Environmental policy and corporate sustainability: the mediating role of Environmental Management Systems in Circular Economy adoption

Abstract: Companies see adopting the Circular Economy (CE) model as an opportunity to become more sustainable and aligned to the growing demand for more environmentally friendly products. Governments, institutions and researchers alike have highlighted the importance of organizations having an environmental policy, and that this policy be implemented though effective Environmental Management Systems (EMS) as the way to achieving corporate sustainability. However, despite exploring the relationship between EMSs and moving towards the circular model in the business world, research on this increasingly critical issue remains limited. To address this gap, research was carried out on 85 Spanish manufacturing companies. Results show that implementing an EMS has a positive effect as the companies analysed adopted a higher number of CE practices. From a managerial perspective, managers are challenged to show leadership initiative by exploring new, more sustainable ways of operating that engage new stakeholders. Implications for regulators focus on enhancing the circularity of EMS.

Keywords: Circular Economy, Environmental Management Systems, Environmental Policy, Manufacturing Industry, Sustainability, Survey

1 Introduction

According to the Circularity GAP Report 2020, only 8.6% of the global economy is currently circular, compared to 9.1% two years ago. This negative evolution in the global circularity gap is explained by high extraction rates, continuous stockpiling and low levels of end-of-use processing and recycling. In this context of overexploited resources under pressure, the importance of taking sustainability into consideration in business strategies, business models and product and service design is no longer being questioned (Lewandowski, 2016; Manninen et al., 2018; Witjes & Lozano, 2016). The latest Eurobarometer survey, in July 2020, asked about the objectives of the European Green Pact (European Commission, 2019), and revealed that Europeans continue to consider sustainable development essential and CE as a top priority. Moving towards a more competitive and responsible CE is key for progress and social welfare. Thus, the European Union (EU) has made CE a strategic policy to promote this new model of production and consumption at all levels. Spain is no newcomer to this situation and already has initiatives at state, regional and local level from which to build a coherent and systematic CE model. Within this context, the Spanish Circular Economy Strategy (EEEC)(Ministerio de Economía Industria y Competitividad, 2018) faces the challenge of implementing circularity in the Spanish economy.

Traditionally, governments and organizations have focused more intensively on the end-of-production-cycle phase (Ministerio de Agricultura, 2015), but CE aims to concentrate efforts on the design phase and to achieve product durability by combating programmed obsolescence and promoting servitisation, reuse, refurbishment, recycling and reprocessing of components. This transition towards CE should be done in a way that enables companies to be efficient without incurring excessive burdens or hindering the company's growth, given that larger size improves productivity, contracting capacity, investment and internationalisation. This is of the utmost importance for Spanish manufacturing firms, which compared to other leading EU countries, are characterised as small companies and micro-enterprises (Prieto-Sandoval et al., 2019). The small size of Spanish manufacturing companies often implies lower investment capacity, especially in product design and R&D&I, and greater difficulty developing projects which can improve the use of production resources, as well as internationalisation projects (Ministerio de Economía Industria y Competitividad, 2018).

Governments, institutions and researchers alike have highlighted the importance of EMSs and eco-labels as tools or instruments that can enable circular transformation and the development of effective eco-innovations within companies (BSI Standards Publication, 2017; European Commission, 2017; Evans et al., 2015) through the organization's established environmental policy. Environmental policy is the driver for implementing and improving an organization's EMS so it can maintain and potentially improve its environmental performance with the aim to be more sustainable. This environmental policy should therefore reflect top management's commitment to complying with requirements, preventing pollution and continual improvement. An organization's environmental policy forms the basis upon which it sets its objectives and targets. Thus, EMSs enable companies to assess, manage and improve their environmental impacts, thus ensuring excellent environmental performance that is consistent with its environmental policy. Thus, the EEEC has established Strategic Orientation #5 in the area of Production Efficiency (SO5) to introduce guidelines to increase innovation and the overall efficiency of production processes. This is done through digital infrastructures and services and by adopting measures such as EMS implementation, thus boosting competitiveness and sustainable business growth. This strategy, therefore, highlights that EMS, through the necessary analysis of the life cycle of products/services, implicitly contribute to the CE model approach, and can help companies make the complex transition to CE. Moreover, proper CE implementation can boost innovation, financial performance and competitiveness of companies by increasing their resource efficiency (European Commission, 2017). Thus, exploring the relationship between EMSs and the business world's move towards the circular model is an increasingly crucial issue.

In the world ranking of EMS certifications, data from the ISO Survey 2019 place Spanish companies in fourth place after China, Japan and Italy in relation to the international standard ISO 14001, with 12,871 certified companies. Regarding the EMS promoted by the European Commission (EC), the European Eco-Management and Audit Scheme (EMAS), Spain is in third position after Germany and Italy, with 968 companies in January 2021 (EMAS Register). Despite these outstanding EU and global positions regarding EMS adoption, the latest Sustainable Development Report 2019 (benchmark) places Spain in 21st position out of 162 countries with respect to Sustainable Development Goals (SDGs). Countries leading the ranking are Sweden, Denmark and Finland, although the report points out that no country in the world has yet achieved the 17 SDGs, nor is on track to achieve them by 2030. This report also mentions that progress towards responsible production and consumption (SDG 12) is a significant challenge for Spain, highlighting the challenging path we have ahead of us.

Although much research has been conducted on the benefits and effects of environmental certifications in organisations (Álvarez-García et al., 2018; Bravi et al., 2020; Daddi et al., 2021; Giménez et al., 2003; Guillot-Soulez et al., 2021; Murmura et al., 2018) recent interest has arisen regarding the relationship between EMS and CE (Marrucci et al., 2019). To the best of our knowledge just two studies (Fonseca et al., 2018; Jain et al., 2020) have explored whether a direct relationship between these certifications and CE adoption in companies exists. This study therefore aims to contribute by providing further information through a quantitative study on the subject.

The main objective of this paper is to analyse the relationship between the implementation of EMSs and the adoption of CE initiatives in Spanish manufacturing firms. The rest of the paper is structured as follows. In section 2, the theoretical framework of the study is presented, including a discussion of the concept of CE and its practices applied to the manufacturing firm and a description of EMSs; the formulation of the hypotheses of the study is also presented in this section. Section 3 describes the methodology of the empirical study. The results of the study are presented in section 4. Section 5 develops the discussion of the results obtained. The paper concludes with a summary of the main conclusions and implications.

2 Theoretical framework

2.1 Definition of Circular Economy

Nowadays the concept of CE is commonly found in the political and scientific sphere, as well as in business and society in general. There is no consensus on its definition as it varies according to the issues it seeks to address, or the field of knowledge from which it is approached (Aranda-Usón et al., 2020; Geissdoerfer et al., 2017; Katz-Gerro & López Sintas, 2018; Pieroni et al., 2019). What is agreed on, however, is that CE is an economic model aimed at achieving more efficient and resilient production and consumption systems that preserve resources within a continuous cycle by optimising their value (Ellen MacArthur Foundation, 2017; Murray et al., 2017; Prieto-Sandoval, Jaca, et al., 2018). Thus, among the numerous definitions of CE proposed in the literature, some authors understand CE as a model with the objective focused on a closed-loop material flow (Kama, 2015; Li et al., 2010; Yuan et al., 2006) while others focus on economic aspects, defining it as an economy integrated with resources, environmental factors and territoriality (Andersen, 2006; Ellen MacArthur Foundation & Granta Design, 2015).

