http://dx.doi.org/10.24212/2179-3565.2018v9i3p38-52

RISUS - Journal on Innovation and Sustainability
volume 9, número 3 - 2018
ISSN: 2179-3565
Editor Científico: Arnoldo José de Hoyos Guevara
Editora Assistente: Lívia Lopes Aguiar
Avaliação: Melhores práticas editoriais da ANPAD

SUSTAINABILITY INDICATORS IN INDUSTRIES: A BIBLIOMETRIC REVIEW

Indicadores de Sustentabilidade em Indústrias: Uma Revisão Bibliométrica

Bianca Carina Valente, Syntia Lemos Cotrim, Ana Carla Gasquez , Gislaine Camila Lapasini Leal, Edwin Vladimir Cardoza Galdamez
State University of Maringá, Brazil
E-mail: biancacvalente1995@gmail.com, slcotrim2@uem.br, acgasquez2@uem.br, gclleal@uem.br, evcgaldamez@uem.br

Abstract: Sustainable development gained prominence in 1992 at the United Nations Conference about Environment and Development, and was presented as a global strategy to ensure society's access to natural resources. One proposed practice to monitor industrial performance is sustainability indicators, commonly divided into three dimensions: environmental, social and economic. The objective of this work is to present a bibliometric study on the scientific production of Sustainability Indicators (SI) in the Industries, from January 2007 to October 2017. Therefore, the methodology used was Proknow-C, with quantitative and qualitative approach, from the keywords: "Sustainability Indicators" and "Indicators of Sustainability" in the database provided by the Scopus platform. The papers selected for the composition of the final portfolio contribute to the construction of knowledge about the proposed theme, offering a broad view of Sustainability Indicators applied to industries. A total of 28 sustainability indicators were identified, of which 11 are related to the environmental dimension, which correspond to three aspects (water, energy and gases emitted), 7 in the economic dimension, framed in two aspects (present value in the plant and investment) and 10 in the social dimension, corresponding to the aspects of accidents, comfort / safety and training. The survey of the Sustainability Indicators allows establishing guidelines for the construction of a management system aligned with the sustainability dimensions in the industries.
Key words: Sustainability Indicators; ProKnow-C; Sustainable Industry

Recebido em: 24/04/2018 Aceito em: 01/09/2018
http://dx.doi.org/10.24212/2179-3565.2018v9i3p38-52

RISUS - Journal on Innovation and Sustainability
volume 9, número 3 - 2018
ISSN: 2179-3565
Editor Científico: Arnoldo José de Hoyos Guevara
Editora Assistente: Lívia Lopes Aguiar
Avaliação: Melhores práticas editoriais da ANPAD

SUSTAINABILITY INDICATORS IN INDUSTRIES: A BIBLIOMETRIC REVIEW

Indicadores De Sustentabilidade Em Industrias: Uma Revisão Bibliométrica

Bianca Carina Valente, Syntia Lemos Cotrim, Ana Carla Gasquez , Gislaine Camila Lapasini Leal, Edwin Vladimir Cardoza Galdamez
State University of Maringá, Brazil
E-mail: biancacvalente1995@gmail.com, slcotrim2@uem.br, acgasquez2@uem.br, gclleal@uem.br, evcgaldamez@uem.br

Resumo: O desenvolvimento sustentável ganhou destaque em 1992, na Conferência das Nações Unidas sobre Meio Ambiente e Desenvolvimento, e foi apresentado como uma estratégia global para garantir o acesso da sociedade aos recursos naturais. Uma prática proposta para monitorar o desempenho industrial são os indicadores de sustentabilidade, comumente divididos em três dimensões: ambiental, social e econômica. O objetivo deste trabalho é apresentar um estudo bibliométrico sobre a produção científica de Indicadores de Sustentabilidade (SI) nas Indústrias, no período de janeiro de 2007 a outubro de 2017. A metodologia utilizada foi a Proknow-C, com abordagem quantitativa e qualitativa, a partir do palavras-chave: "Indicadores de Sustentabilidade" e "Indicadores de Sustentabilidade" no banco de dados fornecido pela plataforma Scopus. Os trabalhos selecionados para a composição do portfólio final contribuem para a construção do conhecimento sobre o tema proposto, oferecendo uma visão ampla dos Indicadores de Sustentabilidade aplicados às indústrias. Um total de 28 indicadores de sustentabilidade foram identificados, dos quais 11 estão relacionados à dimensão ambiental, que correspondem a três aspectos (água, energia e gases emitidos), 7 na dimensão econômica, enquadrados em dois aspectos (valor presente na planat e investimento) e 10 na dimensão social, correspondendo aos aspectos de acidentes, conforto / segurança e formação. O levantamento dos Indicadores de Sustentabilidade permite estabelecer diretrizes para a construção de um sistema de gestão alinhado às dimensões de sustentabilidade nas indústrias.
Palavras-chave: Indicadores de Sustentabilidade; ProKnow-C; Industrias Sustentáveis

Recebido em: 24/04/2018 Aceito em: 01/09/2018

INTRODUCTION

For ABNT NBR ISO 26000 (ABNT, 2010) it is fundamental for the performance of the organization to evaluate the impacts generated by the product and industrial operations in society and the environment. When industrial operations are carried out without control or evaluation, they can contribute to increase air pollution, contamination of water and soil, cause climate change, generate toxic waste, and other environmental impacts (Azevedo, 2006).

