Analysis of synergies between Circular Economy and Integrated Management Systems: a bridge to unite sustainable solutions and business efficiency

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Abstract

Circular Economy (CE) is a fundamental instrument for public institutions, organizations, the population, among others, to take safe steps towards sustainability. Integrated Management Systems (IMS) is defined as a set of interconnected processes that share information regarding human, financial, material and infrastructure resources, among others, in order to successfully achieve organizational goals that satisfy their stakeholders. The objective of this article is to cross analyze the main topics between the CE and IMS and develop a discussion that allows exploring the synergies between both. The methods chosen were bibliographic review and content analysis. Most of the analyses between the clusters of the CE and IMS present a significant synergy. The contribution applied was the availability of strategies that can be incorporated into the management of organizations with socio-environmental and profitability goals or that seek to improve their relationships with their stakeholders.

Keywords: Circular Economy, Integrated Management Systems, Sustainability, Content Analysis, Synergy

1. Introduction

Since the beginning of the Industrial Revolution, new manufacturing methods have allowed large-scale production, enabling the great availability of products at low cost (Lieder and Rashid 2016). With this productivity growth, there have been impacts such as loss of biodiversity, water, soil, and air pollution; depletion of resources, and the possibility of compromising the systems that support life on the planet (Geissdoerfer et al., 2017). Based on this scenario, international organizations such as the United Nations sought to promote models that take into account environmental limitations and that prioritize the use of renewable energy (Ellen MacArthur Foundation 2017). This change in mentality can help solve an "equation" that presents population growth and the need for economic development as variables, while at the same time having in this formula the limitation of resources (Lieder and Rashid 2016). The Circular Economy (CE) emerged as an alternative to transform both the elements for maintaining nature and meeting the material needs of the population into a common denominator, with a proposition to reconcile these two aspects and not leave them in a dichotomous condition or even competitors (Ghisellini, Cialani, and Ulgiati 2016). With the insertion of the CE in the economic activities, the productive systems are built and rebuilt, integrating the totality of this same system. Like cotton or wood, which when no longer used can be destined to processes like composting and aerobic digestion, regenerating living systems that will return to economic activity as renewable resources (Ellen MacArthur Foundation 2017). The CE is a fundamental tool for public institutions, organizations, population, among others, to take safe steps towards sustainability (Geissdoerfer et al., 2017). Sustainability is a principle supported by the environment, society, and the economy, which values the balance of these three pillars with a view to sustainable development (Elkington 1997). Although there are many studies on the subject, with over a thousand articles cataloged in Scopus' database, the CE presents itself in the eyes of the business community and public management as an incipient and disorganized concept, which needs to be better improved to be implemented and contribute to the emerging demands (Korhonen, Honkasalo, and Seppälä 2018).

Starting from the integrating vocation of the Circular Economy and the current applied and conceptual misunderstanding of the CE, research gaps were identified that indicate a possibility that the Integrated Management System (IMS) could complement and improve the CE about the modus operandi in the corporate scenario, directing organizations to reconcile economic competitiveness without running into environmental depredation (Lieder and Rashid 2016; Witjes and Lozano 2016). IMS not only can contribute to the improvement of management, but also provides organizations with a sense of social responsibility (Mežinska, Lapiņa, and Mazais 2015). It is a rational approach with the potential to reduce costs, motivate employees, manage resources more efficiently, provide competitive advantages, making the corporate environment more conducive to environmental awareness and sustainable development (Muthu Samy, Palani Samy, and Ammasaiappan 2015). So far, there are only three publications that involve CE and IMS simultaneously, considering the words contained in the titles or keywords. The three works are: "Circular economy - a new direction for the sustainability of the hotel industry in Romania?", "Circular economy and real estate: the legal (im)possibilities of operational lease" and "Usage of Interface Management System in Adaptive Reuse of Buildings".

