

Comparative Analysis of the World's Scientific Production in the Area of Sustainable Development and Environmental Impact

Henry A. Lambis-Miranda^{*a}, Alvaro J. Garzón^b, Guillermo E. Valencia^c

^a Process Engineering program. CIPTec Research Group. Fundación Universitaria Tecnológico Comfenalco. Cr44D N 30A, 91, Cartagena, Bolívar, Colombia. Affiliation ID: 60110627

^b Mechanical Engineering Department, Universidad Del Atlántico, Barranquilla, Colombia

^c Mechanical Eng., Efficient Energy Management Research Group, Kaí, College of Engineering, Universidad del Atlántico. Barranquilla, Colombia
hlambis@tecnocomfenalco.edu.co

This study examines world scientific production on sustainable development on the basis of bibliometric indicators (scientific production, percentage variation of production, average cites per document, normalized impact, etc.) for the period 2007-2017. The analysis is made by country, by research institution, by art per millions of inhabitants and by gross domestic product, using Histcite database of scientific literature. The results show the total world production to have increased during the period studied, and that this topic has been attracting great scientific interest. Two groups of countries with high production are distinguished, one of which has highly specialized subject focus. There also three groups of countries with the major production compare articles per millions of inhabitants, which also have high impact.

1. Introduction

The government policies of different countries at present have been based on the use of renewable energy, sustainability and environmental preservation, but a topic of greater interest is sustainable development (Ocetkiewicz et al. 2017). Few have been the bibliometric studies of the research results in this area, however, there is a great need to review these investigations in order to identify the important actors in this area (Fleming et al. 2017). The last decade has been noted for having the greatest growth in the effort for research into sustainable development and thus advancing in the use of new energy resources (Annan-Diab, 2017).

In this sense, the work of research groups in the field of biomass energy generation was evaluated, considering areas outside the USA and the European economic community, with the aim of comparing the results of research and priorities of 10 countries in this sustainable energy source between 1997-2017, using as a measure the number of publications, their increase and the factors that affect the development of a sustainable energy source (Koukios, E., 2017).

Sustainable development as a fundamental and necessary element has been considered the ideal scenario for Europe, giving priority to sustainable consumption, taking into account future challenges and generating efficient solutions, sustainable water systems, sustainable management, clean production and sustainable urban development (Lukman, 2016). The People's Republic of China is the perfect country to be the example for our research, taking Shaanxi Province as an example, on the basis of introducing the status quo of Shaanxi chemical energy and economic development, the relationship between Shaanxi chemical energy development and regional economic development is analysed. (Duan, 2017)

Likewise, it is important to highlight the academic capacity of some researchers and specialized center's to generate a worldwide impact in the development of scientific potential, based on the premise that man plays the fundamental role in the society of producing knowledge, so there is a close relationship between the progress of scientific research and the volume of published research results (Madirov, 2015). Therefore, a comparative analysis of the differences between researchers belonging to the European Union and the changes observed in the field of sustainable development was carried out, so that the application of relative

measures made it possible to assess the situation of a given country in relation to all other countries (Szopik-Depczyńska et al. 2017).

In a research co-directed by scientists and engineers from countries of the European Union, the deep and complex systematic crisis of countries such as Portugal, Spain and Italy was evidenced, and the adoption of a new development model based on the objective of sustainable development was proposed (Urteaga, 2009).

It is important to know that the economic aspect is an important point in any sustainable method, so Europe, being the oldest continent in the world and something traditionalist in some parts of its geography, needs a sustainable development model that is viable to its needs and meets expectations. In addition, adopting an effective sustainable development model makes a region an area of tourist interest, so the current generation is aware that immediate and effective change is needed to preserve the integrity of the planet, so it is researched and tested in regions that exemplify what is the path to take (Urteaga, 2009).

Similarly, medical research specifically in the field of chemistry is key to creating a sustainable and equitable society, so that in the European chemical sector it is an important player in industry and the global marketplace (Madirov, 2015), as found in the European Technology Platform for Sustainable Chemistry project, which has as its initiative a new solution that will reduce the environmental impact in this sector (Lukman, 2016)..

