ISO 14001 standard: Literature review and theory-based research agenda

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ABSTRACT

Environmental sustainability has gained momentum in the business world and academia. After about 20 years of research in this field, this paper presents a holistic literature review specifically focused on ISO 14001, which is widely considered the most important environmental certification. The authors apply an antecedents-process-consequences framework to analyze systematically the scientific debate in this field. They identify six streams of ISO 14001 research, that is, drivers, barriers, tools and methods, impact on performances, enabling factors affecting adoption, and enabling factors affecting performances. The authors then summarize these research streams and highlight conflicting results and unexplored research areas. Finally, they propose a theory-based research agenda.

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Introduction

Environmental sustainability has become a key priority for managers, scholars, and policy makers (McKinsey 2013; Walker et al. 2014; Lee and Klassen 2008; European Commission 2014). Several environmental management systems (EMS) and certifications have been created as a way to control companies’ environmental impact and encourage the spread of green practices (for example, ISO 14001, EMAS, Carbon Trust Standard, FSC, and MCERTS).

ISO 14001 – issued by the International Organization for Standardization (ISO) in 1996 – is the most popular environmental certification today (Delmas and Montes-Sancho 2011; Aravind and Christmann 2011). During the last decade, the number of certified companies has increased continuously (23 percent average annual growth), leading to more than 300,000 certified companies in 2017 (ISO 2018).

The breakdown of ISO 14001 certified companies by industry and country is presented in Tables 1 and 2. These tables show that the certification is spread across a very wide set of industries (primary, secondary, and tertiary) and countries (more than 170 in all the continents). The most important industries, not surprisingly, are construction (18.63 percent) and manufacturing, in particular metal products (9.48 percent), electrical and optical equipment (9.30 percent), machinery and equipment (5.88 percent), rubber and plastic products (5.11 percent), and chemical products (4.25 percent). As for the distribution by country, the importance of China (45.69 percent), and more generally the East Asia and Pacific region (almost 60 percent of the total number of certified companies), is of particular interest. Companies from these countries probably feel a prominent need to show their environmental commitment, particularly to Western customers. On the other hand, Europe also is an important region for ISO 14001 certification (about 30 percent), in particular the UK, Italy, Spain, and Germany. Not many American firms seek to obtain the ISO 14001 certification. This might be due to the already cogent and well-structured environmental laws and regulations of the country, which entail a significant set of mandatory activities in this field.

The steady rise in the adoption of ISO 14001 has drawn the attention of many researchers who have studied a wide set of topics, including motivations for companies to pursue this certification (for example, Bansal and Bogner 2002; Vastag 2009), problems faced during its adoption and management (for example, Alberti et al. 2000; Vastag and Melnyk 2002), and effects on firm performance (for example, De Jong, Paulraj, and Blome 2014; Melnyk, Sroufe, and Calantone 2003; Paulraj and de Jong 2011).

Despite the primary importance of ISO 14001 certification for both managers and scholars, previous literature reviews had a wide focus, such as green supply chain management (for example, Srivastava...
2007; Molina-Azorín et al. 2009; Sarkis, Zhu, and Lai 2011; Fahimnia, Sarkis, and Davarzani 2015) and environmental sustainability (for example, Marchet, Melacini, and Perotti 2014). Some literature reviews analyzed ISO 14001 together with other standards, mainly ISO 9001 (for example, Heras-Saizarbitoria, Landín, and Molina-Azorín 2011; Boiral 2012), paying limited attention to this environmental standard. The review developed by Tárrí, Molina-Azorín, and Heras (2012), for instance, analyzed only 29 papers on ISO 14001; most of the authors’ efforts were focused on the analysis of ISO 9001 literature.

Almost all the aforementioned literature reviews do not consider papers published after 2012, even if the annual number of scientific contributions was relevant after this date. The only exception is the paper published by Boiral et al. (2017), which considered contributions published until 2015. This paper, however, is focused mainly on the impacts of ISO 14001 and the obstacles and contingent factors that may influence the successful adoption of the standard. Moreover, this work does not provide a detailed analysis of the most adopted theories; therefore, a theory-based research agenda also is missing.

Consequently, a holistic and updated map of the research on ISO 14001 is still absent. It is useful to review the main research trends in this field, to highlight conflicting results and unexplored research areas, to understand the most important theoretical lenses adopted in this research field.

Therefore, the authors identified, selected, and summarized existing papers on ISO 14001. They: 1) analyzed the distribution of the papers in relation to geographical focus and underpinning theories; 2) identified gaps and conflicting results in the literature; and 3) suggested a theory-based research agenda.

In this way, the authors offer a contribution to theory and practice. From an academic point of view, they review a field no other authors have approached in a holistic way so far, therefore contributing to an advancement of the maturity level in the field. From a practitioner standpoint, their literature review may help managers to leverage more effectively the academic knowledge to make better decisions concerning this certification.

The remainder of the paper is structured as follows. First, the authors describe the approach adopted for reviewing the literature. Second, they present the descriptive findings of the review and provide a

### Table 1. Breakdown of ISO 14001 certificates by industry.
(adapted from ISO, 2018).

| Industry                                      | No. of certificates in 2017 | %     |
|-----------------------------------------------|----------------------------|-------|
| Agriculture, fishing, and forestry            | 2396                       | 0.87% |
| Mining and quarrying                         | 2429                       | 0.88% |
| Food products, beverage, and tobacco         | 6402                       | 2.32% |
| Textiles and textile products                | 4299                       | 1.56% |
| Pulp, paper, and paper products              | 2894                       | 1.05% |
| Printing companies                           | 2871                       | 1.04% |
| Chemicals, chemical products, and fibers     | 11734                      | 4.25% |
| Rubber and plastic products                  | 14091                      | 5.11% |
| Non-metallic mineral products                | 3410                       | 1.24% |
| Concrete, cement, lime, plaster, etc.        | 4433                       | 1.61% |
| Basic metal and fabricated metal products    | 26136                      | 9.48% |
| Machinery and equipment                      | 16202                      | 5.88% |
| Electrical and optical equipment             | 25642                      | 9.30% |
| Other transport equipment                    | 3696                       | 1.34% |
| Manufacturing not elsewhere classified       | 4173                       | 1.51% |
| Recycling                                     | 2788                       | 1.01% |
| Electricity supply                            | 2017                       | 0.73% |
| Construction                                  | 51384                      | 18.63%|
| Wholesale and retail trade, repairs of motor vehicles/personal/household goods | 23848                      | 8.65% |
| Transport, storage, and communication        | 7585                       | 2.75% |
| Financial intermediation, real estate, renting | 6063                      | 2.20% |
| Information technology                        | 8620                       | 3.13% |
| Engineering services                          | 16213                      | 5.88% |
| Other                                         | 26450                      | 9.59% |

### Table 2. Breakdown of ISO 14001 certificates by country.
(adapted from ISO, 2018).

| Continent/country | No. of cert. in 2017 | %     |
|-------------------|----------------------|-------|
| Africa            | 3083                 | 0.85% |
| South Africa      | 1230                 | 0.34% |
| Egypt             | 721                  | 0.20% |
| Tunisia           | 216                  | 0.06% |
| Other countries   | 916                  | 0.25% |
| North America     | 8124                 | 2.24% |
| USA               | 5251                 | 1.45% |
| Mexico            | 1701                 | 0.47% |
| Canada            | 1172                 | 0.32% |
| Central/South America | 10301           | 2.84% |
| Colombia          | 2954                 | 0.81% |
| Brazil            | 2948                 | 0.81% |
| Argentina         | 1458                 | 0.40% |
| Chile             | 1419                 | 0.39% |
| Other countries   | 1522                 | 0.42% |
| Europe            | 112790               | 31.11%|
| United Kingdom    | 17559                | 4.84% |
| Italy             | 14571                | 4.02% |
| Spain             | 13053                | 3.60% |
| Germany           | 12176                | 3.36% |
| Sweden            | 6486                 | 1.79% |
| France            | 6318                 | 1.74% |
| Other countries   | 42627                | 11.76%|
| East Asia and Pacific | 214621            | 59.19%|
| China             | 160655               | 45.69%|
| Japan             | 23901                | 6.59% |
| South Korea       | 5351                 | 1.48% |
| Australia         | 3938                 | 1.09% |
| Thailand          | 3405                 | 0.94% |
| Other countries   | 12361                | 3.41% |
| Central and South Asia | 8896              | 2.45% |
| India             | 7887                 | 2.18% |
| Pakistan          | 350                  | 0.10% |
| Other countries   | 659                  | 0.18% |
| Middle-East       | 4795                 | 1.32% |
| United Arab Emirates | 1711              | 0.47% |
| Israel            | 883                  | 0.24% |
| Iran              | 710                  | 0.20% |
| Other countries   | 1491                 | 0.41% |
thematic analysis of the findings. Finally, they draw some conclusions from the review in order to provide an agenda for future studies.

**Approach to the literature review**

To ensure rigor, objectivity, and transparency in the research process, the authors adopted a systematic literature review approach to obtain replicable and valid results (Rousseau, Manning, and Denyer 2008; Tranfield et al. 2003; Radziwill 2013; Thomé et al. 2016). First, the authors defined the criteria for including papers in their review. They restricted their literature review to contributions published in peer-reviewed English-language scientific journals, as often done in previous studies. Furthermore, since their goal was to identify articles of indisputable quality, they decided to focus on the two highest-grade journals (that is, 4 and 3) according to the Association of Business Schools’ (ABS) Academic Journal Guide (Harvey et al. 2010). The quality of the journal is frequently considered as a proxy for the quality of its papers (Gosling and Naim 2009; Lightfoot, Baines, and Smart 2013; Müller, Pemsel, and Shao 2014; Evans, Foster, and Linderman 2014). Furthermore, the ABS list is widely recognized as a good indicator of journal rigor and quality (Johnsen 2009; Miemczyk, Johnsen, and Macquet 2012) since it is based not only on citation metrics, such as the Scimago Journal Rank (SJR) or the Impact Factor, but also on the assessments performed by leading scholars in each research field. A methodological approach similar to the authors’ was adopted in some previous literature reviews (for example, Pallaro et al. 2015; Müller, Pemsel, and Shao 2014).

The authors performed a keyword search on two of the most important electronic databases, that is, Elsevier’s Scopus and Thomson Reuters Web of Science, to identify any relevant contribution meeting the criteria described previously. They used the “ISO140*” OR “ISO 140*” search string, as the asterisk allowed them to consider both the general ISO 14000 series of standards and the specific ISO 14001 standard. The authors further examined the reference lists of the identified papers to spot any additional contributions missing in the initial selection (that is, “snowball sampling” approach). In total, 125 papers were identified.

Finally, the authors read the full text of the papers and excluded 38 of them because they only mention the ISO 14001 certification without providing any significant analysis and result related to it. Therefore, the final analyzed sample consists of 87 papers.

The coding and analysis process followed an inductive-deductive approach. Categories were defined a priori by drawing from other literature reviews on similar topics (for example, ISO 9001 and SA8000 certifications) and by the authors’ research experience (deductive approach). Such categories were adjusted during the analysis, considering the themes emerging from the articles (inductive approach). The papers were first classified according to: author, year, journal title, research purpose, methodology, unit of analysis, sample dimension, headquarter country/countries, underpinning theories, industry, company size, and research topics (see Appendix A1). The authors then codified the ISO 14001 research topics following the antecedents – process – consequences framework by Narayanan, Zane, and Kemmerer (2011): the antecedents section consists of drivers/barriers/enabling factors related to the adoption of ISO 14001; the process section summarizes the tools and approaches connected to the certification process; and the consequences section focuses on the effects of ISO 14001 on firm performances and their enabling factors (see Figure 1). Finally, the authors developed a detailed table for each research topic, which frames and summarizes the main findings (see Tables 4–9).