The first article verified the capacity of the Romanian hotel structure to adopt the circular economy in tourist activities, what was called "circular tourism". However, due to the lack of integrated management instruments, it was found that there was a gap pending the efficient adoption of this new form of tourism (Pamfilie et al. 2018). The second article analyzes that the conventional interpretation of responsibility for civil construction is usually attributed to the supplier; and that the client only exchanges his financial resource for the purchased good. However, in situations where the law requires changes in the façade of a building to comply with a legal and important device for the environment, the clients end up having responsibility for the good that was acquired. From this, the author suggests that specific laws be produced based on circular economy and management efficiency so that construction companies meet the requirements of a more environmentally friendly construction (Ploeger et al. 2019). The third article proposes the implementation of interface management to improve the results of adaptive reuse projects in construction works. It was found, however, that the main limiting agent of material utilization in this sector are "management problems" because, in the face of highly complex projects, organizations are unable to provide the definitions of responsibility structure (Eray, Sanchez, and Haas 2019). As much as these studies mention important themes involving the CE and IMS, none of them explored the synergistic relationships between the two themes. Given the above, the question that will guide this research is: what are the main synergies presented between the theories of Circular Economy and Integrated Management Systems and how can they be integrated to enhance their application? To answer it, the general objective of this research is to cross analyze the main topics between the CE and the IMS and to develop a discussion that allows exploring the synergies between both. This research is divided into the following sections, besides this introduction: theoretical reference, research method, results and discussion, conclusion, and references.

2. Literature Review

The theoretical reference that composes this article is divided into two subsections: Circular Economy and Integrated Management Systems. The main contents of each topic will be addressed, based on the most relevant references available in the databases.

2.1 Circular Economy

Human activities have impacted the maintenance of the climate and the availability of natural resources, generating increasing pressure on government institutions and business organizations; and in this context, the CE emerges as a set of knowledge and practices that can bring mitigating applications to such pressures contributing to the preservation of nature (Bocken et al. 2016). Two types of meanings are attributed to the CE: linguistic and descriptive (Murray, Skene, and Haynes 2017). When the linguistic parameter is analyzed, it is considered the antonym of the "linear economy", whose prevailing characteristic is the prioritization of economic objectives and the lack of care with ecological and social issues; converting natural resources into waste (Murray, Skene, and Haynes 2017; Sauvé, Bernard, and Sloan 2016). Regarding the descriptive meaning, reference is made to the concept of circulation, especially biogeochemical cycles and definitions of product recycling, with the proposition of a regenerative system that minimizes waste of resources and inefficient use of energy (Murray, Skene, and Haynes 2017). The concept of CE presents similarities to Sustainability, assuming that its dimensions focus on the economy, the environment, and society (Elkington 1997). What differentiates them is the fact that Sustainability presents a more extensive horizon and the CE is a very promising field of knowledge to promote sustainable development (Geissdoerfer et al., 2017). The studies involving the CE seek to replace the concept of "end of life" of a given resource by more sustainable practices such as "reduce", "reuse", "recycle" and "recover" materials that are both in production processes and distribution or still available for consumption (Kirchherr, Reike, and Hekkert 2017). The environmental objectives of the CE focus on reducing the production-consumption system of virgin materials, application of material cycles, and renewable energy; about the economic objectives, it seeks the reduction of raw material costs, improvement of waste management to the relevant production chains, mitigation of environmental risks, among others; and about the social objectives, it seeks the solidarity economy, the increase of employment, democratic and participative decisions and the diffusion of a culture that stimulates the consumption of services to the detriment of the acquisition of physical goods (Korhonen, Honkasalo, and Seppälä 2018).

Based on the three objectives mentioned in Circular Economy, the CE is seen as a new business model, which helps a more sustainable development and which can serve as a basis for a society with a better quality of life (Ghisellini, Cialani, and Ulgiati 2016). One of the most plausible reasons for adopting the CE is that it makes resources less subject to depletion, unlike the linear model that accelerates and cheapens production at the expense of the shortcuts that organizations find in bad practices or environmental crimes, and also fails to adopt sustainable standards in product disposal (Sauvé, Bernard, and Sloan 2016). For the planning and implementation of the CE, legal regulations should be developed with the details that each business segment must comply with and that environmental costs are embedded in the pricing of products (Sauvé, Bernard, and Sloan 2016). Thus, allowing the adoption of controls that reduce the flow of materials, stimulating the extension of the durability of products present in a given system (Bocken et al. 2016). At the same time that there is an increase in costs for its inclusion in the calculation basis, there are savings in the reuse or recycling of products (Murray, Skene, and Haynes 2017). To illustrate the decrease in the cycle of resource use, the Systemic Diagram of the CE (Figure 1), which identifies the continuous flow of technical and biological materials through the value cycle, is presented. This model has the perspective of promoting the elimination of waste and pollution from the origin of a production chain; the maintenance of the use of products and materials; and the regeneration of natural systems (Ellen MacArthur Foundation 2017). The structure of the Systemic Diagram of the CE illustrates the continuous flow in which technical and biological materials can go through before being discarded, feeding back the cycle itself or being inserted in another, reducing the number of elements to be excluded (Blomsma and Brennan 2017). Principle 1 stresses the importance of preserving and improving natural capital by controlling finite stocks and balancing the flow of renewable elements. Principle 2 mentions the importance of extending the circulation of components, resources, and materials, which are inserted in both biological and technical cycles. Principle 3 seeks the effectiveness of the system focusing on the mitigation of negative externalities from the origin of each of the elements (Ellen MacArthur Foundation 2017).