Sustainable development is becoming an increasingly important practice in industrial decisionmaking, since the impact of humans on the environment is becoming increasingly complex (Perlin et al., 2013). Social responsibility and consequently concern for sustainable development in a company directly interferes with its reputation, promotes competitive advantage in the market, and can improve its productivity, among other factors, as a reference to ABNT NBR ISO 26000 (ABNT, 2010).

Corporate management with the help of Sustainability Indicators has been fundamental for the monitoring of actions, measurement of company results, and guarantee of sustainable development, a fact that motivated this research. The Sustainability Indicators (SI) bring the company's compliance with standards, monitoring and evaluation of processes and the communication of performance (results) to the stakeholders, leading to greater credit to the company, as it demonstrates the concern with sustainability and ethics (ABNT, 2010). According to Padilha and Nascimento (2015), SI are parameters used to monitor and control activities, from the analysis of three dimensions: environmental, social and economic.

One of the difficulties in the business environment is to find SIs that are of greater relevance for the development, deployment and use of performance dimensions that portray a sustainable approach (Vilela, 2012). Thus, the objective of this work is to present a bibliometric study on Sustainability Indicators in Industries.

For Macedo, Roedel and Duarte (2010) the bibliometric revision can direct new research with greater precision, causing the researcher to make decisions with a smaller margin of error. The publication of scientific journals is one of the most used mechanisms for the dissemination of research results by researchers in the scientific community (Pizzani, Silva & Hayashi, 2008). The authors also state that "the greater the degree of visibility, the greater the chances of the researcher being read, evaluated and quoted."

Afonso et al. (2011) emphasize that the literature review is the first step to build knowledge about a theme; it makes possible to construct a research based on the resumption of knowledge accumulated by other available researches. According to the authors, it is extremely important that in the literature selection process, the researcher does not perform it in a random manner, since this type of research requires careful selection and methodological guidance (Afonso et al., 2011).

It is noticed in this context the importance of the bibliometric revision, which according to Macedo et al. (2010) allows the researcher to select and analyze existing intellectual knowledge to develop the proposed study. Bibliometric analysis aims to manage the information and scientific knowledge of a given subject by means of quantitative parameters analysis in a set of defined papers, known as bibliographic portfolio (Lacerda & Ensslin, 2012).

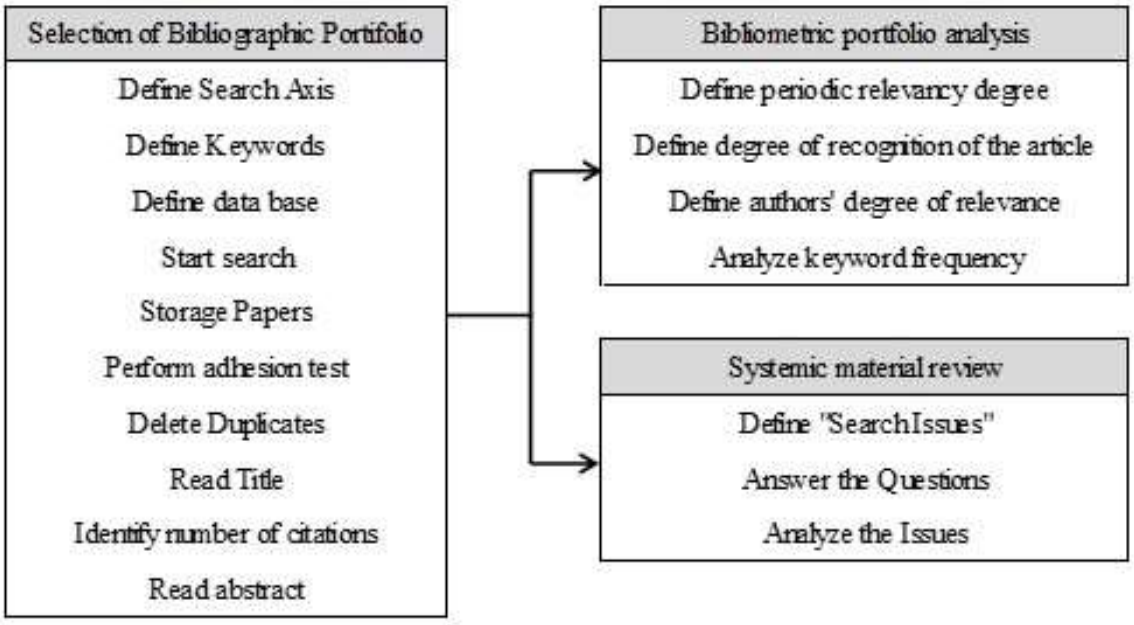
The ProKnow-C method can be proposed as a method of bibliometric revision due to the difficulty of selecting papers with scientific prestige to justify new research in a justified manner in the choice of its concepts (Vilela, 2012).

Next, in section 2 the research method adopted is highlighted. The results of the bibliometric review are presented below. Finally, the authors' final considerations are related.

RESEARCH METHOD

In order to carry out the structuring of the bibliographic research stages, a method called Knowledge Development Process (ProKnow-C) is used (Ensslin, et al., 2010). ProKnow-C consists of the following steps i) portfolio selection; ii) bibliometric analysis; iii) systemic revision, as shown in Figure 1, described below.

Figure 1 –ProKnow Research Method



Source: Adapted from Ensslin et al. (2010, p.21)

SELECTION OF THE BIBLIOGRAPHIC PORTFOLIO

The first phase was subdivided into two stages, where the first, of an exploratory nature with a quantitative approach, consisted in defining the search axis, its keywords, the database, the first search and storage of the papers found.