To enhance the reliability of the results (Duriau, Reger, and Pfarrer 2007), three researchers conducted the coding and analysis process independently. A few cases of disagreement or different evaluation among the three coders were jointly discussed until agreement was reached.

**Descriptive findings**

In this section, the authors present the general trends coming to light from their literature review. These comprise the distribution of the publications over time, their publication outlets, the geographic areas of the studies, and the theories used.

The first article included in the review was published in 1997, one year after the introduction of the ISO 14001 standard. During the following years (2000–2017), an average of 4.8 contributions per year were made, with a peak of 11 papers in 2012.

Reviewed papers were published in a wide set of journals belonging to different disciplines, including operations management, business ethics, economics,
innovation, strategic management, and general management. Operations management journals account for about 50 percent of the reviewed papers.

From a geographical point of view, the majority of articles refer to the American continent (27), followed by Asia (20) and Europe (17); only four studies focus on Oceania. This distribution partially reflects the global spread of the standard (ISO 2015). Despite the international dimension of ISO 14001 and the possible influence of country-specific socio-environmental factors, only nine papers adopt a cross-country approach focusing on Europe, the United States, and Asia (for example, Johnstone and Labonne 2008; Bansal and Bogner 2002). This indicates the need for future studies to adopt a cross-country approach to extend the results of previous research and evaluate the influence of different geographical and cultural aspects.

About one third of the reviewed studies (28 papers) are theory-grounded. Literature reviews in the closely related field of sustainable supply chain management (Carter and Easton 2011; Touboulic and Walker 2015) present similar percentages. Table 3 provides an overview of the main concepts of these theories and their application in ISO 14001 studies.

The table highlights that a wide spectrum of theories have been adopted so far. The institutional and neo-institutional theories (Selznick 1957; DiMaggio and Powell 1983) have been the most frequently applied (16 articles). These theories provide a useful framework for analyzing the behavior of a company facing various pressures from the environment. Another theory frequently embraced is the resource-based view (Barney 1991) (seven articles), as various authors argue that ISO 14001 could be seen as an intangible resource (for example, Delmas 2008; Schoenherr 2012). Finally, the stakeholder theory (Freeman 1984) is a further lens used to explain the diffusion of ISO 14001 (three articles). As emerged in some recent literature reviews (for example, Sartor et al. 2016), this theory has been extensively adopted until now for dealing with ISO 9001 and SA8000.

**Thematic findings**

In this section, the main research topics of ISO 14001 literature are presented with particular attention to the most important or conflicting findings. A set of tables is also enclosed to provide the reader with detailed information about each theme (see Tables 4–9).

**Antecedents**

**Drivers**

The *drivers* that may encourage companies to seek ISO 14001 certification have been examined by 36 reviewed papers. Table 4 summarizes the drivers and classifies them according to the source (internal vs. external) and type (economic, environmental, or hybrid).

Among the most cited drivers, there is the desire to improve a company’s image (internal-economic, 20 papers). The certification is seen as a source of competitive advantage, improving the company’s external perception (for example, King, Lenox, and Terlaak 2005; Viadiu, Fa, and Heras-Saizarbitoria 2006) and exerting a positive effect on public opinion (Orsato 2006).

In some studies (for example, Hsu et al. 2013; Zhu, Tian, and Sarkis 2012), ethical reasons related to the environmental sensitivity of the company’s management have also been reported (internal-environmental, eight papers). Melnyk, Sroufe, and Calantone (2009) argue that companies often perceive the certification as “the right thing to do,” without expecting an economic return in the short term. These ethical reasons seem to prevail at the beginning of the certification process (González-Beníto and González-Beníto 2005).

Several studies (for example, Teixeira, Jabbour, and Jabbour 2012; Alberti et al. 2000) suggest that firms seek ISO 14001 certification in response to pressure by customers (external-hybrid, 24 papers). This pressure usually derives from larger business clients who play an important role in the supply chain (González,
Table 3. Underpinning theories.

| Theory                                      | Key issues                                                                 | # papers | Adoption in ISO14001 research                                                                 |
|---------------------------------------------|---------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------|
| Institutional and Neo-Institutional Theories | Companies receive pressure from the environment in which they operate and tend to conform to these to survive (institutional theory); Among these pressures, there are also social ones. They can be classified into three main categories: coercive pressures, normative pressures, mimetic pressures (neo-institutional theory). | 16       | Adoption and diffusion of ISO 14001 is primarily related to coercive, normative or mimetic pressures (Delmas and Montes-Sancho 2011; Heras-Saizarbitoria, Landín, and Molina-Arzorí 2011; Hsu et al. 2013; Zailani et al. 2012; Jiang and Bansal 2003; Zhu, Cordeiro, and Sarkis, 2012; King, Lenox, and Terlaak 2005; Husted et al. 2016; Baek 2017). Firms that are subjected to different external pressures adopt distinct sets of management practices (Delmas and Toffel 2008; González, Sarkis, and Adenso-Díaz 2008; Schoenherr and Talluri 2013; Testa et al. 2012; He, Yang, and Choi 2016). The external pressure could force firms to adopt ISO 14001 just for its signaling role (Aravind and Christmann 2011; Boiral 2007; Montiel, Husted, and Christmann 2012). |
Table 4. Drivers (number of papers is reported within square brackets).

| ECONOMIC                      | HYBRID                          | ENVIRONMENTAL                  |
|-------------------------------|---------------------------------|--------------------------------|
| INTERNAL Improve a company’s image [20] | Reduce resource consumption [4] | Reduce toxics release [4]     |
| González-Benito and González-Benito 2008; King, Lenox, and Terlaak 2005; González-Benito and González-Benito 2005; Orsato 2006; Heras-Saizarbitoria, Landin, and Molina-Arzorín 2011; Viadiu, Fa, and Heras-Saizarbitoria 2006; Vastag and Melnyk 2002; Alberti et al. 2000; Jiang and Bansal 2003; Bansal and Bogner 2002; Vastag 2009; Corbett and Kirsch 2009a; Delmas and Montiel 2009; King, Lenox, and Terlaak 2005; Montiel and Husted 2009; Nakamura, Takahashi, and Vertinsky 2001; Nishitani 2009; Vastag 2009; Iatridis and Kesidou 2018; Neves, Salgado, and Beijo 2017 | (Alberti et al. 2000; Miles et al. 1997; Reynolds and Yutras 2008; Neves, Salgado, and Beijo 2017) |
| Increase efficiency [12]       | Reduce packaging and raw materials usage [1] | Environmental sensitivity [8] |
| González-Benito and González-Benito 2005; Orsato 2006; Heras-Saizarbitoria, Landin, and Molina-Arzorín 2011; Vastag and Melnyk 2002; Alberti et al. 2000; Jiang and Bansal 2003; Melnyk, Sroufe, and Calantone 2003; Corbett and Kirsch 2009b; Zutshi and Sohal 2004b; Zutshi and Sohal 2004b; Johnstone and Labonne 2008; Iatridis and Kesidou 2018; Tuppura et al. 2016 | (González-Benito and González-Benito 2008; González-Benito and González-Benito 2005; Hsu et al. 2013, Heras-Saizarbitoria, Landin, and Molina-Arzorín 2011; Boiral 2007; Melnyk, Sroufe, and Calantone 2003; Corbett and Kirsch 2009b; Zhu, Tian, and Sarkis 2012) |
| Reduce resource consumption [4] | Improve Customer satisfaction [1] | Environmental legal requirements [17] |
| (Lo, Yeung, and Cheng 2012; Alberti et al. 2000; Reynolds and Yuthas 2008) | (Tuppura et al. 2016) | (King, Lenox, and Terlaak 2005; Delmas and Montes-Sancho 2011; Heras-Saizarbitoria, Landin, and Molina-Arzorín 2011; Hsu et al. 2013; Del Brío and Junquera 2003; Alberti et al. 2000; Bansal and Bogner 2002; Delmas and Toffel 2008; Zutshi and Sohal 2004a; Zutshi and Sohal 2004b; Baek 2017; Iatridis and Kesidou 2018; Neves et al. 2017; Gupta and Innes 2014; Fryxell and Szeto 2002; Kwon, Seo, and Seo 2002) |
| Reduce packaging and raw materials usage [1] | Improve quality of processes and products [2] | |
| (González-Benito and González-Benito 2005) | (Tuppura et al. 2016; Kwon, Seo, and Seo 2002) | |
| Focus on foreign market [12]   | Reduce information asymmetries between suppliers and buyers [4] | |
| Bansal and Bogner 2002; Bansal and Hunter 2003; Corbett and Kirsch 2009a; Delmas and Montiel 2009; King, Lenox, and Terlaak 2005; Montiel and Husted 2009; Nakamura, Takahashi, and Vertinsky 2001; Nishitani 2009; Vastag 2009; Iatridis and Kesidou 2018; Neves, Salgado, and Beijo 2017 | |
| Reduce toxics release [4]      | Pressures by customers [24]     | |
| Alberti et al. 2000; Bansal and Bogner 2002; Melnyk, Sroufe, and Calantone 2003; Corbett and Kirsch 2009a; Zhu, Tian, and Sarkis 2012; Delmas and Montes-Sancho 2011; Zhu, Tian, and Sarkis 2012; Teixeira, Jabbour, and Jabbour 2012; Iatridis and Kesidou 2018 | (Lo et al. 2012; King, Lenox, and Terlaak 2005; Orsato 2006; Hsu et al. 2013; Del Brío and Junquera 2003; Alberti et al. 2000; Miles, Munilla, and Russell 1997; Delmas and Montiel 2009; Jiang and Bansal 2003; Bansal and Bogner 2002; Melnyk, Sroufe, and Calantone 2003; Corbett and Kirsch 2009a; Zhu, Tian, and Sarkis 2012; Delmas and Toffel 2008; Zutshi and Sohal 2004a; McGuire 2014; González, Sarkis, and adenso-Diaz 2008; Vastag and Melnyk 2002; Vadiu, Fa, and Heras-Saizarbitoria 2006; Montiel, Husted, and Christmann 2012; Delmas and Montes-Sancho 2011; Zhu, Tian, and Sarkis 2012; Teixeira, Jabbour, and Jabbour 2012; Iatridis and Kesidou 2018) |
| Reduce toxics release [4]      | Pressures by customers [24]     | |
| (Alberti et al. 2000; Miles et al. 1997; Reynolds and Yuthas 2008; Neves, Salgado, and Beijo 2017) | (Lo et al. 2012; King, Lenox, and Terlaak 2005; Orsato 2006; Hsu et al. 2013; Del Brío and Junquera 2003; Alberti et al. 2000; Miles, Munilla, and Russell 1997; Delmas and Montiel 2009; Jiang and Bansal 2003; Bansal and Bogner 2002; Melnyk, Sroufe, and Calantone 2003; Corbett and Kirsch 2009a; Zhu, Tian, and Sarkis 2012; Delmas and Toffel 2008; Zutshi and Sohal 2004a; Delmas and Montes-Sancho 2011; Zhu, Cordeiro, and Sarkis, 2012; Teixeira, Jabbour, and Jabbour 2012) |
| Environmental sensitivity [8] | Pressures by suppliers [10]     | |
| (González-Benito and González-Benito 2008; González-Benito and González-Benito 2005; Hsu et al. 2013, Heras-Saizarbitoria, Landin, and Molina-Arzorín 2011; Boiral 2007; Melnyk, Sroufe, and Calantone 2003; Corbett and Kirsch 2009b; Zhu, Tian, and Sarkis 2012) | (Vadiu, Fa, and Heras-Saizarbitoria 2006; Jiang and Bansal 2003; Bansal and Bogner 2002; Zhu, Tian, and Sarkis 2012; Montiel, Husted, and Christmann 2012; Delmas and Montes-Sancho 2011; Zhu, Cordeiro, and Sarkis, 2012; Teixeira, Jabbour, and Jabbour 2012) |
| Environmental legal requirements [17] | Pressures by suppliers [10]     | |
| (King, Lenox, and Terlaak 2005; Delmas and Montes-Sancho 2011; Heras-Saizarbitoria, Landin, and Molina-Arzorín 2011; Hsu et al. 2013; Del Brío and Junquera 2003; Alberti et al. 2000; Bansal and Bogner 2002; Delmas and Toffel 2008; Zutshi and Sohal 2004a; Zutshi and Sohal 2004b; Baek 2017; Iatridis and Kesidou 2018; Neves et al. 2017; Gupta and Innes 2014; Fryxell and Szeto 2002; Kwon, Seo, and Seo 2002) | (Vadiu, Fa, and Heras-Saizarbitoria 2006; Jiang and Bansal 2003; Bansal and Bogner 2002; Zhu, Tian, and Sarkis 2012; Delmas and Toffel 2008; Zutshi and Sohal 2004a; Delmas and Montes-Sancho 2011; Zhu, Cordeiro, and Sarkis, 2012; Teixeira, Jabbour, and Jabbour 2012) |
| Environmental legal requirements [17] | Competitors imitation [7]       | |
| (King, Lenox, and Terlaak 2005; Delmas and Montes-Sancho 2011; Heras-Saizarbitoria, Landin, and Molina-Arzorín 2011; Hsu et al. 2013; Del Brío and Junquera 2003; Alberti et al. 2000; Bansal and Bogner 2002; Delmas and Toffel 2008; Zutshi and Sohal 2004a; Zutshi and Sohal 2004b; Baek 2017; Iatridis and Kesidou 2018; Neves et al. 2017; Gupta and Innes 2014; Fryxell and Szeto 2002; Kwon, Seo, and Seo 2002) | (Hsu et al. 2013; Bansal and Bogner 2002; Zhu, Tian, and Sarkis 2012; Delmas and Toffel 2008; Husted et al. 2016; Tuppura et al. 2016; Kwon, Seo, and Seo 2002) |
Table 5. Barriers.

