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sustainability

Review

Challenges Presented in the Implementation of Sustainable Energy Management via ISO 50001:2011

Izabela Simon Rampasso [1,2], Geraldo Pereira Melo Filho [2], Rosley Anholon [2], Robson Amarante de Araujo [1], Gilson Brito Alves Lima [1], Luis Perez Zotes [1] and Walter Leal Filho [3,4,*]

1 Laboratory of Technology, Business and Environment Management, Federal Fluminense University, Passo da Pátria Street, 156. Niterói, CEP-24020-971, Brazil; izarampasso@gmail.com (I.S.R.); robsonadea@gmail.com (R.A.d.A.); glima@id.uff.br (G.B.A.L.); lpzotes@gmail.com (L.P.Z.)
2 School of Mechanical Engineering, University of Campinas, Mendeleyev Street, 200 Campinas, CEP-13083-860, Brazil; geraldo.melo.f@gmail.com (G.P.M.F.); rosley@fem.unicamp.br (R.A.)
3 Research and Transfer Centre “Sustainable Development and Climate Change Management”, Hamburg University of Applied Sciences, Ulmenliet 20, D-21033 Hamburg, Germany
4 School of Science and the Environment, Manchester Metropolitan University, Manchester M1 5GD, UK
* Correspondence: walter.leal2@haw-hamburg.de

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Abstract: Considering the importance of ISO 50001 in sustainable development, the objective of this research is to identify the challenges found by organizations during the implementation of ISO 50001:2011, according to the literature. To address this objective, a systematic search was conducted. Scientific papers from the following international databases were used: Science Direct, Emerald Insight, Scopus, Springer, Wiley, and Taylor and Francis. Permutations of the terms “ISO 50001” and “Challenges”, “Barriers”, “Lacks”, “Gaps”, “Obstacles”, “Problems”, and “Limitations” were searched. Following this strategy, 206 documents were found. After removing book chapters, articles from proceedings, duplicate articles, and articles that did not mention any challenge related to ISO 50001, 17 articles were left. Eleven challenges were found in these articles. The most cited challenges were: “Lack of Resources-Limitations (HR, Technologies, Infrastructure, Financial, Time)”, “Difficulty to determine the energy baseline and energy performance indicators”, “Human Resources deficiencies (competences, knowledges, and abilities)”, and “Lack of management support and/or commitment”. The challenges most cited shows the need for better planning before implementation as well as a comprehensive analysis of the organization’s requirements and features. The findings of this research show that this theme is still underexplored. The results presented can contribute to future industrial policies to potentialize countries’ economies.

Keywords: sustainable energy; ISO 50001:2011; implementation; barriers; obstacles

1. Introduction

Sustainability requires that the activities of the current generation do not hinder the capacity of future generations to satisfy their own needs [1–3]. Considering this issue, the United Nations [4,5] released in 2015 the 2030 Agenda for Sustainable Development, in which 17 Sustainable Development Goals (SDGs) were established to guide countries in the search for sustainable development. Among them, the seventh goal focuses on energy issues: “Ensure access to affordable, reliable, sustainable, and modern energy for all”. That is, a whole goal is dedicated to energy, and targets were established to meet the goal [4]. Table 1 shows these targets and their indicators.

Table 1. Targets and indicators of the Seventh Goal. Source: Adapted from [4].

Targets of the Seventh Goal	Indicators of the Targets
7.1 "By 2030, ensure universal access to affordable, reliable and modern energy services".	7.1.1 "Proportion of population with access to electricity". 7.1.2 "Proportion of population with primary reliance on clean fuels and technology".
7.2 "By 2030, increase substantially the share of renewable energy in the global energy mix".	7.2.1 "Renewable energy share in the total final energy consumption".
7.3 "By 2030, double the global rate of improvement in energy efficiency".	7.3.1 "Energy intensity measured in terms of primary energy and GDP".
7.a "By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency, and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology".	7.a.1 "International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems".
7.b "By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular, least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support".	7.b.1 "Investments in energy efficiency as a proportion of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to sustainable development services".