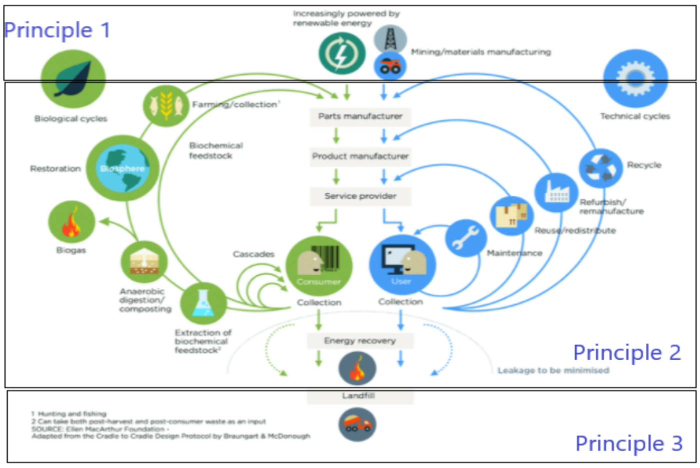

Figure 1. Systemic Diagram of the Circular Economy

Through the three principles, the CE contributes directly to the well-being of society, acting as a tool directly linked to the development of green businesses and fostering the generation of employment that results in important social attenuators such as the promotion of equity and poverty eradication (Ghisellini, Cialani, and Ulgiati 2016). These benefits can be perceived by society due to a realignment of economic activity to social and ecological management models, reverberating positively in ethical and sustainable business practices (Murray, Skene, and Haynes 2017). Ecological models are becoming increasingly targeted by consumers as they realize that much of the products purchased are not fully used, implying losses related to depreciation, maintenance, and storage (Bernard, Sloan, and Sauvé 2016). The change in paradigms through consumer awareness provides better perspectives on the issues of resource scarcity, environmental impact, job generation, and business competitiveness (Lieder and Rashid 2016). Thus, research at the JV is directed towards the transformation of economic structures and business thinking, regenerative projects and critical materials, industrial ecology, remanufacturing and closed-loop supply chains, conservative production of resources, and government initiatives of the JV (Lieder and Rashid 2016). However, it differs on the main motivations in guiding the studies of the JV, as the academic authors seek to build knowledge focused on environmental issues, while the companies that conduct studies in the area focus on economic prosperity (Kirchherr, Reike, and Hekkert 2017). The consensus is that the social dimension of the CE has many gaps in how it can be instrumentalized to contribute to gender equality, racial and religious equality, and other diversities (Murray, Skene, and Haynes 2017). In general, through the development of the applications of the CE, it seeks to promote integration in the supply chain in which companies can use the discarded items one of the others as resources, reducing the cycle of use of raw materials and delaying the production of waste (Kirchherr, Reike, and Hekkert 2017).

2.2 Integrated Management Systems

The Integrated Management System (IMS) is defined as a set of interconnected processes that share information regarding human, financial, material, and infrastructure resources, among others, to successfully achieve organizational goals that satisfy their stakeholders (Karapetrovic and Jonker 2003). Where organizations that adhere to an IMS can become more efficient and even better exploit their synergies (Bernardo et al. 2018). The integration of a Management System in a given company enables a homogeneous language that eliminates the duplicity of concepts, contributing to the satisfaction of the parties involved (Oliveira 2013). The greater the range of information systems a company has, aligning them synchronously, the results are potentially more positive (Muthu Samy, Palani Samy, and Ammasaiappan 2015). When organizations integrate their functions, they can increase their productivity while lowering the costs of their activities (Nunhes, Barbosa, and Oliveira 2017). Another usefulness that the Integrated Management System can offer to organizations is the resolution of multifunctionality problems, allowing decision-makers more clarity in the interpretation of processes (Escobar Lanzuela et al. 2015). For an organization to follow an IMS implementation program, it must prioritize three aspects: the content, which would be the management systems to be integrated; the context, which would include both the organizational context and the organizational culture context; and the process, which would instrumentalize the IMS in a given company (Muthu Samy, Palani Samy, and Ammasaiappan 2015).