| ADOPTION | ONGOING MANAGEMENT | BOTH | Difficulty to evaluate progress if there was already an EMS |
|-----------|--------------------|------|-------------------------------------------------------------|
| Risk of underestimating the required resources | Risk of spreading confidential information | Reduction in productivity due to administrative tasks required | Formal (ineffective) implementation | Lower overall efficiency | No requirements concerning cultural change | Time spent for frequent control visits | Inadequate technical competence of auditors | Limited economic performance improvement | Cost of certification | Low employees commitment | Difficult outcome evaluation |
| Alberti et al., 2000 | x | x | x | x | x | x | x | x | x | x | x |
| Bansal and Bogner, 2002 | x | x | x | x | x | x | x | x | x | x | x |
| Baral, 2007 | x | x | x | x | x | x | x | x | x | x | x |
| Baral, 2011 | x | x | x | x | x | x | x | x | x | x | x |
| Chiau, 2017 | x | x | x | x | x | x | x | x | x | x | x |
| Del Rio and Junquera, 2003 | x | x | x | x | x | x | x | x | x | x | x |
| Delmas, 2009 | x | x | x | x | x | x | x | x | x | x | x |
| Ferrón-Vilchez, 2016 | x | x | x | x | x | x | x | x | x | x | x |
| Iatridis and Kesidou, 2018 | x | x | x | x | x | x | x | x | x | x | x |
| Jacobs, Singhal, and Subramanian, 2010 | x | x | x | x | x | x | x | x | x | x | x |
| Jiang and Bansal, 2003 | x | x | x | x | x | x | x | x | x | x | x |
| Kitzawa and Sarkis, 2000 | x | x | x | x | x | x | x | x | x | x | x |
| Melnyk, Soufe, and Calantone, 2003 | x | x | x | x | x | x | x | x | x | x | x |
| Montiel, Husted, and Christmann, 2012 | x | x | x | x | x | x | x | x | x | x | x |
| Orsato, 2006 | x | x | x | x | x | x | x | x | x | x | x |
| Schoenheer and Talluri, 2013 | x | x | x | x | x | x | x | x | x | x | x |
| Sullivan, 2005 | x | x | x | x | x | x | x | x | x | x | x |
| Testa et al., 2018 | x | x | x | x | x | x | x | x | x | x | x |
| Vastag and Melnyk, 2002 | x | x | x | x | x | x | x | x | x | x | x |
| Zhu, Tian, and Sarkis, 2012 | x | x | x | x | x | x | x | x | x | x | x |
| Zutshi and Sohal, 2004a | x | x | x | x | x | x | x | x | x | x | x |
| Zutshi and Sohal, 2004b | x | x | x | x | x | x | x | x | x | x | x |
| TOTAL | 2 | 4 | 3 | 8 | 3 | 1 | 1 | 1 | 2 | 8 | 2 | 4 |
Table 6. Enabling factors (N: negative; P: positive; X: no effect; M: mixed).

| Low percentage of sells to end customers | Strategic proactivity | Presence of a previous EMS | Previous adoption of Lean Production | High asset specificity | Low debt-to-value | Low environmental performance | Low average age of employees | Large companies | Firm with high number of env. inspections | Firm in a chemical industry | High level of capital investment intensity | New companies | Dependence on foreign markets | High economic development of headquarters’ region | Plants located in Europe or Japan | Government commitment to environment | ISO 9001 diffusion level in the country | High local density of ISO 14001 certifications |
|-----------------------------------------|----------------------|-----------------------------|-------------------------------------|------------------------|-------------------|-----------------------------|-----------------------------|----------------|-----------------------------|-----------------------------|------------------------------------------|----------------|-----------------------------|------------------------------------------|--------------------------|------------------------|------------------------------------------|------------------------------------------|------------------------|
| Alberti et al., 2000                    | P                    |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Amold, 2015                             |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Bank, 2017                              | N                    | N                           | P                                   | X                      | M                 | P                           | P                           | P               | P                           | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Bansal and Bogner, 2002                 |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Bansal and Hunter, 2003                 |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Corbett and Kinch, 2009a                |                      |                             |                                     |                        |                   |                             |                             |               |                             | X                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Corbett and Kinch, 2009b                |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Del Brío and Junquera, 2003             |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Delmas and Montiel, 2009                |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Delmas and Toffé, 2008                  |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| González-Benito and González-Benito, 2005 |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| González-Benito and González-Benito, 2008 |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Graafland and Smit, 2016                |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Gupta and Innes, 2014                   |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| He, Yang, and Choi, 2016                |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Heras-Saizarbitora, Landín, and Molina-Arzón, 2011 |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Hustad, Montiel, and Christmann, 2016   |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Jacob, Singhal, and Subramaniam, 2010   |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Jiang and Bansal, 2003                  |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| King and Lenox, 2009                    |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| King, Lenox, and Taska, 2005            |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Klassen and Vachon, 2009                |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Melbyk, Sroufe, and Galantone, 2003     |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Miles, Munilla, and Russell, 1997       |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Montiel and Hustad, 2009                |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Nakamura, Takahashi, and Vertinsky, 2001 |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Nieves Salgado, and Beija, 2017         |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |
| Nishitani, 2009                         |                      |                             |                                     |                        |                   |                             |                             |               |                             | P                           |                                         |               |                             |                                         | P                        |           |                             |                                         |                        |           |

(Continued)
Table 6. Continued.

| Low percentage of sells to end customers | Presence of a previous EMS | Previous adoption of Lean Production | High asset specificity | Low debt-ratio | Low environmental performance | Low average age of employees | Large companies | Firm with a high number of EMS inspections | Firm in a chemical industry | Firm in a mechanical industry | Dependence on foreign markets | High level of capital investment intensity | New companies | High economic development of headquarters' region | Plants located in Europe or Japan | Government commitment to environment | ISO 9001 diffusion level in the country | High local density of ISO 14001 certifications |
|----------------------------------------|-----------------------------|-------------------------------------|------------------------|---------------|-----------------------------|-------------------------------|---------------------------|-----------------------------|-------------------------------|-----------------------------|---------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------|-----------------------------|
| Schoenherr, 2012                       |                             |                                     |                        |               |                             |                               |                           |                             |                               |                              |                                 |                              |                             |                             |                                |                                |                             |
| Schoenherr and Talluri, 2013           |                             |                                     |                        |               |                             |                               |                           |                             |                               |                              |                                 |                              |                             |                             |                                |                                |                             |
| Teixeira, Jabbour, and Jabbour, 2012   |                             |                                     |                        |               |                             |                               |                           |                             |                               |                              |                                 |                              |                             |                             |                                |                                |                             |
| Vastag, 2009                           |                             |                                     |                        |               |                             |                               |                           |                             |                               |                              |                                 |                              |                             |                             |                                |                                |                             |
| Vastag and Mehty, 2002                 |                             |                                     |                        |               |                             |                               |                           |                             |                               |                              |                                 |                              |                             |                             |                                |                                |                             |
| Wadhwa, Fa, and Heras-Sarboriota, 2006 |                             |                                     |                        |               |                             |                               |                           |                             |                               |                              |                                 |                              |                             |                             |                                |                                |                             |
| Zhu, Tran, and Sarkis, 2012            |                             |                                     |                        |               |                             |                               |                           |                             |                               |                              |                                 |                              |                             |                             |                                |                                |                             |
| Zutshi and Sidhu, 2004b                |                             |                                     |                        |               |                             |                               |                           |                             |                               |                              |                                 |                              |                             |                             |                                |                                |                             |
| **TOTAL**                             | 1P                          | 9P                                  | 7P                     | 1X            | 2P                          | 3P                            | 1P                        | 12P                        | 1P                            | 1P                          | 1M                            | 2P                            | 1N                          | 5P                          | 4P                          | 7P                            | 1P                            |
|                                       | 1N                          | 1M                                  | 1N                     | 1N            | 1M                          | 1N                            | 1N                        | 1N                          | 1N                            | 1N                          | 1M                            | 2P                            | 1N                          | 5P                          | 4P                          | 7P                            | 1P                            |
| Tools/methods | PDCA approach | Life Cycle Assessment | TQM | Environmental technologies | Green purchasing | Systematic communication with stakeholders | Incentive programs | Data-envelop analysis (DEA) | ISO 14063 principles | ISO 19011 principles | Information Technology | Environmental monitoring |
|---------------|---------------|----------------------|-----|---------------------------|------------------|-----------------------------------|-------------------|----------------------------|------------------|------------------|---------------------|-------------------------|
| Alberti et al., 2000 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Aravind and Christmann, 2011 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Bansal and Bogner, 2002 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Bansal and Hunter, 2003 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Boiral, 2011 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Cagno, Micheli, and Trucco, 2012 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Corbett and Kirsch, 2009a |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| De Oliveira Matias and Coelho, 2002 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Delmas, 2009 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Delmas and Montiel, 2009 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Delmas and Toffel, 2008 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Ferrón-Vilchez, 2016 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| González-Benito and González-Benito, 2005 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| González-Benito and González-Benito, 2008 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| González, Sarkis, and Adenso-Diaz, 2008 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Hsu et al., 2013 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Iatridis and Kesidou, 2018 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Ivanova, Gray, and Sinha, 2014 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| King and Lenox, 2009 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Kitazawa and Sarkis, 2000 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Kwon, Seo, and Seo, 2002 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Link and Naveh, 2006 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Lo, Yeung, and Cheng, 2012 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Melnyk, Sroufe, Calantine, and Montabon, 2002 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Melnyk, Sroufe, and Calantine, 2003 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Miles, Munilla, and Russell, 1997 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Montiel and Husted, 2009 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Muskin, 2000 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Nakashima, Nose, Kuriyama, 2006 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Paulraj and De Jong, 2011 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Reynolds and Yuthas, 2008 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Schoenherr, 2012 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Sullivan, 2005 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Teixeira, Jabbour, and Jabbour, 2012 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Vastag and Melnyk, 2002 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Zhu, Tian, and Sarkis, 2012 |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Zutshi and Sohal, 2004a |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| Zutshi and Sohal, 2004b |               |                      |     |                           |                  |                                   |                   |                            |                  |                  |                     |                         |
| **TOTAL** | **29** | **5** | **5** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **1** | **2** |
Table 8. Impact on performance (N: negative; P: positive; X: no effect).

