Data & Metadata. 2022; 1:6
doi: 10.56294/dm20226

ORIGINAL ARTICLE

Trends in scientific production in the Industrial and Manufacturing Engineering area in Scopus between 2017 and 2021

Tendencias de la producción científica en el área Industrial and Manufacturing Engineering en Scopus entre 2017 y 2021

Alejandro Luis Cisnero-Piñeiro[1], Maria Carla Fernández Delgado[2], Julio Alberto Ramírez-Mendoza[3]

[1]Universidad de Pinar del Río "Hermanos Saíz Montes de Oca." Facultad de Ciencias Técnicas, Carrera de Ingeniería Industrial. Pinar del Río, Cuba.
[2]Universidad Tecnológica de La Habana "José Antonio Echeverría". Facultad de Ingeniería Química. La Habana, Cuba.
[3]Universidad Tecnológica de La Habana "José Antonio Echeverría". Facultad de Ingeniería Civil. La Habana, Cuba.

Cite as: Cisnero-Piñeiro AL, Fernández-Delgado MC, Ramírez-Mendoza JA. Trends in scientific production in the Industrial and Manufacturing Engineering area in Scopus between 2017 and 2021. Data & Metadata. 2022; 1:6. https://doi.org/10.56294/dm20226

Submitted: 12-10-2022 **Revised:** 28-10-2022 **Accepted:** 19-11-2022 **Published:** 24-11-2022

Editor: Prof. Dr. Javier González Argote

Peer-reviewed article

ABSTRACT

Introduction: industrial and manufacturing engineering focuses on designing, improving and optimizing production systems and business operations to improve the efficiency, effectiveness, quality and profitability of companies.
Objective: to characterize the scientific production published in Scupus in the Industrial and Manufacturing Engineering research area between 2017 and 2021.
Method: observational, descriptive and bibliometric analysis of the articles published in Scopus in the Industrial and Manufacturing Engineering research area between 2017 and 2019. SciVal was used as a metric tool based on the data collected from Scopus for the analysis of the area based on indicators of production citation and collaboration.
Result: 357 310 articles were published in the Industrial and Manufacturing Engineering research area, where 21 % responded equally to the Environmental Sciences area, 18,7 to Energy and 17,8 % to the Computer Science area. The most productive themes were the topics T.1114 (n= 3285) and T.3401 (n=1883). 41,1 % of the articles presented only institutional collaboration. According to the percentile based on the CiteScore, 49,2 % of the articles were published in Q1 journals. The Chinese Academy of Sciences was the most productive institution (5 853).
Conclusions: scientific production in the Industrial and Manufacturing Engineering area was characterized by increasing trends in volume and decreasing citations, as well as by transdisciplinarity, interdisciplinarity, and international and national collaboration. The articles were mostly published in high-impact journals.

Keywords: Bibliometrics; Scientific Production; Industrial Engineering; Industrial and Manufacturing Engineering.

RESUMEN

Introducción: la ingeniería industrial y de manufactura se enfoca en diseñar, mejorar y optimizar sistemas de producción y operaciones empresariales para mejorar la eficiencia, efectividad, calidad y rentabilidad de las empresas.
Objetivo: caracterizar la producción científica en publicada en Scupus en el área de investigación *Industrial and Manufacturing Engineering* entre 2017 y 2021.
Método: análisis observacional, descriptivo y bibliométrico de los artículos publicados en Scopus en el área

de investigación *Industrial and Manufacturing Engineering* entre 2017 y 2019. Se empleó SciVal como herramienta métrica basada en los datos colectados desde Scopus para el análisis del área basado en indicadores de producción citación y colaboración.
Resultado: fueron publicados 357 310 artículos en el área de investigación *Industrial and Manufacturing Engineering,* donde el 21 % respondió de igual forma al área Ciencias Ambientales, el 18,7 a Energía y el 17,8 % al área de Ciencias de la Computación. Las temáticas más productivas fueron los tópicos T.1114 (n= 3285) y T.3401 (n=1883). El 41,1 % de los artículos presentaron solo colaboración institucional. Según el percentil basado en el CiteScore, el 49,2 % de los artículos se publicaron en revistas Q1. La Academia China de Ciencias resultó la institución más productiva (5853).
Conclusiones: la producción científica en el área *Industrial and Manufacturing Engineering* se caracterizó por tendencias crecientes en volumen y decrecientes en citación, así como por la transdisciplinariedad, la interdisciplinariedad y la colaboración internacional y nacional. Los artículos fueron publicados mayormente en revistas de alto impacto.