The implementation processes can be sequential or simultaneous. The simultaneous process presents a more favorable cost-benefit ratio, considering the fact that expenditures are lower and the number of systemic disturbances is lower (Nunhes, Barbosa, and Oliveira 2017). The IMS can be identified as an organizational innovation that can induce a given company to innovate, but companies should consider that the IMS can be a facilitator or an inhibitor of innovation, depending on their institutional values and their strategic, tactical and operational efficiency (Gianni, Gotzamani, and Tsiotras 2017; Klute-Wenig and Refflinghaus 2015). Among the benefits expected with the implementation of the IMS, it is worth mentioning the increase in management quality that a given organization will have by including a set of good global management practices in its own structure (Ribeiro et al. 2017). Due to its higher organizational level, it is possible to do business with more demanding clients and with a complex supply chain (Bernardo et al. 2018). The implementation of IMS may allow an improvement in the organizational culture and its internal communication (Nunhes, Barbosa, and Oliveira 2017). This is mainly due to the possibilities of better acceptance among employees and the systematic implementation of integrated training programs (Muthu Samy, Palani Samy, and Ammasaiappan 2015). IMS has the capacity to improve the organizational culture, but the companies face as one of the main barriers to employee resistance in starting its implementation (Bernardo et al. 2018). This demotivation usually happens because of the difficulty and the long time that the operationalization of IMS usually takes (Moumen and El Aoufir 2017). In addition, the large number of norms and laws inhibit companies from implementing the IMS, considering that its updates require highly qualified labor (Muthu Samy, Palani Samy, and Ammasaiappan 2015; Ribeiro et al. 2017). The lack of financial availability to meet implementation and maintenance costs also makes it difficult to adhere to the IMS (Bernardo et al. 2018). IMSs can be "non-certifiable" or "certifiable" (Gianni and Gotzamani 2015). Among the non-certifiable systems, we can mention mainly ISO 26000 (Guidance on Social Responsibility), British BSI PAS 99; Danish DS 8001; Spanish UNE 66177; Australia/New Zealand AS/NZS4581 IMS (Bernardo et al. 2018; Gianni and Gotzamani 2015).

Among the certifiable systems that can be integrated, we highlight ISO 9001 (Quality Management System), ISO 14001 (Environmental Management System), and OHSAS 18001 (Occupational Health and Safety Assessment Series), recently replaced by ISO 45001 (Occupational Health and Safety Management System), which include a significant part of the processes necessary to optimize efforts and resources of a given organization (Dragomir et al. 2017; Gianni and Gotzamani 2015; Nunhes, Barbosa, and Oliveira 2017). ISO 9001 is associated with the improvement of organizational processes, improvement of products and services, aiming at increasing its market share with better financial results (Nunhes, Barbosa, and Oliveira 2017). ISO 14001 aims to develop the operational and administrative activities of a company for the management of its environmental resources and processes (Nunhes, Barbosa, and Oliveira 2016). ISO 45001 establishes the requirements of an occupational health and safety management system and contributes to the development of social responsibility (Nunhes, Bernardo, and Oliveira 2020). It is essential to have the integration of ISO 9001, ISO 14001, and ISO 45001, among others, so that the results are more satisfactory, making the corporate environment better directed to innovation, social responsibility, sustainable development, continuous improvement, among others (Bernardo et al. 2018). From the association of the three ISO systems, the integration of systems makes the organization more capable of transforming products and/or undesirable results (outcomes) into desirable products, a reduction of impacts on the environment and society, and a reduction of risks to occupational health and safety (Neto, Tavares, and Hoffman 2008).

3. Methods

The research method used in this article is presented in Figure 2.

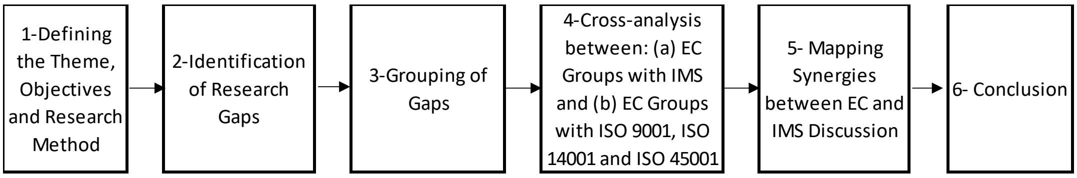

Figure 2. Research Method

In Stage 1, the theme of the research was defined, accompanied by the objectives and the method. The methods chosen were bibliographic review and content analysis, which contributed to the identification of research gaps (Alvarenga et al. 2021). In Stage 2, the 15 most cited articles in both CE and IMS were selected, from 2016 to 2020. From these articles, the research gaps of each of them were highlighted. In Stage 3, the research gaps of the CE and IMS were grouped in four clusters (groups) by theme. In Step 4, (a) cross-analysis between the literature and the CE and IMS clusters was performed to identify possible synergies between them; (b) and a cross-analysis between the CE clusters and the main integrable certifiable systems (ISO 9001, ISO 14001, and ISO 45001). In Step 5, the main synergies analyzed in the previous step were established and discussed. Finally, in Stage 6, the work was concluded, identifying the main contributions, research limitations, and indications for future studies.