For this work, only one research axis was established: Sustainability Indicators. Next, as a criterion, it was decided to restrict the search by searching for the key words “Sustainability Indicators” and “Indicators of Sustainability” used only in the titles of scientific papers published between January 2007 and October 2017.

The next step was to choose the databases that would be used in the survey. The choice was made according to the experience of the authors and it was chosen to execute the research in the base Scopus. Scopus contains over 60 million records, including more than 21500 peer-reviewed journals, 130000 books, and 1100 book series containing more than 34,000 individual volumes.

Once the database was determined, the search for papers was carried out and these were stored composing the raw portfolio of the work. In this step, the Mendeley software was used to store and manage papers. According to Gil (2010), exploratory research is developed with the aim of providing an approximate overview of a given fact.

In the selection stage of the bibliographic portfolio, the test of adhesion of the keywords was carried out, where two stored papers were chosen randomly and verified if the keywords of the papers coincided with the search keywords. According to Ensslin (2010), the test has the purpose of verifying if there is a need to include new keywords in the search axis of the work. From this check, the repeated items from the gross portfolio were deleted. Then, the titles of all the papers were read and those that fall outside the Sustainability Indicators segment in industries were excluded.

After reading the titles of papers, the degree of academic relevance of the papers was identified, through the number of citations in Google Scholar. Once the citation numbers were defined, a cut-off point of 85% of the most representative papers was established, as recommended by the methodology. Moreover, the summary of the remaining papers was read.

Finally, the number of final papers was greatly reduced when compared to the initial gross portfolio, which enabled all papers to be read in full and evaluated in line with the research objective.

BIBLIOMETRIC ANALYSIS

In this phase, the quantification of the selected papers was emphasized. Firstly, the analysis of the

journal degree of relevance was carried out, identifying which periodical contained the highest number of publications among the papers selected and the Qualis classification.

Thereafter, the article degree of recognition was analyzed considering the number of citations of each article in the portfolio. Finally, the authors' degree of relevance was identified with the objective of finding out which journals have published the most and contributed most to this topic.

SYSTEMIC REVIEW OF MATERIAL

The last step of this work, classified as descriptive with a qualitative approach, was to identify, record and analyze the characteristics, factors or variables that are related to the phenomenon or process. In it, the "Research Questions" were defined, which guided the systemic review, answered the questions and analyzed the results generated by each one.

SELECTION OF THE BIBLIOGRAPHIC PORTFOLIO

After the quantitative approach search was carried out, a total of 384 papers were obtained, which compose the gross portfolio referring to the established research axis. After the definition phase of the research portfolio, the second phase of filtering the papers began. This started with the adhesion test. Thereunto, two papers were selected randomly and checked if the keywords were in line with the keywords of the research. For the test, the bibliographic references highlighted in Table 1 were selected.

Table 1: Adherence test

References	Keywords
Al-Sharrah, Elkamel & Almanssoor (2010)	*Multi agent simulation*
	Risk perception
	Sustainability indicators
	Lifestyles
	Policy intervention
	Climate chane risks
Garet *et al. (2012)*	*Boreal forest*
	Forest age structure
	Time since last disturbance
	Forest managemente plannnig
	Sustainability indicators
	Stand age

Source: Authors (2018)

After checking the adherence of the keywords with the search axis, duplicate papers were eliminated, resulting in 379 papers remaining. Due to the use of only one database there were few duplicate papers found. With the updated portfolio, it was possible to read the titles of the papers in order to exclude those that were not included in the application of Sustainability Indicators in industries.

Papers dealing with Sustainability Indicators focused on: agriculture, biological sciences, energy, medicine, urban engineering, forests, among others, were excluded. After this stage, there were 11 papers in the portfolio.

Then the degree of academic relevance was identified based on the number of citations that each article contained. Searching for papers in Google Scholar brought the results presented in Table 2.

Table 2: Distribution of papers by frequency of relative and accumulated citation

Title	Year	Number of citations	%	% Acumulated
Sustainability indicators for decision-making and optimisation in the process industry: The case of the petrochemical industry	2010	45	31%	31%
Defining sustainability indicators of iron and steel production	2013	32	22%	53%
Corporate Sustainability Indicators: An Australian Mining Case Study	2014	24	17%	70%
Process based approach to select key sustainability indicators for steel companies	2013	18	12%	82%
Evaluation of sustainability indicators of industrial buildings focused on petrochemical projects	2015	14	10%	92%
Integrating sustainability indicators and Lean Manufacturing to assess manufacturing processes: Application case studies in Brazilian industry	2017	7	5%	97%
Text mining-based categorization and user perspective analysis of environmental sustainability indicators for manufacturing and service systems	2010	3	2%	99%
Development of sustainability indicator scoring (SIS) for the food supply chain	2016	1	1%	99%
Evaluations of corporate sustainability indicators based on fuzzy similarity graphs	2017	1	1%	100%
Measuring an Organization's Performance: The Road to Defining Sustainability Indicators	2016	0	0%	100%
Sustainability indicators and the degree of internationalization of chemical companies producing thermoplastic resins	2011	0	0%	100%

Source: Authors (2018)

The cut-off point suggested by the Proknow-C method is 85%, however this value may vary according to the research and its authors. For this work, due to the low number of papers and citations of these, a cut-off points of 97% was defined for selection of representative papers, resulting in 6 papers for the next stage.