In short, this new economic paradigm implied by CE requires a change of vision which is both corporate and individual, and which involves rethinking ways of producing and consuming. Various authors (Kirchherr et al., 2017; Mathews & Tan, 2011; Saidani et al., 2017) have established three stages of analysis in the field of CE. The upper, so-called "macro" stage includes the national and supranational level, where the government works on promoting recycling and a circularity-oriented society which includes cities and states. The intermediate, "meso" stage deals with local experiences of industrial symbiosis and eco-parks. The "micro" stage refers to companies and organisations and the CE objectives are mainly focused on making production more environmentally sustainable.

The December 2019 Eurobarometer survey revealed that 80% of citizens believe that industry is not doing enough to protect the environment, rising to 90% for Spanish citizens. The July 2020 edition also found that Europeans continue to identify the development of renewable energy and the fight against plastic waste as top priorities: 36% percent believe that the main priority should be to promote CE, and 31% think that reducing energy consumption should be the top priority. Thus, companies in general, and the manufacturing sector in particular, have a significant role to play in this process of transition towards CE due to the impact their activities have on the environment. Identifying and highlighting the progress companies are making in different regions is a necessary starting point in order to attract new initiatives to help shape a better framework with which to encourage more circular business strategies. In the process of transitioning towards a CE model, companies face similar challenges and opportunities (Agyemang et al., 2019; Geng & Doberstein, 2008; Mura et al., 2020; Ormazabal et al., 2018; Shi et al., 2008). However, their motivation for moving in this direction and the incentives they pursue may differ, depending on the particular sector and its geographical scope (Bassi & Dias, 2019; Klein et al., 2021). Companies should consider that there are other ways of approaching business beyond the traditional ones, not only to be more sustainable (Schöggl et al., 2020), but also more competitive and innovative. They should therefore analyse the optimal route and the potential benefits that the circular transition can offer them (Mura et al., 2020; Thorley et al., 2019). Despite the existence of circularity opportunities along the entire value chain, it is important to incentivise all developments that have positive impacts, even if they only affect part of the value chain initially, or only integrate some, rather than all possible actors.

Public incentives promote the adoption of circular practices within companies (Despeisse et al., 2015; Fischer & Pascucci, 2017; Fletcher et al., 2018; Gharfalkar et al., 2015; Ghisellini et al., 2018; Hu et al., 2018; Moktadir et al., 2018; Testa et al., 2016; Zink & Geyer, 2017), but it is new circular business models such as circular sourcing, resource recovery, product life extension, or platform and product-as-a-service sharing (Lacy & Rutqvist, 2015) that companies should focus their interest on, and see them as business opportunities to increase their revenues in this area. New digital technologies such as social media, cloud computing, analytics and mobility (Accenture Strategy, 2015) are also delivering unprecedented levels of speed and flexibility. By virture of these business models and technologies, companies can approach circular advantage from the customer's point of view, and not only from the perspective of sustainability.

2.2 Measuring the implementation of the CE at micro level

Measuring or assessing levels of CE implementation at a business level is a complex task (Harris et al., 2021) because of the absence of standard indicators to track progress on circularity (Rincón-Moreno et al., 2021). A number of studies have developed micro level indicators of circularity (Kristensen et al., 2021; Linder et al., 2017; Mitchell et al., 2020; Rossi et al., 2020; Walker et al., 2018). Various proposals for models to measure circularity activities or practices in companies have also been identified, and all of them list circular initiatives (Masi et al., 2017; Mura et al., 2020) or try to group these concrete circularity actions into key characteristics (European Environment Agency, 2016), fields of action (Ormazabal et al., 2018; Prieto-Sandoval, Ormazabal, et al., 2018), factors (Garza-Reyes et al., 2019), levels (Aranda-Usón et al., 2020), dimensions (Fonseca et al., 2018) or processes (Rizos et al., 2016). Some of these models have been used to measure the degree to which CE has been adopted by businesses at both national and regional level (see Table 1). Nonetheless, there is still no consensus in academia on how circularity should be measured at the micro level.

Insert Table 1

This study follows the model proposed by Prieto-Sandoval, Ormazabal, et al. (2018) as we considered it the most appropriate for analysing the CE initiatives and actions of manufacturing companies in Spain, thus fulfilling the aim of the study: to relate CE adoption to EMS implementation through an analysis of the life cycle of products. This model defines CE as a cyclical flow that involves extracting, transforming, distributing, using and recovering materials and energy from products and services. The model proposes assessing circularity at the micro level through five fields of action covering a product's life cycle, from extracting raw materials to recovery of materials at the end of their life: Take, Make, Distribute, Use and Recover.

If the definition of CE is now approached from the perspective of an integrated economy with resources, environmental factors and territoriality (Ellen MacArthur Foundation, 2015), then business initiatives related to industrial symbiosis also need to be analysed. This concept builds on industrial metabolism to close loops across different value chains and engage traditionally separate industries in a collective approach to competitive advantage and involves the physical exchange of materials, energy, water and/or by-products (Marchi et al., 2017). Industrial symbiosis has been widely documented and applied in ecosystems within firms (Domenech et al., 2019; Mallawaarachchi et al., 2020; Rincón-Moreno et al., 2021; Wen & Meng, 2015). This study thus encompasses industrial symbiosis as a further field of action with which to evaluate companies' circular initiatives. Table 2 describes the circular practices or initiatives contemplated in the theoretical model proposed by the authors of this study for each field of action.

Insert Table 2

2.3 Environmental Management Systems

A management system is a formal methodology, or framework, that helps companies control and continuously improve their processes. Its aim is to achieve better results through actions and decision-making based on data and facts. EMS is the management system to use if the objective is business sustainability and reducing the environmental impact of products and processes. Therefore, organisations with EMS in place are in an advantageous strategic position that enables them to align their operations with the circular model (Zhu et al., 2013). EMS helps the company in this regard as it provides a systematic and robust approach for organisations to migrate towards environmentally sustainable operations (Delmas & Toffel, 2008). These companies become pioneers, leading other organisations towards adopting CE practices.

The Pact for a Circular Economy (European Commission, 2015) has guidelines aimed at increasing innovation and overall efficiency of production processes through measures such as EMS implementation. Since the Pact was formed, the adoption of certifiable EMSs (Ma et al., 2021) among companies and institutions has been remarkable (Chiarini, 2017; Daddi et al., 2015; Matuszak-Flejszman et al., 2019), and a number of studies have been published highlighting their strengths and weaknesses (Barón et al., 2020; Boiral et al., 2018; Daddi et al., 2016; Heras-Saizarbitoria et al., 2016; Merli & Preziosi, 2018; Testa et al., 2016, 2018). Two EMS models exist at European level: the ISO 14001 standard and the Eco-Management and Audit Scheme EMAS; both serve as a basis for developing an effective EMS. Industry standards (norms set by industry bodies and organisations), regulations and expectations from various stakeholders put pressure on organisations to adopt dominant organizational conventions and practices (Wang et al., 2018), constituting the core of institutional pressure.

One such standard is ISO 14001, originally published in September 1996, and revised in 2015 (International Organization for Standardization-ISO, 2015). ISO 14001 is defined as an overall management system that includes the organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for preparing and implementing a company's environmental policy (and also for reviewing and maintaining that policy in the future). The standard is not intended to measure the environmental impact of companies that have implemented it, but rather sets out methods for systematising and formalising environmentally sound procedures. Consequently, this standard is more about procedures than targets or results.