4. Results and Discussion

This section will present the results of the scientific gap analysis of the CE and IMS, as well as a synergy analysis between the clusters and the three main integrable certifiable systems.

4.1 Clustering of Gap's identified in the literature

The gaps in the CE articles were studied and grouped by similarity in four clusters (Table 1).

Table 1. Gap Clusters of CE and IMS Articles

Autores	Cluster (CE)
Winans, Kendall and Deng, 2017.	Solid Waste
Witjes and Lozano, 2016.	
Blomsma and Brennan, 2017.	
Ghisellini, Cialani d Ulgiati, 2016.	
Sauve, Bernard and Sloan, 2016.	Ecology
Tukker, 2015.	
Bocken et al., 2016.	
Lewandowski, 2016.	
Genovese et al., 2017.	
Murray, Skene and Haynes, 2017.	
Geissdoerfer, 2017.	
Pan, 2015.	Energy
Korhonen, Honkasalo and Seppala, 2018.	
Kirchherr, Reike and Hekkert, 2017.	Society
Lewandowski, 2016.	
Winans, Kendall and Deng, 2017.	
Murray, Skene and Haynes, 2017.	
Sauve, Bernard and Sloan, 2016.	
Lieder and Rashid, 2016.	

Autores	Cluster (IMS)
Bernardo et al., 2018.	Check
Escobar et al.,2015.	
Moumen and El Aoufir, 2017.	
Muthu, Palani and Ammasaiappan, 2015.	
Nunhes, Ferreira and Oliveira, 2016.	
Domingues, Sampaio and Arezes, 2016.	Standard
Domingues, Sampaio and Arezes, 2015.	
Nunhes, Ferreira and Oliveira, 2016.	
Domingues, Sampaio and Arezes, 2015.	
Gianni, Gotzamani and Tsiotras, 2017.	
Klute-Wenig and Refflinghaus, 2015.	
Muthu, Palani and Ammasaiappan, 2015.	
Nunhes, Motta and Oliveira, 2017.	
Moumen and El Aoufir, 2017.	
Mi et al., 2016.	Enviromental
Mezinska, Lapina and Mazais, 2015.	
Escobar et al.,2015.	
Savino and Batbaatar, 2015.	Society
Mezinska, Lapina and Mazais, 2015.	
Escobar et al.,2015.	
Mezinska, Lapina and Mazais, 2015.	
Souza and Alves, 2017.	
Ribeiro et al., 2017.	

According to Table 1, the gaps identified in the CE were grouped into the solid waste, ecology, energy, and society clusters, according to the similarity of actions and initiatives proposed in each gap. The same procedure was carried out with the gaps in the IMS articles, grouped into check, standard, environmental, and society.

In CE, the "solid waste" cluster contemplates the waste of a circular system, including the quality of the materials and the impacts caused by them, considering alternatives for reducing environmental impacts through management strategies. These strategies have as their main basis the waste hierarchy elaborated by the European Union, encouraging the minimization, reduction, recovery, and recycling of waste. In "ecology", involves alternatives to develop and assist the process of circularization of production systems, protecting the environment, and promoting sustainability. This cluster also presents the relationship between the implementation of circular systems and their impacts on the environmental dimension. "Energy" is aligned with the management of energy in circular systems, and in it are analyzed the increase in energy efficiency and the use of renewable energy. The "society" cluster contemplates the influence of the application of circular economy systems in society and the perspectives of the social dimension in the development of these systems. The public sector's commitment to circular systems is included in the analyses.

In IMS, the "check" cluster is directed to the analysis and comparison of the main characteristics of the implication of certifications. Addressing the difficulties, influencing factors, experiences, and results of implementing an integrated management system in organizations. In "standard" it is related to the certification standards and the guidelines for their implication. It is composed of alternatives for the publication, evaluation, integration, and application of the standards. "Environmental" is aligned with environmental management alternatives for companies and their results in the environment. The "society" cluster covers the social sphere and presents the mutual relationship between the social sector and the application of integrated management systems. It contains gaps in the evaluation and influence of the social dimension in the application of standards and how the implementation of integrated management systems can affect society.