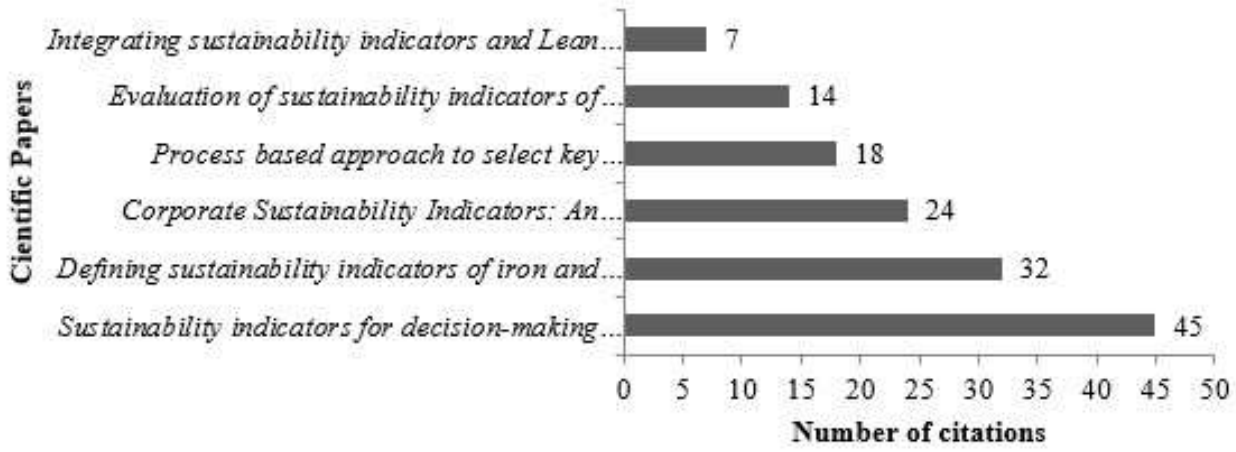
After analyzing the degree of academic relevance, the papers that were above the cut-off point had their summaries read for judgment as to the relevance of the article to the research axis. In this stage of reading the summaries all 6 papers were kept in the portfolio and judged relevant.

Completely read all the papers, the selection stage of the bibliographic portfolio was completed and then followed for the bibliometric analysis of the portfolio.

BIBLIOMETRIC ANALYSIS

This stage began with the analysis of the number of citations per article. Figure 2 highlights the number of citations from the remaining 6 papers in the portfolio, using Google Scholar as a source.

Figure 2: Number of citations per papers

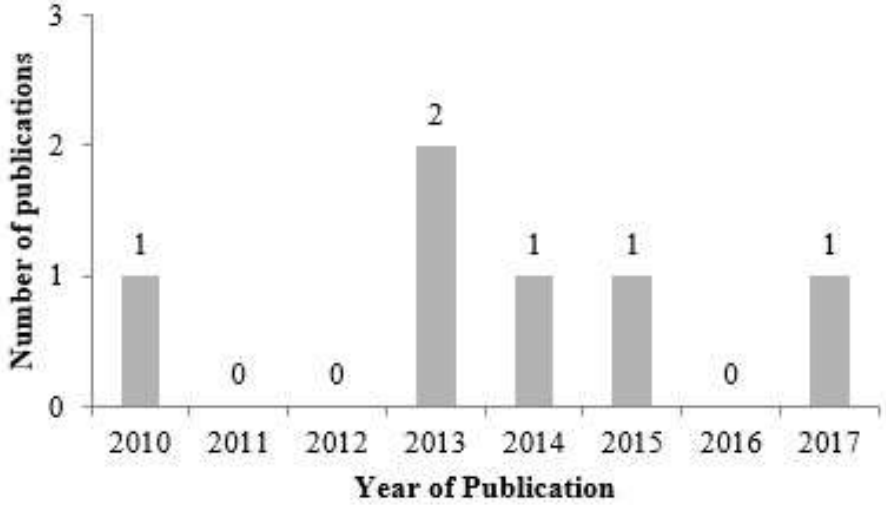


Source: Authors (2018)

The papers "Sustainability Indicators for Decision Making and Optimization in the Process Industry: The Case of the Petrochemical Industry" and "Defining Sustainability Indicators for Iron and Steel Production" were the papers with the largest number of citations, together making up more than half (77%) of the total citations of all papers in the portfolio. We also analyzed the cumulative percentage of citations, where 4 of the 6 papers represented 82% of all citations.

When analyzing the number of publications per year, it is observed that the number of publications on SI is constant and reduced in all years, with a maximum of two publications per year in 2013 (Figure 3). The reduced number indicates that the theme Sustainability Indicators focused on the industry segment is still little explored by the researchers, offering a large area for future research.

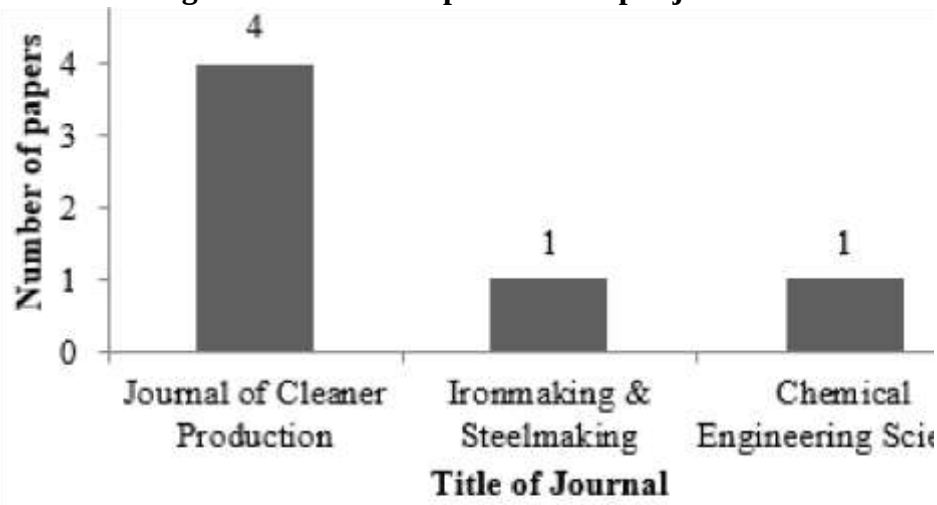
Figure 3: Number of publications per year