Palabras clave: Bibliometría; Producción Científica; Ingeniería Industrial; *Industrial and Manufacturing Engineering*.

INTRODUCTION

Industrial Engineering (II) is a branch of engineering focused on designing, improving, and optimizing production systems, including manufacturing processes, logistics, and operations management. The main objective of industrial engineering is to improve the efficiency and effectiveness of production and operations systems to maximize productivity, minimize costs and improve the quality of products and services.(1)

The object of II covers various aspects of production and business processes, including supply chain management, factory and production line design, process analysis and improvement, industrial automation and robotics, planning and production programming, logistics and product distribution, and quality management.(2)

In coping with societal challenges, novel technology plays an important role. For the advancement of technology, the socialization of research results is necessary. In the field of engineering, and specifically in industrial and production systems, reality is no different.

The growing volumes of information produced by the expansion of science led to the creation of databases, indexes, and catalogs of scientific journals. However, to have the best evidence for decision-making, it is not enough to organize. It is necessary to quantify and evaluate science. In this regard, Scopus and the Web of Science are established as leading bibliographic databases incorporating bibliometric tools and modules. Similarly, bibliometric software has been created that allows scientific maps, citation and co-word maps, and trend analysis.(3)

Decision-making as a process presents a high complexity, as it is not only based on the professional skills of the decision-maker and his experience and practice but also requires skills that allow information to be collected, analyzed, and interpreted.

Research and publication make it possible to create new knowledge available to the academic community and the general public. This, in turn, fosters collaboration and the exchange of ideas and helps improve quality and innovation in production processes and the management of systems and organizations.(4) At the same time, the experiences resulting from this process are used to form future generations.

From the perspective of researchers, the evaluation of scientific production constitutes a necessity in today's society. The application of production, visibility and impact metrics allows us to evaluate current trends in research, identify emerging areas and opportunities, and assess institutions, journals, research groups, and researchers.(5)

The present investigation was developed to characterize the scientific production indexed in Scopus in the Industrial and Manufacturing Engineering research area between 2017 and 2021.

METHODS

Metric analysis of the information was carried out on the articles published in the Industrial and Manufacturing Engineering research area between 2017 and 2021 in journals indexed in Scopus.

The following metric indicators were studied:

- Number of documents (Ndoc). Total number of documents published in the area
- Percentage of documents (% Ndoc) concerning the total number of articles studied.
- Appointments (NCit). Total citations received by the articles indexed in Scopus.
- Citations per document (Cpd). The average number of citations received by the documents.
- Types of collaboration:

- ✓ Without collaboration or sole authorship: document where only one national author appears.
- ✓ Institutional collaboration: documents signed by two or more authors where they all belong to the same institution.
- ✓ National collaboration: documents signed by two or more authors where not all are from the same institution within the country.
- ✓ International Collaboration: documents in which the affiliation of their authors includes domicile in more than one country.