As can be seen in these targets, the costs associated with energy generation and security are also objects of concern. Therefore, energy efficiency has increasingly been a focus of governments and researchers [6]. An important avenue in which governments can support renewable energy is through public policies. The importance of public policies is highlighted by Marques et al. [7]. According to the authors, they are an important means to overcome market failures. This is because the negative environmental impacts generated by using fossil fuels as energy sources are not entirely transformed into costs, which means that the benefits generated by changing to renewable sources of energy are not completely observed in monetary gains in the market. Another important contribution of public policies is mentioned by Surana and Anadon [8]. The authors pointed out the role of public policies in minimizing risks associated with investments in renewable energy.

There are several mechanisms of public policies to stimulate investments in renewable energy. These mechanisms include fiscal and financial incentives through grants and subsidies, influence on prices, loans from the government to the private sector, and direct investments from the government. Additionally, incentives based on market mechanisms can also be used, which enables the commercialization of renewable energy certificates. The prevalence of laws and regulations is another important feature that stimulates this kind of investment. In the same line of reasoning, regulatory measures that obligate companies to invest in renewable energies may have a positive impact too [9].

Another important factor in developing renewable energy is technological innovation [10–12]. Yang et al. [11] pointed out the prevalence of technological innovation to stimulate industrial improvements and, consequently, increase energy efficiency and reduce pollution generated. Santra [13] also observed the benefits of increasing energy productivity and reducing energy consumption, which was enabled by technological innovations. In addition to technological innovation, energy management can also contribute to increasing energy efficiency [14].

In this same line of reasoning, António da Silva Gonçalves and Mil-Homens dos Santos [15] highlight the impact of energy production in sustainable development, and the role of energy management to increase energy efficiency. The concern about energy is increasingly important, especially due to the expansion of energy use and the impact it has on institutions, and on the environment [15–19].

In the last thirty years, the consumption of energy increased by more than 50% [20]. In some countries, this expansion was even greater. In the Middle East, between 1990 and 2008, it increased by 170%; in India, it rose by 91% [21]. Energy is an essential component of practically every product and service created and negotiated [6]. Since the first industrial revolution, the use of energy has grown significantly. The replacement of handwork by machines has enabled the manufacturing sector to dictate the pace of economic growth, and the use of energy played an essential role in this [22]. Currently, considering only the industrial and commercial sectors, energy use is responsible for almost 40% of greenhouse gas emissions [23]. The industrial sector alone is responsible for more than 50% of energy use [24]. However, the impact of energy use in production systems historically was not considered in studies on economic growth [25], but energy efficiency and use, and their positive impact on economic growth have been gaining attention in recent years [6,10]. Additionally, energy issues are a relevant source of environmental concern [6,19,23,26]. The use of non-renewable sources of energy has serious consequences for the environment and society. This is especially worrying, considering that non-renewable sources are still the main source of energy generation worldwide [17,23].

There is a clear relationship between energy use and climate change, being that the energy sector is responsible for almost 60% of the greenhouse gas emissions generated by society [20]. In addition to climate change, fossil fuels are a finite resource, imposing an inevitable end to their availability [10]. Thus, clean energy is sought to reduce environmental damage through the use of renewable sources of energy. These renewable sources replace fossil fuels in energy generation, helping to reduce the negative impact on the environment. Among these renewable energies, it can be seen that wind and solar energy are cited as the most commonly used [27,28], but hydropower is an important source of renewable energy as well, being the largest generator of electricity in the world. In addition to presenting an advanced technological development, hydropower presents many benefits [29,30].

In this sense, energy management systems are important in their ability to support organizations seeking to increase energy efficiency and minimize their negative environmental impact [17,31,32]. In this context, the standard ISO 50001 performs an important role in guiding organizations to implement an energy management system [15,22]. Presenting a structure increasingly similar to the others ISO (International Organization for Standardization) standards, the integration of ISO 50001 with them is facilitated [33]. Despite its importance, Marimon and Casadesús [32] called attention to the lack of researches about ISO 50001; and de Sousa Jabbour et al. [34] highlighted the need for research to identify the challenges related to ISO 50001 adoption for supply chains. However, the current literature fails in providing a study regarding the challenges associated with ISO 50001 in general. In this sense, the objective of this research is to identify the challenges found by organizations during the implementation of ISO 50001:2011, according to the literature, the research question proposed was: What are the challenges presented in the literature regarding the implementation of ISO 50001:2011? To answer this question, a systematic search was conducted.

