Bibliometric analysis of innovation in Mexico

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Abstract

This article aims to use bibliometric techniques to analyze the production of scientific documents related to innovation research carried out in the territory of Mexico. The study focuses on a period of thirty-eight years, from 1980 to 2019. Knowing the direction that innovation takes in Mexico during this period is what motivates its implementation. The main source of information for this study is the "Web of Science" database. The results show an exponential increase in publications starting in 2010, with the participation of Spanish- or English-speaking authors; more research on innovation in the areas of health; the adoption of a broader concept of innovation; and language as a limiting factor for collaborations.

Key Words: *Bibliometrics, Innovation, Mexico, Web of Science.*

JEL codes: O32, Y10, Z00

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Análisis bibliométrico de la innovación en México

Resumen

Este artículo tiene como objetivo utilizar técnicas bibliométricas para analizar la producción de documentos científicos relacionados a la investigación en innovación realizada en el territorio de México. El estudio se enfoca en un periodo de treinta y ocho años, comprendido desde el año 1980 a 2019. Conocer la dirección que toma la innovación en México durante este periodo es lo que motiva su realización. La principal fuente de información de este estudio es la base de datos "Web of Science". Los resultados muestran un aumento exponencial en las publicaciones a partir del año 2010, con participación de autores de habla hispana o inglesa; mayor investigación sobre innovación en las áreas de la salud, la adopción de un concepto más amplio de innovación y el idioma como limitante para realizar colaboraciones.

Palabras Clave: Bibliometría, Innovación, México, Web of Science.

Códigos JEL: O32, Y10, Z00

1. INTRODUCTION

Currently, one of the factors to which the economic growth of countries is linked is innovation, arising from its new products that are generated, or different or more efficient uses that are found for products that already exist (Independent Evaluation Group, 2013). Over time, the interest of researchers in innovation has been reflected not only in the increase in research centers for new products, but also in the increase in scientific articles published on the subject (Cancino et al., 2017). Similarly, other types of innovation have been formally considered, including process, marketing and organizational innovation. Currently, innovation is understood as a "new or improved product or process (or a combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or positions in use by the unit (process)". (OECD/Eurostat, 2018). As the subject of innovation acquires more importance for the growth of nations, it is necessary to know more about the trends of researchers' works. Although there are currently published works on the subject (Cancino et al., 2017; Fagerberg et al., 2012; Linton, 2004; Shafique, 2013; Yang and Tao, 2012), they do not perform individual analyses on development of research on the subject of innovation in Mexico.

This article aims to apply bibliometric tools to analyze the development of research on innovation in Mexico to observe its evolution over time, trends and key information on productivity and the influence of the various actors linked to the subject. The period covered for this study ranges from 1980 to 2018, considering the scientific articles contained in the "Web of Science" database, with the search performed with the word "innovation", filtering only for articles, reviews, notes and letters. Finally, the search was narrowed to the country Mexico, and articles published by Mexican

authors or by foreign authors related to Mexican institutions were obtained.

In the "Methodology" section, bibliometric methods are briefly reviewed. The "Results" section presents the evolution of publications by universities, a citation structure and an analysis of universities. The "Conclusions" section summarizes the main findings and conclusions of the study.

Over time, bibliometric studies have become very common in the literature, since through the application of mathematics and statistics, quantitative studies of bibliographic units published physically or electronically are carried out to understand the nature and course of a discipline (Broadus, 1987; Cancino et al., 2017; Prithchard, 1969).

However, over time, bibliometric studies have been used to explore, organize and analyze large amounts of historical information to find patterns that can help researchers to make decisions to understand previously analyzed information in different disciplines, including several in the area of economics (Bonilla et al., 2015; Carvalho et al., 2013; Chun-Hao and Jian-Min, 2012; Daim et al., 2006; Neely, 2005; Wagstaff and Culyer, 2012).

Specifically concerning innovation research, it is already possible to find studies that have based their analysis on bibliometric methodologies (Martin, 2012). Around the world, though the topic was previously overlooked, networks of researchers are now interacting and collaborating on innovation research. One of the recent studies belongs to Cancino et al., (2017). In their results, they show a greater concentration of publications on this subject from American universities, which are published in leading management magazines. In addition, Fagerberg et al., (2012) describes the increase in innovation studies from the 1950s, which is divided into three stages in which each one of them shows a different degree of evolution in field research, going from conducting studies focused on economic and social aspects to the association of specialized professionals for the development of the discipline. Now, the studies generated around the topic of innovation involve the particularities of the region and have multidisciplinary natures (Cancino et al., 2017).

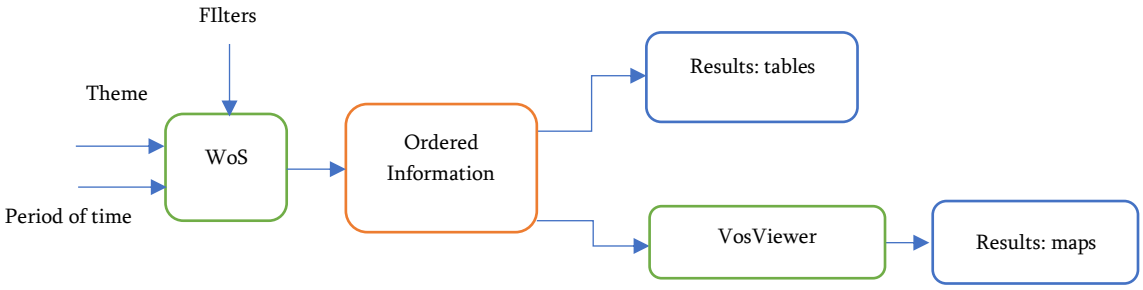
2. METHODOLOGY

Some bibliometric studies have focused on counting numbers of publications, which measures the productivity of authors and universities; however, an optimal analysis implies the evaluation of the influence of groups of articles written by authors or universities through a citation analysis. The h-index is an indicator that shows the number of studies that received a certain number of citations, which allows a study to be carried out while jointly considering the parameters of the number of articles and the number of citations (Cancino et al., 2017).

The development of specialized databases such as the Web of Science (WoS) allows the acquisition of research information in a simple way, which has made bibliometric studies more popular in the literature (Merigó et al., 2015). For this work, the WoS database was used to collect information on research on innovation in Mexico, the authors and universities conducting these studies, as well as the journals that publish the studies. This tool is used due to the vast content of articles available, which are classified into 250 categories and 150 research areas (Cancino et al., 2017).

The information for this work was collected during January and February 2019, considering all the articles published in academic journals registered in the WoS. The use of WoS facilitates the curation of the information by providing filtering tools, which allow data to be obtained on indexed scientific publications with specific characteristics. This filtering allows the establishment of relationships and identification of relevant information on a research topic. The data collection process in this study was carried out as follows. Initially, the data were filtered by the word innovation; additionally, a series of filters was generated, first for a range of time between 1980 and 2018, and later limiting studies only to those with production related to Mexico, either as first authors, co-authors, Mexican universities or foreign universities with Mexican collaborators. This was achieved by choosing only "Mexico" in the filter by country option of the database. Once the required data had been obtained, the information was arranged in tables. VosViewer software was also used to graphically analyze the information through the construction of a heat map where the words are shown most frequently in the articles related to the topic of innovation and a relationship map that shows the groups of authors of articles with less than ten co-authored researchers. This process is summarized in a flow chart (Figure 1).

FIGURE 1 FLOW CHART OF THE PROCESS FOR OBTAINING THE RESULTS.



Source: Own elaboration

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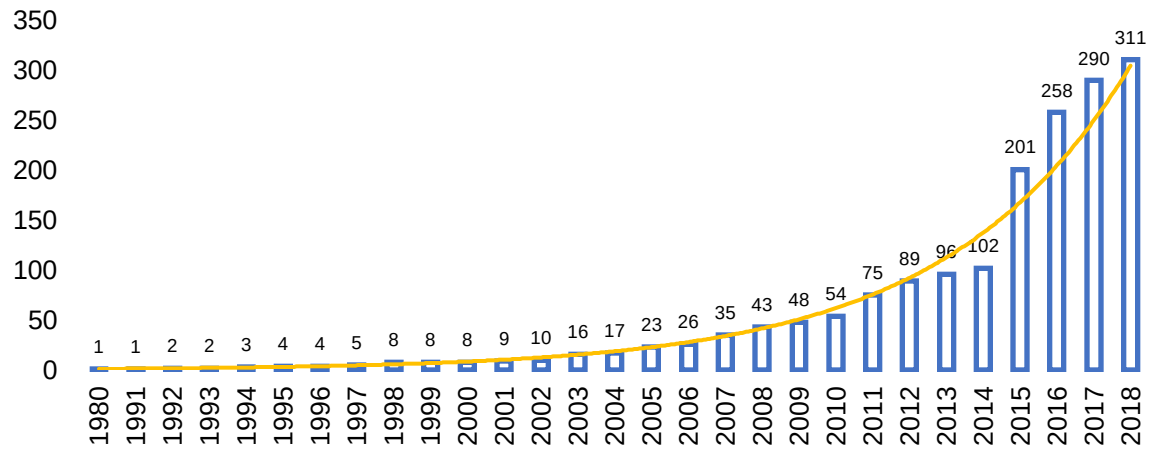
3. RESULTS

This section presents the results of the work. First, the behavior of publications related to Mexico on the subject of innovation was analyzed. According to the results obtained, it is observed that there has been a gradual increase in scientific production around the subject of innovation in Mexico, gaining strength from the year 2010, the year in which increases began to be noted, and a particular increase was observed from 2014 to 2018 (Figure 2). During this period of time, a total of 1749 articles were written, of which 1476 were published after 2010; however, only 22% of articles had 10 citations or more (Table 1).