EMAS was first introduced in 1993, one year after the Rio Summit, where the United Nations Commission for Sustainable Development was established, and still continues as a benchmark of excellence for EMSs today. Over the years, the scheme has evolved by working hand in hand with organisations, adapting to their needs and expectations and changes in European policies and strategies. It has undergone four revisions, the last in January 2019 (European Commission, 2018). The benefits of adopting a circular model are realised by considering the context and stakeholders; identifying environmental aspects and legal requirements, and associated risks and opportunities; and, in short, adopting a life-cycle perspective and risk-based thinking. Furthermore, it enables organisations to ensure legal compliance and anticipate the adoption of new environmental requirements, which helps minimise risks and identify new business opportunities. One of EMAS's strengths is its measurement requirement. In line with the statement "what gets measured, gets managed", EMAS organisations must assess all their environmental impacts and report on indicators such as energy and material efficiency, water, waste and emissions (European Commission, 2017). Under EMAS, organisations are required to demonstrate continuous improvement in their environmental performance on an ongoing basis. It enables the organisation to investigate resource efficiency, process changes, search for less polluting materials, and other actions that are drivers of innovation (Khan et al., 2020). The annual publication of the environmental statement also gives EMAS organisations an opportunity to achieve greater transparency. This additional effort compared to ISO 14001, for example, is recognised by all stakeholders, including public administrations (Seifert & Guenther, 2020).This is what makes it a very powerful communication tool which can be used to highlight actions taken in order to move towards circular model. It also sets an example for other organisations, showing them the benefits of adopting the principles of the CE. Both EMS models emphasise a life-cycle perspective of products and services that is fundamental to companies if they are to adopt circular initiatives.

2.4 Research hypothesis

Although research has been carried out in the field of EMS and CE performance (Fonseca et al., 2018; Jain et al., 2020), the authors have not found any studies that explore whether there is a direct relationship between EMS implementation and CE adoption in firms. Thus, in relation to implementing EMS and adopting CE initiatives in manufacturing companies, we proposed to test the following hypothesis:

H1. There is a correlation between the implementation of EMS and a higher adoption of CE initiatives in Spanish manufacturing companies.

Based on the proposed theoretical model, two subordinate hypotheses were proposed:

H1.1. There is a correlation between EMS implementation and the adoption of circular initiatives in the five fields of action covering the product life cycle.

H1.2. There is a correlation between the implementation of EMS and the adoption of business initiatives related to industrial symbiosis.

3 Methodology

With the aim of addressing the research questions this section describes the methodology used for the testing of the hypotheses.

3.1 Study sample

The empirical data used to test the hypotheses were collected from the Spanish sub-sample of the 2018 European Manufacturing Survey. This is an international questionnaire developed by the Fraunhofer Institute for Systems and Innovation Research (ISI) in 1993 (Lay & Maloca, 2004) that has been updated every two years since then. The Survey assesses the adoption of circular initiatives by manufacturing companies together with other aspects of business innovation. In 2018, the survey received 3,985 responses from 14 European countries (Austria, Croatia, Denmark, Germany, Lithuania, Netherlands, Norway, Portugal, Serbia, Slovakia, Slovenia, Spain, Sweden, and Switzerland). The Spanish survey sample comprised manufacturing establishments (NACE codes 10-33) with at least 20 employees. In total, 15,068 Spanish enterprises from the National Statistics Institute met these requirements. A questionnaire was sent both by post and telematically to the top management of approximately 27% of these companies (4000 surveys), followed by a phone-call a week later. After the initial e-mail, a remainder mail was sent two times (after one and three months). The final dataset consisted of 85 responses, with a confidence level of 80%, taking into account a margin of error of 7% (p=q=0.7). The response rate may be attributed to the length and the complexity of the questionnaire. These results impose precaution for generalizing the conclusions and stresses the exploratory nature of the performed research. Table 3 shows some descriptive statistics of the responses.

Insert Table 3

3.2 Measurement

The European Manufacturing Survey covers the implementation of EMS. Thus, the companies were asked directly whether they had an EMS (ISO 14001 or EMAS). This detailed, specific question enabled the authors of the present study to classify companies into two groups according to EMS implementation: companies with an EMS, or in the process of implementation; and companies with no EMS. The survey also asked questions about various practices or initiatives associated with CE. Several of these were of interest for the present study and have been taken as variables. From the survey questions, 22 variables were chosen for analysis. The first variable is "Intensity in CE practices adoption" (IA), which seeks to determine the impact of the EMS on the adoption of CE practices. For this variable, 9 degrees of intensity were defined, with 9 being the highest and 0 the lowest. The one-way ANOVA test was used for the analysis since these are continuous scale variables. For the other 21 variables a cross-tabulation and Pearson's Chi-Square were used in the statistical analysis as it was a homogeneous random sample with dichotomous variables, proceeding to the statistical treatment of the data with the SPSS v25 programme. Table 4 classifies the variables in relation to the fields of action of the proposed theoretical model.

Insert Table 4

4 Results

In relation to the descriptive analysis of the results obtained, these show that of the 6 fields of action contemplated in the theoretical reference model, Take is the one in which most companies (with or without EMS) are working on (see Figure 1), followed by business initiatives related to Industrial Symbiosis. The field of action in which less firms are working on is the one related to Recover.

Insert Figure 1

Figure 2 shows that the circular practice most adopted by the companies in the study is related to the introduction of technological improvements (M4) with 58% of response rate, related to the use of new materials and changes in the production system at the Make stage of the product life cycle. This is followed by practices related to the use of reused and recycled raw materials (T1) at the Take stage, the product maintenance and repair services (U4) at the Use stage, both with 35% of response rate, the R&D cooperation with other companies (IS4) related to Industrial Symbiosis with 33% and finally, practices related to the cooperation with other companies in distribution processes (D1) with 32% at the Distribute stage.

Insert Figure 2

For the variable of Intensity of adoption (IA) in CE practices Table 5 shows a correlation between EMS adoption and the intensity of adoption of circular practices, which supports hypothesis H1.

Insert Table 5

On the other hand, for the dichotomous variables (see Table 6) a correlation is observed between the implementation of EMS and the actions that take place at the Make stage of the product life cycle, particularly in relation to practices related to the Implementation of energy management systems (M2), Implementation of life cycle assessment tools (M3) and the Introduction of technological improvements (M4). A correlation is also observed between EMS and the field of action Use, but only in the practice related with the development of Products with reduced energy consumption during use (U1). This means that hypothesis H1.1 is only partially supported. The results do not support hypothesis H1.2, and no correlation was found between EMS adoption and experiences of Industrial symbiosis.

Insert Table 6

5 Discussion

Our research is the first attempt at examining the relationship between EMS implementation and CE adoption in companies, further expanding the academic literature on the topic. This study analysed the relationship between manufacturing companies' implementation of EMS in Spain, and their adoption of CE initiatives. Our results confirm previous literature on the topic (Fonseca et al., 2018; Jain et al., 2020), and recognises the positive effect of EMS on CE performance. This provides an affirmative answer to the research question posed, and indicates that EMS companies show a higher degree of adoption to circularity practices than companies which have not implemented this type of management system.

Thus, an organization's approach to circularity could demand certain information (KPI), resources, processes and relationships. EMS supports organizations in achieving their CE strategy and objectives in accordance with their environmental policy. EMS can encourage organizations to consider adopting and implementing a range of environmental management techniques to achieve their environmental objectives. This can be done systematically, in a way that produces optimal outcomes for all interested parties. In addition, the EMS measurement requirement can help visualise the company's actions on the arduous path towards the sustainable development of its activities.

Thus, establishing circular KPIs and their systematic measurement can be considerably helpful, as everything that is measured can be managed in a more efficient way.

Regarding hypothesis H1.1, in relation to the fields of action covering the product life cycle, findings show that only the Make field has a clear correlation with the adoption of EMS, i.e. adopting EMS favourably influences taking up circular initiatives in the field of development of best technological practices and eco-innovations so that both the product and the process are carried out in the most sustainable way possible.