4.2 Synergy between clusters of the CE and IMS

In this topic, a synergy analysis between the CE and IMS clusters was performed. The synergy was determined from the number of articles returned by the query used in the research, where a return of zero was considered as there was no synergy between the themes, return greater than zero and return less than five was classified as low synergy and return of five or more articles was classified as significant synergy between the themes.

4.2.1 Synergy between Solid Waste (CE) and IMS clusters

The "Check" cluster has significant synergy with "Solid Waste". This synergy is presented through residues that can be analyzed and used differently from the one predestined. The structuring of standardized criteria for these analyses is fundamental for the reuse of waste in possible different alternatives (Gigli, Landi, and Germani 2019). For example, the use of discarded tires in the form of fabric. However, there are significant levels of toxicity that must be considered to be used in another way. Another way is to insert additives into production based on residues in cement, minimizing cost when compared to using virgin components (Czop and Lazniewska-Piekarczyk 2020). The "Standard" cluster has significant synergy with "Solid Waste". It is important to highlight the contributions that standardization can implement in waste management, retaining value-added waste in the production chain, and thus contributing to the environment in reducing greenhouse gases, reducing costs, among others (Paes et al. 2019). The "Environmental" cluster has significant synergy with "Solid Waste". For the preservation of the environment, metrics can be adopted that measure the benefits of waste recovery in a circular economy system, with an accessible and applicable language (Iacovidou et al. 2017). Circular Economy can be applied as a toolbox to solve issues such as recycling municipal waste, electronic waste, wastewater, among others (Schroeder, Anggraeni, and Weber 2019). The "Society" cluster has significant synergy with "Solid Waste". Since the legal frameworks that establish regulations on waste aim at sustainable environmental management and the measurement of waste impacts on society (Zorpas 2020). Another relevant aspect that waste touches on social issues is the activities of informal and formal recyclers, which must be integrated so that their synergy can improve overall results (Villalba 2020).

4.2.2 Synergy between Ecology (CE) and IMS clusters

The "Check" cluster has significant synergy with "Ecology" since the analyses are essential for new and future discoveries. Among the identified analyses can be highlighted: Intensify the analysis of raw materials that are biological allowing the fulfillment of the principles of the CE and the implementation strategies of the CE (Prieto-Sandoval, Jaca, and Ormazabal 2018), especially the monitoring methods based on Material Flow Accounting (Genovese et al. 2017; Kalmykova, Sadagopan, and Rosado 2018). Analyze synergies and limitations between CE, GE, and BE (Circular Economy, Green Economy, and Bioeconomy) and possibilities of harmonizing them among themselves (D'Amato et al. 2017). To develop and analyze new approaches to production and consumption to comply with the principles of the CE (Merli, Preziosi, and Acampora 2018). The "Standard" cluster has significant synergy with "Ecology", as it was possible to identify in the literature standards that should be used to ensure that the principles of the CE are achieved, thus aiming at promoting more ecological production alternatives (Loste, Roldán, and Giner 2020; Sommerhuber et al. 2017; Sommerhuber, Wang, and Krause 2016; Yang et al. 2018). The "Environmental" cluster has significant synergy with "Ecology" since one of the premises of the CE is to minimize the impacts that the linear economy causes to the environment (D'Amato et al. 2017). It is recommended, from a methodological point of view, that environmental indicators be always considered for a relevant comparison between linear and circular economy systems (Genovese et al. 2017). And although the implementation of the CE, at a global level, is still at an early stage of development, it allows a radical improvement of the current business model towards a preventive and regenerative eco-industrial development, as well as greater well-being based on the full recovery of the environment (Ghisellini, Cialani, and Ulgiati 2016; Murray, Skene, and Haynes 2017). The "Society" cluster has significant synergy with "Ecology". This relationship is because the CE is linked to sustainable initiatives, after all, it can be conceptualized as a new business model that leads to sustainable development and a harmonious society (Ghisellini, Cialani, and Ulgiati 2016). Among the strategies of the CE, the social and solidarity economy is an instructive and constructive example, increasing labor-intensive activities while increasing the quality and diversity of human labor involved in the remanufacturing and recycling of products (Moreau et al. 2017). Also, the CE has a positive impact on society from the reduction of emissions, resulting in the well-being of the local population (Baldassarre et al. 2019).