The citations of the documents published during this period of time began in 1995 and reached a very high number in 2004, representing a boom in the subject within the academic field and reaching the highest number of citations during 2012.

FIGURE 2. NUMBER OF ANNUAL PUBLICATIONS IN THE WOS FROM 2010 TO 2018.



Source: Own elaboration from the information obtained in the WoS. Number of annual posts in the WoS from 2010 to 2018

TABLE 1. GENERAL STRUCTURE OF CITATIONS IN THE WOS QUANTITATIVE RESEARCH

Citations	Full period of time		2010-2018	
	Number of articles	%Articles	Number of articles	%Articles
≥100	34	2%	16	1%
≥50	74	4%	41	3%
≥10	389	22%	256	17%
<10	1360	78%	1220	83%
Total	1749	100%	1476	100%

Source: Own elaboration from the information obtained in the WoS. Citations: Base number under which the number of articles that have that number of citations are counted. Number of articles: number of articles that have the number of citations indicated in the group. % Articles: Percentage of articles that represents the number of articles contained in the indicated group.

However, according to the number of citations of the articles in proportion to the number of articles published in a year, the year 2004 had the best ratio, while there was a considerable drop in 2018.

The above shows a clear production of literature with a low level of impact within the academic world (Table 2). Among the most cited articles, it is found that most were produced after 2010 and dealt with topics in the area of natural sciences. The article with the highest number of citations was published in 2012 and currently has an average of 309 citations per year. It should be noted that most of the articles that occupy the first places on this list were written in collaboration with more than five authors, and when moving down the table, the number of collaborators is reduced to a maximum of two or three (Table 3).

Of the total articles published, the most productive authors on the subject of innovation were analyzed, and it is found that groups of authors formed research teams who continually publish together. It is also observed that only five authors reported a production greater than 10 articles, while the rest of the 25 most productive had only 8 articles on average. It is observed that the first five authors with the highest number of publications belong to the American continent, to Mexico mostly, while the next five are from the European continent.

TABLE 2. ANNUAL ANALYSIS OF PUBLICATIONS RELATED TO INNOVATION IN MEXICO ACCORDING TO THE WOS QUANTITATIVE ANALYSIS

Year	TP	TC	Avg. CP	≥100	≥50	≥10
1980	1	0	0	0	0	0
1991	1	0	0	0	0	0
1992	2	0	0	0	0	0
1993	2	0	0	0	0	0
1994	3	0	0	0	0	0
1995	4	89	22.25	0	1	2
1996	4	93	23.25	0	0	3
1997	5	146	29.20	1	0	3
1998	8	81	10.13	0	1	2
1999	8	83	10.38	0	0	3
2000	8	237	29.63	0	2	7
2001	9	479	53.22	2	0	4
2002	10	363	36.30	1	2	3
2003	16	949	59.31	2	0	6
2004	17	1416	83.29	3	5	13
2005	23	539	23.44	2	3	11
2006	26	679	26.12	2	5	13
2007	35	870	24.86	1	6	19
2008	43	712	16.56	2	3	17
2009	48	981	20.44	2	5	27
2010	54	838	15.52	1	3	20
2011	75	1567	20.89	5	9	37
2012	89	3291	36.98	2	6	33
2013	96	1932	20.13	5	7	31
2014	102	1470	14.41	2	0	28
2015	201	1894	9.42	1	7	41
2016	258	1423	5.52	0	4	46
2017	290	829	2.86	0	4	15
2018	311	288	0.93	0	1	5
Total	**1749**	**21249**	**595.01**	**34**	**74**	**389**
%	**100.00%**			**1.94%**	**4.23%**	**22.24%**

Sources: Own elaboration from the information obtained in WoS. Year: year of publication, TP: Total publications, TC: Total citations, Avg. CP: Average citations per publication.

The lack of relationship between the number of publications and the authors' h-index is shown since the author with the highest number of published articles is not the one with the highest impact index (Table 4).

Of the most productive universities, the National Autonomous University of Mexico stands out, with more than 200 articles, followed by the Tecnológico de Monterrey, with more than 100; the first is the main public university in the country, and the second is its counterpart among the private

institutes (Table 5). Moreover, in this table, most of the universities included are Mexican; thus, it is concluded that foreign authors are those who are linked to Mexican institutions.

TABLE 3. THE 15 MOST CITED ARTICLES IN QUANTITATIVE RESEARCH IN THE WOS.

	Title	Author	TC	Year	C/Y
1	"Guidelines for the use and interpretation of assays for monitoring autophagy"	DJK, et al.	2163	2012	309.00
2	"Phylogenomics resolves the timing and pattern of insect evolution"	MB, et. al.	749	2014	149.80
3	"Recent advances in removing phosphorus from wastewater and its future use as fertilizer (1997-2003)"	LEB, et al.	717	2004	47.80
4	"Beans (Phaseolus spp.) - model food legumes"	WJB, et al.	533	2003	33.31
5	"The IPBES Conceptual Framework - connecting nature and people"	DS, et al.	383	2015	95.75
6	"A randomised, double-blind, parallel-group study to demonstrate equivalence in efficacy and safety of CT-P13 compared with innovator infliximab when coadministered with methotrexate in patients with active rheumatoid arthritis: the PLANETRA study"	DHY, et al.	317	2013	52.83
7	"Predicting distributions of known and unknown reptile species in Madagascar"	CJR, et al.	309	2003	19.31
8	"A randomised, double-blind, multicentre, parallel-group, prospective study comparing the pharmacokinetics, safety, and efficacy of CT-P13 and innovator infliximab in patients with ankylosing spondylitis: the PLANETAS study"	WP, et al.	293	2013	48.83
9	"The conservation status of the world's reptiles"	BM, et al.	292	2013	48.67
10	"Integrating seaweeds into marine aquaculture systems: A key toward sustainability"	TC, et al.	282	2001	15.67
11	"Business Model Innovation through Trial-and-Error Learning The Naturhouse Case"	SM, et al.	238	2010	26.44
12	"Exactly integrable nonlinear Schrodinger equation models with varying dispersion, nonlinearity and gain: Application for soliton dispersion managements"	VNS, et al.	199	2002	11.71
13	"Transportation of heavy and extra-heavy crude oil by pipeline: A review"	RMP, et al.	194	2011	24.25
14	"Revision of Begomovirus taxonomy based on pairwise sequence comparisons"	JKB, et al.	188	2015	47.00
15	"Conservation Agriculture and Soil Carbon Sequestration: Between Myth and Farmer Reality"	GB, et al.	186	2009	18.60

Source: Own elaboration from the information obtained in the WoS. Title: article title, Author: article author, TC: Total Citations, Year: year of publication, C/Y: reason for citations per year.

TABLE 4. THE 50 AUTHORS WITH THE HIGHEST PRODUCTION IN QUANTITATIVE RESEARCH IN THE WOS

	Author	University	Country	TP	TC	TC ws	Avg.TC	Avg. TC ws	H	≥100	≥50	≥10
1	Dutrenit G	UAM	MEX	16	182	168	11.38	10.50	7	0	1	4
2	Frenk J	UM	EUA	12	664	654	55.33	54.50	10	3	6	11
3	Reynoso J	ITESM	MEX	12	186	168	15.50	14.00	6	0	1	4
4	Castaneda-Hernandez G	IPN	MEX	11	73	65	6.64	5.91	5	0	0	2
5	Hellin J	CIMMYT	MEX	10	295	291	29.50	29.10	6	2	3	5
6	Castano Vm	UNAM	MEX	9	60	59	6.67	6.56	4	0	0	1
7	Bachert C	UDG	BEL	8	288	267	36.00	33.38	8	0	2	7
8	Bousquet J	ICN2	ESP	8	288	267	36.00	33.38	8	0	2	7
9	Demoly P	UHA	FRA	8	288	267	36.00	33.38	8	0	2	7
10	Kuna P	UŁ	POL	8	288	267	36.00	33.38	8	0	2	7
11	Mullol J	UB	ESP	8	288	267	36.00	33.38	8	0	2	7
12	Park W	UI	KOR	8	831	817	103.88	102.13	6	2	5	6
13	Passalacqua G	UGEN	ITA	8	288	267	36.00	33.38	8	0	2	7
14	Rosales-Mendoza S	UASLP	MEX	8	90	86	11.25	10.75	8	0	0	4
15	Samolinski B	UW	POL	8	288	267	36.00	33.38	8	0	2	7
16	Yoo Dh	HYU	KOR	8	831	817	103.88	102.13	6	2	5	6
17	Zermeno Mgg	ITESM	MEX	8	0	0	0.00	0.00	0	0	0	0
18	Zuberbier T	CI	GER	8	288	267	36.00	33.38	8	0	2	7
19	Aguilar-Avila J	CIESTAAM	MEX	7	24	20	3.43	2.86	2	0	0	1
20	Canonica Gw	IUHI	ITA	7	277	261	39.57	37.29	7	0	2	6
21	Chavannes Nh	RUL	NLD	7	275	259	39.29	37.00	7	0	2	6
22	Cruz Aa	UFB	BRA	7	275	259	39.29	37.00	7	0	2	6
23	Fonseca J	UPORTO	PRT	7	275	259	39.29	37.00	7	0	2	6
24	Gil-Garcia Jr	CIDE	MEX	7	142	141	20.29	20.14	4	1	0	2
25	Husted Bw	ITESM	MEX	7	218	217	31.14	31.00	4	1	1	3
26	Iqbal Hmn	ITESM	MEX	7	121	118	17.29	16.86	3	0	1	2
27	Klimek L	CRA	GER	7	243	228	34.71	32.57	7	0	2	6
28	Knaul Fm	HU	MEX	7	362	359	51.71	51.29	6	1	3	6
29	Lozano R	INSP	MEX	7	211	211	30.14	30.14	5	1	2	4
30	Muraro A	UP	ITA	7	279	263	39.86	37.57	7	0	2	7
31	Price D	ABERD	GBR	7	277	261	39.57	37.29	7	0	2	6
32	Sheikh A	EDIN	GBR	7	277	261	39.57	37.29	7	0	2	6
33	Valiulis A	VU	LTU	7	275	259	39.29	37.00	7	0	2	6