For this, the present article was developed in five sections. In addition to this introduction, there is a section dedicated to the theoretical background. The third section details the methodological procedures used to conduct this research. In Section 4, the results are presented. Section 5 is dedicated to conclusions, limitations, and future research indications.

2. Theoretical Background

2.1. Energy Management System and ISO 50001

Energy management aims to reduce energy costs through enhancing energy efficiency, using technologies, as well as promoting activities and management procedures to reach this efficiency [14]. While energy conservation means a reduction in energy use, to increase energy efficiency requires a more optimized use of energy, that is, to be able to use less energy to perform the same activities [17].

The international standard that provides guidelines for the implementation of energy management systems is ISO 50001 [15]. First published in 2011, and currently in its second edition (published in

2018), ISO 50001 is an energy management system focused on continuous improvement, and it is based on a PDCA (Plan–Do–Check–Act) cycle. It aims to enable companies to continuously improve their energetic performance and energy management system through a systematic path. The standard does not establish specific criteria; it is up to organizations to evaluate them according to their conditions [35].

ISO 50001:2018 is divided into 10 sections: 1. Scope, 2. Normative references, 3. Terms and definitions, 4. Context of the organization, 5. Leadership, 6. Planning, 7. Support, 8. Operation, 9. Performance Evaluation, and 10. Improvement. In the first section, the standard coverage is presented; it states that it can be applied to organizations of any size, from any sector and localization. As highlighted above, in this section, it is stated that ISO 50001 focuses on the continuous improvement in energetic performance and energy management systems. In the second section, no normative references are presented. The third section aims to define terms relevant for people to understand the standard's text. The fourth section—a new section following the version delivered in 2011—requires that the organization properly characterize itself and its stakeholders in relation to its energetic performance and energy management system. In the fifth section, the need for top management commitment to the energy management system is emphasized, as well as the need for top management to establish the energetical policy and properly designate the employees' roles and responsibilities. The next section presents the requirement of the organization to plan for risks and opportunities for them to reach their goals related to energetic performance and energy management systems. The risks and opportunities assessment is new in this version. The need for an energetical review, performance indicators, energetical baseline, and a plan for energetical data collection are also mentioned in this section. In section seven, all the support required for the energy management system is outlined, from the resources and attributed competencies/roles to communication and documented information. Operational planning and control related to energy consumption, as well as projects and acquisitions, are placed in section eight. Section nine is dedicated to performance evaluation, regarding energetic performance and energy management systems. Monitoring, analysis, evaluation, internal auditing, and top management critical evaluation are considered in this section as well. Finally, the tenth section is dedicated to corrections and continuous improvement. This section is also new in the 2018 version [35].

As a result of its implementation, besides the support provided to reduce the energy consumption of the company, ISO 50001 also enables better cost management and greenhouse gas emission reduction. These advantages have been leading companies worldwide to adopt the standard. Additionally, national, local, and global policies have been established to encourage the adoption of it [23].

ISO 50001 does have areas that require improvements. António da Silva Gonçalves and Mil-Homens dos Santos [15] analyzed the effectiveness of ISO 50001 through a literature review and a survey with experts. These authors aimed to identify improvement opportunities of the standard. As a result, they pointed out four gaps in ISO 50001, and proposed improvements to overcome these gaps. The gaps were: "Strategic energy risk management", "Developments in energy efficiency technology", "Follow up of energy efficiency development techniques", "Reduction of environmental impacts related to the use of energy". The improvements recommended by the authors focused on filling these gaps. They were all validated by the experts.

Despite gaps in the standard, the reasons behind why companies are implementing it are investigated in the literature and research on this was published by Sousa Lira et al. [17]. The objective of their study was to understand why organizations adopt ISO 50001 and how this process has progressed. They observed that Europe is the region with most certifications, with emphasis on Germany and the United Kingdom; Asia is rising in the number of certifications faster than other regions, and China is the highlight. According to the authors, the concern for the environment, especially climate change, is the main reason for the adoption of the standard. The search for higher customer acceptance, and to reduce costs associated with energy, are also important reasons for the implementation of ISO 50001. Another interesting finding is that ISO 9001 and ISO 14001 are usually adopted before the implementation of ISO 50001.

