Chang and Sam, 2015), as well as environmental management policies and tools (Wu, 2009; Daddi et al., 2015; Guenther et al., 2016). The most popular tools on the international market to support the organizations to evaluate and reduce environmental impacts with a holistic overview are the Environmental Management System (EMS) and the Life Cycle Assessment (LCA). On the other hand, there are still poorly experiences on the adoption of these environmental tools in a combined way at the territorial level. This section presents an overview about the adoption on EMA at the territorial level and the LCA to support the EMS implementation, with the aim of emphasizing some key elements in the scientific debate and determining the research goals.

### 1.1. EMS at the territorial level

EMS represents the part of an organization's management system that supports public and private organizations to coherently and systematically tackle significant environmental issues (e.g., use of natural resources, air pollution, water consumption and pollution, soil and subsoil consumption, and waste production and treatment) to reduce the environmental impact of an organization's processes (Raines, 2002; Ruskko et al., 2014). The EMS leads organizations to formalize policies, procedures and practices that control environmental aspects and prevent or reduce environmental impacts through a continuous improvement process (Johnstone and Labonne, 2009; McGuire, 2015). The flexibility of the EMS, derived by a management-based approach (Lannelongue et al., 2015), makes it easily applicable to all sectors and all types of organizations worldwide (Siew, 2015).

The most important standards of EMS are ISO 14001 (ISO, 2015) at the international level and Eco-Management and Audit Scheme (EMAS) (EC, 2009) at the European level. Since the nineties, the trend of adopting these standards has been continuously growing. This is due to the effectiveness of the EMS standards to demonstrate the environmental responsibility of organizations that adopt them and to obtain effective results in terms of reducing environmental impacts (Nguyen and Hens, 2015; Puig et al., 2015), assuring the prevention of incidents (Singh et al., 2015), complying with the regulatory requirements (Cole et al., 2006; López-Gamero et al., 2010; Mazzi et al., 2016) and improving environmental performances (Morrow and Rondinelli, 2002;

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Darnall, 2006; Demirel and Kesidou, 2011; Neuteleers and Engelen, 2015; Siew, 2015).

At the European level, organizations are encouraged by the European Union to adopt the EMAS scheme to assure legal compliance and improve environmental performance. The main benefits derived by EMAS application are their effectiveness to improve environmental performance (Iraldo et al., 2009; Heras-Saizarbitoria et al., 2015), notably reducing polluting emissions, reducing waste production, reducing energy use and efficiently using natural resources (Erkkoa, 2005; Testa et al., 2014). Moreover, EMAS registration assures the compliance of organizations with regulatory requirements (Neugebauer, 2012; Phan and Baird, 2015) and transparent communication regarding environmental performance to the stakeholders (Skouloudis et al., 2013; Pavaloaia, 2015; Bennett et al., 2016), with positive consequences in terms of market reputation (Udo de Haes and de Snoo, 1996; Martín-Peña et al., 2014). At the same time, complying with these standard permits results in internal benefits, as well as a concrete and continuous improvement of process performance (Abeliotis, 2006) and a significant involvement and motivation of the staff to contribute to the environmental targets (Lannelongue et al., 2015; Heras-Saizarbitoria et al., 2016).

Within the discussion about sustainable development, one of the most tangible outcomes is to focus international attention on the role of municipalities and public administrations as central actors in the Earth's ecosystem (Brugmann, 1996). With this mandate, in the last decade, the public administration sector widely agreed to EMS adoption and environmental certification (Emilsson and Hjelm, 2002; Nogueiro and Ramos, 2014; Daddi et al., 2016; Wangel et al., 2016), especially in Italy, which has the highest number of EMAS registrations by the Public Administration (D'Amico and Ubaldini, 2008; Mazzi et al., 2012; Petrosillo et al., 2012).

One of the most discussed applications of EMAS is at the territorial level: this type of application considers all of the territories managed by the public administration as the "organization" that adopts the EMS (Iraldo et al., 2009; Mazzi et al., 2012). Several authors demonstrated difficulties in applying an EMS at the territorial level.

Generally, the difficulty of measuring environmental sustainability at the territorial level finds many insights in the scientific debate (Alberti, 1996; Scipioni et al., 2008; Scipioni et al., 2009; Mascarenhas et al., 2010; Moreno-Pires and Fidélis, 2012; Domingues et al., 2015). With references to EMS implementation, the environmental impact assessment is widely recognized as the main relevant and critical step at the territorial level (Zobel and Burman, 2004; Perotto et al., 2008; Wangel et al., 2016).