34	Valovirta E	UTU	FIN	7	275	259	39.29	37.00	7	0	2	6
35	Wickman M	UU	SWE	7	275	259	39.29	37.00	7	0	2	6
36	Arnavielhe S	KYOINN	FRA	6	199	187	33.17	31.17	6	0	2	5
37	Bedbrook A	UMONT	FRA	6	199	187	33.17	31.17	6	0	2	5
38	Bergmann Kc	HUB	GER	6	199	187	33.17	31.17	6	0	2	5
39	Bewick M	IQ4U	GRB	6	167	155	27.83	25.83	6	0	1	5
40	Custovic A	UMAN	GRB	6	167	155	27.83	25.83	6	0	1	5
41	De Fuentes C	MSMU	CAN	6	118	113	19.67	18.83	4	0	1	2
42	De Sousa Jc	UMI	PRT	6	230	219	38.33	36.50	6	0	2	5
43	Devillier P	UFR	FRA	6	201	189	33.50	31.50	6	0	1	5
44	Fokkens Wj	KYOINN	FRA	6	199	187	33.17	31.17	6	0	2	5
45	Haahtela T	HY	FIN	6	199	187	33.17	31.17	6	0	2	5
46	Hellings Pw	UCL	BEL	6	167	155	27.83	25.83	6	0	1	5
47	Just J	APHP	FRA	6	167	155	27.83	25.83	6	0	1	5
48	Keil T	FUB	GER	6	199	187	33.17	31.17	6	0	2	5
49	Larenas-Linnemann D	CEAA	MEX	6	288	267	48.00	44.50	6	0	2	6
50	Lee Sj	SNU	KOR	6	713	706	118.83	117.67	4	2	3	4

Source: Own elaboration from the information obtained in WoS. University: University to which the author belongs (U.), Country: Country of collaboration of the author, TP: Total articles published, TC: Total citations published, TC ws: Total citations without self-citations, Avg. TC: Reason of total citations per article, Avg. TC ws: Ratio of total citations without self-citation H: h-index. APHP: Paris Public Assistance Hospital, CEAA: Center for Asian and African Studies, CI: Cumberland Infirmary, CIDE: Center for Economic Research and Teaching, CIESTAAM: Center for Economic, Social and Economic Research Technologies of Agribusiness and World Agriculture, CIMMYT: International Maize and Wheat Improvement Center, CRA: Clinical Research Association, EDIN: University of Edinburgh, FUB: Free University of Berlin, HABERD: University of Aberdeen, HU: Harvard University, HUB: University of Humbolt, HY: University of Helsinski, HYU: Hanyang University, ICN2: Catalan Institute of Nanoscience and Nanotechnology, INSP: National Institute of Public Health, IPN: National Polytechnic Institute, IQ4U: IQ4U Consultores, ITESM: Technological and Higher Studies Institute of Monterrey, IUHI: Instituto Universitario Hospital Italiano, KYOINN: KYomed Innovation, MSMU: Mount St. Mary's University, RUL: University of Leiden, SNU: National University l of Seoul, UAM: Metropolitan Autonomous University, UASLP: Autonomous University of San Luis Potosí, UB: University of Barcelona, UCL: Catholic University of Leuven, UDG: University of Ghent, UFB: Federal University of Brazil, UFR: University of Paris - Sclay, UGEN: University of Genoa, UHA: Humanist University of the Americas, UI: INHA University, UL: University of Lodz, UM: University of Michigan, UMAN: University of Manchester, UMI: University of Miño, UMONT: University of Montpellier, UNAM: National Autonomous University of Mexico, UP: University of Padua, UPORTO: University of Porto, UTU: University of TURKU, UU: University of Uppsala, UW: University of Warsaw, VU: University of Vilna.

TABLE 5. THE 44 UNIVERSITIES WITH THE HIGHEST PRODUCTION IN QUANTITATIVE RESEARCH IN THE WOS.

	Institution	Country	TP	TC	H	C/P	≥100	≥50	≥25	ARWU 2018	QS 2018
1	UNAM	MEX	266	3567	23	13.41	5	13	23	201-300	122
2	ITESM	MEX	139	855	13	6.15	2	3	9	-	199
3	IPN	MEX	84	2563	10	30.51	1	2	4	-	651-700
4	UDEG	MEX	56	975	9	17.41	1	2	2	-	801-1000
5	UAEM	MEX	46	318	9	6.91	1	0	5	-	801-1001
6	UASLP	MEX	33	312	9	9.45	0	1	3	-	-
7	UABC	MEX	31	338	5	10.90	1	1	1	-	-
8	NIPH	MEX	28	433	11	15.46	1	3	4	-	-
9	UANL	MEX	28	265	10	9.46	0	0	3	-	801-1000
10	INSP	MEX	27	310	9	11.48	0	2	4	-	-
11	UAM	MEX	24	79	4	3.29	0	0	0	-	751-800
12	UG	MEX	23	80	5	3.47	0	0	0	-	-
13	UADY	MEX	22	160	5	7.27	0	1	3	-	-
14	USP	BRA	21	3401	12	161.95	4	8	9	151-200	121
15	UV	MEX	21	87	6	4.14	0	0	0	-	-
16	UAMI	MEX	19	132	5	6.94	0	1	1	-	-
17	UAMX	MEX	19	161	7	8.47	0	0	3	-	-
18	UAQ	MEX	19	315	7	16.57	1	2	4	-	-
19	CIMMYT	MEX	18	674	10	37.44	2	4	8	-	-
20	CINVESTAV	MEX	18	249	5	13.83	1	1	1	-	-
21	IMWIC	MEX	18	363	6	20.17	2	3	4	-	-
22	UAEH	MEX	18	27	3	1.50	0	0	0	-	-
23	UNISON	MEX	18	56	4	3.11	0	0	0	-	-
24	CIDE	MEX	17	203	4	11.94	1	2	2	-	-
25	UH	USA	17	2855	11	167.94	2	5	7	1	3
26	UDLAP	MEX	17	115	6	6.76	0	0	1	-	801-1000
27	UA	MEX	17	2763	13	162.52	2	4	7	-	-

28	UACH	MEX	17	48	3	2.82	0	0	1	-	-
29	COLPOS	MEX	16	80	4	5.00	0	0	1	-	-
30	UAEMOR	MEX	16	142	7	8.87	0	0	1	-	-
31	BUAP	MEX	15	223	4	14.87	1	1	1	-	801-1000
32	UB	ESP	15	2427	8	161.8	1	3	4	151-200	156
33	ITAM	MEX	14	104	4	7.42	0	1	1	-	651-700
34	UDEC	MEX	14	70	3	5.00	0	0	1	-	-
35	UMSNH	MEX	14	37	3	2.64	0	0	0	-	-
36	UO	GBR	14	2897	9	206.92	2	6	7	7	6
37	ININ	MEX	13	79	6	6.07	0	0	0	-	-
38	IK	SWE	13	2606	11	200.46	1	4	7	44	-
39	US	AUS	13	2910	9	223.84	2	6	7	68	50
40	IMSS	MEX	12	256	7	21.33	0	2	4	-	-
41	UCL	BEL	12	2583	9	215.25	2	3	5	86	71
42	USDC	USA	12	2373	6	197.75	1	3	3	15	38
43	UL	CAN	12	3147	8	262.25	2	4	5	201-300	378
44	UPV	ESP	12	94	4	7.83	0	2	2	401-500	373

