

SUSTAINABILITY INDICATORS AND SOCIAL TECHNOLOGIES IN THE BRAZILIAN SEMI-ARID: A SYSTEMATIC REVIEW

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Abstract

Among the innovative strategies used to coexist with the semi-arid, there is the use of Social Technologies, defined by its attribution to a product or technique created and modified to solve a social problem in the most varied aspects. Its relevant performance in assigning sustainability indicators, which are responsible for measuring the degree of efficiency and promoting sustainable development. The research aims to identify publications on sustainability indicators related to the use of social technologies in the semi-arid. In this sense, a bibliographic survey was carried out followed by Systematic Review, in which the articles were selected by search of the combination of keywords, or strings, in the bases of Scopus, Web of Science

and Engineering Village. The search results were exported for analysis in the Start software adopting inclusion and exclusion criteria to select articles that included the object of study. The Scopus database presented more publications in this area of research, focusing its publications on sustainability journals. The systematic review made it possible to verify the absence of publications that involve the use of sustainability indicators with Social Technologies in the Brazilian semi-arid region.

Keywords: coexistence with drought; innovation; sustainable development.

1. Introduction

The term social technology begins to be debated in Brazil from the sixties, with the denomination still appropriate technologies. They were characterized by the innovative, affordable and low-cost aspects of responding to the issues faced by the most vulnerable segments of society. The areas that were most responsive to the questions were: education, environment, energy, food, housing, water, work and income, health (CHRISTMANN, 2016).

Social technologies (TS) constitute their own methodological procedures that respond to the solution of a social action. The parameters of life, deficiencies and options are numerous in each culture. A disposition of circumstances that denote very singular attributes: they influence the attitudes of acting, thinking and feeling, external to the individual, and that are favored of a capacity for coercion in attribute of which these questions present themselves (MURÃO, 2017).

Therefore, one of the main objectives of TS is to provide a socioeconomic space, with technological and social support, that allows to positively infer the production of goods and services and, consecutively, to the quality of life of its members, generating sustainable results (FONSECA, 2010).

Social Technologies are characterized by small financial contributions; be directed to the internal mass market; the releasing and creative potential of the direct producer; besides being able to economically make feasible self-managed ventures; and are still exempt from a discriminatory employer relationship (DAGNINO, 2004).

Thus, this theme has been discussed in the various areas of knowledge, since its implementation has the purpose of social improvement, since it serves the human dimension, and collective interests guaranteeing a sustainable improvement in quality of life (SANTOS, 2000).

In Brazil, the publications that involve the use of social technologies come, demonstrating the researchers' concern to meet the needs of the communities through innovative alternatives. Therefore, identifying and systematizing articles in this theme can contribute to verify the scientific production generated in the area and relate such knowledge to sustainability indicators.

Therefore, the choice of systematic review is due to the fact that the method is an instrument that uses relevant explicit and systematic methods to identify, evaluate and interpret available research evidence for a specific topic, assist in providing practical and policy information, provide integrated evidence and impartial to support decisions; identify gaps in the literature to inform future studies and minimize trends (MacLure et al., 2016). In this context, the research aims to carry out a systematic survey of scientific publications on the use of sustainability indicators in the applicability of Social Technologies in the

semiarid.

2. Theoretical Framework

2.1. Conceptual Assumptions of Social Technology

The history of the development of humanity over the centuries shows the importance of technology in shaping economic and labor relations, in the environment and in peoples' lives, significantly impacting life in society (COSTA, 2013). The population growth of nations, in general, results in the need to increase productivity and resource efficiency, which is made possible by technological innovation (KON, 2017).

The social technologies (TS) have been developed for many years in Brazil, with this terminology its landmark was the 1970s, are understood as procedures, tools and practices linked to solve local problems (DAGNINO, 2004, 2009; ITS, 2007). TSs constitute an important component of strategies for sustainable local development, since they can favorably improve the living conditions of communities (SILVA, 2007). This type of technology originates from a process of innovation resulting from knowledge created collectively by stakeholders interested in their employment, in a political and social context, in which the elaboration of inclusive social policies, the processes, techniques and methodologies developed in the interaction with population are an alternative to facilitate social inclusion and improvement in quality of life (CHRISTOPOULOS, 2011).