This is explained by the fact that an EMS has a high impact at the processing level and provides a systematic way for an organisation to identify those environmental aspects that they can control directly and to determine those that are significant and should be prioritized by the organisation's EMS. There is also a correlation between the initiatives that the company undertakes in relation to product design and the reduction of energy consumption during use, within the actions of the Use field of action. None of the other fields of action covering the product life cycle (Take, Distribute and Recover) show a clear correlation with adopting EMS. It can be concluded, therefore, that EMS's influence as a management tool, is weak with regard to helping companies in the following areas: efficient and responsible use of resources; distribution and reverse logistics; and actions associated with the impacts of product use and recovery. This may be due to the fact that an organization's control of and influence over environmental aspects of products supplied to them can vary significantly as they depend on the organization's market situation and its suppliers. For example, a company that designs its own products, can have considerable influence by simply substituting a particular raw material for a more circular one. A very different case would be that of a company that is faced with product specifications set by the customer, so they may not have the opportunity to change to the product design in any significant way. Also, in relation to products purchased from suppliers, many companies have limited control over how end-users use and dispose of their products. However, they may consider, where possible, communicating appropriate handling and disposal mechanisms in order to exert some influence over end-users.

The results do not support hypothesis H1.2, and no correlation was found between EMS adoption and establishing synergies or collaborative practices between companies. This could be explained by the fact that currently, EMS has no direct influence over an organisation's awareness of collaborations outside the usual peer group (competitors, research councils, stakeholders, standardisation bodies) that can help companies move towards a more circular and sustainable way of operating and creating value. This is seen as a weakness as it is unlikely that any company can make substantial progress in the transition to a more circular and sustainable mode of operation without collaboration.

Our results have several implications for practitioners and regulators. Namely, companies should focus on designing potential circular strategies and reflecting them in a clear way in their environmental policy so they can be materialised through their EMS. Thus, managers should manifest their leadership by promoting a new, non-traditional, way of doing things by exploring alternative approaches and finding new solutions. Here, the overarching values, mission, and vision of the organization can also be considered in terms of alignment and ambition. Businesses should ensure design strategies that take into account the source of materials used in products or components, as well as their lifetime and durability, whether they can be easily reclaimed, and where they are to end up after use. When designing the product, locations and supply chain also play a role and must be taken into account so as to minimize or eliminate waste in distribution. Optimising shape and volume for efficient packaging density and optimizing distribution in relation to fuel and emissions are also design improvement options. In relation to industrial symbiosis, managers should consider external collaboration strategies. This would advance their circular strategy by creating synergies of exchange and sharing through an active process that could identify new stakeholders, beyond suppliers and consumers.

Results of this study can also help public authorities and policy makers develop specific plans to encourage organizations to make their operations and processes environmentally sustainable. One mechanism to achieve this could be through enhancing the circularity of EMS; for example, when preparing their environmental report or statement, firms could include their CE strategy and clear indicators related to the CE. Public authorities could also reward firms with EMS by providing regulatory relief. This would encourage the spread of CE and best environmental practices, and at the same time highlight opportunities for stakeholders to collaborate, thus helping ensure that the future economy is, indeed, circular. Likewise, regulators and standard bodies should also include aspects of EMS related to external collaboration by creating mutual value through formal and/or informal arrangements. Progressive collaborations between companies (e.g. in supply chains and cross-sector), governments, academia and consumers are essential for this to take place. EMSs could include these aspects at the planning stage, within the framework of the continuous improvement cycle underpinning the management system. Regarding this, the standard bodies or regulators could favour industrial symbiosis through mechanisms that help establish a climate of trust and collaboration with the aim of favouring business synergies between companies in the same geographical areas that are registered or certified with an EMS. One example along these lines would be EMAS clubs. These are private non-profit associations working on a regional level, comprised of EMAS registered organisations and other EMAS stakeholders linked to them through a common interest for environmental best practices (https://ec.europa.eu/environment/emas/join_emas/emas_clubs_en.htm). EMAS Club Catalonia (Spain) is the oldest EMAS club in Europe, with over fifteen years' experience. This association organises workshops on sustainability and the adopting CE practices, and promotes collaborative projects among its members and is aimed at facilitating industrial symbiosis in Catalonia.

6 Conclusions

Our study investigates the relationship between EMS and CE adoption in the case of Spanish manufacturing industry. As indicated in literature review to the best of our knowledge there is few empirical evidence on this topic, so the present paper tries to investigate this research gap.

The results demonstrate the positive effect of EMS on a higher degree of CE practices adoption by the analysed companies. The most innovative contribution of the study is related to the fact that although the EMS is shown to positively influence a greater adoption of CE practices in manufacturing companies, these practices focus only on activities related to the Make stage, in the field of development of best technological practices and eco-innovations so that both the product and the process are carried out in the most sustainable way possible and no direct relationship is observed with the other fields of action covering the product life cycle nor with the practices associated with industrial symbiosis.

Outcomes of this study provide useful implications for academics, regulators and practitioners. From a theoretical perspective, this research consolidates the debate on how EMS can contribute to CE adoption in firms, as well as adding empirical evidence. From a managerial perspective, companies must commit to sustainability and develop circular strategies that can be very clearly reflected in their environmental policy. In this way, policies can be implemented and measured through the continuous improvement process established in their EMS. To this end, managers are challenged to show leadership by exploring new ways of doing things in a more sustainable way and engaging new stakeholders beyond customers and suppliers. Implications for regulators are focused on enhancing the circularity of EMS with regulations that mean a company must include its CE strategy in its environmental policy and define clear circular KPIs that help it visualise and manage actions taken in favour of sustainable development more clearly.

One of the main limitations that this study bears is the response rate obtained. A larger sample of participating firms could produce more representative results. The second limitation regards to the fact that the study reflects the Spanish business environment and the specific socioeconomic framework. Also, a sector analysis would allow further progress in determining the role of environmental certifications and CE practices adoption as each industry sets different priority issues along their value chains. Furthermore, similar research should be applied in order to assess whether similarities or differences exist according to parameters such as country, company size or sector.

References

Accenture Strategy. (2015). *Insights circular advantatges*. https://www.accenture.com/es-es/insight-circular-advantage-innovative-business-models-value-growth

Agyemang, M., Kusi-Sarpong, S., Khan, S. A., Mani, V., Rehman, S. T., & Kusi-Sarpong, H. (2019). Drivers and barriers to circular economy implementation: An explorative study in Pakistan's automobile industry. *Management Decision*, *57*(4), 971–994. https://doi.org/10.1108/MD-11-2018-1178

Álvarez-García, J., del Río-Rama, M. de la C., Saraiva, M., & Ramos Pires, A. (2018). The influence of motivations and barriers in the benefits. An empirical study of EMAS certified business in Spain. *Journal of Cleaner Production*, *185*, 62–74. https://doi.org/10.1016/j.jclepro.2018.03.023

Andersen, M. S. (2006). An introductory note on the environmental economics of the circular economy. *Sustainability Science*, *2*(1), 133–140. https://doi.org/10.1007/s11625-006-0013-6

Aranda-Usón, A., Portillo-Tarragona, P., Scarpellini, S., & Llena-Macarulla, F. (2020). The progressive adoption of a circular economy by businesses for cleaner production: An approach from a regional study in Spain. *Journal of Cleaner Production*, *247*. https://doi.org/10.1016/j.jclepro.2019.119648

Barón, A., de Castro, R., & Giménez, G. (2020). Circular Economy Practices among Industrial EMAS-