| BUSINESS PROCESS | FINANCIAL |
|------------------|-----------|
| Increased process productivity and control | Reduced insurance cost |
| Optimized use of raw material | Improved health and safety condition in the workplace |
| Decreased inspections frequency | Reduced R&D investment and innovation |
| Improved quality of products/services | Improved firms’ profitability |
| Increased flexibility | Performance on Stock Exchange |
| Reduced waste and consumption of resources | Smaller decline in stock prices after environmental violation |
| Reduced negative env impact (e.g., air pollution) | |
| | |

Alberti et al. 2000  PP PP PP P P
Aravind and Christmann 2011  PP PP P P
Arimura, Darnall, and Katayama 2010  PP P
Arimura et al. 2016  P P P
Arnold 2015  P P
Bansal and Bogner 2002  P
Bansal and Hunter 2003  P X
Baño 2007  P
Boral 2007  P
Charimi 2017  P
Darnall and Kim 2012  P
De Jong, Paulraj, and Borne 2014  P
Delmas 2009  P P
Ferrón-Vilchez 2016  P P
Fryxell and Szeto 2002  P
González-Beníto and González-Beníto 2005  P
González-Sarkis, and Adenso-Díaz 2008  P
Graafland and Smid 2016  P P
He and Shen 2017  P
He, Yang, and Choi 2016  P
Hernández-Saizarbitoria, Landín, and Molina-Azorín 2011  P
Inoue, Arimura, and Nakano 2013  P
Jacobs, Singhal, and Subramanian 2010  P
King, Lenox, and Terlaak 2005  P
Kitsuwara and Sarkis 2000  P
Klassen and Vachon 2009  P
Kwon, Seo, and Seo 2002  P
Lim and Paaksh 2014  P X X
Link and Naveh 2006  P
Lo, Yeung, and Cheng 2012  P
McGuire 2014  P P P
Melnik, Sroufe, Calantone, and Montis 2002 (Continued)
Table 8. Continued.

| BUSINESS PROCESS | FINANCIAL | CUSTOMER | LEARNING AND GROWTH |
|------------------|-----------|----------|---------------------|
| Increased process productivity and control | Optimized use of raw material | Decreased inspections frequency | Improved quality of products/services |
| Increased flexibility | Reduced waste and consumption of resources | Reduced negative environmental impact (e.g., air pollution) | Improved health and safety condition in the workplace |
| Melnyk, Sroufe, and Calantone 2003 | Mijatovic and Stokic 2010 | Miles, Munilla, and Russell 1997 | Montiel, Husted, Christmann, 2012 |
| Muskin 2000 | Onar 2006 | Paulraj and de Jong 2011 | Pragjpo, Tang, and Lai 2014 |
| Schoenher 2012 | Schoenher and Tallini 2013 | Sullivan 2005 | Texeira, Jabbour, and Jabbour 2012 |
| Testa et al. 2012 | Vastag 2009 | Vastag and Melnyk 2002 | Wiengarten et al. 2017 |
| Xu et al. 2016 | Zailani et al. 2012 | Zutshi and Sohal 2004a | Zutshi and Sohal 2004b |
| TOTAL P | TOTAL P | TOTAL P | TOTAL X |

| Improved corporate image and reputation | More credible communication with partners | Increased on time delivery and reduced lead times | Increased customer satisfaction |
| Improved relations with communities and authorities | Diffusion of environmental practices among supply chain | Improved employees’ awareness and morale | Improved compliance with law/regulation |
| Development of capabilities to reduce environmental impact | Easier implementation of other environmental practices |

| Melnyk, Sroufe, and Calantone 2003 | Mijatovic and Stokic 2010 | Miles, Munilla, and Russell 1997 | Montiel, Husted, Christmann, 2012 |
| Muskin 2000 | Onar 2006 | Paulraj and de Jong 2011 | Pragjpo, Tang, and Lai 2014 |
| Schoenher 2012 | Schoenher and Tallini 2013 | Sullivan 2005 | Texeira, Jabbour, and Jabbour 2012 |
| Testa et al. 2012 | Vastag 2009 | Vastag and Melnyk 2002 | Wiengarten et al. 2017 |
| Xu et al. 2016 | Zailani et al. 2012 | Zutshi and Sohal 2004a | Zutshi and Sohal 2004b |
| TOTAL P | TOTAL P | TOTAL P | TOTAL X |

(Continued)
| Improved corporate image and reputation | More credible communication with partners | Increased on time delivery and reduced lead times | Increased customer satisfaction | Improved relationships with communities and authorities | Diffusion of environmental practices among supply chain | Improved employees’ awareness and morale | Improved compliance with law/regulation | Development of capabilities to reduce environ. impact | Easier implementation of other environmental practices |
|------------------------------------------|-------------------------------------------|-------------------------------------------------|---------------------------------|-----------------------------------------------|---------------------------------------------|---------------------------------|---------------------------------|-----------------------------------------------|-----------------------------------------------|
| Darnall and Kim 2012                    |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| De Jong, Pauraj, and Blame 2014           |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Delmas 2009                               |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Ferrón-Vilchez 2016                      |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Fryxell and Szeto 2002                    |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| González-Benito and González-Benito 2005 |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| González, Saks, and Adenso-Díaz 2008      |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Graafland and Smid 2016                   |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| He and Shen 2017                          |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| He, Yang, and Choi 2016                   |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Heiss-Saizarbitoria, Landin, and Molina-Azorin 2011 | P | P | P | P | P | P | P | P | P |
| Inoue, Arimura, and Nakano 2013           |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Jacobs, Singhal, and Subramanian 2010     |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| King, Lenox, and Terlisa 2005             |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Kitszawa and Saks 2000                    |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Klassen and Vachon 2009                   |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Kwon, Sae, and Seo 2002                   |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Lim and Prakash 2014                      |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Link and Naveh 2006                       |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Lo, Yeung, and Cheng 2012                 |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| McGuire 2014                              |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Melnyk, Sroufe, Calantone, and Montabon 2002 | P | P | P | P | P | P | P | P | P |
| Melnyk, Sroufe, and Calantone 2003        |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Mijatovic and Stotic 2010                 |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Miles, Munilla, and Russell 1997          |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Montiel, Husted, Christmann 2012          |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Muskin 2000                               |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Osato 2006                                |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Pauraj and de Jong 2011                    |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Prajogo, Tang, and Lai 2014                |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Schoenherr 2012                           |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Schoenherr and Talluri 2013               |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Sullivan 2005                             |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Teixeira, Jabbour, and Jabbour 2012       |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Tests et al. 2012                         |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Vastag 2009                                |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Vastag and Melnyk 2002                     |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Wengen et al. 2017                        |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Xu et al. 2016                            |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Zalani et al. 2012                        |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Zutshi and Sohal 2004a                    |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| Zutshi and Sohal 2004b                     |                                           |                                                 |                                 |                                               |                                            |                                 |                                 |                                               |                                               |
| **TOTAL**                                | **10P**                                   | **4P**                                          | **3P**                          | **3P**                                        | **8P**                                     | **5P**                          | **7P**                          | **12P**                                      | **10P**                                      | **6P**                                      |
Table 9. Variables affecting the performance (P: positive; X: no effect; E: effect).

| Top management commitment | High strategic coherence | High involvement of employees | Presence of previous standard | High implementation quality | Big company size | External stakeholder involvement | Sector in which the company operates | Implementation timing relative to rivals | System designed around existing internal processes | Use of consultant | Duration of ISO 14001 | State ownership or political participation | Presence of multiple certification | Substantive approach (not symbolic) | Strong internal motivation |
|---------------------------|-------------------------|-------------------------------|-------------------------------|-----------------------------|-----------------|---------------------------------|-------------------------------------|------------------------------------------|---------------------------------------------|-----------------|-----------------------|------------------------------------------|-------------------------------|-----------------------------|----------------------------------|
| Aravind and Christmann 2011 | P                       | P                             |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Arora et al. 2016         | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Arnold 2015               | P                       | P                             |                               | P                           | P               | P                               |                                      |                                           |                               |                |                      |                           |                               |                |
| Boiral 2011               | P                       |                               |                               | P                           | P               | P                               |                                      |                                           |                               |                |                      |                           |                               |                |
| Boiral and Henri 2012     | P                       |                               |                               | X                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Ciaranis 2014             | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| De Jong, Paulraj, and Blome 2014 | P                     |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| De Oliveira Matas and Coelho 2002 | P                     |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Delmaz 2009               | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Fernández-Vilchez 2016    | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Frywell and Deto 2002     | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| He, Yang, and Choi 2016   | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Hernández-Silabatorio, Landin, and Midlna- Arozin 2011 | P |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Iatridis and Kesidou 2018 | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Ivanova, Gray, and Sinha 2014 | P                   |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Kitazawa and Sarks 2000   | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Lee et al. 2015           | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Link and Naveh 2006       | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Paulraj and De Jong 2011  | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Schoenher 2012            | P                       |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Su, Dhanokar, and Lindeman 2015 | P |                               |                               | P                           | P               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Testa et al. 2018         | E                       |                               |                               | E                           | E               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Vatag and Melnyk 2002     | E                       |                               |                               | E                           | E               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| Wang et al. 2017          | E                       |                               |                               | E                           | E               |                                 |                                      |                                           |                               |                |                      |                           |                               |                |
| TOTAL                     | 4P                      | 7P                            | 3P                            | 1P                          | 2P              | 3P                              | 5P                                   | 2E                                     | 1E                          | 1E              | 1P                    | 1E                          | 1E                      | 1X             |

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Sarkis, and Adenso-Díaz 2008). For instance, corporations like Ford, General Motors, and Toyota asked their key suppliers to get this certification (Orsato 2006).

Some authors (for example, Jiang and Bansal 2003; Montiel, Husted, and Christmann 2012) argue that ISO 14001 is perceived by companies as a useful tool (in particular in international relations) to reduce information asymmetries between suppliers and buyers (internal-hybrid, four papers). Companies seek this certification to avoid opportunistic behaviors by their suppliers (Montiel, Husted, and Christmann 2012).

Another motivation that leads companies to obtain ISO 14001 certification (for example, Del Brio and Junquera 2003; Delmas and Toffel 2008) is the presence of environmental legal requirements (external-environmental, 17 papers). Companies are frequently pushed by regulatory bodies or governments to embrace management practices that ensure a sustainable exploitation of the environment (Miles, Munilla, and Russell 1997). This is particularly true in some industries, for example, the chemical sector, in which environmental issues are critical, due to the intensive use of toxic materials (Alberti et al. 2000; Delmas and Montiel 2009). However, according to Johnstone and Labonne (2008), the use of ISO 14001 certification for compliance reasons makes more sense for larger companies (more than 250 employees), which usually are more exposed to inspections.