The main contribution of this work is to carry out a bibliometric study of scientific production in the field of sustainable development, considering the volume of research results in the periods 2007-2017, with the aim of analyzing the evolution of trends in this subject and identifying the relevant factors that have predominated in this area.

2. Metodology

The bibliometric analysis developed in this work is a systematic approach that allows the user to quickly and quantitatively analyze scientific publications, to obtain as a result the milestones in certain research topics (Jacobs, 2010; Chen, 2017), This analysis allows a much clearer visualization of the development and scientific behavior in a given topic, facilitating the identification of significant contributions to that topic or field.

Local and global citation rates were used as bibliometric indicators, which was first proposed by Hirsch. (Hirsch, 2010; Chen, 2017) in 2005, and is used for the evaluation of a researcher's research achievements/publication/journal in both quality and quantity aspects.

The information used to generate the reports was obtained from Web of Science (WoS) (Falagas et al. 2007), which provides an important source of data for the development of any bibliometric analysis to be performed (Chen, 2014; Bettencourt, 2011) as it allows your users to access more consistent and standardized records compared to other databases such as Scopus (Bettencourt, 2011, Hou, 2015; Chen, 2017).

Two other indicators were also used: per capita production and production relative to gross domestic product (GDP), with population data for European countries and other continents, allowing important conclusions to be drawn regarding the issue of sustainable development and environmental impact.

3. Results

The world's leading countries, with the largest production of scientific articles in the field of sustainability and environmental impact were analyzed, focusing primarily on those with a production of at least 50 documents published in the most productive journals and institutions of this category.

Table 1 presents in an objective, clear and efficient manner the results distributed by country, with 1237 documents in total with their respective bibliometric indicator of local and global citation.

Table 1: Countries, number of publications in local (TLCS) and number of global (TGCS) citations.

Country	Publications	TLCS	TGCS
Iran	216	468	2361
USA	201	275	3746
P.R. China	185	147	2015
India	135	379	2208
U.K.	104	510	3046
Canada	87	283	3368
Spain	85	187	3384
Brazil	85	193	1287
Italy	72	274	2609
Australia	67	80	695

Table 1 shows how Iran, not being one of the world powers in economics, has concentrated its development on sustainability and environmental impact, with 13.37% of the total global publications leading this issue, with a population of only 80.28 million inhabitants, almost a third of the number of inhabitants who occupy the second place, while USA, People's Republic of China and India who have the largest number of inhabitants remain in the following positions. It is also important the number of inhabitants that a country has, but also the economic growth over the last decade that these countries have experienced, which have bet on a model of sustainable development in their countries. Figure 1 shows how in 2011 Iran had a research peak, reaching first place as a country with the largest number of documents published in the range of years analyzed in this Scientiometric study, while the USA had a more stable behavior during the period having a decline in the last years of the decade of the 2000. In the case of People's Republic of China, it is observed that its research interest increases with respect to how its economy grows and is reflected in the results of documents in the area of sustainable development.

On the other hand, India ranked fourth with one of the most fragile economies compared to the other countries studied, but it is experiencing significant growth between 2014 and 2017, which may be associated with a significant population and birth problems, forcing it to resort to new solutions such as sustainable development to find economic stability based on education and innovation.

For their part, the European countries such as UK and Italy do not stand out among the first places as they should, since they have economic stability and the capacity to invest in research. Spain despite having a marked economic crisis in recent years shows an increase in the number of publications in 2015, which is a consequence of the need to look for a sustainable development method to help overcome the crisis in which they live.

Countries such as, Australia and Brazil do not exceed the average percentage of publications even though their economic growth and population are quite high compared to other countries on the list. On the other hand, People's Republic of China is the country with the highest growth and effort in renewable energy, sustainability and environmental impact.

Figure 1 shows the total number of publications in the period studied, total local and global citations, specified year by year and comparing Iran with other countries below the ranking. Considering the countries with the highest production index, it is observed that the largest number of citations per document correspond to People's Republic of China, USA, Canada and Brazil, while the percentage of countries cited locally is led by the UK followed by Iran and India.