Registered SMEs in Spain. *Sustainability*, *12*(21), 9011. https://doi.org/10.3390/su12219011
Barreiro-Gen, M., & Lozano, R. (2020). How circular is the circular economy? Analysing the implementation of circular economy in organisations. *Business Strategy and the Environment*, *29*(8), 3484–3494. https://doi.org/10.1002/bse.2590
Bassi, F., & Dias, J. G. (2019). The use of circular economy practices in SMEs across the EU. *Resources, Conservation and Recycling*, *146*, 523–533. https://doi.org/10.1016/j.resconrec.2019.03.019
Boiral, O., Guillaumie, L., Heras-Saizarbitoria, I., & Tayo Tene, C. V. (2018). Adoption and Outcomes of ISO 14001: A Systematic Review. *International Journal of Management Reviews*, *20*(2), 411–432. https://doi.org/10.1111/ijmr.12139
Botezat, E., Dodescu, A., Văduva, S., & Fotea, S. (2018). An Exploration of Circular Economy Practices and Performance Among Romanian Producers. *Sustainability*, *10*(9), 3191. https://doi.org/10.3390/su10093191
Bravi, L., Santos, G., Pagano, A., & Murmura, F. (2020). Environmental management system according to ISO 14001:2015 as a driver to sustainable development. *Corporate Social Responsibility and Environmental Management*, *27*(6), 2599–2614. https://doi.org/10.1002/csr.1985
Brydges, T. (2021). Closing the loop on take, make, waste: Investigating circular economy practices in the Swedish fashion industry. *Journal of Cleaner Production*, *293*. https://doi.org/10.1016/j.jclepro.2021.126245
BSI Standards Publication. (2017). *Framework for implementing the principles of the circular economy in organizations – Guide*.
Chiarini, A. (2017). Setting Strategies outside a Typical Environmental Perspective Using ISO 14001 Certification. *Business Strategy and the Environment*, *26*(6), 844–854. https://doi.org/10.1002/bse.1969
Colucci, M., & Vecchi, A. (2021). Close the loop: Evidence on the implementation of the circular economy from the Italian fashion industry. *Business Strategy and the Environment*, *30*(2), 856–873. https://doi.org/10.1002/bse.2658
Daddi, T., Heras-Saizarbitoria, I., Marrucci, L., Rizzi, F., & Testa, F. (2021). The effects of green supply chain management capability on the internalisation of environmental management systems and organisation performance. *Corporate Social Responsibility and Environmental Management*, *28*(4), 1241–1253. https://doi.org/10.1002/csr.2144
Daddi, T., Iraldo, F., & Testa, F. (2015). Environmental certification for organisations and products: Management approaches and operational tools. In *Environmental Certification for Organisations and Products: Management Approaches and Operational Tools*. Taylor and Francis Inc. https://doi.org/10.4324/9781315768182
Daddi, T., Testa, F., Frey, M., & Iraldo, F. (2016). Exploring the link between institutional pressures and environmental management systems effectiveness: An empirical study. *Journal of Environmental Management*, *183*, 647–656. https://doi.org/10.1016/j.jenvman.2016.09.025
Delmas, M. A., & Toffel, M. W. (2008). Organizational responses to environmental demands: opening the black box. *Strategic Management Journal*, *29*(10), 1027–1055. https://doi.org/10.1002/SMJ.701
Despeisse, M., Kishita, Y., Nakano, M., & Barwood, M. (2015). Towards a circular economy for end-of-life vehicles: A comparative study UK - Japan. *Procedia CIRP*, *29*, 668–673. https://doi.org/10.1016/j.procir.2015.02.122
Dey, P. K., Malesios, C., De, D., Budhwar, P., Chowdhury, S., & Cheffi, W. (2020). Circular economy to enhance sustainability of small and medium-sized enterprises. *Business Strategy and the Environment*, *29*(6), 2145–2169. https://doi.org/10.1002/bse.2492
Domenech, T., Bleischwitz, R., Doranova, A., Panayotopoulos, D., & Roman, L. (2019). Mapping Industrial Symbiosis Development in Europe_ typologies of networks, characteristics, performance and contribution to the Circular Economy. *Resources, Conservation and Recycling*, *141*, 76–98. https://doi.org/10.1016/j.resconrec.2018.09.016
Elia, V., Gnoni, M. G., & Tornese, F. (2020). Evaluating the adoption of circular economy practices in industrial supply chains: An empirical analysis. *Journal of Cleaner Production*, *273*, 122966. https://doi.org/10.1016/j.jclepro.2020.122966
Ellen MacArthur Foundation. (2015). Growth within: a circular economy vision for a competitive europe. In *Ellen MacArthur Foundation*.
Ellen MacArthur Foundation. (2017). Achieving 'Growth' Within. *Ellen MacArthur Foundation*, 149. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf
Ellen MacArthur Foundation, & Granta Design. (2015). Circularity Indicators: An Approach to Measuring Circularity. In *Ellen MacArthur Foundation*. https://doi.org/10.1016/j.giq.2006.04.004
European Commission. (2015). *Closing the loop - An EU action plan for the Circular Economy*.
European Commission. (2017). Moving towards a circular economy with EMAS. In *Circular Economy Strategy. Roadmap*. https://doi.org/10.2779/463312

European Commission. (2018). COMMISSION REGULATION (EU) 2018/2026 of 19 December 2018 amending Annex IV to Regulation (EC) No 1221/2009 of the European Parliament and of the Council on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS). *European Commission*, *2016*(68), 48–119. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32018R2026

European Commission. (2019). The European Green Deal. In *European Commission* (Vol. 53, Issue 9). https://doi.org/10.1017/CBO9781107415324.004

European Environment Agency. (2016). Circular economy in Europe: Developing the knowledge base. In *European Environment agency* (Issue 2). https://doi.org/10.2800/51444

Evans, L., Nuttall, C., Gandy, S., Iraldo, F., Barberio, M., Paglialunga, A., Gasbarro, F., & Iefe, B. N. (2015). *Project to Support the Evaluation of the Implementation of the EU Ecolabel Regulation* (Issue October). https://doi.org/10.2779/358489

Fischer, A., & Pascucci, S. (2017). Institutional incentives in circular economy transition: The case of material use in the Dutch textile industry. *Journal of Cleaner Production*, *155*, 17–32. https://doi.org/10.1016/j.jclepro.2016.12.038

Fletcher, C. A., Hooper, P. D., & Dunk, R. M. (2018). Unintended consequences of secondary legislation: A case study of the UK landfill tax (qualifying fines) order 2015. *Resources, Conservation and Recycling*, *138*, 160–171. https://doi.org/10.1016/j.resconrec.2018.07.011

Fonseca, L. M., Domingues, J. P., Pereira, M. T., Martins, F. F., & Zimon, D. (2018). Assessment of circular economy within Portuguese organizations. *Sustainability (Switzerland)*, *10*(7), 1–24. https://doi.org/10.3390/su10072521

Garza-Reyes, J. A., Salomé Valls, A., Peter Nadeem, S., Anosike, A., & Kumar, V. (2019). A circularity measurement toolkit for manufacturing SMEs. *International Journal of Production Research*, *57*(23), 7319–7343. https://doi.org/10.1080/00207543.2018.1559961

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? In *Journal of Cleaner Production* (Vol. 143, pp. 757–768). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2016.12.048

Geng, Y., & Doberstein, B. (2008). Developing the circular economy in China: Challenges and opportunities for achieving 'leapfrog development'. *International Journal of Sustainable Development and World Ecology*, *15*(3), 231–239. https://doi.org/10.3843/SusDev.15.3:6

Gharfalkar, M., Court, R., Campbell, C., Ali, Z., & Hillier, G. (2015). Analysis of waste hierarchy in the European waste directive 2008/98/EC. *Waste Management*, *39*, 305–313. https://doi.org/10.1016/j.wasman.2015.02.007