Motivations to adopt ISO 14001 differ during the diffusion period (Baek 2017). Early adopters use ISO 14001 as a competitive resource; later adopters are more influenced by institutional pressure. As ISO 14001 spreads, it comes to be “taken for granted.” Baek shows that firms’ drivers for the adoption of ISO 14001 change as the program becomes widely recognized in the country. Additionally, the importance of motives seems to differ among business sectors (Tuppura et al. 2016) and countries (Neves, Salgado, and Beijo 2017).

Barriers

The barriers that may affect ISO 14001 have been discussed by 22 studies in the authors’ sample. They summarize these contributions in Table 5, classifying the barriers into three categories: those expected during the adoption of the certification, in the ongoing management, or in both these phases.

An interesting barrier that emerges from the literature (for example, Delmas 2009; Boiral 2011) is the risk of spreading confidential information (adoption, four papers). In many cases, the management of the certification process is outsourced to consultants (Boiral 2011). This may lead to a risk of sharing sensitive information (ibid.). Long-term relationships with consultants as well as legal measures might be adopted to mitigate this risk (Zutshi and Sohal 2004a). However, the involvement of the same external consultants over time can initiate some dependencies (Boiral 2011).

Another important barrier is the expected reduction in productivity due to administrative tasks required (ongoing management, three papers). Certified companies have to archive and manage the documentation related to environmental impacts and actions taken to improve past performances (for example, Bansal and Bogner 2002). This can lead to a high level of bureaucratization and the need for dedicated resources (Boiral 2011). In many cases, companies underestimate the efforts for administrative actions necessary for the ongoing management of the certification (Zutshi and Sohal 2004b).

Some studies (for example, Montiel, Husted, and Christmann 2012; Del Brio and Junquera 2003; Boiral 2011) argue that companies occasionally perform a formal (ineffective) implementation of ISO 14001 (ongoing management, five papers), that is, they implement the certification primarily for its potential commercial value rather than for really improving business practices. Such a focus limits the efficacy of ISO 14001, in particular in its ongoing management (Boiral 2007; Ferrón-Vilchez 2016; Iatridis and Kesidou 2018).

The most debated barrier of ISO 14001 (for example, Orsato 2006; Alberti et al. 2000) is the cost of certification (both, eight papers), defined by some authors as the “cost to be green” (Orsato 2006). This cost includes the work of the certification bodies, the time spent by the company analyzing its own processes, modifying them, developing the necessary documentation, and training the personnel (Zutshi and Sohal 2004b). Besides the aforementioned initial certification costs, there is an annual cost for maintaining the certification (for example, auditing and documentation management) (Bansal and Bogner 2002). These costs may represent a further obstacle to ISO 14001, especially for small and medium enterprises (Orsato 2006).

Finally, another relevant barrier is the difficult outcome evaluation (Delmas 2009; Sullivan 2005) (longitudinal, four papers). In particular, the lack of quantifiable benefits is a significant obstacle to actively pursue the certification (Vastag and Melnyk 2002). Companies driven mainly by economic motivations
can see the benefits of ISO 14001 as particularly uncertain (Melnyk, Sroufe, and Calantone 2009).

**Enabling factors affecting the ISO 14001 adoption**

A significant number of studies have focused on the variables that may facilitate the adoption of ISO 14001 (38 papers). The role of these variables is to reinforce the drivers’ effect and/or to reduce the barriers’ effect. The authors summarize this debate in Table 6, classifying them into *firm-specific* and *contextual* enabling factors.

Some studies (for example, Zutshi and Sohal 2004b; Viadiu, Fa, and Heras-Sazarbitoria 2006) show the presence of a previous EMS is an enabling factor in the adoption of ISO 14001 since it tends to increase the likelihood of implementing the certification (firm-specific factor, eight papers). The adoption of a standard/management system could simplify the implementation thanks to the experience gained and the opportunity to share common activities (King and Lenox 2009). While most authors agree with this finding, Melnyk, Sroufe, and Calantone (2009) present a conflicting result. These authors argue that while the new development of an EMS can be seen as an opportunity to become ISO 14001 certified, companies with a consolidated EMS are more reluctant to get the certification because they are already internally aligned with environmental requirements.

Some scholars (for example, Alberti et al. 2000; González-Benito and González-Benito 2005; Nishitani 2009) assert that large companies are more likely to adopt the ISO 14001 certification (firm-specific factor, 12 papers). The adoption of ISO 14001 requires investments in time and financial resources, and small and medium enterprises (SMEs) may have greater difficulty finding these resources (Miles, Munilla, and Russell 1997; Montiel and Husted 2009). According to Graafland and Smid (2016), SMEs prefer to use simple formal management tools to raise the quality of environmental management without incurring high bureaucratic costs. Furthermore, larger companies can obtain the certification more quickly due to higher competences on average (Nakamura, Takahashi, and Vertinsky 2001). In the end, since their corporate marketing division can be more influential, large firms tend to emphasize more customers’ requests of obtaining the certification (Delmas and Toffel 2008).

According to several studies (for example, Corbett and Kirsch 2009a; Jacobs, Singhal, and Subramanian 2010) there is a positive relation between a company’s strategic proactivity – defined as the tendency to implement the most advanced and modern practices (González-Benito and González-Benito 2008) – and the likelihood of implementing ISO 14001 (internal factors, nine papers). Under this perspective, the adoption of the certification might be considered as a proactive way of managing regulatory changes, community relations, and public opinion (Jiang and Bansal 2003).

More conflicting results have been obtained with reference to contextual enabling factors.

Corbett and Kirsch (2009a) find no effect from the economic development of headquarters’ region. Vastag (2009) claims that in the most economically advanced countries there are more opportunities to get certified due to a higher availability of skills and resources. Schoenherr (2012) shows that the certification is better accepted in emerging economies (for example, China and Brazil) than in industrialized countries. He argues that this may because industrialized countries have, in many cases, already reached their performance frontier (or are very close to it); therefore, improvements are more difficult to obtain.

Husted, Montiel, and Christmann (2016) find the local density of certifications among geographically proximate firms increases the likelihood of obtaining ISO 14001 certification. In particular, the local density of certifications has a larger effect on domestic firms’ certification decisions than on certification decisions of multinational enterprise subsidiaries.

Delmas and Montes-Sancho (2011) highlight that a positive relationship exists between the ISO 9001 diffusion level in the country and the adoption of ISO 14001. Due to similarities between the two standards (also in their implementation paths), positive experiences with ISO 9001 could facilitate the adoption of ISO 14001. However, there are conflicting results in this instance as well. Melnyk, Sroufe, and Calantone (2009) show ISO 9001 certified plants are less likely to welcome the ISO 14001 certification. The authors provide two possible explanations for this result: 1) firms having difficulties with ISO 9001 or a bad experience with the certification process are reluctant to start another audit and certification process; and 2) ISO 9001 certified firms often have an EMS as well and therefore do not necessitate to get ISO14001 certified.

**Process**

The literature devoted to tools and methods used with ISO 14001 is presented here and summarized in Table 7.

Many studies (29) (for example, Corbett and Kirsch 2009b; Schoenherr 2012; Teixeira, Jabbour, and...
Jabbour 2012) deal with the plan-do-check-act (PDCA) cycle role – explicitly mentioned by ISO 14001 – that force the adoption of a continuous improvement logic and fix increasing challenging (environmental) targets.

A relevant technique, discussed in six studies (for example, Lo, Yeung, and Cheng 2012; González-Beníto and González-Beníto 2008), is life-cycle assessment (LCA), utilized for the evaluation of the environmental impacts associated with all stages of a product’s life from cradle to grave. Literature highlights that LCA is useful to assess direct environmental impacts, but also indirect ones that are typically harder to be estimated. The technique allows companies to (re)design their products/processes to improve their practices.

Some studies (for example, Reynolds and Yuthas 2008; Zutshi and Sohal 2004a; 2004b) indicate the use of some elements of total quality management (TQM) (for example, the “team-based” approach, the cross-functional integration, the enlargement of the employees’ mansions) is effective in the ISO 14001 implementation.

Five articles highlight the importance of activating a systematic communication with the stakeholders. Paulraj and De Jong (2011), for instance, show the convenience of a bidirectional communication with external stakeholders, focusing on the relevant elements and informing them about the activities already achieved. In addition, the use of information technology is an important tool to gain high implementation effectiveness (Ivanova, Gray, and Sinha 2014).

Among the techniques analyzed in single studies, Nakashima, Nose, Kuriyama (Nakashima, Nose, and Kuriyama 2006) suggest the use of the data envelopment analysis (DEA) in the evaluation of environmental performances. This method can be applied taking into consideration different inputs (for example, trash quantity, CO2 gas emission) and outputs (for example, total revenues) to determine the efficiency.

Consequences

Impact on performance

The performance impact of ISO 14001 is the most debated topic in the literature (49 papers). The authors summarize this research stream in Table 8, classifying the analyzed performance dimensions according to the four perspectives of Kaplan and Norton’s (1992) balanced scorecard.

Some authors (for example, Alberti et al. 2000; Boiral 2007) show the adoption of ISO 14001 led to increased process productivity and control (business process perspective, nine papers). During the implementation process, employees working in various corporate functions are called to examine and improve their business processes. This usually leads to the achievement of better operational performance (Melnyk, Sroufe, and Calantone 2009). Only one article (Schoenherr and Talluri 2013) presents the certification as having a negative effect on productivity. According to them, the implementation of ISO 14001 certification requires time and often radical changes within the company. This causes a decrease in productivity (at least) in the short term until the new procedures are assimilated.

Another effect of ISO 14001 certification highlighted by the reviewed studies (for example, Zailani et al. 2012; Alberti et al. 2000) is a reduced waste and consumption of resources (business process perspective, 14 papers). Lo, Yeung, and Cheng (2012), for instance, focus on fashion and textiles – which sometimes have a high level of emissions – and argue that the adoption of ISO 14001 allows them to reduce the pollution production and associated costs. Darnall and Kim (2012) show all types of EMS (that is, 14001-certified EMSSs, complete noncertified EMSSs, and incomplete EMSSs) lead to a reduction of natural resources consumption, solid wastes, and global air pollutants.

According to He and Shen (2017), ISO 14001 certification improves company-wide practices of resource management, which enables firms to better invest their resources in R&D and innovation activities.

Three studies analyzed the efficacy of ISO 14001 on the firm’s performance on the stock exchange (financial perspective). Paulraj and De Jong (2011) elucidate that the announcement of certification has a negative impact on the value of the shares, since it is perceived as misaligned with the typical short-medium term orientation of the shareholders. Jacobs, Singhal, and Subramanian (2010) underline that ISO 14001 leads to a long-term positive reaction of the financial markets. Shareholders perceive the certification as a signal of the company’s commitment to align its processes with international best practices, and to improve environmental management as well as operational performance. This positive effect is more significant in sectors in which the ISO 14001 certification is considered a prerequisite to operate (ibid.). Additionally, Xu et al. (2016) assert that ISO 14001 certified firms face a smaller decline in stock prices after environmental violation.

The impact of the certification on sales performance is still a debated issue (financial perspective, nine papers). On the one hand, Jacobs, Singhal, and...
Subramanian (2010) claim ISO 14001 could improve financial performance via the revenue gains from enhanced reputation. On the other hand, Link and Naveh (2006) find no correlation between environmental and sales performance.