According to Silva (2012), these practices are based on the commitment to the needs, potentialities and interests of local populations, especially peasants, and these actions are based on the conservation, sustainable use and environmental recomposition of the natural resources of the semi-arid region.

2.2. The Semiarid in Brazil

The Brazilian semi-arid region is the largest in the world, with an area of 982,566 km², which corresponds to 18.2% of the national territory, 53% of the Northeast region and covers 1,133 municipalities. It occupies 86.8% of the state of Ceará, 93.4% of the territory of Rio Grande do Norte, 86.6% of Paraíba, 88.0% of Pernambuco, 59.9% of Piauí, 69.7% of Bahia, 45.6% from Alagoas, 50.9% from Sergipe, and 17.7% from the North of Minas Gerais and about 1% from the state of Maranhão. The population of the semi-arid region is about 22 million inhabitants and it is the largest concentration of rural population in Brazil (ASA, 2009). Semi-arid areas in Northeast Brazil represent a particularly important challenge for increasing productivity and improving natural resources due to their uncertainty characteristics in rainfall, low soil fertility and population pressures in typically fragile environments, so that the production systems are vulnerable to climate change and pluviometric variability (SANTOS et al., 2011, BRITO et al., 2012).

It is considered that the problem of the development of the semi-arid region is beyond environmental problems, also involving political issues that have generated dependence and have maintained the poverty and exclusion of a large contingent of farmers in the region (GALINDO, 2003). Therefore, development in the semi-arid region is closely linked to the introduction of a new mentality in relation to its environmental characteristics and changes in practices and the indiscriminate use of natural resources (CONTI, SCHROEDER, 2013).

2.3. Understanding the Systematic Review of Literature

Systematic reviews are particularly useful for integrating information from a set of studies conducted separately on a particular therapy / intervention, which may present conflicting and / or overlapping results, as well as identify issues that require evidence and assist in guiding future research (LINDE WILLICH, 2003).

In the case of research in the social sciences, its importance is justified by the need to use methods that make it possible to verify contradictions in order to transform them into knowledge (MENDES, FRACOLLI, 2008). Whitmore and Knafl (2005) argue that the systematic review process combines evidence from multiple studies.

3. Methodology

A systematic review was carried out to review the literature, from October to December 2018, using the combination of the keywords (strings). To construct the strings, the keywords "technology", "appropriate", "social", "semi-arid", "indicators" and "sustainability" were translated into English along with the Boolean operators "AND" and "OR" (Table 1). For these same keywords the search for their synonyms in English was made through the Thesaurus website.

The survey was conducted on the Scopus, Web of Science and Engineering Village platforms. And the elaborated strings were calibrated and validated using the Scopus base.

Scopus is a broader database of scientific publications that brings together work worldwide and in the various fields of knowledge, making it available to the researcher to be able to track, analyze and visualize research of interest to the work (SCOPUS, 2019).

The Web of Science (WOS) is one of the largest databases of bibliographic and multidisciplinary research, presenting reliable and relevant information for research, since it is linked to other sources and databases (WOS, 2019).

Engineering Village brings together a larger quantity of engineering work (VILLAGE, 2019), chosen for its focus in the area of the object of this research, articles on the use of technologies.