Source: Own elaboration from the information obtained in WoS. TP: Total articles published, TC: Total citations published, H: h-index, C/P: Reason of citations per article. BUAP: Meritorious Autonomous University of Puebla, CIDE: Center for Economic Research and Teaching, CIMMYT: International Center for Corn and Wheat Improvement, CINVESTAV: Center for Research and Studies Avanzados del Instituto Politécnico Nacional, COLPOS: Colegio de Postgraduados, HU: Harvard University, IK: Instituto Karlinska, IMSS: Instituto Mexicano del Seguro Social, IMWIC: International Maize and Wheat Improvement Center, ININ: Instituto Nacional de Investigaciones Nucleares, INSP: National Institute of Public Health, IPN: National Polytechnic Institute, ITAM: Instituto Tecnológico Autónomo de México, ITESM: Instituto Tecnológico y de Estudios Superiores de Monterrey, NIPH: National Institute of Public Health, UA: University of Arizona, UABC: Autonomous University of Baja California, UACH: Universidad Autónoma de Chapingo, UADY: Universidad Autónoma de Yucatán, UAEH: Universidad Autónoma del Es tado de Hidalgo, UAEM: Autonomous University of the State of Mexico, UAEMOR: Autonomous University of the State of Morelos, UAM: Metropolitan Autonomous University, UAMI: Iztapalapa Metropolitan Autonomous University, UAMX: Xochimilco Metropolitan Autonomous University, UANL: Nuevo León Autonomous University, UAQ: Autonomous University of Querétaro, UASLP: Autonomous University of San Luis Potosí, UB: University of Barcelona, UCL: Catholic University of Leuven, UDEC: University of Colima, UDEG: University of Guadalajara, UDLAP: University of the Americas Puebla, UG : University of Guanajuato, UL: Laval University, UMSNH: Michoacan University of San Nicolás de Hidalgo, UNAM: National Autonomous University of Mexico, UNISON: University of Sonora, UO: University of Oxford, UPV: Polytechnic University of Valencia, US: University from Sydney, USDC: University of San Diego California, USP: University of Sao Paulo, UV: Universidad Veracruzana.

The most cited article of the first fifteen authors is shown in the following table (Table 6). According to the titles of the publications, it is also notable that most of them correspond to the medical field. Bousquet is also present in five of these publications over a period of two years between 2015 and 2017, which places him as the author with the highest production and with the highest number of highly cited articles. Similarly, it stands out that the most cited articles by the authors with the highest production are concentrated between the years 2012 and 2017. When relating this period with the information presented in Figure 1, a possible coincidence between the increase in interest in the innovation theme and the number of citations observed in the articles is observed. This possible relationship should be studied in future works. The nationalities of these researchers are diverse; however, the most productive associations are with groups from the United States, Spain and England (Table 7). It is likely that this situation is due to linguistic barriers with the rest of the countries since speaking English as a second language is a requirement for Mexican researchers. Countries such as Denmark and Lithuania stand out as having fairly high proportions of papers per inhabitant, and the fact that they are small countries stands out. Both countries have articles with more than fifty citations, which indicates that scientific production in the area of innovation has an impact on the academic environment.

TABLE 6. THE MOST CITED ARTICLES OF THE 15 AUTHORS WITH THE MOST PRODUCTION.

	Article	Author/Year
1	"Best channels of academia-industry interaction for long-term benefit"	C De Fuentes y Dutrenit, 2012
2	"Health system reform in Mexico 1 - Comprehensive reform to improve health system performance in Mexico"	Frenk et al., 2006
3	"Shaping, organizing, and rethinking service innovation: a multidimensional framework"	Rubalcaba et al., 2012
4	"Biopharmaceuticals for rheumatic diseases in Latin America, Europe, Russia, and India: Innovators, biosimilars, and intended copies"	Castaneda-Hernandez et al., 2014
5	"Improving market access and agricultural productivity growth in Africa: what role for producer organizations and collective action institutions?"	Shiferaw et al., 2011
6	"Covalently Bonded Chitosan on Graphene Oxide via Redox Reaction"	Bustos-Ramirez et al., 2013
7	"Information networks that generate economic value: A study on clusters of adopters of new or improved technologies and practices among oil palm growers in Mexico"	Aguilar-Gallegos et al., 2015
8	"Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines-2016 revision"	Brozek et al., 2017
9	"MACVIA-ARIA Sentinel NetworK for allergic rhinitis (MASK-rhinitis): the new generation guideline implementation"	Bousquet et al., 2015
10	"MACVIA clinical decision algorithm in adolescents and adults with allergic rhinitis"	Bousquet, Schunemann, et al., 2016
11	"ARIA 2016: Care pathways implementing emerging technologies for predictive medicine in rhinitis and asthma across the life cycle"	Bousquet, Hellings, et al., 2016
12	"Scaling up strategies of the chronic respiratory disease programme of the European Innovation Partnership on Active and Healthy Ageing (Action Plan B3: Area 5)"	Bousquet, Farrell, et al., 2016
13	"A randomised, double-blind, parallel-group study to demonstrate equivalence in efficacy and safety of CT-P13 compared with innovator infliximab when coadministered with methotrexate in patients with active rheumatoid arthritis: the PLANETRA study"	Yoo et al., 2013
14	"CHRODIS criteria applied to the MASK (MACVIA-ARIA Sentinel NetworK) Good Practice in allergic rhinitis: a SUNFRAIL report"	Bousquet et al., 2017
15	"Over-expression of Dof-type transcription factor increases lipid production in Chlamydomonas reinhardtii"	Ibanez-Salazar et al., 2014

Source: Own elaboration from the information obtained in the WoS. Article: Most cited article, Author/Year: Author and year of publication.

TABLE 7. THE MOST PRODUCTIVE COUNTRIES INVOLVED ACCORDING TO THE WOS QUANTITATIVE RESEARCH.

	Country	TP	TC	H	C/P	≥250	≥100	≥50	Population	P/Po	C/Po
1	MEX	1749	21551	64	12.32	10	35	82	129.16	13.54	166.85
2	USA	306	10641	42	34.78	9	17	37	325.72	0.94	32.67
3	SPA	206	5605	28	27.21	3	8	21	46.57	4.42	120.35
4	ENG	92	5231	23	56.86	4	6	13	54.79	1.68	95.47
5	FRA	88	4435	23	50.39	3	4	14	67.12	1.31	66.08
6	CAN	82	5592	26	68.19	5	6	19	36.71	2.23	152.34
7	BRA	72	4179	19	58.04	3	5	12	209.29	0.34	19.97
8	GER	69	5552	24	80.46	6	6	17	82.69	0.83	67.14
9	COL	55	1962	17	35.67	3	4	9	49.07	1.12	39.99
10	ITA	51	3832	18	75.14	3	3	10	60.55	0.84	63.29
11	SWI	47	4845	26	103.09	4	5	16	8.47	5.55	572.29
12	ARG	40	3442	15	86.05	3	3	6	44.27	0.90	77.75
13	NET	40	3005	17	75.13	1	1	6	4.81	8.31	624.27
14	PEO	40	4612	18	115.30	4	5	11	1386.39	0.03	3.33
15	AUS	39	4755	19	121.92	4	6	14	24.59	1.59	193.30
16	CHI	36	4317	21	119.92	5	6	14	18.06	1.99	239.11
17	SWE	32	3798	14	118.69	4	4	9	10.07	3.18	377.24
18	BEL	31	3738	15	120.58	3	4	7	11.37	2.73	328.70
19	DEN	28	4320	14	154.29	4	4	11	5.77	4.85	748.75
20	IND	25	3451	11	138.04	3	4	7	1339.18	0.02	2.58
21	POL	25	3842	15	153.68	4	4	10	37.98	0.66	101.17
22	AUS	24	3654	13	152.25	3	3	5	8.81	2.72	414.79
23	SOU	24	4032	16	168.00	4	5	12	51.47	0.47	78.34
24	FIN	21	2900	13	138.09	2	2	6	5.51	3.81	526.19
25	JAP	21	4516	15	215.05	4	6	11	126.79	0.17	35.62
26	POR	21	2639	11	125.67	1	1	4	10.29	2.04	256.37
27	SCO	21	3261	14	155.29	2	3	8	5.37	3.91	606.92
28	VEN	21	641	9	30.52	1	1	3	31.98	0.66	20.05
29	GRE	17	3733	13	219.59	3	3	7	10.76	1.58	346.92
30	SOU	17	3574	13	210.24	3	5	8	56.72	0.30	63.01
31	TUR	17	3294	11	193.77	3	3	6	80.75	0.21	40.80
32	CZE	16	2790	10	174.38	2	2	4	10.59	1.51	263.42
33	PAK	15	562	8	37.47	0	1	4	197.02	0.08	2.85
34	SIN	15	2593	9	172.87	1	2	4	5.61	2.67	462.02
35	UKR	15	3316	11	221.07	3	3	9	44.83	0.33	73.97
36	URU	15	537	6	35.80	1	1	3	3.46	4.34	155.35
37	PER	14	1023	8	73.07	2	2	4	32.166	0.44	31.80
38	RUS	14	2879	11	205.64	2	2	5	144.49	0.10	19.92
39	ISR	13	3140	10	241.54	3	4	6	8.71	1.49	360.41

40	IRE	12	2541	9	211.75	1	1	4	4.81	2.49	527.88
41	MAL	12	884	6	73.67	2	2	4	31.62	0.38	27.95
42	NEW	12	4070	9	339.17	4	6	7	4.79	2.50	849.00
43	ECU	11	326	3	29.64	1	1	1	16.63	0.66	19.61
44	HUN	11	3008	10	273.46	2	3	5	9.78	1.12	307.53
45	ROM	11	558	8	50.73	1	1	3	19.59	0.56	28.49
46	COS	10	2342	5	234.20	1	1	2	4.91	2.04	477.40
47	CUB	10	326	3	32.60	1	1	1	11.485	0.87	28.39
48	ETH	10	587	5	58.70	1	1	3	104.96	0.10	5.59
49	LIT	10	2498	9	249.80	1	1	4	2.83	3.54	883.40
50	NOR	10	2548	8	254.80	1	1	4	5.28	1.89	482.37

Source: Own elaboration from the information obtained in the WoS. TP: Total of articles, TC: Total of citations, H: h-index, C/P: Reason of citations per article, Population: Population number of the country, P/Po: Ratio of total articles by population, C/Po: Ratio of total citations by population.