Several contributions (for example, Melnyk et al. 2002; Orsato 2006) point out that the adoption of ISO 14001 leads to an improved corporate image and reputation (customer perspective, 10 papers). Vastag and Melnyk (2002) argue that certified companies are better accepted by external stakeholders (including customers) since they demonstrate more responsibility toward environmental issues.

Finally, many authors (for example, Delmas 2009; Muskin 2000) highlight the positive impact of ISO 14001 on compliance with law/regulations (learning and growth perspective, 12 papers). Certified firms tend to be compliant with all the relevant environmental regulations and are therefore less likely of being cited for violating them (McGuire 2014).

**Enabling factors affecting the performance**

Many studies (23 papers) have evaluated the factors that might facilitate the performance impact of ISO 14001. This debate is summarized in Table 9.

Strategic coherence (that is, the consistency between the certification goals, policies, and actions) is the most frequently highlighted variable (seven papers) affecting the performance impact of ISO 14001. Delmas (2009) argues that the interests of shareholders should be aligned in the search for environmental sustainability. Boiral (2011) echoes that the firm should be able to define and effectively communicate: 1) why the standard should be adopted; 2) which could be the internal advantages; and 3) the relationship among advantages, mission, and strategic goals of the organization.

Four studies show a positive effect of top management commitment. An environmentally sensitive top management is able to influence the way certification is adopted and results are achieved.

Another enabling factor supporting the performance impact of ISO 14001 (three papers) is the involvement of employees. Human resources should be aware of the requirements of the standard and its objectives, and should attend training programs on environmental issues (Boiral 2011). However, Kitzazawa and Sarkis (2000) argue that, although training is of prominent importance, it is not always able to guarantee the required cultural change. To support and motivate employees, incentive mechanisms are welcome. Four studies (Paulraj and De Jong 2011; Schoenherr 2012; Ivanova, Gray, and Sinha 2014; Fryxell and Szeto 2002) stress that the impact of ISO 14001 may be contingent on company size. Paulraj and De Jong (2011) prove that the negative reaction of the financial market, which in some cases follows the announcement of the certification, is less significant for large companies. This is mainly due to the fact that large companies may more easily reassure investors that the decision to pursue the certification is the result of a careful analysis about costs and benefits, persuading them that the certification is the right strategic decision (ibid.). Schoenherr (2012) echoes that the effect of ISO 14001 on operational performance is higher for large companies. However, Ivanova, Gray, and Sinha (2014) note the size of the company has no effect on the performance.

Delmas (2009) argues that stakeholder involvement (suppliers, customers, government agencies, and shareholders) can help the adoption of ISO 14001 more effective. Also, Lee et al. (2015) state that, among ISO 14001 certified firms, having green suppliers increases environmental performance and competitive advantage.

Literature also shows that the industrial sector in which the company operates moderates the performance impact of the certification (Vastag and Melnyk 2002). Companies belonging to the chemical sector tend to achieve, for instance, the best results due to ISO 14001 adoption. On the contrary, companies competing in the machinery, electronic, and electrical components industries obtain the worst results. This can be explained by the fact that in these sectors the short-term certification impact is less significant since improvements in the processes require a long-term redesign (ibid.). Furthermore, Chiarini (2014) claims manufacturing companies are not as confident as service companies about ISO 14001 as an effective strategy for improving the environmental performance of the supply chain.

According to Arimura et al. (2016), the performance impact of certification also is affected by the type of environmental regulation in the home country. In fact, plants located in countries with stronger and more flexible environmental regulations can develop more creative and effective solutions.

Su et al. (2015) also argue that early ISO 14001 implementation timing relative to industry rivals positively affects firm performance. The performance benefits increase in a highly competitive environment, and also prior ISO 9001 experience moderates the relationship between the implementation timing and firm performance.
### Research agenda

This systematic literature review of ISO 14001 certification has highlighted the main research trends and identified some conflicting results and unexplored research areas. The authors therefore conclude their study by elaborating an agenda for future research on ISO 14001. This agenda is organized according to the framework adopted in the review, that is, antecedents, process, and consequences, and summarized in Figure 2. They also show in their findings that little research draws on theory. Hence, their recommendations for future research also attempt to address this shortcoming.

#### Future research avenues on antecedents

While the drivers of certification have attracted considerable attention, there are several potential avenues for future research that contribute to a better understanding of antecedents. Certification has been seen as a prerequisite to compete in certain markets (Alberti et al. 2000). However, the international dimension of the certification has not been analyzed in a systematic way. For instance, none of the reviewed studies focus on the relationship between ISO 14001 and global sourcing. Extant operations management and international business research have analyzed the internationalization process of companies’ activities, highlighting some sequential evolutionary stages (for example, Johanson and Wiedersheim-Paul 1975; Rajagopal and Bernard 1993; Hemerling and Lee 2007). Future ISO 14001 research could focus on the possible link among these evolutionary stages and the adoption and management of this certification. This may help show and understand possible interdependencies between internationalization phases and ISO 14001. As far as manufacturing internationalization is concerned, future research could study the relationship between the adoption of ISO 14001 and the four sequential stages highlighted by the Uppsala school, that is, no regular export/import activities, using agents, establishing a foreign sales branch and establishing a production unit (Johanson and Wiedersheim-Paul 1975).

Future research on antecedents can also shed light on the motivational differences between large and small companies adopting ISO 14001. For example, it may be interesting to explore the role of firms’ (inter-
dependence on the adoption of ISO 14001. SMEs may feel pressure to adopt the certification in order to maintain a relationship with larger companies. On the contrary, large companies may adopt ISO 14001 independently (for example, visibility and reputational motivations). With a deeper understanding of these differences it is possible to further consider the role of institutional factors as well as interorganizational aspects. Resource dependence theory would be a fruitful lens to adopt in this context. Other theories, such as contingency theory and signaling theory, may be useful to understand in which context organizations should adopt a certification like ISO 14001.

The topic of the certification barriers is the least-studied aspect within antecedents. Contributions in this area tend to focus on the cost of certification (for example, Orsato 2006). Recent studies on other barriers (for example, the difficult outcome evaluation) are lacking. For these reasons, significant attention should be devoted to this research topic. In the same line, as one of the authors’ earlier suggestions, it would be interesting to understand the country-specific effects on the barriers. This could be achieved by conducting comparative studies across different nations, hence offering a more international and contextually relevant perspective of barriers to certification. Such research would provide major insights on the role of regulatory and industrial contexts in preventing the certification.

As far as enabling factors are concerned, it is worth recalling that research found conflicting evidence regarding the role played by the previous implementation of an EMS on the adoption of ISO 14001. In particular, it was shown that previous experience could either support or hinder the adoption of the certification. Given the lack of consensus on this topic, this is an interesting avenue to further explore. Theoretically, an organizational learning and/or a sense-making perspective (Easterby-Smith 1990; Weick 1995) could help conceptualize the role of organizational previous experience on the decision to adopt ISO 14001.

**Future research avenues on process**

There are three main avenues for future research around the implementation and diffusion of the certification. First, limited attention has been paid to exploring the implementation and diffusion aspects of ISO 14001 at the interorganizational level. For instance, it would be possible to analyze the implementation and diffusion of ISO 14001 from an ecological modernization theory (EMT). EMT would be a powerful lens not only to constitute the macro-level institutional and legal framework required for ISO 14001, but also to understand diffusion mechanisms and interorganizational relationships between large buyers and small suppliers (Murphy and Gouldson 2000; Sarkis, Zhu, and Lai 2011). By bringing attention to the interorganizational level, researchers would also be able to explore the potential power mechanisms that may be at play in ISO 14001 implementation.

An additional shortcoming of current research on ISO 14001 diffusion is the predominant focus on organizational-level factors, with little consideration given to micro behavioral aspects. A deeper understanding of the role of individuals in championing or hindering the adoption and diffusion of certification practices would be valuable in guiding managerial decisions and actions, in particular to ensure employee engagement. An understanding of the behavioral aspects of environmental practices has been already called for by some authors (for example, Carter and Easton 2011; Pagell and Shevchenko 2014; Toubolouic and Walker 2015).

Finally, as highlighted previously, resource dependence theory would be well suited to explore motivational aspects. It may also serve to enhance the understanding of how ISO 14001 may contribute in reducing information asymmetry (Sarkis, Zhu, and Lai 2011; Simpson, Power, and Samson 2007) and in mitigating potential risks, especially when cultural distance may exist between trading partners. This could help enhance the understanding of the certification implementation and diffusion in an international context.

**Future research avenues on consequences**

Impact on performance is the most debated topic, but also the research area with the most conflicting results. The authors found no agreement among authors on the effect of the certification on sales (for example, Muskin 2000; Schoenherr and Talluri 2013) and on stock market performance (Paulraj and De Jong 2011; Jacobs, Singhal, and Subramanian 2010). Future research is needed in this field. A possible framework that could be adopted is Kaplan and Norton’s (1992) balance scorecard (BSC). It considers both short-term and long-term horizons and organizes the performance indicators into four prominent dimensions, that is, business process, financial, customer, and learning and growth. Future research could examine the combined effects of ISO 14001 on all four dimensions, identifying possible
interdependencies and tradeoffs. Another theory that may be useful to study the overall value of ISO 14001 certification is the stakeholder theory (Freeman, 1984). The basic assumption of this theory is that the company should identify those actors who can affect or be affected by its activities (that is, the stakeholders) and shape its strategy to address their concerns. Three reviewed studies (González, Sarkis, and Adenso-Diaz 2008; Zailani et al. 2012; Testa et al. 2018) adopted stakeholder theory but only focused on a specific geographical area (that is, Spain, Malaysia, and Europe). Scholars should therefore conduct more extensive and systematic analyses adopting this theory to shed light on how ISO 14001 contributes to meeting the interests of different stakeholders’ groups in the short and long term.

There also may be opportunities to consider performance measures more broadly in light of the three dimensions of sustainability (environmental, economic, and social). In particular, it would be interesting to compare the achievements of ISO 14001 on some key measures of environmental sustainability with those of different certifications or EMS. Researchers could draw on recent studies that focused on performance metrics in green and sustainable supply chains (Ahi and Searcy 2015). Once again, information theory may help establish the mediating role of ISO 14001 certification on overall environmental performance. Some recent contributions (Matthews et al. 2016; Montabon, Pagell, and Wu 2016; Pagell and Shevchenko 2014) also have called for a more eco-centric perspective on sustainable SCM, emphasizing the need to understand the true ecological impact of green SC practices. Research examining the performance impact of ISO 14001 is well suited to respond to this call, and could potentially examine how, if at all, ISO 14001 contributes to reducing companies’ impact on planetary boundaries (Whiteman et al. 2013).

Finally, only four papers (Vastag and Melnyk 2002; Delmas 2009; Chiarini 2014; Arimura et al. 2016) have focused on contextual factors that can moderate the impact of the ISO 14001 certification on firm performance. There is therefore a need to deepen the understanding of the influence of contextual factors on the effectiveness of certification implementation. These contextual factors include the location of the company, the location of its main suppliers, the location and characteristics of its sales markets (for example, perfect competition, oligopoly), industry (for example, labor intensive vs. capital intensive), and product characteristics. A theoretical lens that might be embraced in this context is contingency theory (for example, Burns and Stalker 1961; Donaldson 2001). This theory postulates that there is no unique best way to manage an organization and that the best strategies and actions are contingent on a number of contextual factors, both internal and external to the firm.

Conclusions

In this paper the authors presented a holistic literature review on ISO 14001. They applied an antecedent–process–consequences framework to organize the scientific debate in this field. They identified six streams of research on ISO 14001, that is, drivers, barriers, tools and methods, impact on performances, enabling factors affecting adoption, and performances.