Table 1. Organization of keywords and search strings

N	Keywords in Portuguese	Keywords in English	Synonyms	Strings
1	Technology	Technology	Automation Machinery	(Technolog* OR automation OR machinery)
2	Appropriate	Appropriate	Applicable Convenient Pertinent Proper Relevant	(Technolog* OR automation OR machinery) AND (appropriate OR applicable OR convenient OR pertinent OR proper OR relevant)
3	Social	Social	Collective	(Technolog* OR automation OR machinery) AND

			Community	(appropriate OR applicable OR convenient OR pertinent OR proper OR relevant OR social OR collective OR community)
4	Semiarid	Semiarid	Without Synonym	(Technolog* OR automation OR machinery) AND (appropriate OR applicable OR convenient OR pertinent OR proper OR relevant OR social OR collective OR community) AND (semiarid)
5	Indicator	Indicator	Index	(Technolog* OR automation OR machinery) AND (appropriate OR applicable OR convenient OR pertinent OR proper OR relevant OR social OR collective OR community) AND (semiarid) AND (Indicat* OR index)
6	Sustainability	Sustainability	-	(Technolog* OR automation OR machinery) AND (appropriate OR applicable OR convenient OR pertinent OR proper OR relevant OR social OR collective OR community) AND (semiarid) AND (Indicat* OR index) AND (Sustainab*)

Source: Prepared by the authors.

The systematic review was carried out with the articles extracted from the three databases using the General String: (Technolog * OR automation OR machinery) AND (appropriate OR applicable OR pertinent OR proper OR social OR collective OR community) AND (semi-indexed) AND (Indicat * OR index) AND (Sustainab *). The data obtained with the string were imported for analysis, using two softwares, JabRef and StArt Version 3.4. For the analysis and accomplishment of the procedure the documents were selected through some inclusion and exclusion criteria (Figure 1).

Among the inclusion criteria are papers of the type published in the last 10 years, the researches are related to the use of sustainability indicators in the applicability of social technologies in the semiarid, and the research has keywords correlated with: appropriate technology, technology social, semi-arid, indicators and sustainability.

The exclusion criteria adopted were as follows, the articles could not be published for more than 10 years (1998 - 2018), the publications are not of the type article, the articles published are not accessible for free reading and are not in the languages Portuguese, English and Spanish. To extract the data, it was necessary initially to read the titles and abstracts and keywords in this order, from each article, selecting them in a systematized way, according to the established criteria.