The area with the highest production in the subject of innovation is business research, followed by engineering (Table 8). This suggests that research on product innovation contained in the area of engineering is not actually the most important.

TABLE 8. THE 25 RESEARCH AREAS WITH THE GREATEST PRODUCTION IN QUANTITATIVE RESEARCH IN THE WOS.

	Research Area	Total Studies
1	Business Economics	284
2	Engineering	187
3	Education Educational Research	155
4	Environmental Sciences Ecology	127
5	Science Technology Other Topics	88
6	Agriculture	85
7	Computer Science	85
8	Social Sciences Other Topics	85
9	Public Administration	68
10	Public Environmental Occupational Health	59
11	Chemistry	57
12	Food Science Technology	50
13	Materials Science	47
14	Information Science Library Science	39
15	Biotechnology Applied Microbiology	38
16	Energy Fuels	37
17	Pharmacology Pharmacy	33
18	Plant Sciences	33
19	General Internal Medicine	32
20	Government Law	32
21	Biochemistry Molecular Biology	29
22	Physics	28
23	Development Studies	25
24	Communication	24
25	Water Resources	24

Source Own elaboration from the information obtained in the WoS. Research area: Study area to which the articles belong, Total studies: Number of published articles.

It is also observed that innovation research in government is in last place among the investigated areas, which reflects the reality of the country. Particularly for the area of Business Economics, the area with the highest number of publications on the topic of innovation in Mexico, once again, the author with the most publications is Dutrenit; however, only six of their twelve articles are classified in this category area, namely, “What hinders innovation performance or services and manufacturing firms in Mexico?”, “Determinants of Innovation and Productivity in the Service Sector in Mexico”, “Economic growth, innovation and inequality in Latin America: improvements, setbacks and pending issues post-Washington Consensus”, “Coevolution, emergence and economic development: some lessons from the Israeli and Mexican experience”, “Premises and Instruments of Innovation Policy: A Reflection from the Mexican Case” and “Technological profile of Mexican Industry and its dynamics of innovation during the eighties” (Claudia De Fuentes et al., 2015; G Dutrenit, 2009; G Dutrenit et al., 2014; G Dutrenit and Teubal, 2011; Gabriela Dutren it and Capdevielle, 1993; Santiago et al., 2017).

The next four most productive authors are not in less important positions in the general table (Table 9); however, their works are the most relevant in the Business and Economics section. Husted stands out for his articles "Opportunity, Discovery and creation in social entrepreneurship: An exploratory study in Mexico", "Sustainability Strategy in Constrained Economic Times", "Value Creation Through Social Strategy", "Strategic corporate social responsibility and value creation among large firms - Lessons from the Spanish experience” and “Corporate social strategy in multinational enterprises: Antecedents and value creation” (Barnett et al., 2015; Gonzalez et al., 2017; Husted et al., 2015; Husted and Allen, 2007b, 2007a). Belausteguigoitia and De Clercq are located in the third and fourth positions of the ranking, coauthoring the articles “The Usefulness of Tenacity in Spurring Problem-Focused Voice: The Moderating Roles of Workplace Adversity”, “Perceptions of Adverse Work Conditions and Innovative Behavior: The Buffering Roles of Relational Resources”, “Intergenerational strategy involvement and family firms' innovation pursuits: The critical roles of conflict management and social capital” and “Entrepreneurial Initiative Selling within Organizations: Towards a More Comprehensive Motivational Framework” (De Clercq et al., 2011, 2016; De Clercq and Belausteguigoitia, 2015, 2017).

Corona is the fifth most productive author in this area, with four articles in the ranking, with the publications “The key elements of innovation infrastructure and the evolution of knowledge regions: a framework for analysis”, “US technology infrastructure and the development of regional innovation poles through incubation mechanisms”, “Mexico: the challenge to create regional innovative environments” and “Canada's innovation poles and their role as technology incubation scapes” (Corona et al., 2006b, 2006c, 2006a; Corona and Doutriaux, 2006).

TABLE 9. GENERAL TABLE OF PUBLISHED ARTICLES ON INNOVATION THAT CORRESPOND TO THE BUSINESS AND ECONOMICS AREAS.

	Year	TP	Author	TP	Country	TP	Source	TP		TP
1	2018	42	Dutrenit G	6	MEX	284	ETE	12	UNAM	23
2	2017	36	Husted Bw	5	ESP	39	EG	9	ITESM	21
3	2016	25	BelausteguigoitiaI	4	USA	23	IE	8	IPN	8
4	2015	28	Corona L	4	GBR	18	TF&SC	7	CIDE	7
5	2014	12	De Clercq D	4	CAN	14	ARLA	5	ITAM	7
6	2013	6	De Lema Dgp	4	COL	6	DE	5	EGADE	6
7	2012	9	Doutriaux J	4	FRA	5	JBR	5	IEU	5
8	2011	8	Guerrero M	4	ARG	3	RBGN	5	UDLAP	5
9	2010	4	Mian Sa	4	DEU	3	ECORFAN	5	UABC	5
10	2009	9	Reynoso J	4	IRL	3	BKRNA	4	UDEG	5
11	2008	8	Urbano D	4	ITA	3	EP	4	BANXICO	4
12	2007	7	Allen Db	3	PAN	3	FIR	4	BROCKU	4
13	2006	4	Cypher Jm	3	SWE	3	JEI	4	IE	4
14	2005	-	De Fuentes C	3	IND	2	MD	4	SUNY	4
15	2004	1	Kawalek P	3	CHE	2	PORTES	4	UAM	4
16	2003	-	Lloret A	3	BOL	1	RCS	4	UAMX	4
17	2002	1	Lorenzo O	3	CHL	1	U&E	4	UC	4
18	2001	3	Unger K	3	CRI	1	WD	4	UDEC	4
19	2000	-	Wharton L	3	CZE	1	AD	3	UG	4
20	1999	1	Aguilar-Avila J	2	ETH	1	EI&T	3	UOTTAWA	4
21	1998	1	Bolivar Hr	2	IDN	1	INNOVAR	3	ALLIANCEMBS	3
22	1997	1	Campos Hm	2	ISR	1	KG&p	3	UDBS	3
23	1996	1	Castillo A	2	KEN	1	LRP	3	FOUR23	3
24	1995	-	Diaz-Pichardo R	2	KWT	1	REH	3	IAE	3
25	1994	-	Edvardsson B	2	NLD	1	RF	3	IESA	3
26	1993	3	Flores D	2	NOR	1	3C	2	LYTI	3
27	-	-	Gajon E	2	CHN	1	AGE	2	LBORO	3
28	-	-	Gama A	2	SVK	1	AE	2	NU	3
29	-	-	Gras N	2	WAL	1	AQLR	2	MSMU	3
30	-	-	Herrera F	2	-		EE	2	UB	3
31	-	-	Merino L	2	-		EI&SE	2	UACH	3
32	-	-	Michel Al	2	-		FUT	2	UAT	3
33	-		Moreno-Brid Jc	2	-		JBE	2	IBERO	3
34	-	-	Munoz-Rodriguez M	2	-		JIK	2	UPAN	3
35	-	-	Ochoa Jn	2	-		JISIB	2	UPCT	3
36	-	-	Padilla-Perez R	2	-		JKE	2	UNISON	3

37	-	-	Parker Sw	2	-	NISSI	2	BUAP	2
38	-	-	Sanchez-Medina Ps	2	-	AHTSI	1	COLEF	2
39	-	-	Santiago F	2	-	ASEIEG	1	COLMEX	2
40	-	-	Scalzo G	2	-	AEZ	1	CEPAL	2
41	-	-	Suarez-Barraza Mf	2	-	ARS	1	GESCT	2
42	-	-	Troncoso K	2	-	BEJTE	1	ITSON	2
43	-	-	Acosta As	1	-	BHR	1	CIMMYT	2
44	-	-	Acosta-Alvarado M	1	-	BH	1	KU	2
45	-	-	Acosta-Gonzaga E	1	-	BRMJ	1	-	
46	-	-	Agarwal N	1	-	BIS	1	-	
47	-	-	Agudo Jc	1	-	CJAS	1	-	
48	-	-	Aguilar-Gallegos N	1	-	CIREC	1	-	
49	-	-	Aigner Dj	1	-	C&C	1	-	
50	-	-	Akbar Yh	1	-	CR	1	-	