This is especially interesting considering that ISO standards have been present since 2012 with similar structures. This is due to the Annex SL published by the organization. This document determined that management system standards of ISO must present the same high-level structure. The objective of it was to facilitate the integration of different management systems [36].

Another important aspect to analyze is the factors that facilitate the successful implementation of ISO 50001. Karcher and Jochem [37] analyzed the factors that enabled successful implementation of ISO 50001. According to the authors, government support is an important factor to stimulate companies to adopt the standard. Additionally, they found that the integration of ISO 50001 with companies' management system was not a problem for most of the organizations they reviewed. The authors also highlighted the importance of internal training for employees to facilitate the implementation of the standard; clearly establishing the responsibilities for an adequate integration of the standard; training workers to accelerate the certification process; a regular comparison between targets and real performance to keep the costs lower; and legal provisions to enhance audit processes, among others.

After implementing ISO 50001, organizations must be aware of the maturity level of their energy system. In this sense, Jovanović and Filipović [31] developed a maturity model to evaluate the ISO 50001 implementation and showed examples of successful implementations of the standard. Through the validation of their maturity model, applying it in companies certified and non-certified, the authors found that although the maturity of certified companies varies, organizations with ISO 50001 certification presented results more consistently than non-certified companies.

2.2. Integrated Management Systems with ISO 50001 and Other ISO Standards

ISO 50001 is a standard published by the International Organization for Standardization. In addition to energy management systems, ISO standards also focus on quality management systems (ISO 9001), environmental management systems (ISO 14001), Occupational health and safety management systems (ISO 45001 based on OHSAS 18001), risks management systems (ISO 31000), among other general and sectorial standards [38]. Since several organizations implemented at least two standards, ISO has been changing its standards to approximate them. A relevant milestone for this was Annex SL, published in 2012 to homogenize the high-level structure of its standards and facilitate integrated management systems [39–41]. The benefits generated in companies by the implementation of these standards are highlighted in the literature [42,43]. Among them, ISO 9001 and ISO 14001 has been received much attention, since they are the most implemented ISO standards in the world [44–46]. These two standards are also the most commonly integrated, too [47].

Focusing on ISO 50001, some studies consider its integration with other ISO standards. Indeed, Durakbasa [33] highlights that the similar structure of ISO 50001 with ISO 9001 and ISO 14001 facilitates the integration of them. Despite the relevance of ISO 50001, few studies consider it in an integrated management system. In the literature review performed by Dahlin and Isaksson [48], no article considered ISO 50001. Although scarce, there is some research addressing the integration of this standard with other ISO standards. According to Laskurain et al. [49], although the complementary role of energy management to environmental management has been known for a long time, the integration between ISO 50001 and ISO 14001 is little explored by the literature. The authors analyzed eight companies with both certificates and verified that ISO 50001 benefits companies that implement it after ISO 14001.

Escorcia et al. [50] analyzed the common points of ISO 9001:2015, OHSAS 18001:2007, ISO 14001:2015, and ISO 50001:2011 for an integrated management system. The authors verify that there is a synergy among the standards that enable integration and conclude that companies that make this integration can gain competitive advantages. Klute-Wenig and Refflinghaus [51] developed an Excel-tool integrated management system. This tool is applied in the so-called sustainable risk management, which integrates ISO 9001 (for quality management), OHSAS 18001 (for work safety management management), ISO 26000 (for social responsibility management), SA 8000 (for social sustainability management), ISO 50001 (for energy management), ISO 14001 (for environmental management), and ISO 31000 (for risk management). In Teixeira et al. [52], a performance indicator matrix was developed to evaluate energy costs and consumption as well as CO_2 emissions of water services. The matrix was based on integrated management systems activities (ISO 9001, ISO 14001, and ISO 50001). To validate the developed matrix, a case study was conducted to evaluate it in a Portuguese city.

3. Method

To carry out a systematic literature review to provide a synthesis of the difficulties associated with the implementation of ISO 50001: 2011, the following methodology was performed: a search following a strict protocol and a rigorous approach (to minimize the risk of bias) also providing a replicable study. For this, we followed the systematic literature review methodological procedures presented in Figure 1.