The authors highlighted the drivers that may encourage companies to seek the ISO 14001 certification and classified them according to the source (internal vs. external) and type (economic, environmental, or hybrid). They presented the barriers that may affect the ISO 14001 adoption and management, including, among the most cited, the procedural implementation, the cost of certification, the risk of spreading confidential information, and the difficulty of evaluating outcomes. They analyzed the enabling factors affecting the certification adoption. They observed a high level of agreement between authors on the effects of firm-specific factors. They highlighted instead more conflicting results for the contextual factors affecting the adoption/diffusion of ISO 14001 such as the economic development of headquarters’ region and the level of diffusion of ISO 9000 in the country. The authors noticed the performance impact of ISO 14001 is the most debated topic in the literature and classified the analyzed performance dimensions according to the four perspectives of the Kaplan and Norton’s (1992) balanced scorecard. Finally, the authors observed that many studies have analyzed the factors that might moderate the performance impact of the certification, such as the strategic coherence, the involvement of employees, and the company dimension. Some contradictory findings were underlined.

This systematic review of ISO 14001 literature allowed the authors to identify a set of knowledge gaps and present a research agenda on the topic. Despite many years of academic interest in this field, several key questions remain. For instance, what is the nature of the relationship between the adoption of
ISO 14001 and the stages of the internationalization process? What role does ISO 14001 play in reducing information asymmetry in the supply chain? What is the role of individuals (managers and employees) in supporting or hindering the implementation and diffusion of the certification? What are the contextual factors that might moderate the impact of ISO 14001 on performance? What are the effects of certification on sales and stock market performance? All these questions are just a subset of potential avenues that could be explored in the future.

In sum, the authors’ study offers a contribution to theory and practice. From an academic standpoint, they review a field no other authors did in such a detailed way, advancing the level of maturity in the field. From a practitioner’s point of view, the authors’ literature review may help managers to understand how organizations address their environmental responsibilities by means of ISO 14001. They can effectively use knowledge created by scholarly research to make more attentive decisions concerning this certification.

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| Author(s), year | Journal title | Research purpose | Methodology | Unit of analysis | Sample dimension | Headquarter country/countries | Underpinning theory | Industry | Company size |
|----------------|---------------|------------------|-------------|-----------------|-----------------|-----------------------------|-------------------|----------|--------------|
| Alberti et al. 2000 | International Journal of Production Research | Exploration | Survey | Firm | 14 | Italy | — | Mainly Chemical | Medium and large |
| Aravind and Christmann 2011 | Business Ethics Quarterly | Exploration | Survey | Plant | 144 | US | Institutional Theory | — | — |
| Arimura et al. 2010 | Journal of Environmental Economics and Management | Theory testing | Survey | Firm | 845 | Japan | — | — | — |
| Arimura et al. 2016 | Journal of Environmental Management | Theory building | Survey | Plant | 1417 | UNITED States, Japan | — | — | — |
| Baek 2017 | Ecological Economics | Exploration | Case study | Firm | 110 | Germany | Evolutionary Theory | Water industry | — |
| Bansal and Bogner 2002 | Journal of Business Ethics | Theory building | Survey | Firm | 982 | Korea | Institutional Theory, RBV | — | — |
| Bansal and Hunter 2003 | Long Range Planning | Theory building | Conceptual | — | — | Canada, Japan, UK, US | — | — | — |
| Barla 2007 | Journal of Business Ethics | Exploration | Simulation | Firm | 46 | US | — | — | — |
| Barla 2012 | Journal of Environmental Economics and Management | Theory testing | Case study | Firm | 37 | Quebec | — | Pulp and paper | — |
| Boiral 2007 | Organization Science | Exploration | Case study | Firm | 9 | Canada | Institutional Theory, Rhetorical Theory of Diffusion | — | Medium and large |
| Boiral 2011 | Long Range Planning | Exploration | Conceptual, interview | Individual | 189 | Canada | — | — | — |
| Boiral and Henri 2012 | Journal of Environmental Management | Theory building | Survey | Firm | 303 | Canada | — | — | — |
| Cagno et al. 2012 | Production Planning & Control | Theory building | Case study | Firm | 1 | Italy | — | Electro-mechanical | Medium |
| Chiarini 2014 | Business Strategy and the Environment | Theory building | Survey | Firm | 800 | Europe | — | — | Large |
| Chiarini 2017 | Business Strategy and the Environment | Theory testing | Survey | Firm | 164 | Europe | — | — | Medium and large |
| Corbett and Kirsch 2009a | Production and Operations Management | Exploration | Simulation | — | — | — | — | — | — |
| Corbett and Kirsch 2009b | Production and Operations Management | Exploration | Conceptual | — | — | — | — | — | — |
| Darnall and Kim 2012 | Public Administration Review | Theory building | Survey | Firm | 4187 | US, Japan, Europe | — | — | Medium and large |
| De Jong, Paulraj, and Blome 2014 | Journal of Business Ethics | Theory building | Simulation | Firm | 219 | US | — | — | — |
| De Oliveira Matias and Coelho 2002 | International Journal of Production Research | Exploration | Conceptual | — | — | — | — | — | — |
| Del Brio and Junqua 2003 | International Journal of Production Research | Theory testing | Survey | Firm | 373 | Spanish | — | — | Medium and large |
| Delmas 2009 | Production and Operations Management | Exploration | Conceptual | Individual | 55 | US | RBV | — | — |
| Delmas and Montes-Sancho 2011 | Business Ethics Quarterly | Theory extension | Conceptual | — | — | — | Institutional Theory | — | — |

(Continued)
| Author(s), year | Journal title | Research purpose | Methodology | Unit of analysis | Sample dimension | Headquarter country/countries | Underpinning theory | Industry | Company size |
|----------------|---------------|------------------|-------------|-----------------|-----------------|-------------------------------|--------------------|----------|--------------|
| Delmas and Montiel 2009 | Journal of Economics & Management Strategy | Theory testing | Survey | Supplier | 3152 | Europe, Japan, US | TCE, Signaling Theory | Automotive | — |
| Delmas and Toffel 2008 | Strategic Management Journal | Theory extension | Survey | pLant | 536 | US | Institutional and Neo-Institutional theory | — | — |
| Ferrón-Vílchez 2016 | Journal of Environmental Management | Theory building | Survey | Firm | 1214 | Canada, France, Germany, Hungary, Japan, Norway, USA | — | — | — |
| Fryxell and Szeto 2002 | Journal of Environmental Management | Theory testing | Survey | Firm | 29 | China | — | — | — |
| González-Benito and González-Benito 2008 | International Journal of Operations & Production Management | Exploration | Survey | Supplier | 157 | Spanish | Institutional, RBV, Stakeholder Theory | Automotive | Stratified sample |
| González-Benito and González-Benito 2005 | British Journal of Management | Theory building | Survey | Firm | 184 | Spanish | — | Chemical, electronics and electrical, furnitur and fixtures | Medium and large |
| González-Benito and González-Benito 2008 | International Journal of Production Economics | Exploration | Survey | Firm | 184 | Spanish | — | Chemical, electronics and electrical, furnitur and fixtures | Medium and large |
| Graafland and Smid 2016 | Corporate Social Responsibility and Environmental Management | Theory building | Survey | Firm | 5205 | Europe | — | — | Small and Medium |
| Gupta and Innes 2014 | Journal of Environmental Economics and Management | Theory building | survey | Firm | 823 | United States | — | — | Large |
| He and Shen 2017 | Journal of Business Ethics and Management | Theory building | Survey | Firm | 770 | China | RBV | — | — |
| He et al. 2016 | Journal of Business Ethics | Theory building | Survey | Firm | 2312 | China | Institutional Theory | — | — |
| Heras-Saizarbitoria et al. 2011 | International Journal of Operations & Production Management | Theory testing | LR, survey | Firm | 214 | Spanish | Institutional Theory | — | — |
| Hsu et al. 2013 | International Journal of Operations & Production Management | Theory testing | Survey | Firm | 132 | Malaysia | Institutional Theory | — | — |
| Hustvedt et al. 2016 | Journal of International Business Studies | Theory testing | Survey | Plant | 451 | Mexico | Institutional Theory | Automotive | — |
| Iatridis and Kesidou 2018 | Journal of Business Ethics | Theory testing | Case study | Firm | 45 | Greece | — | — | Small and Medium |
| Inoue et al. 2013 | Ecological Economics | Theory testing | Survey | Firm | 1499 | Japan | — | — | — |
| Ivanova et al. 2014 | International Journal of Operations & Production Management | Theory building | Case study | Plant | 10 | United States | — | — | — |
| Jacobs et al. 2010 | Journal of Operations Management | Theory extension | Case study | — | 780 | — | — | — | — |
| Jiang and Bansal 2003 | Journal of Management Studies | Theory building | Conceptual | — | 16 | Canada | Institutional Theory | Pulp and paper | — |