Source: Authors (2018)

After analyzing the list of publications per year, the list of publications with the journals found was identified (Figure 4). Among the journals, 2 have Qualis A1, they are: Journal of Cleaner Production and Chemical Engineering Science and 1 has Qualis B1: Ironmaking & Steelmaking.

Figure 4: Number of publications per journal



Source: Authors (2018)

The publication of papers by scientific journal showed that 66% was found in the Journal of Cleaner Production, 16.7% in Chemical Engineering Science and 16.7% in Ironmaking & Steelmaking as presented.

Of the selected papers that were available in English, complete and online in the selected platform, it is possible to notice that all have at least 2 authors, 3 being the largest number of authors (Table 3).

Table 3: Title, year and authors of the publications

Title	Year	Authors
Corporate Sustainability Indicators: An Australian Mining Case Study	2014	LODHIA, S.; MARTIN, N.
Defining sustainability indicators of iron and steel production	2013	STREZOV, V.; EVANS, A.; EVANS, T.
Evaluation of sustainability indicators of industrial buildings focused on petrochemical projects	2015	HERAVI, G.; FATHI, M.; FAEGHI, S.
Integrating sustainability indicators and Lean Manufacturing to assess manufacturing processes: Application case studies in Brazilian industry	2017	HELLENO, A, L.; MORAES, A. J.I.; SIMON, A.T.
Process based approach to select key sustainability indicators for steel companies	2013	ARENA, M.; AZZONE, G.
Sustainability indicators for decision-making and optimisation in the process industry: The case of the petrochemical industry	2010	AL-SHARRAH, G.; ELKAMEL, A.; ALMANSSOOR, A.

In this analysis 15 authors were counted in the 6 papers, of which no one repeats about the studied subject. Thus, after the analysis of citations, year of publication, journals and authors, a study was made on the references cited in the papers of the bibliographic portfolio in order to define the most cited works. 262 references were found in all 6 papers in the portfolio, of which only 1 was quoted in more than one article, the book "Stakeholder Theory: the state of the art", Cambridge University. The scarcity of citations of references from journals or other books can be explained by the low scientific production regarding the studied subject, which causes in the absence of studies considered as reference in the area.

SYSTEMIC REVIEW OF PUBLICATIONS IDENTIFIED

The systemic review aimed to identify which Sustainability Indicators are most present in the

studies referring to industries within its three dimensions: environmental, social and economic. For this study, three research questions were defined, which had as objective to guide the study of this research:

1. What is the central objective of the publication?
2. Which industries were analyzed?
3. What sustainability indicators have been addressed?

All these questions were answered by all the papers in the portfolio, as presented in Table 4.

Table 4: Central Objectives of the Publications, Industry Segment and SI Dimension

Authors	Central Objective	Industry Segment	SI Dimension
Lodhia & Martin (2014)	Contribute to the dissemination of sustainability reports, noting that developing integrated sustainability indicators, where a sustainability dimension is driven by other dimensions of sustainability, is a possible approach for integrating economic, social and environmental issues.	Australian Mine	Environmental, Social and Economic
Strezov, Evans & Evans (2013)	Evaluate indicators and parameters relevant to the definition of the role of iron and steel production operations in sustainable development and to analyze key environmental challenges that need to be addressed by science and industry. Three major iron fabrication technologies, the blast furnace, the electric arc furnace and the direct reduction iron (Midrex) were comparatively evaluated.	Iron and Steel	Environmental, Social and Economic
Heravi, Fathi & Faeghi (2015)	Investigate and identify sustainability indicators (environmental, social and economic) for three phases of construction, operation and maintenance and demolition of petrochemical projects	Civil construction in petrochemical projects	Environmental, Social and Economic
Helleno, Moraes & Simon (2017)	To propose a conceptual method to integrate a new set of sustainability indicators into the VSM tool to evaluate manufacturing processes	Multinational of cosmetic; Multinational Thermoplastic Products, Aluminum for Kitchenware	Environmental, Social and Economic
Arena & Azzone (2010)	Propose a process to obtain key sustainability indicators capable of supporting the strategies of steelmakers	Steel industry	Environmental, Social
Al-Sharrah, Elkamel & Almanssoor (2010)	Identify an optimization model to plan the development of a petrochemical industry through sustainability indicators	Petrochemical industry	Environmental, Security and Economic