Source Own elaboration from the information obtained in WoS. TP: Total articles 3C: 3c Company, AD: Ad Minister, AE: Applied economics, AEZ: Agricultural economics-Zemedelska Ekonomika, AGE: Agricultural economics, AHTSI: Advances in hotel tourism and the service industry, AQLR: Application of quality of life Best research practices, ARLA: Academia Revista Latinoamericana de Administración, ARS: Annals of Regional Science, ASEIEG: Advances In The Study of Entrepreneurship Innovation and Economic Growth, BEJTE: BE Journal of Theoretical Economics, BH: Business Horizons, BHR: Business History Review, BIS: Business & Society, BKRNA: Building Knowledge Regions In North America Emerging Technology Innovation Poles, BRMJ: Business Process Management Journal, C&C: Competition & Change, CIRIEC: Ciriec España Revista de Economia Publica Social y Cooperativa, CJAS: Canadian Journal of Administrative Sciences Revue Canadienne des Sciences de la Administration, CR: Competitiveness Review, DE: Business dimension, ECORFAN: Ecorfan Magazine, EE: Ecological Economics, EG: Management Studies, EI&SE: Best practices and implications for the quality of life of innovative and sustainable business ecosystems, EI&T: Business innovation and technology A Guide to Core Models and Tools, EP: Energy policy, ETE: Economic Quarter, FIR: Faedpyme International Review Fir, FUT: Futures, IE: Economic Research, INNOVATE: Innovate Revista de Ciencias Administrativas y Sociales, JBE: Journal of Business Ethics, JBR: Journal of Business Research, JEI: Journal of Economic Issues, JIK: Journal of Knowledge Innovation, JISIB: Journal of Business Intelligence Studies, JKE: Knowledge Economy Journal, KG&P: Knowledge Generation and Protection, LRP: Long-Term Planning, MD: Management Decision, NISSI: National Systems of Innovation, Inclusion and Social Development The Latin American Experience, PORTES: Portes Mexican Journal of Studies on the Pacific Basin, RBGN: Brasileira Magazine de Gestao de Negocios, RCS: Social Science Magazine, REH: Business and Humanism Magazine, RF: Routledge Focus, TF&SC: Technological Projection and Social Change, U&E: Business University Magazine, WD: World Development. ALLIANCEMBS: Alliance manchester business school, BANXICO: Banco de México, BROCKU: Brock University, BUAP: Benemérita Universidad Autónoma de Puebla, ECLAC: Economic Commission for Latin America and the Caribbean, CIDE: Center for Economic Research and Teaching, CIMMYT: International Center of Corn and Wheat Improvement, COLEF: Colegio de la Frontera Norte, COLMEX: Colegio México, EGADE: Egade Business School, FOUR23: FOUR23 Studio, GESCT: Groupe ESC Troyes en Champagne, IAE: IAE Bussines School, IBERO: Universidad Iberoamericana, IE: ie Business School, IESA: Instituto de Estudios Superiores de Administración, IEU: Instituto Empresa, IPN: Instituto Politécnico Nacional, ITAM: Instituto Tecnológico Autónomo de México, ITESM: Instituto Tecnológico y de Estudios Superiores de Monterrey, ITSON: Instituto Tecnológico de Sonora, KU: Karlstad University, LBORO: Loughborough University, LYIT: Letterkenny Institute of Technology, MSMU: Mount St. Mary's University, NU: University No rthum bria, SUNY: State University of New York, UABC: Universidad Autónoma de Baja California, UACH: Universidad Autónoma de Chapingo, UAM: Universidad Autónoma Metropolitana, UAMX: Universidad Autónoma Metropolitana Xochimilco, UAT: Universidad Autónoma de Tamaulipas, UB: Universidad de Barcelona, UC: University of Cantabria, UDBS: Deusto Business School, UDEC: University of Colima, UDEG: University of Guadalajara, UDLAP: University of the Americas Puebla, UG: University of Guanajuato, UNAM: National Autonomous University of Mexico, UNISON: University of Sonora, UOTTAWA: University of Ottawa, UPAN: Universidad Panamericana, UPCT: Universidad Politécnica de Cartagena.

TABLE 10. THE 25 JOURNALS WITH THE MOST PUBLICATIONS ACCORDING TO QUANTITATIVE RESEARCH OF THE WOS WITHIN THE JCR CATALOG, PART 1.

No	Journal	TP	TC	H	C/P	≥100	≥50	≥25	≥10	≥5	≥1	Country	Índice H	Quartile	Total Citation
1	SPP	26	241	9	9.27	0	1	4	8	10	20	MEX	46	3	1,787
2	GPP	14	21	3	1.50	0	0	0	0	0	10	MEX	6	4	86
3	JCP	14	135	7	9.64	0	0	0	5	8	14	NLD	132	1	45,454
4	ETE	12	11	2	0.92	0	0	0	0	0	4	MEX	9	4	124
5	SUS	11	16	2	1.46	0	0	0	0	1	5	CHE	42	2	8904
6	GMM	10	7	2	0.70	0	0	0	0	0	5	MEX	18	4	426
7	INT	10	10	2	1.00	0	0	0	0	0	6	VEN	30	4	915
8	RIC	9	25	3	2.78	0	0	0	0	2	8	MEX	24	Q3	519
9	RMCP	9	9	1	1.00	0	0	0	0	1	3	MEX	6	3	254
10	AGS	8	77	4	9.63	0	0	1	4	4	6	NLD	88	1	5,624
11	IE	8	4	1	0.50	0	0	0	0	0	3	MEX	6	4	90
12	SCPP	8	98	4	12.25	0	0	2	3	4	7	GRB	51	3	1,730
13	JSM	7	170	5	24.29	0	1	2	4	5	6	GRB	40	1	1,479
14	LAN	7	527	6	75.29	2	4	6	6	7	7	GRB	670	Q1	233,269
15	RP	7	209	6	29.86	0	1	4	6	6	7	NLD	191	1	20,135
16	TF&SC	7	77	5	11.00	0	0	1	2	5	7	NLD	86	2	8,374
17	CC	6	1	1	0.17	0	0	0	0	0	1	MEX	13	Q4	313
18	IJEE	6	24	4	4.00	0	0	0	0	3	5	IRL	41	Q4	1,253
19	IB	6	2	1	0.33	0	0	0	0	0	1	MEX	6	Q4	108
20	P1	6	32	4	5.33	0	0	0	2	3	4	USA	241	Q1	582,878
21	ARLA	5	7	1	1.40	0	0	0	0	1	3	COL	7	Q4	106
22	EP	5	240	4	48.00	1	2	2	3	4	5	GRB	159	1	41,513
23	GIQ	5	149	3	29.80	1	1	1	3	3	5	USA	76	1	2,837
24	PL	5	2	1	0.40	0	0	0	0	0	1	NLD	5	Q4	180
25	SR	5	30	3	6.00	0	0	0	2	3	4	GRB	122	Q1	192,841
	Total	**216**				**4**	**10**	**23**	**48**	**70**	**147**				
	%	**100%**				**2%**	**5%**	**11%**	**22%**	**32%**	**68%**				

Source: Own elaboration from the information obtained in WoS. TP: Total articles, TC: Total citations, H: H index in the innovation area, C / P: Reason of citations per article, Country: Country of origin of the publication, H Index: H index of the publication in general, Quartile: Quartile of the general publication. AGS: Agricultural Systems, ARLA: Academia Revista Latinoamericana de Administracion, CC: Cirugia y Cirujanos, EP: Energy Policy, ETE: Economic Quarter, GIQ: Government Information Quarterly, GMM: Gaceta Medica de Mexico, GPP: Gestion y Politica Publica, IB : Investigacion Bibliotecologica, IE: Investigacion Economica, IJEE: International Journal of Engineering Education, INT: Interciencia, JCP: Journal of Cleaner Production, JSM: Journal of Service Management, LAN: Lancet, P1: Plos One, PL: Latin American Profiles, RIC : Revista de Investigacion Clinica Clinical and Translational Investigation, RMCP: Revista Mexicana de Ciencias Pecuarias, RP: Research Policy, SCPP: Science and Public Policy, SPP: Salud Publica de Mexico, SR: Scientific Reports, SUS: Sustainability, TF&SC: Technological Forecasting and Social Change.

TABLE 11. THE 43 MAGAZINES WITH THE MOST PUBLICATIONS ACCORDING TO QUANTITATIVE RESEARCH OF THE WOS WITHIN THE JCR CATALOG, PART 2.