- Quartiles (Q): Journal quartiles are defined by journal metrics CiteScore, SNIP (Source-Normalized Impact per Paper), or SJR (SCImago Journal Rank). CiteScore, SNIP, or SJR percentiles are used to calculate each quartile: Q1 (≤ top 25 percentile), Q2 (26-50 percentile), Q3 (51-75 percentile), and Q4 (76-100 percentile). These thresholds are calculated separately for CiteScore, SNIP, and SJR, not once for a combination of both journal metrics.[6]
- CiteScore is a simple way to measure the citation impact of titles in serials, such as journals. The CiteScore calculation is based on the number of document citations (articles, reviews, conference papers, book chapters, and data papers) from a journal over four years, divided by the number of the same types of documents indexed in Scopus and published in those same four years.[7]
- Source-Normalized Impact per Paper (SNIP): measures the impact of a journal's citations. SNIP is a ratio between the "Gross Impact per Article," a type of calculation of Citations per publication received by the journal, compared to the "Citation Potential," or Expected Citations per publication, of that journal's field. The SNIP considers differences in disciplinary characteristics and can be used to compare journals in different areas. The weighted average value of SNIP for all journals in Scopus is 1.
- SCImago Journal Rank (SJR): is a quality indicator of scientific journals based on the number of citations received by the articles published in it and the importance of the journals that cite them. The SJR is calculated using an algorithm that considers the relevance and quality of the citations received, where citations from more important journals have a greater weight in calculating the metric. The SJR measures the relative importance of scientific journals in research.[8]
- Thematic areas: a classification system the Scopus bibliographic database uses to organize academic journals according to their subject matter. Each Scopus journal is assigned to one or several ASJC subject areas based on the topics covered in their articles. These subject areas are broad categories that span several related fields and are divided into subcategories to refine the classification further.[9]
- Publications: refers to the journal indexed in Scopus where the article was published
- Institutions: refers to the institutions the researchers reported being affiliated with.

To obtain the information, SciVal was accessed in October 2022. The thematic areas were filtered in the section -Research area- until the "Engineering" area and the Industrial and Manufacturing Engineering subarea (area 2209) were selected. The analysis was carried out based on the SciVal tool, from which the indicators referring to the 2017-2021 period were extracted.

RESULTS

Scientific production of 357 436 articles was reported, and 4 046 606 citations were received. The year 2021 was identified as the most productive (20,93 %) and the year with the highest volume of citations in 2018 (23,98 %). The most significant variation in scientific production was reported between 2017 and 2018 (9,63 %); Similarly, a decreasing trend was recorded in citations, whereas between 2020 and 2021, there was a variation of -60 % (table 1).

Table 1. Distribution by year of scientific production and citations of the Industrial and Manufacturing Engineering area in Scopus, 2017-2021

Año	Ndoc	% Ndoc	TvarNd	NCit	%	Tvar
2017	63610	17,8	0	968631	23,94	0
2018	70387	19,69	9,63	970530	23,98	0,20
2019	73992	20,7	4,87	896521	22,15	-8,26
2020	74642	20,88	0,87	745188	18,42	-20,31
2021	74805	20,93	0,21	465736	11,51	-60

The analysis of the thematic areas showed that 100 % responded to the Engineering area, 21 % to Environmental Sciences, 18,7 % to the Energy area, and 17,8 % to Computer Sciences (figure 1). The analysis at the micro level within the Engineering area identified that 22 % responded to the Mechanical Engineering area, 17,1 % to Electrical Engineering, and 15,2 % to Systems and Control engineering.