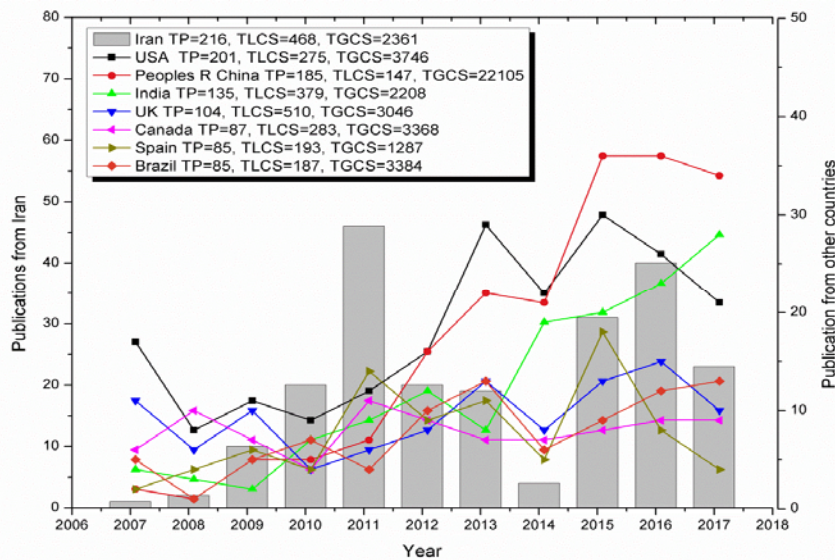


Figure 1: Publications from Iran and others countries.

Five groups of countries were established according to the value of the citation indicators studied. The first group, which receives the "Outstanding" label, includes those countries with the highest production, which had the greatest growth in 2007-2017, with a stabilized impact at high levels and high specialization in the area. The best examples of this are countries such as Iran, USA and People's Republic of China.

The second group, which receives the label of advanced, countries characterized as the previous group by its high production but this time fairly stable, and an impact increasingly normalized but without obtaining good grades in the specified area. Countries such as UK and India appear in this group.

The third group, which we call the intermediate group, is characterized by low production, standardized impact and focus on the specific area. However, its production increased in the period studied. Some examples of this would be countries such as Canada and Spain.

The fourth group, which is called specialists, consists of countries characterized by medium-low productive growth. Almost average for the area of specialization. And a high and growing normalized impact. The best example of this group would be Brazil and Italy.

Finally, the fifth group, which we call initiates, consists of countries with low production, low normalized impact and a high level of specialization. The country that best represents this group is Australia.

Sustainable development now goes hand in hand with its ability to help and change the daily lifestyle of all people in a given country, which is linked to the Gross Domestic Product (GDP) and how it varies with respect to its research capacity. Three groups are established that relate these aspects according to the values indicated in Figure 2.

Group 1 is dominated by Iran, the first in our general list who stands out for being the one who has produced the most items having a population below its direct rivals and with an economy that has only tried to solidify in recent years. It is followed by Canada and Australia who are worthy followers for their efforts to generate research on an issue that may not be their strong suit.

Group 2 where we find countries like UK, Spain and Italy, where the first two are closer to each other with a similar population and an economy with high and low due to the lack of European economic stability. A little further away but still in the group is Italy, which has some scientific documents but which have not created a standard impact.

Group 3 formed by USA, Brazil, People's Republic of China and India where some of them have solid economies that are growing, are affected by the immense population compared to other countries in the ranking. On the contrary, India is a country that appears in the last place because of its high poverty rate and huge population.