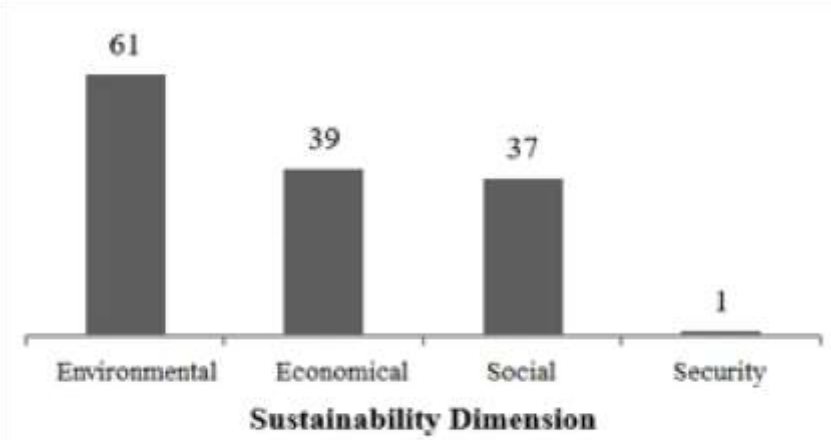
Source: Authors (2018)

Among the papers, some showed how to propose ways of defining, identifying or evaluating sustainability indicators, which again shows the difficulty of industries in finding a universal model for defining and elaborating reports of their indicators.

The industries selected for study by the publications have been comprehensive, which reinforces the idea that the Sustainability Indicators can be adapted according to the segment of the industry.

In order to answer the last question, it was necessary to carry out the survey of the sustainability indicators mentioned in the studies and in which aspect they are inserted. The ratio of quantity per Indicator is presented in Figure 5. The total identified 138 indicators divided into four aspects, being 44% environmental indicators, 28% economic, 27% social and 1% security.

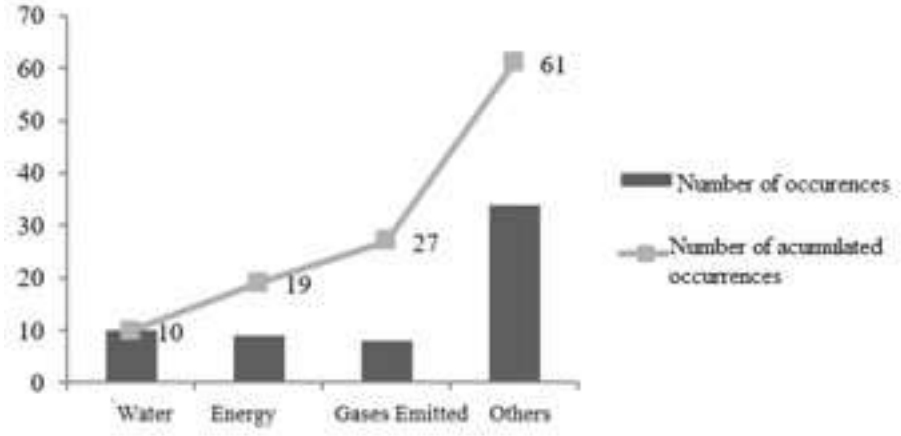
Figure 5: Number of Indicators by Sustainability Dimension



Source: Authors (2018)

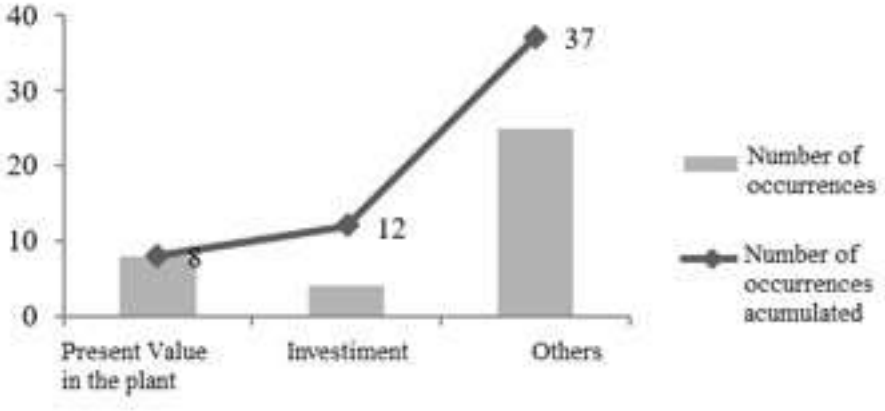
After identifying the Sustainability Indicators in each aspect, it was analyzed which occurred more frequently, according to the categories established and highlighted in Figures 6, 7 and 8.

Figure 6: Aspects present as Environmental SI



Source: Authors (2018)

Figure 7: Aspects present as Economic SI



Source: Authors (2018)

Figure 8: Aspects present as Social SI

Source: Authors (2018)

When analyzing sustainability indicators from the environmental perspective, which consists of respecting the ecosystem's capacity to restore its natural characteristics, the aspects and indicators listed in Table 5 were framed.

Table 5: Environmental sustainability indicators found in the final portfolio

Aspect	Environmental Sustainability Indicator	Reference
Water	Ratio of consumption by time or employee	LODHIA, MARTIN (2014); STREZO, EVANS & EVANS (2013); HELLENO, MORAES & SIMON (2017)
	Total quantity issued	ARENA, M.; AZZONE, G. (2010)
	Total amount reused	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015); ARENA, M.; AZZONE, G. (2010)
	Total amount recycled	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015); ARENA, M.; AZZONE, G. (2010)
Energy	Ratio of consumption by time or employee	LODHIA, S.; MARTIN, N. (2014); STREZOV, V.; EVANS, A.; EVANS, T. (2013)
	Total amount consumed	HELLENO, A, L.; MORAES, A. J.I.; SIMON, A.T. (2017); ARENA, M.; AZZONE, G. (2010)
	Efficiency	ARENA, M.; AZZONE, G. (2010)
	Renewable energy volume	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015)
Gases emitted	Air Pollution	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015)
	Carbon emissions	LODHIA, S.; MARTIN, N. (2014); STREZOV, V.; EVANS, A.; EVANS, T. (2013)
	Emission of other gases	STREZOV, V.; EVANS, A.; EVANS, T. (2013); ARENA, M.; AZZONE, G. (2010); HELLENO, A, L.; MORAES, A. J.I.; SIMON, A.T. (2017)

Source: Authors (2018)

In the economic indicators, which measure the competitive advantage, generation of results, business strategies, the aspects and indicators of sustainability highlighted in Table 6 were framed.