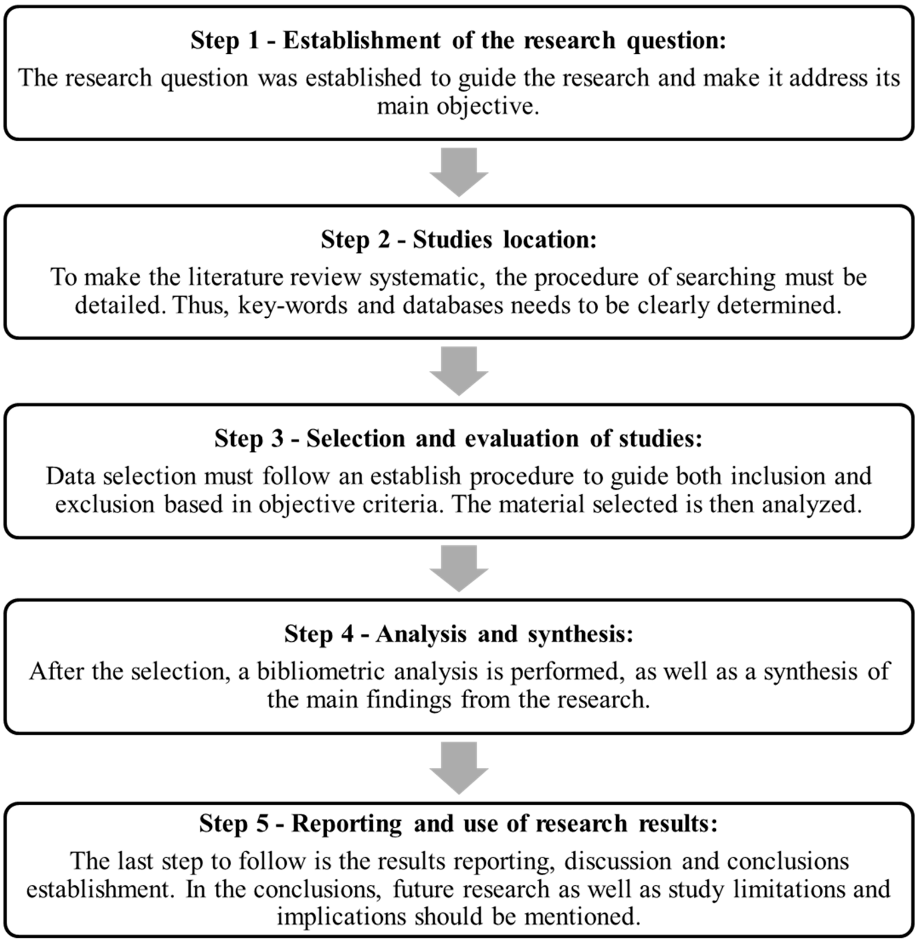

Figure 1. Methodological procedures flowchart. Source: Adapted from [52–54].

Following the procedures presented in Figure 1, the establishment of the research question was the first step taken. Since the objective of this research was to identify the challenges found by organizations during the implementation of ISO 50001:2011, according to the literature, the research question proposed was: What are the challenges presented in the literature regarding the implementation of ISO 50001:2011? To answer this question, a systematic search was conducted. Scientific papers were searched on the following international databases: Science Direct, Emerald Insight, Scopus, Springer, Wiley, and Taylor and Francis. The articles were searched for using the following terms in the abstract field: "ISO 50001". Additionally, the words "Challenges", "Barriers", "Lacks", "Gaps", "Obstacles", "Problems", and "Limitations" were searched in any part of the texts. The period of this search was from 25 July 2019 to 22 September 2019. It is also important to highlight that the focus on ISO 50001 was defined to eliminate possible problems due to the specificities of different energy management systems. The selection of ISO 50001 was based on the relevance and coverage of it worldwide.

Following this strategy, 206 documents were found. After deleting book chapters, articles from proceedings, duplicate articles, and articles that did not mention any challenge related to ISO 50001, 17 articles were left. An important restriction made in the search was to only consider challenges that were clearly related to ISO 50001 in this study. The reason for this was to ensure that all the challenges listed were regarding the mentioned standard, and were not from any other energy management system. In this sense, the fact that only 17 articles left from the 206 documents initially encountered is already an important result, it shows the lack of peer-reviewed and published research on this issue. This first finding also helps to confirm the necessity of more studies in this underexplored topic, which should receive more interest from both researchers and journals. The next section presents the main findings of this research.