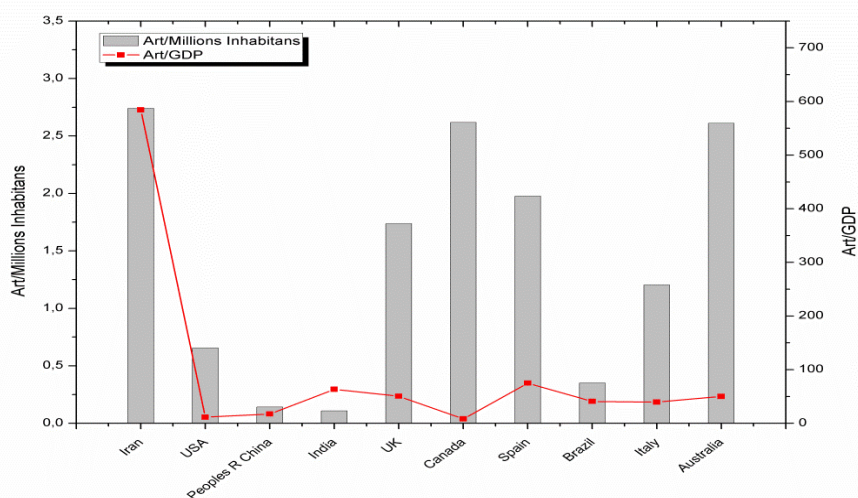


Figure 2: Articles per millions of inhabitants and articles per GDP.

Now, in Europe, it could be said that, as the continent has the largest number of countries involved in the research process, it is a great indicator to compare how the world is with respect to a complex geographical place that needs to put effort into improving the lifestyle of its inhabitants and have taken the path of sustainable development. UK and Spain take the lead, as the countries that have been most interested in this topic, Figure 3 shows the evolution year after year of the comparison between Europe and the number of publications from the rest of the world.

It can be seen how interest and the number of publications in the field studied grew. On the first years Europe was behind of the rest of the countries but maintained a stable production of publications. Nothing how in 2010 Europe is notably hit by the "euro crisis" which had direct consequences on the rate and the growth that was

evident in recent years. 2011 and 2015 are the best years for Europe, demonstrating that although it came from being strongly affected it was able to overcome due to the strong bases that I build. Focusing on the quality of life of its inhabitants based on a friendly and sustainable environment is the best example of the capacity and power of a geographical environment to put scientific effort into a subject that will change the way of life of all human beings.

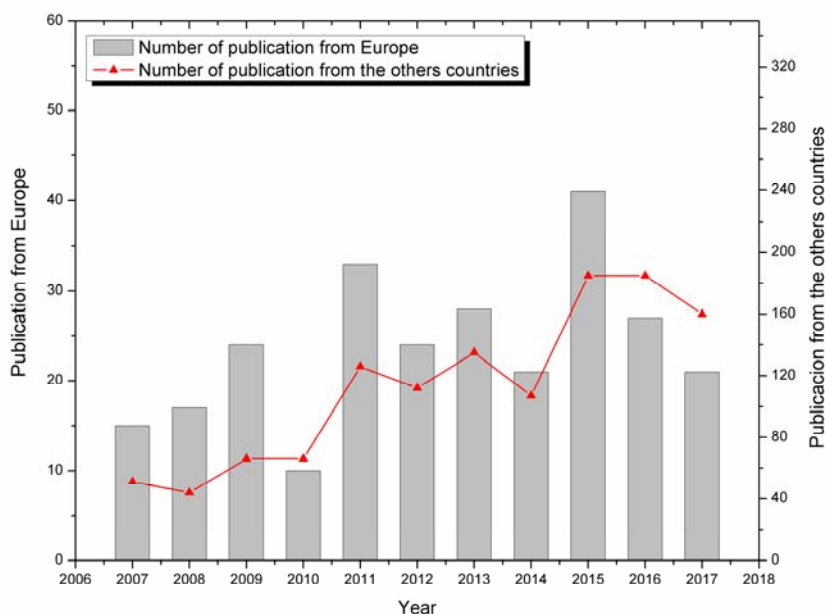


Figure 3: Evolution in the number of publications at Europe compared with the rest of the world.

4. Conclusions

Analyses show that total production has increased over the course of our period of study (2007-2017), and as developing countries stand out in the world due to the variables studied.

During this period Iran, USA, People's Republic of China, India and UK were the countries with the largest production of articles and also the most cited globally. Spain, Canada and Brazil make a great effort to research in the area of sustainable development. The country with the greatest impact has been Iran, which has provided a high research capacity to decant its society as an example of a sustainable and clean region.

Countries such as Australia, due to their great quantity and immense territory are relegated to the bottom of the list, their production on this subject has been precarious, something very rare because it is an isolated area with a strong economy that could find in this type of research a society and economy that lead them to be world powers.

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