Ghisellini, P., Ji, X., Liu, G., & Ulgiati, S. (2018). Evaluating the transition towards cleaner production in the construction and demolition sector of China: A review. *Journal of Cleaner Production*, *195*, 418–434. https://doi.org/10.1016/j.jclepro.2018.05.084

Giménez, G., Casadesús, M., & Valls, J. (2003). Using environmental management systems to increase firms' competitiveness. *Corporate Social Responsibility and Environmental Management*, *10*(2), 101–110. https://doi.org/10.1002/csr.32

Guillot-Soulez, C., Saint-Onge, S., & Soulez, S. (2021). Green certification and organizational attractiveness: The moderating role of firm ownership. *Corporate Social Responsibility and Environmental Management*, *January*, 1–11. https://doi.org/10.1002/csr.2194

Harris, S., Martin, M., & Diener, D. (2021). Circularity for circularity's sake? Scoping review of assessment methods for environmental performance in the circular economy. *Sustainable Production and Consumption*, *26*, 172–186. https://doi.org/10.1016/j.spc.2020.09.018

Heras-Saizarbitoria, I., Arana, G., & Boiral, O. (2016). Outcomes of Environmental Management Systems: the Role of Motivations and Firms' Characteristics. *Business Strategy and the Environment*, *25*(8), 545–559. https://doi.org/10.1002/bse.1884

Hu, Y., He, X., & Poustie, M. (2018). Can legislation promote a circular economy? A material flow-based evaluation of the circular degree of the Chinese economy. *Sustainability (Switzerland)*, *10*(4). https://doi.org/10.3390/su10040990

International Organization for Standardization-ISO. (2015). *ISO 14001:2015, Environmental management systems — Requirements with guidance for use*. ISO. https://www.iso.org/obp/ui#iso:std:iso:14001:ed-3:v1:en

Jain, N. K., Panda, A., & Choudhary, P. (2020). Institutional pressures and circular economy performance: The role of environmental management system and organizational flexibility in oil and gas sector. *Business Strategy and the Environment*, *29*(8), 3509–3525. https://doi.org/10.1002/bse.2593

Janik, A., & Ryszko, A. (2019). Circular economy in companies: an analysis of selected indicators from a managerial perspective. *Multidisciplinary Aspects of Production Engineering*, *2*(1), 523–535. https://doi.org/10.2478/mape-2019-0053

Kama, K. (2015). Circling the economy: resource-making and marketization in EU electronic waste policy. *Area*, *47*(1), 16–23. https://doi.org/10.1111/area.12143
Katz-Gerro, T., & López Sintas, J. (2018). Mapping circular economy activities in the European Union: Patterns of implementation and their correlates in small and medium-sized enterprises. *Business Strategy and the Environment*, *28*(4), bse.2259. https://doi.org/10.1002/bse.2259
Khan, O., Daddi, T., & Iraldo, F. (2020). The role of dynamic capabilities in circular economy implementation and performance of companies. *Corporate Social Responsibility and Environmental Management*, *27*(6), 3018–3033. https://doi.org/10.1002/csr.2020
Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005
Klein, N., Ramos, T. B., & Deutz, P. (2021). Factors and strategies for circularity implementation in the public sector: An organisational change management approach for sustainability. *Corporate Social Responsibility and Environmental Management*, *June*, 1–15. https://doi.org/10.1002/csr.2215
Kristensen, H. S., Mosgaard, M. A., & Remmen, A. (2021). Integrating circular principles in environmental management systems. *Journal of Cleaner Production*, *286*. https://doi.org/10.1016/j.jclepro.2020.125485
Lacy, P., & Rutqvist, J. (2015). The Sharing Platform Business Model: Sweating Idle Assets. In *Waste to Wealth* (pp. 84–98). Palgrave Macmillan UK. https://doi.org/10.1057/9781137530707_7
Lay, G., & Maloca, S. (2004). Dokumentation der Umfrage Innovationen in der Produktion 2003. In *Arbeitspaper des Fraunhofer ISI.*
Lewandowski, M. (2016). Designing the Business Models for Circular Economy—Towards the Conceptual Framework. *Sustainability*, *8*(1), 43. https://doi.org/10.3390/su8010043
Li, H., Bao, W., Xiu, C., Zhang, Y., & Xu, H. (2010). Energy conservation and circular economy in China's process industries. *Energy*, *35*(11), 4273–4281. https://doi.org/10.1016/j.energy.2009.04.021
Linder, M., Sarasini, S., & van Loon, P. (2017). A Metric for Quantifying Product-Level Circularity. *Journal of Industrial Ecology*, *21*(3), 545–558. https://doi.org/10.1111/jiec.12552
Ma, Y., Liu, Y., Appolloni, A., & Liu, J. (2021). Does green public procurement encourage firm's environmental certification practice? The mediation role of top management support. *Corporate Social Responsibility and Environmental Management*, *28*(3), 1002–1017. https://doi.org/10.1002/csr.2101
Mallawaarachchi, H., Sandanayake, Y., Karunasena, G., & Liu, C. (2020). Unveiling the conceptual development of industrial symbiosis: Bibliometric analysis. In *Journal of Cleaner Production* (Vol. 258, p. 120618). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2020.120618
Manninen, K., Koskela, S., Antikainen, R., Bocken, N., Dahlbo, H., & Aminoff, A. (2018). Do circular economy business models capture intended environmental value propositions? *Journal of Cleaner Production*, *171*, 413–422. https://doi.org/10.1016/j.jclepro.2017.10.003
Marchi, B., Zanoni, S., & Zavanella, L. E. (2017). Symbiosis between industrial systems, utilities and public service facilities for boosting energy and resource efficiency. *Energy Procedia*, *128*, 544–550. https://doi.org/10.1016/j.egypro.2017.09.006
Marrucci, L., Daddi, T., & Iraldo, F. (2019). The integration of circular economy with sustainable consumption and production tools: Systematic review and future research agenda. *Journal of Cleaner Production*, *240*, 118268. https://doi.org/10.1016/j.jclepro.2019.118268
Masi, D., Day, S., & Godsell, J. (2017). Supply chain configurations in the circular economy: A systematic literature review. In *Sustainability (Switzerland)* (Vol. 9, Issue 9). MDPI AG. https://doi.org/10.3390/su9091602
Mathews, J. A., & Tan, H. (2011). Progress Toward a Circular Economy in China. *Journal of Industrial Ecology*, *15*(3), 435–457. https://doi.org/10.1111/j.1530-9290.2011.00332.x
Matuszak-Flejszman, A., Szyszka, B., & Jóhannsdóttir, L. (2019). Effectiveness of EMAS: A case study of Polish organisations registered under EMAS. *Environmental Impact Assessment Review*, *74*, 86–94. https://doi.org/10.1016/j.eiar.2018.09.005
Merli, R., & Preziosi, M. (2018). The EMAS impasse: Factors influencing Italian organizations to withdraw or renew the registration. *Journal of Cleaner Production*, *172*, 4532–4543. https://doi.org/10.1016/j.jclepro.2017.11.031
Ministerio de Agricultura, A. y M. (2015). *BOE.es - BOE-A-2015-13490 Resolución de 16 de noviembre de 2015, de la Dirección General de Calidad y Evaluación Ambiental y Medio Natural, por la que se publica el Acuerdo del Consejo de Ministros de 6 de noviembre de 2015, por el que se aprueba el Plan* . «BOE» Núm. 297, de 12/12/2015. https://www.boe.es/buscar/act.php?id=BOE-A-2015-13490
Ministerio de Economía Industria y Competitividad. (2018). Circular Economy Spanish Strategy 'España Circular 2030'. In *Exacutive Summary*. https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/economia-circular/espanacircular_2030_executivesummary_en_tcm30-510578.pdf
Mitchell, S., O'Dowd, P., & Dimache, A. (2020). Manufacturing SMEs doing it for themselves: developing,