4.2.3 Synergy between Energy (CE) and IMS clusters

The "Check" cluster has low synergy with "Energy" and is related to sustainability. Among the analyses carried out, the need for guidance for integrating the CE concept into sustainable business development was identified (Núñez-Cacho et al. 2018) and providing guidelines for implementing eco-technologies (Johannesdottir et al. 2020). The cluster "Standard" has significant synergy with "Energy", it was possible to identify in the literature directives for energy efficiency with the use of CE (Tecchio et al. 2017) and environmental regulations that use waste for energy production (Malinauskaite et al. 2017). However, studies are needed to identify how companies implement and develop environmental standards (Dalhammar 2016). The proposal of value-based resource efficiency (VRE) indicators (Di Maio et al. 2017) was identified for evaluation, and a methodology was developed to support decision-making involving the CE (Fregonara et al. 2017). The "Environmental" cluster has significant synergy with "Energy", being widely discussed the concept of Waste-to-energy in the production of energy by incineration, being discussed its contribution to the JV, since, the production of energy by this model ends when there is no waste to burn (Krausmann et al. 2017; Malinauskaite et al. 2017). Also, the energy efficiency gain ratio is evaluated as a function of consumption, since the value of the product decreases and energy consumption increases, which can generate negative environmental impacts (Schroeder, Anggraeni, and Weber 2019; Zink and Geyer 2017), for which indicators have used that account for cycles with and without a Life Cycle Thinking (LCT) approach (Moraga et al. 2019). The "Society" cluster has significant synergy with "Energy". This relationship seeks sustainable social development, harmonizing academia, businesses, and governments with the premise of preservation and reuse, and then applies the concept of circularity to the development of society (Kirchherr, Reike, and Hekkert 2017; Korhonen, Honkasalo, and Seppälä 2018; Saavedra et al. 2018). Also discussed are the Social and Solidarity Economy (SSE) approach, which takes the focus off profitability and puts it on people and the planet (Moreau et al. 2017), and the market value approach to evaluate resource efficiency in a market value approach (Di Maio et al. 2017).

4.2.4 Synergy between Society (CE) and IMS clusters

The "Check" cluster has significant synergy with "Society" since the analyses are fundamental for the development of the society through the CE and the IMS's. One of the needs found was to perform a deeper analysis of sustainable policy concepts such as life cycle, material flow and its circulation in society, and environmental management systems as part of the ISMS (D'Amato et al. 2017; Ikram, Zhang, and Sroufe 2020). The analysis of these basic concepts and the application of new tools and technologies, such as the Internet of Things and Big Data, integrating the social dimension, has an important role in the development of a better society (Moreau et al. 2017). The "Standard" cluster has significant synergy with "Society" since there is a great correlation between standardization and society development. One of the needs met addresses the importance of creating new standards and the application and better development of existing standards to assist in the development of sustainable policies, such as guidelines that facilitate the closing of production cycles and the application of ISO certifications. These actions can change the institutions and general rules of society and promote the effectiveness of policies and incentive systems. And in this way, leads society towards a better future (Paes et al. 2019; Tisserant et al. 2017). The "Environmental" cluster has significant synergy with "Society" since environmental and social development is strongly linked. One of the analyses found was the need to improve the efficiency of resource use, to provoke several environmental, socio-technical, and economic implications in society. Thus, the consequences caused by this decrease in impacts are essential to establish a win-win relationship between society and the environment (Ghisellini, Cialani, and Ulgiati 2016; Zeng et al. 2017). Another relationship found is the need for environmental protection and integrated social responsibility to achieve sustainable economic development

(Aquilani, Silvestri, and Ruggieri 2016). The "Society" cluster has significant synergy with "Society" since the analysis of society is of extreme importance for both issues. One of the needs met is to create guidelines that integrate the social dimension with IMS's and the CE, including social actors and community involvement, to promote the achievement of a more harmonious global society (Tisserant et al. 2017). This can be facilitated by developing alternatives to "shutting down" circular economy systems, increasing producer and consumer awareness, and developing integrated management systems involving the environmental dimension (Ghisellini, Cialani, and Ulgiati 2016; Ikram, Zhang, and Sroufe 2020).

4.3 Synergy analysis of the CE clusters and the main Integrable Certifiable Systems

In this topic, a synergy analysis was performed between the CE gap clusters and the main integrable certifiable systems, considering ISO 9001, ISO 14001 and ISO 45001. The synergy was determined considering the same aspects of the synergy analysis between CEs and IMS presented previously.