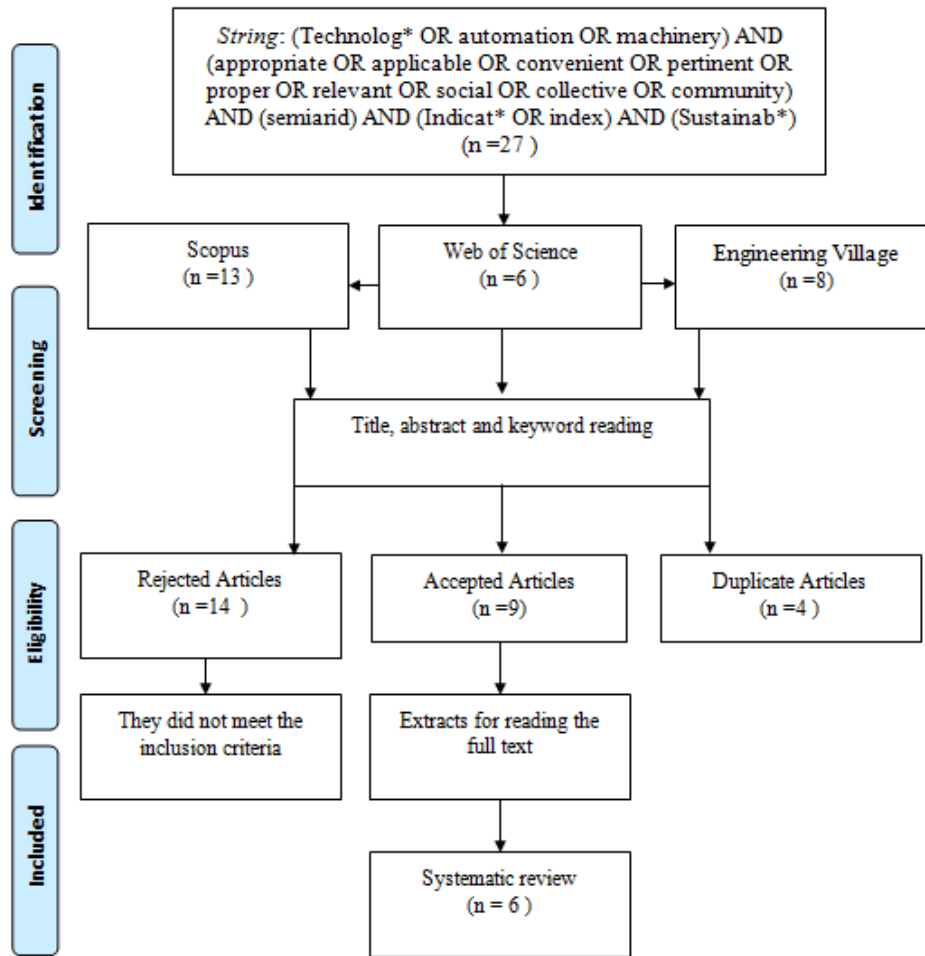


Figure 1. Stages of the procedures of the systematic review, elaborated by the authors.

In order to conduct the systematic review, some research questions were defined in Table 1. Since the systematic review was carried out with the purpose of identifying the objectives and methodologies used in the publications on the applicability of sustainability indicators in social technologies to coexist with the semi-arid (Table 1).

Table 1. Research Questions for Systematic Review

N	Research Questions
1	What are the definitions of Social Technology;
2	What are the main authors?
3	What are the areas of publications;
4	What are the objectives of the work?
5	Which regions of research are developed.

Source: prepared by the authors.

4. Results

As the keywords were inserted in the analyzed combinations (n = 1 to n = 7), there was a bottleneck in the number of publications. In the systematic mapping using the word technology resulted 3,441,484 publications. Scopus presented the highest percentage with 47.74%, followed by Web of Science with 26.80% and Engineering Village with 25.46% (Table 2).

However, the search using the word technology and its synonyms (n = 2) totaled 572,524 publications. The highlight was for Base Engineering Village (58.73%), highlighting its potential in the area of engineering. Scopus presented 25.74% and the Web of Science 15.53%.

Analyzing string number 3, the combination of technology, appropriate and social keywords, we notice that the quantitative of publications increases considerably in the three bases to 864,200 articles. In relation to the string n = 2, the Web of Science search grew by approximately 84.12%, Scopus 82.26% and Engineering Village with 28.88% in publications.

By using one more keyword in the combination of the string (n = 5), a combination of appropriate or social technology in the semi-arid region reveals a reduction in publications, only 375 articles found in the three databases, continuing with Scopus with the highest quantitative of results (183 publications). By using the word "indicator" in the string (n = 6), we notice a large drop in the number of publications, and even so, Scopus continues with the largest quantity in publications on the research topic, 51 articles.

Finally, the use of sustainability indicators in the applicability of social technologies in the semi-arid region led to a decrease in publications, resulting in 13 publications in Scopus, 8 in the Engineering Village and 6 in the Web of Science (Table 2).

Table 2. Systematic mapping of scientific production.

<i>N</i>	<i>Strings</i>	<i>Scopus</i>	<i>Web of Science</i>	<i>Engineering Village</i>
1	(Technolog* OR automation OR machinery)	1.642.804	922.037	876.643
2	(Technolog* OR automation OR machinery) AND (appropriate OR applicable OR convenient OR pertinent OR proper OR relevant)	147.404	88.861	336.259
3	(Technolog* OR automation OR machinery) AND (appropriate OR applicable OR convenient OR pertinent OR proper OR relevant OR social OR collective OR community)	267.197	163.616	433.387
5	(Technolog* OR automation OR machinery) AND (appropriate OR applicable OR convenient OR pertinent OR proper OR relevant OR social OR collective OR community) AND (semiarid)	183	92	100
6	(Technolog* OR automation OR machinery) AND (appropriate OR applicable OR convenient OR pertinent OR proper OR relevant OR social OR collective OR community) AND (semiarid) AND (Indicat* OR index)	51	24	32
7	(Technolog* OR automation OR machinery) AND (appropriate OR applicable OR convenient OR pertinent OR proper OR relevant OR social	13	6	8

OR collective OR community) AND (semiarid) AND (Indicat* OR index) AND (Sustainab*)			
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Source: Prepared by the authors.