testing and piloting an online sustainability and eco-innovation toolkit for SMEs. *International Journal of Sustainable Engineering*, *13*(3), 159–170. https://doi.org/10.1080/19397038.2019.1685609
Moktadir, M. A., Rahman, T., Rahman, M. H., Ali, S. M., & Paul, S. K. (2018). Drivers to sustainable manufacturing practices and circular economy: A perspective of leather industries in Bangladesh. *Journal of Cleaner Production*, *174*, 1366–1380. https://doi.org/10.1016/j.jclepro.2017.11.063
Mura, M., Longo, M., & Zanni, S. (2020). Circular economy in Italian SMEs: A multi-method study. *Journal of Cleaner Production*, *245*, 118821. https://doi.org/10.1016/j.jclepro.2019.118821
Murmura, F., Liberatore, L., Bravi, L., & Casolani, N. (2018). Evaluation of Italian Companies' Perception About ISO 14001 and Eco Management and Audit Scheme III: Motivations, Benefits and Barriers. *Journal of Cleaner Production*, *174*, 691–700. https://doi.org/10.1016/j.jclepro.2017.10.337
Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics*, *140*(3), 369–380. https://doi.org/10.1007/s10551-015-2693-2
Oncioiu, I., Căpuşneanu, S., Türkeş, M., Topor, D., Constantin, D.-M., Marin-Pantelescu, A., & Ştefan Hint, M. (2018). The Sustainability of Romanian SMEs and Their Involvement in the Circular Economy. *Sustainability*, *10*(8), 2761. https://doi.org/10.3390/su10082761
Ormazabal, M., Prieto-Sandoval, V., Jaca, C., & Santos, J. (2016). An overview of the circular economy among SMEs in the Basque country: A multiple case study. *Journal of Industrial Engineering and Management*, *9*(5), 1047. https://doi.org/10.3926/jiem.2065
Ormazabal, M., Prieto-Sandoval, V., Puga-Leal, R., & Jaca, C. (2018). Circular Economy in Spanish SMEs: Challenges and opportunities. *Journal of Cleaner Production*, *185*, 157–167. https://doi.org/10.1016/j.jclepro.2018.03.031
Pieroni, M. P. P., McAloone, T. C., & Pigosso, D. C. A. (2019). Business model innovation for circular economy and sustainability: A review of approaches. *Journal of Cleaner Production*, *215*, 198–216. https://doi.org/10.1016/j.jclepro.2019.01.036
Prieto-Sandoval, V., Jaca, C., & Ormazabal, M. (2018). Towards a consensus on the circular economy. *Journal of Cleaner Production*, *179*, 605–615. https://doi.org/10.1016/j.jclepro.2017.12.224
Prieto-Sandoval, V., Jaca, C., Santos, J., Baumgartner, R. J., & Ormazabal, M. (2019). Key strategies, resources, and capabilities for implementing circular economy in industrial small and medium enterprises. *Corporate Social Responsibility and Environmental Management*, *26*(6), 1473–1484. https://doi.org/10.1002/csr.1761
Prieto-Sandoval, V., Ormazabal, M., Jaca, C., & Viles, E. (2018). Key elements in assessing circular economy implementation in small and medium-sized enterprises. *Business Strategy and the Environment*, *27*(8), 1525–1534. https://doi.org/10.1002/bse.2210
Rincón-Moreno, J., Ormazábal, M., Álvarez, M. J., & Jaca, C. (2021). Advancing circular economy performance indicators and their application in Spanish companies. *Journal of Cleaner Production*, *279*, 123605. https://doi.org/10.1016/j.jclepro.2020.123605
Rizos, V., Behrens, A., van der Gaast, W., Hofman, E., Ioannou, A., Kafyeke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., & Topi, C. (2016). Implementation of circular economy business models by small and medium-sized enterprises (SMEs): Barriers and enablers. *Sustainability (Switzerland)*, *8*(11). https://doi.org/10.3390/su8111212
Rossi, E., Bertassini, A. C., dos Santos Ferreira, C., Neves do Amaral, W. A., & Ometto, A. R. (2020). Circular economy indicators for organizations considering sustainability and business models: Plastic, textile and electro-electronic cases. *Journal of Cleaner Production*, *247*, 119137. https://doi.org/10.1016/j.jclepro.2019.119137
Saha, K., Dey, P. K., & Papagiannaki, E. (2021). Implementing circular economy in the textile and clothing industry. *Business Strategy and the Environment*, *May 2020*, 1–34. https://doi.org/10.1002/bse.2670
Saidani, M., Yannou, B., Leroy, Y., & Cluzel, F. (2017). How to Assess Product Performance in the Circular Economy? Proposed Requirements for the Design of a Circularity Measurement Framework. *Recycling*, *2*(1), 6. https://doi.org/10.3390/recycling2010006
Schöggl, J. P., Stumpf, L., & Baumgartner, R. J. (2020). The narrative of sustainability and circular economy - A longitudinal review of two decades of research. *Resources, Conservation and Recycling*, *163*(August), 105073. https://doi.org/10.1016/j.resconrec.2020.105073
Seifert, C., & Guenther, E. (2020). Who cares?—Stakeholder relevance for voluntary environmental management in hospitals. *Corporate Social Responsibility and Environmental Management*, *27*(4), 1786–1799. https://doi.org/10.1002/csr.1925
Shi, H., Peng, S. Z., Liu, Y., & Zhong, P. (2008). Barriers to the implementation of cleaner production in Chinese SMEs: government, industry and expert stakeholders' perspectives. *Journal of Cleaner Production*, *16*(7), 842–852. https://doi.org/10.1016/j.jclepro.2007.05.002
Testa, F., Boiral, O., & Iraldo, F. (2018). Internalization of environmental practices and institutional complexity: Can stakeholders pressures encourage greenwashing? *Journal of Business Ethics*, *147*(2), 287–307.

https://doi.org/10.1007/s10551-015-2960-2
Testa, F., Heras-Saizarbitoria, I., Daddi, T., Boiral, O., & Iraldo, F. (2016). Public regulatory relief and the adoption of environmental management systems: a European survey. *Journal of Environmental Planning and Management*, *59*(12), 2231–2250. https://doi.org/10.1080/09640568.2016.1139491
Thorley, J., Garza-Reyes, J. A., & Anosike, A. (2019). The circular economy impact on small to medium enterprises. *WIT Transactions on Ecology and the Environment*, *231*, 257–267. https://doi.org/10.2495/WM180241
Trigkas, M., Karagouni, G., Mpyrou, K., & Papadopoulos, I. (2020). Circular economy. The Greek industry leaders' way towards a transformational shift. *Resources, Conservation and Recycling*, *163*(December 2019), 105092. https://doi.org/10.1016/j.resconrec.2020.105092
Walker, S., Coleman, N., Hodgson, P., Collins, N., & Brimacombe, L. (2018). Evaluating the Environmental Dimension of Material Efficiency Strategies Relating to the Circular Economy. *Sustainability*, *10*(3), 666. https://doi.org/10.3390/su10030666
Wang, S., Li, J., & Zhao, D. (2018). Institutional Pressures and Environmental Management Practices: The Moderating Effects of Environmental Commitment and Resource Availability. *Business Strategy and the Environment*, *27*(1), 52–69. https://doi.org/10.1002/bse.1983
Wen, Z., & Meng, X. (2015). Quantitative assessment of industrial symbiosis for the promotion of circular economy: A case study of the printed circuit boards industry in China's Suzhou New District. *Journal of Cleaner Production*, *90*, 211–219. https://doi.org/10.1016/j.jclepro.2014.03.041
Witjes, S., & Lozano, R. (2016). Towards a more Circular Economy: Proposing a framework linking sustainable public procurement and sustainable business models. *Resources, Conservation and Recycling*, *112*, 37–44. https://doi.org/10.1016/j.resconrec.2016.04.015
Yuan, Z., Bi, J., & Moriguichi, Y. (2006). The Circular Economy: A New Development Strategy in China. *Journal of Industrial Ecology*, *10*(1–2), 4–8. https://doi.org/10.1162/108819806775545321
Zhu, Q., Cordeiro, J., & Sarkis, J. (2013). Institutional pressures, dynamic capabilities and environmental management systems: Investigating the ISO 9000 - Environmental management system implementation linkage. *Journal of Environmental Management*, *114*, 232–242.
Zink, T., & Geyer, R. (2017). Circular Economy Rebound. *Journal of Industrial Ecology*, *21*(3), 593–602. https://doi.org/10.1111/jiec.12545