Table 6: Economic sustainability indicators found in the final portfolio

Aspect	Economic Sustainability Indicator	Reference
Present value in the plant	Distributed economic value	AL-SHARRAH, G.; ELKAMEL, A.; ALMANSSOOR, A. (2010)c
	Construction cost	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015)
	Cost of equipment	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015)
	Installation cost	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015)
	Stock Cost	HELLENO, A, L.; MORAES, A. J.I.; SIMON, A.T. (2017)
Investiment	Investment in technology	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015)
	Investment in structure	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015)

Source: Authors (2018)

In social indicators, which are concerned with the human condition and increase the quality of life in these conditions, the related aspects and indicators listed in Table 7 were framed.

Table 7: Social sustainability indicators found in the final portfolio

Aspect	Social Sustainability Indicator	Reference
Accidents	Frequency of accidents	ARENA, M.; AZZONE, G. (2010)
	Number of accidents	HELLENO, A, L.; MORAES, A. J.I.; SIMON, A.T. (2017); ARENA, M.; AZZONE, G. (2010)
	Cost per accident	LODHIA, S.; MARTIN, N. (2014)
	Loss of time worked by accident	ARENA, M.; AZZONE, G. (2010)
Comfort / Safety	Personal and professional comfort	HERAVI, G.; FATHI, M.; FAEGHI, S. (2015)
	Health Expenses	ARENA, M.; AZZONE, G. (2010)
	Security Expenses	ARENA, M.; AZZONE, G. (2010)
	Concern with noise level	HELLENO, A, L.; MORAES, A. J.I.; SIMON, A.T. (2017)
Training	Training time	ARENA, M.; AZZONE, G. (2010)
	Number of trainings	ARENA, M.; AZZONE, G. (2010)

Source: Authors (2018)

Due to the absence of standardized sustainability indicators, it can be seen that the variation of the aspects analyzed is broad, and it is difficult to establish which indicators are most present in the industries. For this reason, a separate analysis of each article present in the portfolio was carried out to identify its contributions to the theme.

The study by Lodhia and Martin (2014) contributed to the literature highlighting the role of CSI in providing integrated data. The authors also highlight the relevance and potentiality of the applicability of CSI. Strezov, Evans and Evans (2013) provide a comparative assessment of the three main steel technologies in relation to the consumption of energy, water and the emission of pollutants and presents as problematic the difficulty of standardized quantification of social impacts, a fact that led authors to stop this aspect in his study.

Heravi, Fathi and Faeghi (2015), through the development of a structural equation to discover the influence of sustainability and the interaction between the environmental, economic and security spheres revealed that the most important indicator in the social dimension was the improvement of infrastructure. In environmental, ecological effects, water, health and waste management activities were of great importance.

Helleno, Moraes and Simon (2017) whose case study was in three different industries (multinational cosmetics industry, multinational thermoplastics industry and aluminum industry for kitchenware) concluded that the industries in question were not sustainable in environmental, social and economic. In their study, also,

the important characteristics were identified with the evaluation method to improve sustainability in the manufacturing process. Among the results were presented as indicators of social sustainability: absenteeism and turnover: as economic indicators: Takt cost and OEE reference and as environmental indicators: water and energy consumption. These indicators together with the traditional indicators of VSM seek to generate continuous improvement actions to develop sustainability in the manufacturing processes.

Arena and Azzone (2010) point out that although there are international and national bodies that provide sustainability reporting models, there are no specific rules and guidelines for the steel industry, as a result they suggest a set of sustainability indicators that have global validity and can be adapted to other industries.

For Sharrah, Elkamel, and Aalmanddoor (2010), sustainability indicators can be used in industries to plan and improve operations and are important in assessing performance. The aspects of sustainable indicators: environmental, economic and security relate to each other and to their planning bring combined results.

The papers selected for study showed the absence of a standard model for the analysis of Sustainability Indicators in industries. The final number of papers returned from the survey (6 papers) compared to the total number of papers in the crude portfolio (384 papers) on the subject of sustainability indicators reflects the difficulty of industries in adopting sustainability indicators in their practices and also the few studies available for consultation and the lack of applicability of existing studies.

CONCLUSIONS

From the bibliometric study on the scientific production referring to Sustainability Indicators in the Industries, 28 indicators were identified distributed in the three dimensions of sustainability (environmental, economic and social). Such SIs reflect eight aspects of performance. In the bibliographic survey it is evident that Sustainability Indicators (SI) can be used for planning and improving operations, are important for evaluating the performance of the industry and that the three dimensions (environmental, social and economic) are related to each other.