4.3.1 Sinergy between ISO 9001 and CE clusters

The "Solid Waste" cluster has low synergy with the ISO 9001 standard. The synergy found is associated with the benefits of certification, and a study was conducted in pharmaceutical companies to assess which of the standards (quality, environmental, and health, and safety) brings greater benefits for the company (Massoud et al. 2015). Regarding the direct relationship, ISO 9001 was used to support the application of tools such as the balanced scorecard (BSC) and Total Quality Management (TQM) (Mendes et al. 2013). In the most current version, a study was identified focusing on item 6.1 of the standard (Risk-Based Thinking) to identify the risks and opportunities of waste management practice (Rodzi, Nopiah, and Basri 2019). The "Ecology" cluster has low synergy with the ISO 9001 standard, and no article was identified to address both topics. The "Energy" cluster has significant synergy with the ISO 9001 standard, being related to the infrastructure requirements with the use of energy, seeking its optimization of consumption (Souza and Alves 2018; Teixeira et al. 2016), the standard also served as a basis for the development of performance indicators for energy consumption (Taher-Ghahremani and Omidvari 2018; Teixeira et al. 2016). Empirical research was conducted to compare the sustainable performance of certified and non-certified companies, and it was identified that companies with certifications have a better sustainable performance than those without (Nadae, Carvalho, and Vieira 2019). Amongst them, in a study conducted by Martínez-Perales et al. (2018), he evaluates the relationship of ISO 9001 with the sustainability parameters and does not establish a relationship with energy management. The "Society" cluster has significant synergy with the ISO 9001 standard, being studied the relationship with Corporate Social Responsibility (CRS) (Cagnina et al. 2019; Mijatovic, Maricic, and Horvat 2019). Besides, it is developed as one of the pillars of sustainable development (Bernardo et al. 2017), still, on sustainability, a matrix of maturity and indicators was developed to measure sustainable social development (Bastas and Liyanage 2019).

4.3.2 Sinergy between ISO 14001 and CE clusters

The "Solid Waste" cluster has significant synergy with the ISO 14001 standard, being carried out a study of the influence of the standard on solid waste generation (Franchetti 2011; Zobel 2015), assisting in the strategic elaboration for waste management (Zorpas 2020) and providing support for life cycle analysis and promoting Risk-Based-Thinking (Kauppila, Härkönen, and Väyrynen 2015). The standard also assists in the development of indicators for monitoring and control of waste produced (Mendes et al., 2013). The "Ecology" cluster has significant synergy with the ISO 14001 standard, is directly related to the product life cycle, control measures, and the search for a cleaner and self-sufficient production (Ljungberg 2007; Salim et al. 2018; Santos-Reyes and Lawlor-Wright 2001). This standard is aligned with the Eco-Management and Audit Scheme (EMAS) helping sustainable development (Zobel; Burman, 2002). The "Energy" cluster has significant synergy with the ISO 14001 standard, aiming at a cleaner production, used from renewable energy sources, seeking increased energy efficiency and sustainable development (Souza and Alves 2018; Zorpas 2020). Besides, it creates indicators for monitoring and controlling energy consumption (Merli and Preziosi 2018; Zorpas 2020). It also helps companies establish energy management practices (EMP) (Cristino, Faria Neto, and Costa 2018). The "Society" cluster has significant synergy with the ISO 14001 standard, being observed through the formulation of a sustainable development strategy, acting on the environmental and social pillars, making the organization leaner and meeting the demand of stakeholders (Bernardo et al., 2017; Merli; Preziosi, 2018). The standard also promotes an analysis of the impact of the company's activities on society (Zorpas, 2020), through cleaner production without exceeding the capacity of ecosystems (Garza-Reyes et al. 2018; Merli and Preziosi 2018).

4.3.3 Sinergy between ISO 45001 and CE clusters

The CE clusters do not present synergies in the literature with the ISO 45001 standard, as it was not possible to identify any article that would address both topics under the criteria of this study. One hypothesis for this may be that the ISO 45001 standards are recent. It was decided not to use OHSAS 18001 (previous version of ISO 45001), due to the possibility of inconsistency between the two standards and this impact on the findings.

5. Conclusion

This article achieved the objective of analyzing the clusters of the CE and IMS in a cross-over manner, observing the main synergies between the two themes. The theoretical contribution of this research was to identify the scenario of publications that bring the CE and IMS closer together, enabling the more efficient development of Circular Economy and a more sustainability-oriented application of Integrated Management Systems. The applied contribution was the availability of strategies that can be incorporated into the management of organizations with socio-environmental and profitability goals or that seek to improve their relationships with their stakeholders. As a suggestion for future studies, case studies are recommended in organizations that have an Integrated Information System and that carry out processes related to Circular Economy.

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