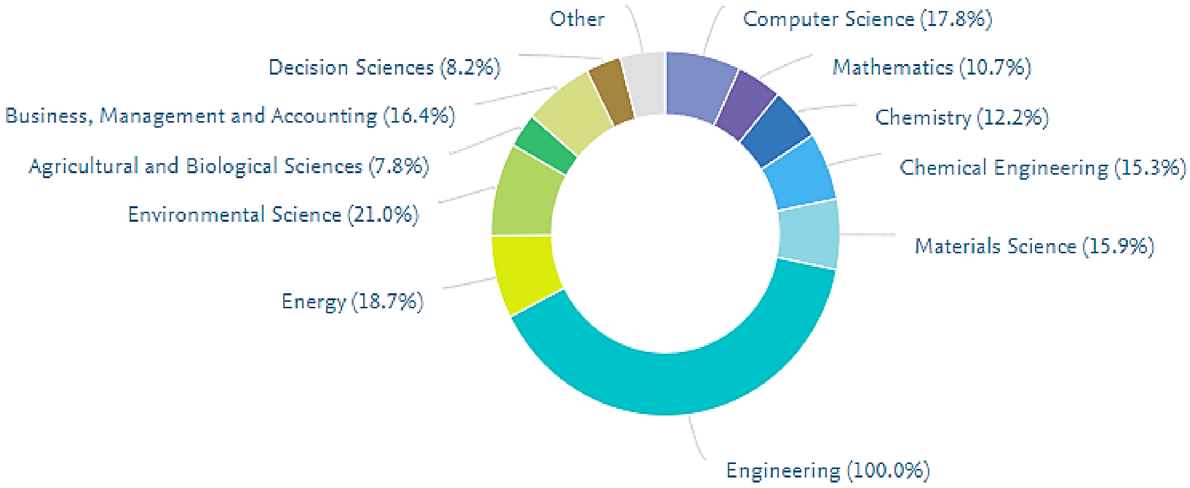

Figure 1. Distribution of scientific production by subject area

At the thematic level, 26 624 themes and 1 419 thematic groups or clusters were identified. The topics with the most significant scientific production are listed in table 2.

Table 2. Most productive topics in the area rea Industrial and Manufacturing Engineering in Scopus, 2017-2021

Topic	Topic ID	Ndoc	FWCI	PP
Microstructure; Titanium Alloy (TiAl6V4); Inconel (Trademark)	T.1114	3282	2,24	99,979
Fused Deposition Modeling; Mechanical Properties; 3D Printers	T.3401	1881	1,96	99,901
Electric Discharge Machining; Wire; Tool Wear	T.79	1325	1,01	99,185
Supply Chain; Environmentally Preferable Purchasing; Green Practices	T.2569	1124	2,87	99,933
Closed-Loop Supply Chain; Remanufacturing; Reverse Logistics	T.338	1085	1,8	99,788

Only institutional collaboration prevailed (41,1 %); only 9,9 % of the articles were published with a single author (table 3). It was also identified that only 3,7 % of the articles showed academic-corporate collaboration.

It was found that taking either the CiteScore, the SNIP, or the SJR as a reference, the highest percentage of the articles were published in Q1 journals (49,2 %, 49,1 %, and 51,5 %, respectively) (figure 2).

Table 3. Distribution of scientific production by type of collaboration

Type of collaboration	%	Ndoc	NCit	Cpd	FWCI
International	18,4	65 700	1 213 775	18,5	1,62
National only	30,7	109 629	1 300 179	11,9	1,12
Institutional only	41	146 719	1 330 108	9,1	0,97
No collaboration	9,9	35 262	104 626	3	0,35

The articles were published in 115 electronic resources indexed in Scopus (journals and conference proceedings). Table 4 shows the ten most productive sources and their indicators. It can be seen that the order of the journals did not coincide when comparing published documents and received citations.

Regarding institutions, 9 of the 10 most productive institutions belong to China. Leading the list is the Chinese Academy of Sciences (Ndoc=5,852), the French National Center for Scientific Research (CNRS) (Ndoc=4,120), and Shanghai Jiao Tong University (Ndoc=3,413).