However, concerning the adoption of EMAS Regulation at the territorial level, it is difficult to select environmental aspects and impacts in the Initial Environmental Analysis (IER) during the start-up phase of EMS (EC, 2009). This difficulty is due to the low consistency in the significance evaluation (Mazzi et al., 2012; Mangolells et al., 2014; Perminova et al., 2016) and, more generally, to the lack of uniformity in the environmental performance indicators (Beccali et al., 2002; Niemeijer and De Groot, 2008a, 2008b; Wangel et al., 2016). Furthermore, at the territorial level, the main difficulties concern the correct identification and evaluation of indirect environmental aspects (ISO, 2016), which are, instead, the most important aspects for public organizations that manage a territory (Lozano and Valles, 2007; Perotto et al., 2008; Ridolfi et al., 2008; Marazza et al., 2010; Mazzi et al., 2012; Bennett et al., 2016; Wangel et al., 2016).

### 1.2. LCA to support EMS

Life Cycle Assessment (LCA) is a methodology for quantifying and analysing environmental impacts associated with the life cycle of products, services and processes and standardized by the ISO 14040 and ISO 14044 norms (ISO, 2006a, 2006b).

In general, LCA is mainly used to compare different products, processes and activities or as a standalone tool to identify hotspots in the life cycle; it is also considered one of the best tools for developing environmental policies and is currently applied to biofuels, energy and wastewater treatment (Jacquemin et al., 2012). Some of the main sectors of the application, considered pioneers in the literature, are plastics, detergents, personal care products and automobiles. Other common sectors of application are agriculture, mining, oil and gas extraction, manufacturing industries and retail (Jacquemin et al., 2012).

LCA together with EMS are considered valuable tools to improve the environmental profile of organizations; however, even if EMS has a procedural approach and LCA is product oriented, they can be used in a complementary way based on the perspective of the comprehensive approach (Finkbeiner et al., 1998; Azapagic and Clift, 1999). From a theoretical perspective, two different approaches, which allow for benefiting from both of these tools, have been proposed in the last few years: integration or combination. The integration of LCA and EMS consists of using one of the two tools to expand its field of application, including the main features of the other one. The combination consists of using both of the tools coherently in a systematic way with the main environmental management problems with a company-oriented approach. For example, LCA can assist EMS by adding objective and scientific elements to the environmental performance evaluation and revealing the burdens of an organization "inside the gates" or "outside the gates" (Finkbeiner et al., 1998). Some authors believe that the most promising solution is the combination of the two tools (Scholl, 1999; Stewart et al., 1999), namely, the organizations that have already implemented an EMS or an LCA can complete the chosen tool by applying the other one and orienting it according to their own needs and problems.

The main areas of the EMS where LCA can be useful are for the identification of environmental aspects and their related impacts, which is usually performed using an environmental review, the assessment of aspect significance and ranking, and the definition of an objective, targets and indicators (Gaudreault et al., 2009). The inclination of LCA towards EMS entails several advantages, especially in the planning phase (Ross and Evans, 2002; Gaudreault et al., 2009); however, it is not possible to establish a unique way to make this interaction profitable (Finkbeiner et al., 1998). The potentiality and identification and assessment problems of the environmental impacts have been further analysed by Lewandowska et al. (2011). Other proposals to integrate LCA into EMS have been advised by Khan et al. (2002), who identified a specific procedure to develop an effective EMS that was able to evaluate environmental programmes that were developed by the organization through an LCA study, as reported in Section 2.1.1. Rebitzer and Buxmann (2005) have also highlighted the peculiarity of LCA by analysing a case study of a company that produces aluminium materials. A framework to include LCA in the significance evaluation of the environmental aspects of an EMS has also been studied at a waste recycling factory (Liu et al., 2012), in the bio-waste sector (Manfredi and Pant, 2013), in a pulp and paper plant (Gaudreault et al., 2009) and to design a municipal energy system (Kostevšek et al., 2013).

Chiarini (2014) highlighted that companies that could improve their supply chain do not have to ignore EMAS Regulations, but should try to apply them to other strategies, such as LCA, even if additional elements of LCA make it difficult, as underlined by Lewandowska and Matuszak-Flejszman (2014).

### 1.3. Territorial LCA

The international community, in recent Standards, as ISO 37101 (ISO, 2016), ISO 14001 (ISO, 2015), ISO 37120 (ISO, 2014) and ISO 26000 (ISO, 2010), underlines the relevance of a life cycle approach in improving a management system with a sustainable perspective, and requires ad-hoc evaluations and coherent management procedures, related to the environmental issues of the life cycle.