Tables

Table 1. Empirical research on CE implementation in firms

Reference	Country (Region)	No. Companies / Sector	Methods
Colucci and Vecchi 2021	Italy	4 / Fashion industry	Case study
Brydges 2021	Sweden	19 / Fashion industry	Interview
Saha, Dey, and Papagiannaki 2021	Bangladesh, Vietnam, India	114 / Textile and clothing industry	Survey
Aranda-Usón et al. 2020	Spain (Aragón)	52 / Food, Industry, Manufacturig, Waste, Service, Transport and Logistics	Interview
Barreiro-Gen and Lozano 2020	Global Reporting Initiative Data base	256	Survey
Barón et al., 2020	Spain (Catalonia)	31(SME) / Industry	EMAS Statement Review
Elia, Gnoni, and Tornese 2020	Ellen MacArthur Foundation Data base	96	Case study
Dey et al. 2020	UK (West Midlands)	130 (SME) / Manufacturing	Case study/Survey/Focus group
Mura et al. 2020	Italy	254 (SME) / Manufacturing, Tourism, Hum services, Plant engineering, ICT	Interview/Survey/Focus group
Trigkas et al. 2020	Greece	32 Leading companies	Survey
Janik and Ryszko 2019	Poland	66	EMAS Statement Review
Fonseca et al. 2018	Portugal	99	Survey
Oncioiu et al., 2018	Romania	384 (SME) / Agriculture, forestry, fishing, Industry, Constructin, Trade, Hotels and restaurants, Transport, Other services	Survey
Ormazabal et al. 2018	Spain (Navarra - Basque Country)	95	Survey
Botezat et al. 2018	Romania	98 / Industry	Survey
Ormazabal et al. 2016	Spain (Basque Country)	17 (SME) / Industry	Case study

Table 2. Circular initiatives in the fields of action model

Fields of action	Circular Initiative
Take	Incorporating resources from the environment, making more efficient and responsible use of biological and technical resources. This includes the selection of suppliers and materials with environmental criteria as well as certifications and labels
Make	Developing the best technological practices and ecological innovations (eco-innovations) so that both the product/service and the process are carried out in the most sustainable way possible
Distribute	How the product/service is delivered to the customer (traceability and reducing environmental impact). Includes reverse logistics
Use	Reducing the energy consumption associated with using the product or the efficiency of the product itself (allowing customers to return the product after use or the development of business models where the final consumer is not the owner of the goods)
Recover	Recovering waste as a biological resource that can be returned to the biosphere or as a technical resource that can be reincorporated into an industrial process.
Industrial Symbiosis	Establishing synergies of exchange and exploitation between industries with the aim of producing a beneficial relationship for the industries involved (e.g. reusing outflows from a particular industry as raw material for another industry, or putting common services, infrastructures and/or projects into effect)

Table 3. Sample description

	No Companies	%
No. Employees		
SME <250	80	94.10%
Large >250	5	5.90%
Sector (NACE Code)		
Manufacture of food, beverages products (10-11)	16	18.80%
Manufacture of textiles, wearing apparel, leather and related products (13-15)	8	9.40%
Manufacture of wood and of products of wood and cork and furniture (16, 31)	9	10.60%
Manufacture of paper, chemical, pharmaceutical products (17-21)	7	8.20%
Manufacture of plastic and non-metallic mineral products (22-23)	6	7.10%
Manufacture of fabricated metal products, except machinery and equipment and basic metals (24-25)	6	7.10%
Manufacture of computer, electronic and optical products, electrical equipment and machinery and equipment (26, 28)	10	11.80%
Manufacture of motor vehicles, trailers and semi-trailers and other transport equipment (29-30)	3	3.50%
Other manufacturing (32)	20	23.50%
EMS Certification		
Yes	43	50.59%
No	39	45.88%
N/A	3	3.53%
Total	85	

Table 4. Variables for measuring circular initiatives in the European Manufacturing Survey

Fields of action	#	Measurement variables of circular initiatives
Take	T1	Use of reused and/or recycled raw materials
	T2	Technologies for recycling and reuse of water
Make	M1	Integration of best sustainable manufacturing technologies
	M2	Implementation of energy management systems
	M3	Implementation of life cycle assessment tools
	M4	Introduction of technological improvements
	M5	Design aimed at extending product lifetime
Distribute	D1	Cooperation in distribution processes
	D2	Product end-of-life service - reverse logistics
Use	U1	Products with reduced energy consumption during use
	U2	Products with reduced environmental pollution during use
	U3	Products with ease of maintenance or retrofitting
	U4	Product maintenance and repair services
	U5	Product refurbishment and modernisation services
	U6	Product, machinery, or equipment rental services
Recover	R1	Kinetic and process energy recovery
	R2	Introduction of recycling/recovery improvements
Industrial Symbiosis	IS1	Joint purchasing
	IS2	Production cooperation
	IS3	Cooperation in service
	IS4	R&D cooperation with other companies

Table 5. Correlation between EMS adoption and the intensity of adoption (IA) of circular practices

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	34.442	1	34.442	7.877	0.006*
Within Groups	341.046	78	4.372		
Total	375.488	79			

*: The correlation is significant at the 0.05 level ($p<0.05$)

Table 6. Correlation between EMS implementation and the adoption of circular initiatives

Var	Description	Chi-Square	Sig
T1	Use of reused and/or recycled raw materials	-0.062	0.582
T2	Technologies for recycling and reuse of water	0.093	0.413
M1	Integration of best sustainable manufacturing technologies	0.082	0.676
M2	Implementation of energy management systems	.283*	0.011*
M3	Implementation of life cycle assessment tools	.289*	0.01*
M4	Introduction of technological improvements	0.220	0.05*
M5	Design aimed at extending product lifetime	-0.321	0.068
D1	Cooperation in distribution processes	-0.106	0.351
D2	Product end-of-life service - reverse logistics	0.027	0.82
U1	Products with reduced energy consumption during use	.355*	0.042*
U2	Products with reduced environmental pollution during use	-0.184	0.305
U3	Products with ease of maintenance or retrofitting	0.050	0.783
U4	Product maintenance and repair services	0.022	0.844
U5	Product refurbishment and modernisation services	0.055	0.635
U6	Product, machinery, or equipment rental services	-0.137	0.227
R1	Kinetic and process energy recovery	0.154	0.176
R2	Introduction of recycling/recovery improvements	-0.012	0.949
IS1	Joint purchasing	0.170	0.129
IS2	Production cooperation	0.001	0.99
IS3	Cooperation in service	-0.036	0.754
IS4	R&D cooperation with other companies	0.213	0.065

*: The correlation is significant at the 0.05 level ($p<0.05$)

Figures

Figure 1. CE adoption related to the Fields of action model

Figure 2. Circular Economy practices adoption