As a limiting aspect of the research can be highlight the variation of the papers returned from the application of the research method and Proknow-C and the quantity adopted for analysis and discussion of the results, which reflects the difficulty or lack of sustainability indicators applied to industries in their practices, also highlighting the need for new theoretical studies on indicators of sustainability or applicability of existing studies. The Proknow-C method contributed to the research by providing guidelines for the structuring of the database and obtaining knowledge about the studied subject, resulting in a portfolio aligned with the Research Questions.

It was possible to verify the absence of a consolidated model for the analysis of sustainability indicators and also a methodology for the choice of indicators, factors that make it difficult to monitor and compare the industries. The paper also emphasized the existence of few studies on this subject applied to Industry, with the selected papers related to the following industrial segments: Australian mine, iron and steel, civil construction in petrochemical projects, multinational cosmetic and thermoplastic products, aluminum for kitchen utensils, steel and petrochemical industry. In addition, the study made it possible to identify a lack of proposing sustainability indicators applied to small and medium-sized enterprises, sectors that are growing in the country, which results in obstacles to the adoption of sustainable concern by these companies.

The papers selected for the final portfolio can be used as a basis for building knowledge about sustainability indicators. In addition, the work contributes to constructions of bibliographic knowledge about the Proknow-C method, since it presented in detail all the steps suggested by the method.

REFERENCES

ABNT. ISO. ABNT NBR ISO 26000. (2010). Diretrizes sobre responsabilidade social. 1ª ed.

Afonso, M. H. F.; Souza, J. V. de, Ensslin, S. R., & Ensslin, L. (2011). Como construir conhecimento sobre o tema de pesquisa? Aplicação do processo Proknow-C na busca de literatura sobre a avaliação do desenvolvimento sustentável. Revista Gestão Social e Ambiental. São Paulo, 5(2), 47-62.

Al-Sharrah, G.; Elkamel, A.; & Almanssoor, A. (2010). Sustainability indicators for decision-making and optimisation in the process industry: The case of the petrochemical industry. Chemical Engineering Science, 65(4), 1452-1461.

Arena, M., & Azzone, G. (2013). Process based approach to select key sustainability indicators for steel companies. Ironmaking & Steelmaking, 37(6), 437-444.

Azevedo, A. L. V. (2006). Indicadores de sustentabilidade empresarial no Brasil: uma avaliação do Relatório do CEBDS. Revista Iberoamericana de Economía Ecológica, 5, 75-93.

Docekalova, M. P., Doubravsky, K., Dohnal, M., & Kocmanova, A. (2017). Evaluations of corporate sustainability indicators based on fuzzy similarity graphs. Ecological Indicators, 78, 108-114.

Ensslin, L et al. (2010). ProKnow-C: Processo de análise sistêmica. Brasil: Processo técnico com patente de registro pendente junto ao INPI.

Gil, A. C. (2008). Métodos e Técnicas de Pesquisa Social. (6th ed.), São Paulo: Atlas.

Helleno, A, L., Moraes, A. J. I., & Simon, A. T. (2017). Integrating sustainability indicators and Lean Manufacturing to assess manufacturing processes: Application case studies in Brazilian industry. Journal of Cleanner Production, 153, 405-416.

Heravi, G., Fathi, M., & Faeghi, S. (2015). Evaluation of sustainability indicators of industrial buildings focused on petrochemical projects. Journal of Cleaner Production, 109, 92-107.

Ias, V.V., Schuster, M.S., & Dias, R. R. (2011). Sustainability indicators and the degree of internationalization of chemical companies producing thermoplastic resins. Revista Espacios, 33, 57.

Lacerda, R. T. O., & Ensslin, S. R. (2012). Uma análise bibliométrica da literatura sobre estratégia e avaliação de desempenho. Revista Gestão & Produção. São Carlos, 19 (1), 59-78.

Mata- Lima, H., Alvino-Borba, A., Akamatsu, K., Incau, B., Jard, J., Silva, A.B., & Morgado-Dias, F. (2016). Measuring an Organization's Performance: The Road to Defining Sustainability Indicators. Environmental Quality Management, 26 (2), 89-104.

Lodhia, S., & Martin, N. (2014). Corporate Sustainability Indicators: an Australian Mining Case Study. Journal of Cleaner Production, 84, 107-115.

Macedo, M., Roedel, L. L. B., & Duarte, M. A. T. (2010). Revisão bibliométrica sobre a produção científica em aprendizagem gerencial. Revista Gestão e Sociedade, 4(8), 619-639.

Manning, L., & Soon, J. M. (2016). Development of sustainability indicator scoring (SIS) for the food supply chain. British Food Journal, 118(9), 2097-2125.

Padilha, de M. L., & Nascimento, F. C. (2015). Indicadores nos processos industriais. São Paulo, SENAI, 176 p.

Perlin, A. P., Guedes, G., Nunes, M., & Ferreira, P. (2013). Indicadores de sustentabilidade da indústria de cortiça portuguesa. Rev. Portuguesa e Brasileira de Gestão,12(3). Lisboa.

Pizzani, L., Silva, R. C., & Hayashi, M. C. P. I. (2008). Base de dados e bibliometria: a presença da Educação Especial na base Medline. Revista Brasileira de Biblioteconomia e Documentação, 4(1), 68–85.

Strezov, V., Evans, A., & Evans, T. (2013). Defining sustainability indicators of iron and steel production. Journal of Cleaner Production, 51, 66-70.

Vilela, L. O. (2012). Aplicação do proknow-c para seleção de um portfólio bibliográfico e análise bibliométrica sobre avaliação de desempenho da gestão do conhecimento. Revista Gestão Industrial, 08(01), 76-92.