	Journal	FI	FIws	FI5	Im	EC	VmC	VmCR	Eig	VIA	% AEC	EigN	PPV
1	SPP	1.039	0.751	1.423	0.238	84	7.8	7.0	0.002	0.372	95.24	0.257	23.248
2	GPP	0.103	0.103	0.228	0.000	20	N/A	10.7	0.000	0.029	100.00	0.005	3.191
3	JCP	5.651	3.809	6.352	1.364	2,741	3.2	6.3	0.055	0.815	94.71	6.469	87.287
4	ETE	0.211	0.211	0.211	0.182	22	12.6	11.2	0.000	0.052	100.00	0.012	3.258
5	SUS	2.075	1.364	2.177	0.483	2,346	2.4	7.0	0.014	0.323	94.50	1.612	50.022
6	GMM	0.342	0.320	0.358	0.048	104	7.2	7.9	0.001	0.085	90.38	0.070	5.484
7	INT	0.258	0.218	0.300	0.026	114	10.6	9.9	0.000	0.055	98.25	0.054	2.188
8	RIC	1.360	1.325	0.818	0.128	39	7.2	5.9	0.001	0.193	79.49	0.087	43.548
9	RMCP	0.768	0.695	0.884	0.080	50	5.2	11.0	0.000	0.169	98.00	0.040	35.833
10	AGS	3.004	2.562	3.756	0.944	162	8.5	7.2	0.006	0.871	97.53	0.751	95.614
11	IE	0.390	0.341	0.427	0.000	16	N/A	9.9	0.000	0.056	100.00	0.000	10.623
12	SCPP	1.368	1.168	2.067	0.309	68	7.6	8.5	0.000	0.509	100.00	0.250	35.278
13	JSM	3.414	2.957	5.407	0.205	39	5.5	10.4	0.002	0.912	92.31	0.238	79.286
14	LAN	53.254	51.896	52.665	13.030	302	8.9	4.5	0.436	21.011	79.80	50.874	99.032
15	RP	4.661	4.261	7.070	0.880	133	10.5	11.2	0.018	1.877	99.25	2.101	94.442
16	TF&SC	3.131	2.535	3.683	0.872	337	5.6	9.5	0.011	0.697	99.11	1.247	80.905
17	CC	0.427	0.415	0.339	0.064	94	6.0	10.3	0.000	0.064	91.49	0.045	4.750
18	IJEE	0.575	0.323	0.663	0.090	144	7.3	8.7	0.001	0.100	97.22	0.133	13.337
19	IB	0.212	0.173	0.427	0.200	30	5.5	10.9	0.000	0.024	100.00	0.005	6.250
20	P1	2.766	2.599	3.352	0.405	20,328	4.3	8.2	1.862	1.000	97.99	217.451	77.344
21	ARLA	0.617	0.595	0.623	0.030	33	4.5	10.7	0.000	0.080	93.94	0.014	6.012
22	EP	4.039	3.297	5.038	0.915	694	6.7	5.6	0.047	0.994	98.99	5.448	84.144
23	GIQ	4.009	2.784	5.231	0.722	54	5.4	7.3	0.003	0.683	98.15	0.353	92.614
24	PL	0.537	0.219	0.640	0.214	28	9.8	10.6	0.000	0.114	100.00	0.016	25.000
25	SR	4.122	3.745	4.609	0.576	24,809	2.2	7.5	0.719	1.356	99.99	83.931	82.031

Source: Own elaboration from the information obtained in the WoS. FI: Impact factor, FIws: Impact factor without self-citations, FI5a: Impact factor at 5 years, Im, Immediacy index, EC: Quotable elements, VmC: Average life of appointments, VmCR: Average life of appointments made, Eig: Eigenfactor, VIA: Item influence value, % AEC: Percentage of items in citable items, EigN; Normalized eigenfactor, PPV: Average percentile of life. AGS: Agricultural Systems, ARLA: Academia Revista Latinoamericana de Administracion, CC: Cirugia y Cirujanos, EP: Energy Policy, ETE: Economic Quarter, GIQ: Government Information Quarterly, GMM: Gaceta Medica de Mexico, GPP: Gestion y Politica Publica, IB: Investigacion Bibliotecologica, IE: Investigacion Economica, IJEE: International Journal of Engineering Education, INT: Interciencia, JCP: Journal of Cleaner Production, JSM: Journal of Service Management, LAN: Lancet, P1: PLOS One, PL: Latin American Profiles, RIC: Revista de Investigacion Clinica Clinical and Translational Investigation, RMCP: Revista Mexicana de Ciencias Pecuarias, RP: Research Policy, SCPP: Science and Public Policy, SPP: Salud Publica de Mexico, SR: Scientific Reports, SUS: Sustainability, TF&SC: Technological Forecasting and Social Change.

TABLE 12. THE 24 JOURNALS WITH THE MOST PUBLICATIONS ACCORDING TO QUANTITATIVE RESEARCH OF THE WOS THAT ARE NOT FOUND IN THE JCR CATALOG.

No	Journal	TP	TC	H	C/P	≥100	≥50	≥25	≥10	≥5	≥1	Country
1	RAX	14	10	2	0.71	0	0	0	0	0	5	MEX
2	INE	11	3	11	0.27	0	0	0	0	0	3	MEX
3	EG	10	13	2	1.30	0	0	0	0	1	5	COL
4	ITFE	9	3	1	0.33	0	0	0	0	0	2	ESP
5	OMN	9	3	1	0.33	0	0	0	0	0	2	ESP
6	DCEPV	8	0	0	0.00	0	0	0	0	0	0	MEX
7	JART	8	5	2	0.63	0	0	0	0	0	3	MEX
8	ASD	7	4	2	0.57	0	0	0	0	0	2	MEX
9	SM	7	16	3	2.29	0	0	0	0	2	5	-
10	EST	6	5	1	0.83	0	0	0	0	0	3	MEX
11	EKS	6	4	1	0.67	0	0	0	0	0	3	-
12	RIEEGE	6	0	0	0.00	0	0	0	0	0	0	MEX
13	RIE	6	1	1	0.17	0	0	0	0	0	1	MEX
14	AGR	5	12	3	2.40	0	0	0	0	0	4	-
15	IJERI	5	0	0	0.00	0	0	0	0	0	0	-
16	CLAD	5	1	1	0.20	0	0	0	0	0	1	-
17	ECORFAN	5	0	0	0.00	0	0	0	0	0	0	-
18	TS	5	4	1	0.80	0	0	0	0	0	4	NLD
19	TCA	5	9	2	1.80	0	0	0	0	0	4	-
20	ANE	4	28	4	7.00	0	0	0	1	3	4	-
21	AEN	4	29	2	7.25	0	0	0	1	2	4	-
22	BKRNA	4	0	0	0.00	0	0	0	0	0	0	MEX
23	CV	4	0	0	0.00	0	0	0	0	0	0	-
24	CEJ	4	51	2	12.75	0	0	1	2	2	2	-
	Total	**157**				**0**	**0**	**1**	**4**	**10**	**57**	
	%	**100%**				**0%**	**0%**	**1%**	**3%**	**6%**	**36%**	

Source: Own elaboration from the information obtained in the WoS. TP: Total articles, TC: Total citations, H: h-index, C/P: Reason of citations per article.

Subsequently, the journals with the highest publication numbers on the subject of innovation registered within the "Journal Citation Report" (JCR) were analyzed. The journal that was the most productive stands out for belonging to the public health area,

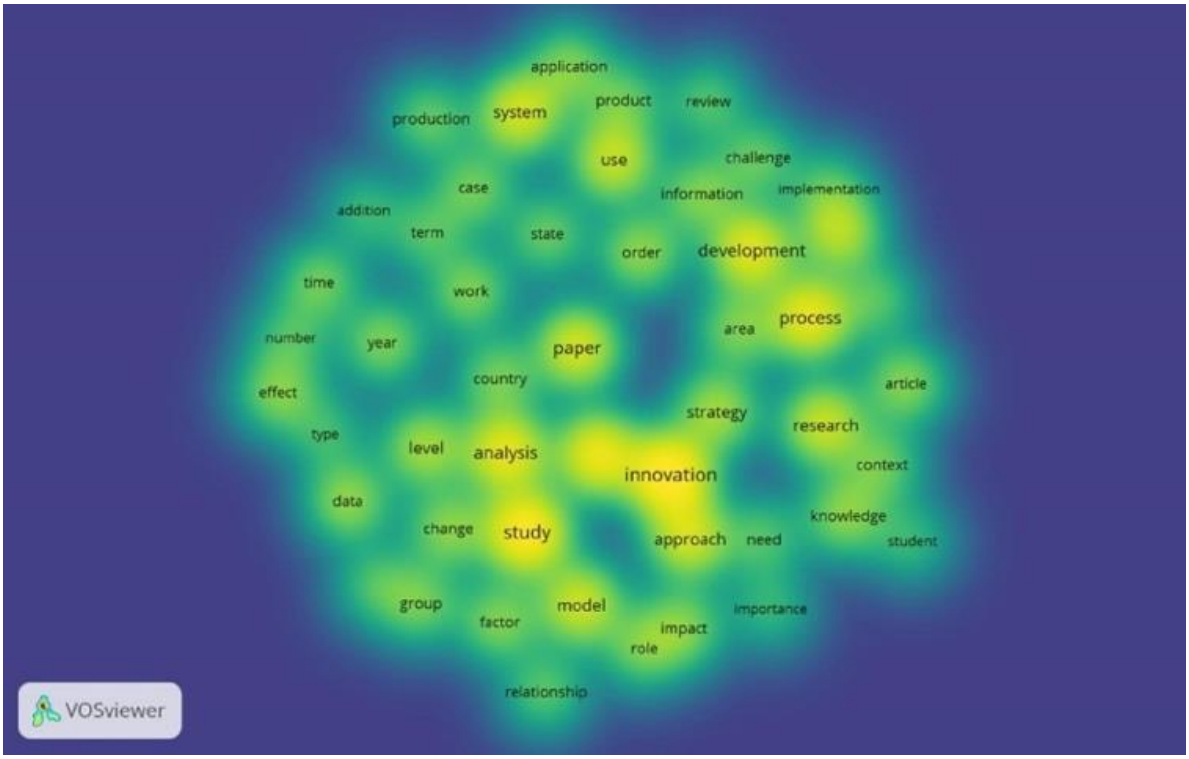
followed by one belonging to the areas of administration and economics, both of Mexican origin. The above can be taken as proof that innovation in Mexico is now taking hold as a broader concept than the creation of a new technological tool. Similarly, it is notable that Mexican journals, despite having a large number of publications on innovation, do not achieve as high of an impact compared to journals from other countries, such as "Journal Cleaner" from the Netherlands or "Lancet" and "PLOS One" from the United Kingdom and the United States of America, respectively (Tables 10 and 11).