It should be noted that using the quantitative and qualitative approach, one can verify the novelty of the research in relation to articles on indicators of sustainability and social technology in the Brazilian semi-arid, through the general string, thus confirms the absence of scientific publications in the Brazil on the theme.

In the Systematic Review, 27 articles were exported for analysis, of which only 34% had some relevance to the research. Once the titles, abstracts and keywords of the articles were read, duplication of publications was verified and only nine publications were systematized. Of these nine articles, two publications were restricted to full reading and one article had its publication outside the limited period, dating to 1994, leaving 6 articles for systematic review (Table 3).

Table 3. Relation of the scientific production of the systematic review on the use of sustainability indicators in the applicability of social technologies in the semi-arid.

n	Title	Authors	Year	Period
1	Converting rain into drinking water: Quality issues and technological advances	Adler, I., Hudson-Edwards, K.A. e Campos, L.C.	2011	Water Science and Technology: Water Supply
2	Integrated assessment of policy interventions for promoting sustainable irrigation in semi-arid environments: A hydro-economic modeling approach	Blanco-Gutiérrez, I., Varela-Ortega, C. e Purkey, D.R.	2013	Journal of Environmental Management
3	Bioeconomic modeling of farm household decisions for ex-ante impact assessment of integrated watershed development programs in semi-arid India	Nedumaran, S., Shiferaw, B., Bantilan, M.C.S., Palanisami, K. e Wani, S.P.	2013	Environment, Development and Sustainability
4	Combining Sustainable Land Management Technologies to Combat Land Degradation and Improve Rural Livelihoods in Semi-arid Lands in Kenya	Mganga, K.Z., Musimba, N.K.R. e Nyariki, D.M.	2015	Environmental Management
5	Multi-site assessment of the effects of plastic-film mulch on the soil organic carbon balance in semiarid areas of China	Wang, Yong Peng, Li, Xiao Gang, Fu, Taotao, Wang, Lin, Turner, Neil C., Siddique, Kadambot H. M. e Li, Feng-Min	2016	Agricultural and Forest Meteorology
6	Energy water food nexus in the Spanish greenhouse tomato production	Irabien, A. e Darton, R.C.	2016	Clean Technologies and Environmental Policy

Source: Prepared by the authors.

The time scale of publications starts in 2011 and ends in 2016, with the greatest number of publications compared to the other years in 2013 and 2016.

The publications are distributed in the following countries: Mexico, Kenya, India, China and Spain, being the last one, with two publications. Research is carried out in semi-arid regions of each country, with the prospect of finding solutions through the use of technological instruments to coexist with the semi-arid region (Figure 2).

The article n = 1, *Converting rain into drinking water: Quality issues and technological advances*, authored by Adler, I., Department of Civil, Environmental and Geomatic Engineering, University of London; and Hudson-Edwards, KA linked to the Department of Earth and Planetary Sciences, University of London and Fields, LC, Department of Civil, Environmental and Geomatic Engineering, University of London, was published in the area of research in Water Science and Technology.

The work of Adler, Hudson, Campos (2011) aimed to determine the potential of an alternative technique to purify the rainwater, using silver ions with conventional filtration techniques in a safe way focusing on human consumption on a micro scale, developed in the region semi-arid region of the municipality of San Miguel in Mexico. It consists of research using social technology to filter the water captured by the roofs and stored in cisterns by means of a device that releases silver ions in the water, as well as small electrical currents to a pair of electrodes, with the purpose of supplying water in quality (ADLER; HUDSON; CAMPOS, 2011).