(Continued)
| Author(s), year | Journal title | Research purpose | Methodology | Unit of analysis | Sample dimension | Headquarter country/countries | Underpinning theory | Industry | Company size |
|----------------|---------------|------------------|-------------|-----------------|-----------------|-------------------------------|-------------------|----------|--------------|
| Johnstone and Labonne 2008 | Ecological Economics | Theory building | Case study | Firm | 4000 | Europe, Japan, US | — | — | Medium and large |
| King and Lenox 2009 | Production and Operations Management Academy of Management Journal | Theory testing | Simulation | Plant | 17499 | US | — | — | — |
| King et al. 2005 | International Journal of Operations & Production Management | Theory extension | Simulation | Dyad | 7899 | US | Neo-Institutional Theory | — | — |
| Kitazawa and Sarkis 2000 | Production and Operations Management | Exploration | Case study | Firm | 3 | US | — | — | Large |
| Klassen and Vachon 2009 | Journal of Environmental Management | Exploration | Survey | Plant | 202 | Canada | — | — | — |
| Kwon, Seo and Seo 2002 | Journal of Environmental Management | Theory testing | Survey | Firm | 138 | Korea | — | — | — |
| Lee et al. 2015 | Production Planning and Control | Theory testing | Survey | Firm | 119 | Malaysia | — | — | — |
| Lim and Prakash 2014 | Public Administration Review | Theory testing | Survey | Firm | 79 | US, Japan, Europe | — | — | Medium and large |
| Link and Naveh 2006 | Ecological Economics | Theory building | Survey | Firm | 40 | Israel | — | — | Chemical, hi-tech, food and beverages, services sector |
| Lo et al. 2012 | International Journal of Production Economics | Exploration | Case study | Firm | 61 | US | — | — | — |
| McGuire 2014 | Ecological Economics | Theory testing | Survey | Firm | 1268 | China | — | — | — |
| Melnyk, Soufe, Calantone, and Montabon 2002 | International Journal of Production Research | Exploration | Survey | Individual | 1510 | US | — | — | — |
| Melnyk, Soufe, and Calantone 2003 | Production and Operations Management | Exploration | Survey | Individual | 1453 | US | — | — | — |
| Melnyk, Soufe, and Calantone 2003 | Journal of Environmental Management | Exploration | Survey | Individual | 1222 | North America | — | — | — |
| Mijatovic and Stokic 2010 | Journal of Business Ethics | Exploration | Survey | Firm | 122 | Serbia | — | — | — |
| Miles et al. 1997 | Marketing Management | Exploration | Conceptual | — | — | — | — | — | — |
| Montiel and Husted 2009 | Journal of Business Ethics | Theory extension | Simulation | Plant | 1328 | Mexico | TCE, Institutional Theory, Signaling Theory | Automotive | Stratified sample |
| Montiel, Husted, and Christmann 2012 | Journal of Business Ethics | Theory testing | Conceptual | Supplier | 433 | Mexico | — | — | — |
| Muskin 2000 | Journal of Business Ethics | Theory building | Conceptual | — | — | — | — | — | — |
| Nakamura, Takahashi, and Vertinsky 2001 | Journal of Environmental Economics and Management | Theory testing | Survey | Firm | 193 | Japan | — | — | — |
| Nakashima, Nose, and Kuriyama 2006 | International Journal of Production Research | Theory building | Conceptual | Firm | 14 | Japan | — | — | Consumer electronics, automotive |
| Neves et al. 2017 | Journal of Environmental Management | Exploration | Survey | — | — | — | — | — |
| Nishitani 2009 | Ecological Economics | Theory building | Case study | Firm | 433 | Japan | RBV | — | — |
| Orsato 2006 | California Management Review | Exploration | Conceptual | — | — | — | — | — | — |
| Author(s), year | Journal title | Research purpose | Methodology | Unit of analysis | Sample dimension | Headquarter country/countries | Underpinning theory | Industry | Company size |
|----------------|---------------|------------------|-------------|-----------------|-----------------|-----------------------------|--------------------|-----------|--------------|
| Paulraj and De Jong 2011 | International Journal of Operations & Production Management | Theory testing | Case study | Firm | 140 | US | | | |
| Prajogo et al. 2014 | International Journal of Operations & Production Management | Theory building | Survey | Firm | 286 | Australia | Theory of Organizational Climate | | |
| Reynolds and Yuthas 2008 | Journal of Business Ethics | Exploration | Conceptual | — | — | — | | | |
| Schoenherr 2012 | International Journal of Production Economics | Theory extension | Survey | Plant | 1211 | — | Theory of Performance Frontiers, RBV | | |
| Schoenherr and Talluri 2013 | IEEE Transactions on Engineering Management | Theory testing | Survey | Plant | 402 | Europe, US | RBV, Institutional Theory | | |
| Su et al. 2015 | Journal of Operations Management | Theory testing | Survey | Firm | 101 | — | Competitive Dynamics | | |
| Sullivan 2005 | Journal of Business Ethics | Exploration | Conceptual | — | — | Australia | | Mining industry | |
| Testa et al. 2012 | Ecological Economics | Theory building | Survey | Firm | 156 | Italy | Neo-Institutional Theory, Stakeholder Theory | | Public sector | |
| Testa et al. 2018 | Journal of Business Ethics | Theory building | Survey | Firm | 243 | Europe | Neo-Institutional Theory, Stakeholder Theory | | |
| Teixeira, Jabbour, and Jabbour 2012 | International Journal of Production Economics | Theory building | Case study | Firm | 9 | Brazil | | | Large |
| Tuppura et al. 2016 | Business Strategy and the Environment | Theory testing | Survey | Firm | 60 | — | | Forest industry | |
| Vastag 2009 | Production and Operations Management | Exploration | Simulation | — | — | — | | | |
| Vastag and Melnyk 2002 | International Journal of Production Research | Exploration | Survey, case study Individual + firm | S:504 CS: 1 | US | | | | |
| Viadiu, Fa, and Heras-Salazarbitoria 2006 | International Journal of Operations & Production Management | Theory building | Simulation | — | — | Spain, UK, Japan, US | | | |
| Wiengarten et al. 2017 | Production Planning and Control | Theory building | Survey | Plant | 59 | Ireland | | | |
| Xu et al. 2016 | Business Strategy and the Environment | Theory building | Simulation | Firm | 173 | China | Signaling theory | | |
| Zailani et al. 2012 | International Journal of Operations & Production Management | Theory testing | Survey | Firm | 132 | Malaysia | Institutional Theory, Stakeholder Theory, Strategic Choice Theory | Medium and large |
| Zhu, Cordeiro, and Sarkis, 2012 | Ecological Economics | Theory building | Survey | Firm | 377 | China | Neo-Institutional Theory | Chemical, electronic, automotive, pharmaceutical |
| Zhu, Tian, and Sarkis 2012 | Production Planning & Control | Exploration | Conceptual | — | — | China | Diffusion of Innovation | | |
| Zutshi and Sohal 2004a | Technovation | Exploration | Survey | Firm | 286 | Australia, New Zealand | | | Stratified sample |
| Zutshi and Sohal 2004b | Technovation | Exploration | Survey | Firm | 286 | Australia, New Zealand | | | Stratified sample |
| Author(s), year | Antecedents | Proc. | Consequences |
|----------------|-------------|-------|--------------|
|                | Drivers | Barriers | Enabling factors affecting the ISO 14001 adoption | Tools and approaches | Performances | Enabling factors affecting the performance |
| Alberti et al. 2000 | x | x | x | x | x |
| Aravind and Christmann 2011 | x | x | x | x | x |
| Arimura et al. 2010 | x | x | x | x | x |
| Arimura et al. 2016 | x | x | x | x | x |
| Arnold 2015 | x | x | x | x | x |
| Baek 2017 | x | x | x | x | x |
| Bansal and Bogner 2002 | x | x | x | x | x |
| Bansal and Hunter 2003 | x | x | x | x | x |
| Barla 2007 | x | x | x | x | x |
| Boiral 2007 | x | x | x | x | x |
| Boiral 2011 | x | x | x | x | x |
| Boiral and Henri 2012 | x | x | x | x | x |
| Cagno et al. 2012 | x | x | x | x | x |
| Chiarini 2014 | x | x | x | x | x |
| Chiarini 2017 | x | x | x | x | x |
| Corbett and Kirsch 2009a | x | x | x | x | x |
| Corbett and Kirsch 2009b | x | x | x | x | x |
| De Jong, Paulraj, and Biome 2014 | x | x | x | x | x |
| De Oliveira Matias and Coelho 2002 | x | x | x | x | x |
| Del Brio and Junquera 2003 | x | x | x | x | x |
| Delmas 2009 | x | x | x | x | x |
| Delmas and Montes-Sancho 2011 | x | x | x | x | x |
| Delmas and Montiel 2009 | x | x | x | x | x |
| Delmas and Toffel 2008 | x | x | x | x | x |
| Ferrón-Vilchez 2016 | x | x | x | x | x |
| Fryxell and Szeto 2002 | x | x | x | x | x |
| González-Benito and González-Benito 2008 | x | x | x | x | x |
| González-Benito and González-Benito 2005 | x | x | x | x | x |
| González-Benito and González-Benito 2008 | x | x | x | x | x |
| Graafland and Smid 2016 | x | x | x | x | x |
| Gupta and Innes 2014 | x | x | x | x | x |
| He and Shen 2017 | x | x | x | x | x |
| Heras-Saizarbitoria et al. 2011 | x | x | x | x | x |
| Hsu et al. 2013 | x | x | x | x | x |
| Husted et al. 2016 | x | x | x | x | x |
| Iatridis and Kesidou. 2018 | x | x | x | x | x |
| Inoue et al. 2013 | x | x | x | x | x |
| Ivanova et al. 2014 | x | x | x | x | x |
| Jacobs et al. 2010 | x | x | x | x | x |
| Jiang and Bansal 2003 | x | x | x | x | x |
| Johnstone and Labonne 2008 | x | x | x | x | x |
| King and Lenox 2009 | x | x | x | x | x |
| King et al. 2005 | x | x | x | x | x |
| Kitazawa and Sarks 2000 | x | x | x | x | x |
| Klassen and Vachon 2009 | x | x | x | x | x |
| Kwon, Seo and Seo 2002 | x | x | x | x | x |
| Lee et al. 2015 | x | x | x | x | x |
| Author(s), year            | Drivers | Barriers | Enabling factors affecting the ISO 14001 adoption | Proc. | Tools and approaches | Performances | Enabling factors affecting the performance |
|---------------------------|---------|----------|-------------------------------------------------|-------|----------------------|--------------|-------------------------------------------|
| Lim and Prakash 2014      | x       |          |                                                 | x     |                      | x            | x                                         |
| Link and Naveh 2006       | x       | x        |                                                 |       |                      | x            | x                                         |
| Lo et al. 2012            | x       |          |                                                 | x     |                      | x            | x                                         |
| McGuire 2014              | x       |          |                                                 | x     |                      | x            | x                                         |
| Melnyk, Sroufe, Calantone, and Montabon 2002 | x | x | x | x | x | x | x |
| Melnyk, Sroufe, and Calantone 2003 | x | x | x | x | x | x | x |
| Melnyk, Sroufe, and Calantone 2003 | x | x | x | x | x | x | x |
| Mijatovic and Stokie 2010 | x       |          |                                                 | x     |                      | x            | x                                         |
| Miles et al. 1997         | x       |          |                                                 | x     |                      | x            | x                                         |
| Montiel and Husted 2009   | x       |          |                                                 | x     |                      | x            | x                                         |
| Montiel, Husted, and Christmann 2012 | x | x | x | x | x | x | x |
| Muskin 2000               | x       |          |                                                 | x     |                      | x            | x                                         |
| Nakamura, Takahashi, and Vertinsky 2001 | x | x | x | x | x | x | x |
| Nakashima, Nose, and Kuriyama 2006 | x | x | x | x | x | x | x |
| Neves et al. 2017         | x       |          |                                                 | x     |                      | x            | x                                         |
| Nishitani 2009            | x       |          |                                                 | x     |                      | x            | x                                         |
| Orsato 2006               | x       |          |                                                 | x     |                      | x            | x                                         |
| Paulraj and De Jong 2011  | x       |          |                                                 | x     |                      | x            | x                                         |
| Prajgo et al. 2014        | x       |          |                                                 | x     |                      | x            | x                                         |
| Reynolds and Yuthas 2008  | x       |          |                                                 | x     |                      | x            | x                                         |
| Schoenherr 2012           | x       |          |                                                 | x     |                      | x            | x                                         |
| Schoenherr and Talluri 2013 | x | x | x | x | x | x | x |
| Su et al. 2015            | x       |          |                                                 | x     |                      | x            | x                                         |
| Sullivan 2005             | x       |          |                                                 | x     |                      | x            | x                                         |
| Testa et al. 2012         | x       |          |                                                 | x     |                      | x            | x                                         |
| Testa et al. 2018         | x       |          |                                                 | x     |                      | x            | x                                         |
| Teixeira, Jabbour, and Jabbour 2012 | x | x | x | x | x | x | x |
| Tuppura et al. 2016       | x       |          |                                                 | x     |                      | x            | x                                         |
| Vastag 2009               | x       |          |                                                 | x     |                      | x            | x                                         |
| Vastag and Melnyk 2002    | x       |          |                                                 | x     |                      | x            | x                                         |
| Viadl, Fa, and Heras-Salazarbitoria 2006 | x | x | x | x | x | x | x |
| Wiengarten et al. 2017    | x       |          |                                                 | x     |                      | x            | x                                         |
| Xu et al. 2016            | x       |          |                                                 | x     |                      | x            | x                                         |
| Zailani et al. 2012       | x       |          |                                                 | x     |                      | x            | x                                         |
| Zhu, Cordeiro, and Sarkis, 2012 | x | x | x | x | x | x | x |
| Zhu, Tian, and Sarkis 2012 | x | x | x | x | x | x | x |
| Zutshi and Sohal 2004a    | x       |          |                                                 | x     |                      | x            | x                                         |
| Zutshi and Sohal 2004b    | x       |          |                                                 | x     |                      | x            | x                                         |
| TOTAL                     | 38      | 22       | 38                                              | 36    | 51                   | 25           |                                           |
Appendix A: Synthesis of the literature