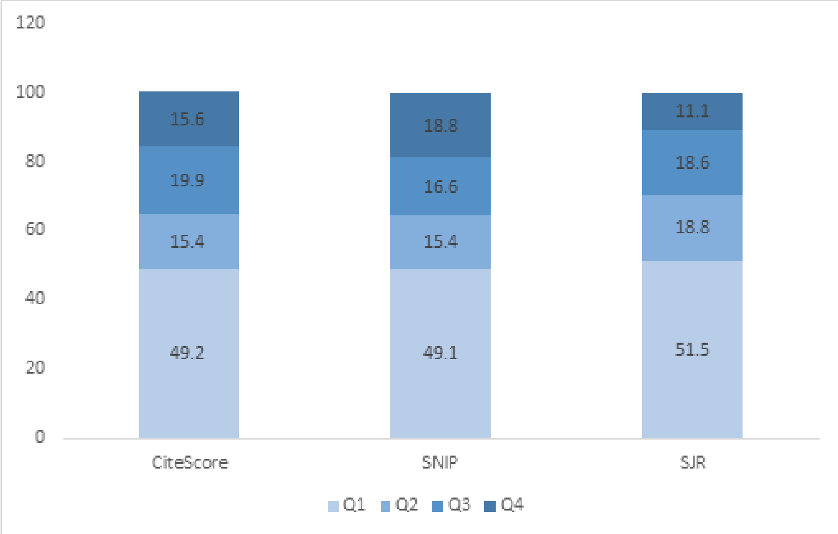

Figure 2. Distribution of articles by journal's quartile according to CiteScore, SNIP an SJR

Table 4. Most productive sources in the Industrial and Manufacturing Engineering area

Source	Ndoc	NCit	Cpd
Lecture Notes in Electrical Engineering	23 216	24 143	1
Journal of Cleaner Production	21 099	713 982	33,8
Chemical Engineering Journal	15 093	632 103	41,9
Energy	11 319	315 109	27,8
SAE Technical Papers	10976	23 018	2,1
International Journal of Advanced Manufacturing Technology	9 083	116 427	12,8
Industrial & Engineering Chemistry Research	9 028	122 691	13,6
Applied Thermal Engineering	8 217	183 269	22,3
Proceedings of the International Conference on Industrial Engineering and Operations Management	5 979	4 152	0,7
Procedia CIRP	5 675	46 513	8,2

DISCUSSION

Engineering is a professional field that systematically uses knowledge in mathematics and natural sciences acquired through educational and experiential processes to develop viable solutions to the needs and challenges of humanity.

Arriojas et al.[10] carried out a study to describe Latin American scientific production in engineering. The study identified an increasing trend in the scientific output, which coincides with what was reported in the present investigation. Similarly, this result coincides with what was identified by Fleitas et al.[11], who placed a positive variation rate in the scientific production of the Faculty of Industrial Engineering of the "José Antonio Echeverría" Technological University of Havana.

The authors consider this fact as expected since the constant advances in science and innovation are significantly linked to engineering. Hence an increase in scientific production is a reflection of the advancement of society.

Similarly, there was agreement with the literature[10] regarding the decrease in the number of citations. This can be considered determined by several factors, such as the increase in the number of journals and scientific production and, therefore, the breakdown of citations.

The identification of Environmental Sciences, Energy, and Computing as interrelated areas with industrial and manufacturing engineering in the scientific publication process are justified by several elements. This may be due to the need to implement sustainable and efficient solutions in industrial production, using renewable energy sources, and applying computing tools and technologies in industrial processes. Furthermore, this could indicate a possible trend towards interdisciplinarity in Industrial Engineering research since these areas are closely related to other scientific and technological disciplines.

On the other hand, from the researchers' point of view, Mechanical Engineering, Electrical Engineering, and Systems and Control Engineering stand out as specific sub-areas within Engineering, which was to be expected as they are fundamental areas of engineering that address problems and complex challenges of great importance in modern society.

The new models of science have changed the dynamics of interrelation between institutions. For this reason, the combination of collaborative work has been established as a mark of opportunity to achieve strategic objectives. For this reason, the relations between the institutions are determined by the possibilities of progress supported by the potential of the cooperating centers.[5]

Collaboration, whether at the level of departments, national entities, or between actors from different countries, allows access to tangible and intangible resources. For this reason, international collaboration has gained weight in recent years, both in innovation and scientific communication.

Similarly, a collaboration between educational institutions and productive institutions (University-Business link) is necessary. On this, a study carried out by Argota-Pérez et al.[5] showed that connections between centers of production and training in science and centers of production of services, for example, technological ones, allow innovation to be generated with an impact on social sustainability. This relationship enables the transfer of knowledge and technology between both entities, encourages innovation, promotes the training of highly trained professionals, and contributes to the economic and social development of the country.