4. Results

From the 17 selected articles, it was possible to perform the analysis presented in the results section. The challenges could be observed before, during, and/or after the implementation of the ISO 50001. The distribution of publication years is presented in Figure 2. Although no restriction regarding the year of publication has been done, no articles were found before 2012. This was expected since ISO 50001 was first published in 2011. The years 2015 and 2017 presented the highest number of articles (five articles in each year).

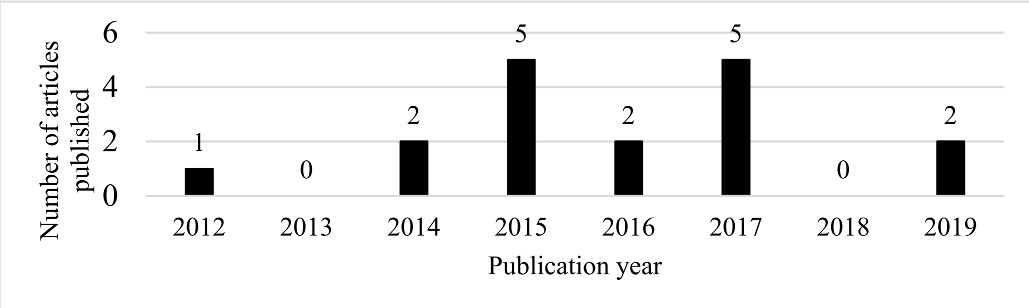

Figure 2. Chronological distribution of the analyzed articles (Source: Authors).

Table 2 shows the data from the selected articles.

Table 2. Challenges related to ISO 50001:2011 implementation (Source: vide Table).

Challenges	References	Portion of References
Lack of Resources–Limitations (HR, Technologies, Infrastructure, Financial, Time)	[31,33,55–61]	9/17
Difficulty in determining the energy baseline and energy performance indicators	[31,55,61–64]	6/17
Human Resources deficiencies (competences, knowledges, and abilities)	[32,37,57,63]	4/17
Lack of management support and/or commitment	[22,57,62]	3/17
Lack of clear policies (organizational or governmental)	[23,62]	2/17
Difficulty with properly evaluating the benefits generated by the adoption of ISO 50001	[23,65]	2/17
Difficulty with fully reaching the energy and carbon efficiency enabled by ISO 50001	[34]	1/17
Barrier in the acquisition of external consultants	[37]	1/17
Difficulty in managing third-party international certifications	[61]	1/17
Lack of proper management of documentation	[63]	1/17
Difficulty in maintaining the certification	[66]	1/17

Analyzing Table 2, it can be seen that the challenge most cited in the research was "Lack of Resources–Limitations (HR, Technologies, Infrastructure, Financial, Time)". It was cited by 52.94% of the articles. This is a relevant item, especially when the resource requirements forthe implementation of ISO 50001 are considered. Among these costs, Siciliano et al. [56] highlighted those associated with the time spent by a company's employees to perform the implementation. Păunescu and Blid [57] also addressed this issue, mentioning the challenges employees face when having to balance their time between activities related to the implementation, and their primary activities. However, the challenges related to the lack of resources are not limited to employees. The financial resources needed to implement ISO 50001 were also pointed out as a relevant issue [34,58]. Menghi et al. [60] highlighted the greater challenge small and medium enterprises face due to their restrictions of employees, time, and financial resources. The technical aspect was also present in this challenge. In addition to technical expertise, the technologies that enable the insertion, or facilitate the management of ISO 50001, are a barrier for many companies [32,34,59,61]. An example of this is the automated system to measure energy consumption in real-time [32]. The need for a user-friendly framework to support the implementation of ISO 50001 through software was mentioned by Gopalakrishnan et al. [59].

The second challenge with the highest number of citations (35.29%) was "Difficulty with determining the energy baseline and energy performance indicators". This is due to the need for measuring and evaluating complex data, with several processes interacting with each other within the companies [32]. This interaction is challenging for the measurement of energy performance in single processes [63]. Additionally, the lack of requirements regarding companies' performance hinders them in their ability to understand how good or bad they are [64]. The establishment of energy consumption features is challenging for companies [61].