However, Mexican journals do have a high h-index compared to other journals when only those articles that refer to the subject of innovation in Mexico are considered for the calculation of said index. This information acquires greater importance if the conclusion raised above is taken, i.e., that if a publication is produced on the subject of innovation in Mexico in foreign journals with a high h-index, for which it is necessary to invest a greater amount of resources, it will not necessarily result in a high-impact article; conversely, if the same article is published in a Mexican journal with a lower h-index, there will be a greater possibility that the article will end up being cited the most. One reason for this behavior may be because the articles deal with very specific issues of the country, and Mexican researchers, who would ultimately have a greater interest in the subject, do not have access to specialized journals but do have access to Mexican journals, which would lead to a greater number of citations of articles published in Mexican magazines. Regarding the quartiles, it is again observed that foreign journals have very high h-index values; consequently, they are considered to be within the first quartile in terms of their publications in society.

Similarly, the behavior of scientific articles on innovation in Mexico published in journals that do not belong to the JCR was studied. In this list is the magazine "Innovación Educativa México", whose h-index is even higher than the highest in the JCR list; however, it is observed that there are no citations of the articles that correspond to innovation in Mexico; thus, a null impact of the articles presented in them is assumed (Table 12).

Finally, with the support of VosViewer software, maps are constructed that allow visual analysis of the information. The heatmap contains those words that are most frequently present within the articles and are used to generate the results. The presence of words such as model, process, study, approach, and strategy stand out, which indicates a tendency for researchers to accept and use a broad concept of innovation and to not restrict it to the creation of a new product or service (Figure 3). However, words such as application, production and implementation are also found within the articles, where innovation works with a concept limited to the creation of new products. The presence of words such as need and challenge is observed, which suggests the use of innovation for solving applied problems. The presence of words such as strategy and process allude to the existence of a set of higher-order elements, of which innovation is part. Moreover, words such as change, effect and impact indicate a possible conception of innovation as an agent of change.

FIGURA 3 HEAT MAP OF THE WORDS PRESENT AT THE HIGHEST FREQUENCIES IN ARTICLES REVISED ACCORDING TO THE WOS.

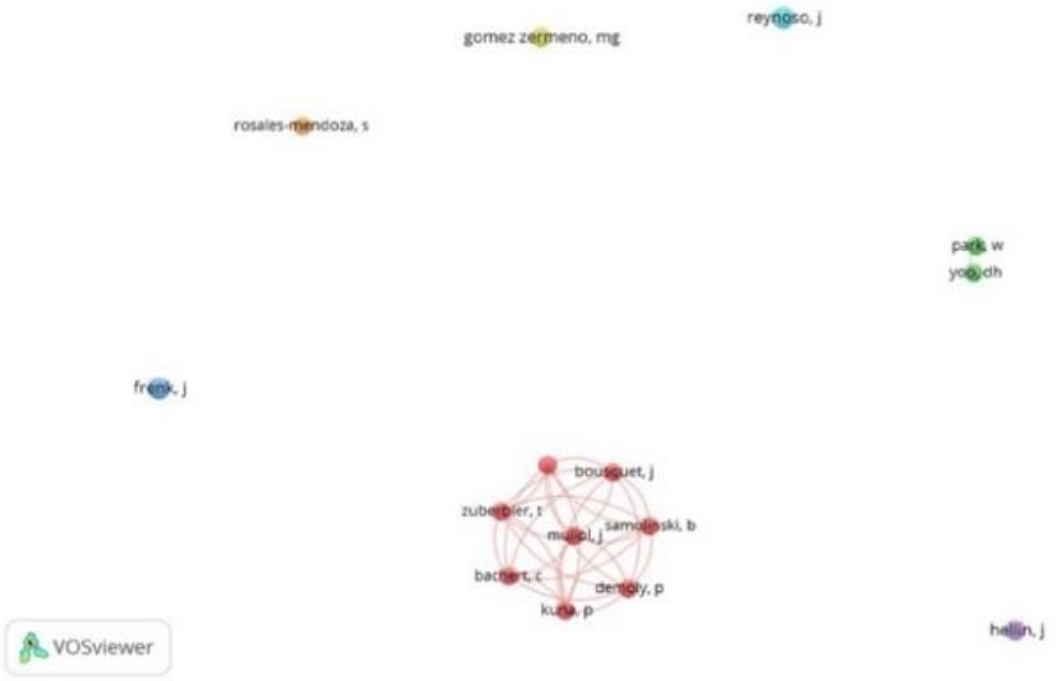


Source: Elaborated using VosViewer software.

Finding words such as data and research within the articles points to the generation of innovation oriented in a conscious way, determining its use, application or role; these words are also present in the articles on innovation.

Similarly, a map is constructed where the relationship that exists between the authors at the time of publishing their articles is shown graphically. For the elaboration of this map, only those authors whose publications included ten coauthors or less were considered. Importantly, it is observed that there is a group of authors who coauthor publications on a regular basis. This is relevant because it is these same authors who are in the top places as those with the highest production in the area and manage to obtain h-indexes that are equal to each other, which also corresponds to one of the highest recorded h-indexes among the research, as shown in Figure 4. Within this map are those authors with the highest production of articles with less than ten coauthored researchers. It is observed that Dutrenit, the author who has the largest number of published articles, is not part of this group. However, Bousquet, the author with the highest number of the most cited articles, is part of this group. Notably, Bousquet is a member of a group of authors who generally participate in coauthorship, and all of them are closely ranked relative to one another in the general ranking of production in the area of Business and Economics (Table 9), with Bachert occupying the highest place (7), followed by Bousquet (8), Demoly (9), Kuna (10), Mullol (11), Samolinski (15) and Zuberbier (18).

FIGURA 4 MAP OF THE AUTHORS WITH THE GREATEST PRODUCTION ON INNOVATION IN MEXICO, ACCORDING TO THE WOS.



Source: Elaborated using VosViewer software

4. CONCLUSIONS

This article presents a bibliometric overview of the production of research on the subject of innovation in Mexico between the years 1980 and 2018, considering the number of publications during this period.

The results of this study reveal that the National Autonomous University of Mexico and the Tecnológico de Monterrey are the most productive institutions in innovation research in Mexico. In particular, the non-Mexican universities that are included among those with the greatest influence are those that are located in other Spanish- or English-speaking countries. Similarly, the study provides an analysis of the journals with the highest publication on innovation in Mexico. While most of the universities that stand out are Mexican, in the case of journals, a greater diversity of countries is observed; however, the fact that they belong to regions of the aforementioned languages remains constant.

The results show an important joint work with foreign researchers within Mexican institutions. There is also a strong tendency to work with authors who also speak Spanish or English, which suggests an important communication barrier for scientific production on this topic. Among the most productive institutions, not only universities are registered, but government institutions that have generated publications on innovation are also listed, and most of them are directed to the areas of health and nutrition. In the same way, four areas of research with the highest levels of production are presented on the subjects of innovation, business economics, engineering, education and environmental sciences. Moreover, in

the WoS, through quantitative research on the articles with the highest numbers of citations, those with the greatest influence within the topic of innovation can be observed, through the use of additional indices such as total citations (TC) and citations per year (C/Y). Finally, the journals with the highest publication of articles show a trend towards the conception of innovation in a broader way; however, it is necessary to carry out a study analyzing the journals impacted by the subject of innovation in Mexico over time to observe their coverage of the research areas.

The above analysis identifies an article from the medical area as the most influential on the subject; that is, although the health area is not the area with the highest production, it has the greatest influence on the subject of innovation. It is also observed throughout this work that the impact of the research on this topic is not guaranteed by publishing in indexed journals such as JCR or that register a high h-index. It is necessary to carry out more in-depth studies on the behavior of the articles published in the different types of journals because, according to the results found, the target journals for the publications depend not only on the visibility of the journal or its status within the academic environment but also on the access that researchers may have to these journals. A thorough study of this phenomenon will help direct resources appropriately to achieve greater impact with less investment.

Regarding the countries with the greatest collaborations in research on innovation in Mexico, it is very noticeable that there is a preference for association with Spanish- and English-speaking authors. However, this work reveals the need to carry out exploratory research to determine the regions with the greatest scientific production on the subject and thus suggest that researchers in the area study a third language to be able to access the best articles on innovation, to have the opportunity to link with these authors, and to create links to form work networks with stronger collaborators.

The results of this article are particularly different from other studies, such as that of Cancino et al., (2017), which carried out the study on the most influential universities with respect to production on the subject of innovation worldwide. However, this study was carried out on the research produced on the subject of innovation directly related to Mexico to determine the evolution of the subject and its current presence in the country's research.

Future in-depth studies into the investigation are required to complement the analysis with the journals with the greatest publication, the impact of the authors as researchers, and the position of the institutions in the world, among other factors.

Finally, in the table of authors, it is observed that those who obtain the highest score carry out their research on their own. However, a small cluster of authors also stands out, i.e., those in the first half of the ranking of authors with the highest production. It is observed that this small group of authors has managed to consolidate a high h-index compared to most of the other authors that make up this list, publishing each article with the names of the other authors. In this case, it will be interesting to study the benefits and areas of opportunity that this publication strategy gives them and the way in which these authors are associated, that is, to determine if they belong

to the same university or if there is a project that motivates them to publish together.

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