Regarding the journals where the most significant number of articles were published, only one of those reported on logistics by Monsalve et al.[12], the Journal of Cleaner Production, coincides. This is because, although both studies focus on scientific production in Industrial Engineering, that study is specific to research in education. In the same way, it differs from what was reported by Madsen et al.[13], who analyzed the emergence and emergence of research and the emergence of the topic Industries 5.0. This is the result of the specialization achieved by journals in this field.

China has become a scientific power in various areas of knowledge. Multiple factors determine this fact, all related to science and technological innovation development and, therefore, research as a policy of institutions and the government.[14]

REFERENCES

1. Davim P, editor. Lecture Notes on Multidisciplinary Industrial Engineering. Springer; 2022.

2. Singh RP, Tyagi M, Panchal D, Davim JP, editors. Proceedings of the International Conference on Industrial and Manufacturing Systems (CIMS-2020). Springer Nature Switzerland AG; 2022.

3. Romero-Silva R, de Leeuw S. Learning from the past to shape the future: A comprehensive text mining analysis of OR/MS reviews. Omega. 2021;100:102388. doi: 10.1016/j.omega.2020.102388.

4. Ahamad Shaik F. La importancia de fomentar la investigación en ingeniería, salud, ciencia y tecnología de la región Asia-Pacífico. Salud Cienc. Tecnol. 2022; 2(S2):270.

5. Argota Pérez G, Aliaga Guillen E, Pari Olarte JB, Solano García CG, Chacaltana Ramos L, Velásquez Salcedo LF. Productividad científica profesional mediante indicadores de reconocimiento o visibilidad y de pertenencia repulsiva. Campus 2019; 24(28):5. https://doi.org/10.24265/campus.2019.v24n28.05

6. SciVal Support Center. Publications in Journal Quartiles - SciVal Support Center. 2022. https://service.elsevier.com/app/answers/detail/a_id/29508/supporthub/scival/

7. SciVal Support Center. CiteScore - SciVal Support Center. 2022. https://service.elsevier.com/app/answers/detail/a_id/29859/supporthub/scival/p/10961/

8. Guerrero-Bote VP, Moya-Anegón F. A further step forward in measuring journals' scientific prestige: The SJR2 indicator. Journal of Informetrics 2012; 6(4):674-688. doi: 10.1016/j.joi.2012.07.004

9. Elsevier. Content coverage guide - Scopus [Internet]. 2022 [cited 2023 Feb 23]. Available from: https://www.elsevier.com/solutions/scopus/how-scopus-works/content/content-coverage-guide

10. Arriojas Tocuyo DDJ, Marín Velásquez TD. Producción científica en Ingeniería: análisis comparativo de países de Suramérica del 2008 al 2018. Revista Universidad y Sociedad 2021; 13(3):84-93.

11. Fleitas Triana M, Hernández Oquendo C, Guerra Castillo S. Visibilidad e impacto de la producción científica de la Facultad de Ingeniería Industrial de la Cujae de Cuba (2003-2012). Investigación Bibliotecológica:

CONFLICTS OF INTEREST

No conflicts of interest exist.

FINANCING

No financing.

AUTHORSHIP CONTRIBUTION

Conceptualization: Alejandro Luis Cisnero Piñero.
Research: Alejandro Luis Cisnero Piñero, Maria Carla Fernández Delgado, Julio Alberto Ramírez Mendoza.
Methodology: Alejandro Luis Cisnero Piñero, Maria Carla Fernández Delgado.
Formal Analysis: Alejandro Luis Cisnero Piñero, Julio Alberto Ramírez Mendoza
Research: Alejandro Luis Cisnero Piñero, Maria Carla Fernández Delgado, Julio Alberto Ramírez Mendoza
Writing - Original draft: Alejandro Luis Cisnero Piñero, Maria Carla Fernandez Delgado, Julio Alberto Ramirez Mendoza
Writing - Proofreading and editing: Alejandro Luis Cisnero Piñero, Maria Carla Fernández Delgado, Julio Alberto Ramírez Mendoza