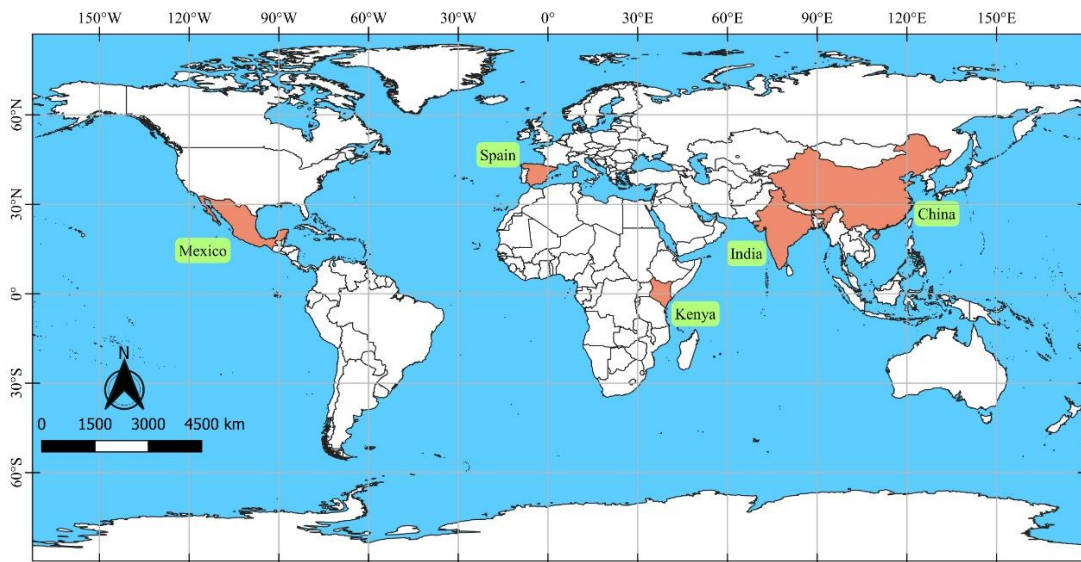


Figure 2. Distribution of the scientific publications of the systematic review in the world, elaborated by the authors, according to the articles analyzed.

The work developed in Spain, n = 2 and n = 6, focuses on the use of models to assess the impacts caused

by political intervention through climate change. The publication of the article n = 2 occurred in the year 2013, in the periodical *Ambiental Management Magazine*. Its authors, Irene Blanco-Gutiérrez, Consuelo Varela-Ortega, and David R. Purkey, whose research is carried out in southwest Spain, a new hydrological-economic modeling to evaluate the impacts caused by the political interventions through the climatic changes that affected the hydrological and agrarian systems of the Middle Guadiana Basin. This model of hydro-economic simulation (WEAP) is independent, but can act together, analyzing hydrological and economic aspects, during its application, connected through automation, being executed simultaneously (BLANCO-GUTIÉRREZ; VARELA-ORTEGA; PURKEY, 2013).

Was based on the year 2016, in the journal *Clean Technologies and Environmental Policy*, through the authors Angel Irabien (Department of Chemical and Biomolecular Engineering, University of Cantabria, Spain) and Richard Darton (Department of Engineering Sciences, University of Oxford, UK). In this paper, we present the relationship between energy, water and food, which play a fundamental role for sustainable preservation in order to measure the PAM method, the simplified method proposed by Chee Tahir and Darton, the degree of sustainability of production and its impacts (IRABIEN DARTON, 2016).