The next challenge listed was "Human Resource deficiencies (competences, knowledge, and abilities)", which was present in 23.53% of the articles. The current literature fails in guiding companies regarding team composition, as well as the abilities required for a successful implementation of energy management systems [37]. Păunescu and Blid [57] highlighted the need to change the mentality of managers and other workers regarding the importance of investing in training, technologies, and resources. Marimon and Casadesús [32] also emphasized the need to make people understand the real impact of the standard in the organization. In addition, workers must know the company's energy policy and properly understand the energy profile. However, the dissemination of this kind of knowledge remains a challenge for many organizations [63].

The "Lack of management support and/or commitment" was mentioned by three articles. Păunescu and Blid [57] highlighted the need to make managers understand that investments in technologies, resources, and training must be done. Jovanović et al. [63] mentioned that although it is a small percentage, there are top managers in Serbia that are not committed to energy management. This is especially worrying since the lack of support from top management hinders the implementation of an energy management system. According to Kanneganti et al. [22], when the implementation happens without managers' commitment, the savings expected with the increase in energy efficiency do not occur as planned.

The "Lack of clear policies (organizational or governmental)" was present in two articles. Du Plessis [62] explored the relationships between energy-efficiency policies, laws, and ISO 50001. The authors highlight the need to use a multidisciplinary approach to insert measures related to energy-efficiency into legislation. Due to the difficulty in establishing legal measures, a policy framework is required. In this same line of reasoning, McKane et al. [23] mentioned that policymakers need to know how to measure energy savings proportioned by ISO 50001.

Pham [65] and McKane et al. [23] cited the challenge "Difficulty in properly evaluating the benefits generated by ISO 50001 adoption". For Pham [65], there was not sufficient foundation to affirm that the market value of the companies increases with ISO 50001 implementation. According to McKane et al. [22], the complexity of measuring CO2 and energy savings due to ISO 50001 adoption is another important challenge to be faced by organizations.

The challenges "Difficulty to fully reach energy and carbon efficiency enabled by ISO 50001", "Barrier in the acquisition of external consultants", "Difficulty in managing third-party international certifications", "Lack of a proper management of documentation", and "Difficulty in maintaining the certification" were cited by a single research study each one. According to De Sousa Jabbour et al. [34], ISO 50001 focuses on energy and carbon efficiency. However, to reach the full potential of it remains a challenge. One way to overcome the employees' lack of knowledge is through the use of external consultants. According to a survey performed by Karcher and Jochem [37], most companies use external consultants after the certification, while less than half of them use this kind of service before and during the certification. Majerník et al. [61] highlighted the challenge faced by companies in managing third-party certification of ISO 50001. Regarding documentation, Jovanović et al. [63] mentioned that there are two kinds of documentation: one presenting the manner in which activities should be performed and the other proving that the activities were conducted. Both kinds of documentation are important, but they have not been implemented by many organizations, as shown by Jovanović et al. [63] in their study of Serbian companies.

5. Conclusions

All of these items are addressed in ISO 50001 in both versions: 2011 and 2018 [34]. However, companies are facing difficulties in properly addressing these issues. The fact that ISO 50001 does not present how companies should perform each item may contribute to this challenge, but organizations need to deeply analyze their realities to correctly plan the standard implementation. This analysis takes time and requires persistence to reduce the challenges during implementation. In this sense, policymakers may have an important role in supporting organizations. Thus, the results presented can contribute to structure industrial policies to potentialize countries' economies.

In terms of the limitations of this study, the databases and keywords used could have hindered this research. However, it should be noted that the databases used were selected based on their international merit; and the keywords used were carefully selected considering the synonym possibilities. Additionally, the lack of similar studies is another item to highlight. In this extensive systematic literature review, only 17 articles were within the scope of the research; that is, only these articles cited challenges explicitly related to ISO 50001. These findings are important as they show the need for more studies reporting experiences of ISO 50001 implementation in organizations from different sectors and from different countries. This dearth in the literature can be partially explained by the standards first publication. While ISO 90001 was first published in 1987 [67,68], ISO 50001 was published for the first time in 2011 [17]. However, research on ISO 50001 is still required for a better understanding of its implications and consequences.

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