Another model developed to be applied in a semi-arid region of India was published in 2014, titled *Bioeconomic modeling of farm household decisions for ex-ante impact assessment of integrated watershed development programs in semi-arid India* (n = 3). Nedumaran et al. (2014) simultaneously assessed the impact of development on the river basin together with the well-being of the poorest population and the conditions of natural resources at a micro level and also identify effective policy instruments and institutional needs to improve the effectiveness of the approach in the river basin. The publication is linked to the research area of the Environment, Development and Sustainability and its purpose is to develop a bioeconomic model to measure the impacts caused by technological development on natural resources in the Adarsha basin, semi-arid region of India.

The use of indicators was also found in the article *Combining Sustainable Land Management Technologies to Combat Land Degradation and Improve Rural Livelihoods in Semi-Arid Lands in Kenya* (n = 4), these indicators serve to identify which social technology should be used, since 80 % of Kenya's territory is covered by a dry area. Some simple technologies are being used to minimize the impacts of climate change on land use (MGANGA; MUSIMBA; NYARIKI, 2015).

Article n = 4 was published in the journal "Environmental Management", in the year 2015, by the authors Mganga, K.Z .; Musimba, N.K.R. and Nyariki, D.M., the first two being linked to the Department of Wildlife Sciences and the last with ties in the Department of Agricultural Economics and Agribusiness, all of the University of Kenya. In this research, it is emphasized that land degradation can be associated with some factors, such as drought, low rainfall, excessive grazing and unsustainable harvesting of trees for the production of firewood. Thus, although these impacts are identified, the use of simple technologies will help to reverse the degradation, increase production, provide food security and improve community livelihoods.

Among the techniques used for local development, the article *Multi-site assessment of the effects of plastic-film mulch on the soil organic carbon balance in semiarid areas of China* or n = 5 mentions the use of a plastic to balance the organic soil and carbon in five locations in Gansu Province, China. Wang, Yong Peng,

Li, Xiao Gang, Fu, Taotao, Wang, Lin, Turner, Neil C., Siddique, Kadambot HM and Li, were published in the journal Agricultural and Forestry Meteorology in 2016. Feng-Min, are active in research in Agroecosystems. The technique was applied in a semi-arid region, which cultivated grains, before the results obtained, it can be identified that the plastic is used to control soil temperature and reduce evaporation in the production of vegetables (WANG et al., 2016).

All publications highlight the use of social technologies, both in the development of a hydro economic modeling, and in the performance of efficiency tests in technologies that are born as an innovative strategy and that enable an improvement in the quality of life of the population that comes being affected by the drought.

5. Threats to viability

In order to minimize the threat and increase the viability of the systematic review, information was confronted using three databases, Scopus, Web of Science and Engineering Village, considered relevant in the area of scientific research.

The use of the keywords: technology, appropriate, social, semi-arid, indicators and sustainability and their synonyms were fundamental for the direction of the research. Another strategy was the validation of the strings using the three search bases, where the most relevant works were selected, and the academic specialties of the authors were identified to guide the concepts, objectives and methodology applied by each researcher.

It is worth mentioning the possibility of the existence of empirical works, besides booklets, which subsidize the activities of agencies and entities linked to the research problem and that are not indexed in the databases researched.

6. Final considerations

The procedures adopted to carry out the research made it possible to observe that there are places in the world that are using social technologies to coexist with the semi-arid, like Spain, Mexico, China, India and Kenya.

Scopus, as a broader base, presented a larger quantity of publications of works that were used to carry out the Systematic Review, and these are concentrated in journals that involve sustainability as a focus for research.

It is noteworthy that the term sustainability is cited in all published articles of the systematic review, representing the concern of scientists about the degradation of natural resources and the preservation of these resources through sustainable technologies.

The publications analyzed were of great relevance in the identification of the authors, objectives and their methodologies used in scientific production, whose emphasis is on Sustainable Development.

It was also identified, the lack of research in the Brazilian semi-arid with this theme. However, there may be publications about the use of Social Technologies in the semiarid, but not associated to the use of sustainability indicators. Demonstrating the need for studies that help in the elaboration of public policies

to coexist with the semi-arid in future works with the use of sustainability indicators.

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