

Women Empowerment Through Engineering Education: A Bibliometric Review

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Abstract: Academia and Industries are facing a problem of lack of diversity, precisely gender diversity. We investigated a review of extant literature and macro data on gender equality in both Academia and Industry. To reduce the gender gap an initiative must have been taken to encourage women in the involvement in the education field. The primary purpose of this bibliometric survey is to determine the scope of the literature available for women's empowerment through engineering education. The commemorative analysis is based on Scopus because it provides research databases from various fields and tools such as Sciencescape and Gephi. In the theoretical survey, we analyze the prominent publications of journals, conferences, and the majority from the United States. The set of data from the time series has begun since 2004 until today. Most research publications are in the field of social science scope, followed by engineering and computer science.

Keywords : Women Empowerment; Feminist Movement; Girl Power; Engineering Education; Bibliometric Review

1. Introduction

Engineering is generally considered a field of study that is very popular with both gender, but women in engineering are not fully represented anywhere. Since the mid-1990s, the number of women studying engineering has increased significantly because of growth and emergence in the IT sector. It provides women with multiple job and career opportunities and empowers them. However, careful observation will present that most women are concentrated in specific engineering fields, mainly at entering the labor market. Several factors limit their professional development speed. This document attempts to study female engineers' opportunities after completing college engineering education and evaluate the factors that limit their career development. Elements in the workplace and social factors also play an essential role in promoting and inhibiting your career development. Although many people today are concerned about women's education and careers, traditional concepts and images of women who mainly focus on family and family are still prevailing. Society expects women to work outside the private sphere, but they can do housework and assume family responsibilities. Since the classic era, many social and cultural factors have prevented women from participating in education, and in addition, they have not been encouraged to engage in scientific research. All of these, as well as workplace factors, will limit your opportunities to a certain extent.

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In light of the previously mentioned situation, the researchers were spurred to complete bibliometric studies and understand in deep research carried out on women empowerment through engineering education. It is standard practice to compose a list of sources at the end of a book, article, or report that are nothing but the number of sources utilized to create it. Bibliometric study in current time has probably grown the best practice which opens a portal to new research subjects. This paper [2] characterized Bibliometrics as applying statistical and mathematical techniques to books and other media of communication. Bibliometric examinations can produce an information-driven vision of scientific research activities covering various research areas and display proof-based depictions, correlations, and representations of research yields [3].

2. Preliminary Data Collection

A bibliometric survey gives more insight into a particular topic. A library portal accesses Scopus Database to meet this goal or access it by using an individual's login credentials. There are different databases. These databases are categorized into two parts: Open Access Database and Paid Database. This paper has considered the Scopus database accessed in July 2021 because it is the largest peer-reviewed database. The following section provides a list of keywords used.

A. Momentous Keywords

The keywords needed to search are "Women Empowerment" and "Engineering Education". The secondary keyword related to women empowerment is "Feminist Movement" or "Girl Power". The search query is expressed as: "Women's Empowerment" or

Table 1 : Planned Search Tactic For Keywords

Primary Keywords (AND)	"Women Empowerment" and "Engineering Education"
Secondary Keyword (OR)	"Women Empowerment" or "Feminist Movement" or "Girl Power"

"Feminist Movement" or "Girl Power" and "Engineering Education".

B. Initial Search Results

Initial Search Query generated 105 publications. These publications are only in the English Language.

For this survey, research has been significant as

Table 2 : Trends In Publishing Language

Language of Publication	PUBLICATION COUNT
English	105
Total	105

Source: <http://www.scopus.com> (July 2021)

being published in journal papers, articles, book chapters, conference proceedings, etc. The researchers in the field of women empowerment by engineering education have publicized recent papers in conferences. 50.5 % of journal articles and 29.5% of conference papers were there. (Figure 1).

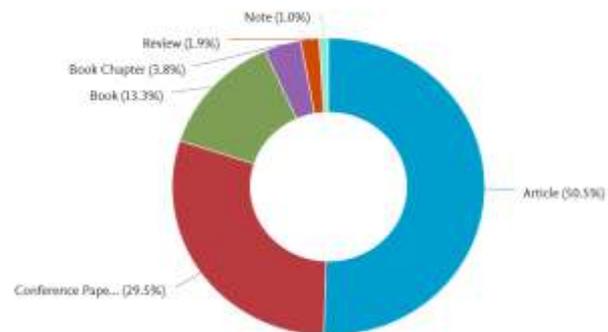


Fig. 1. Analysis by Publication Type

Source: <http://www.scopus.com> (July 2021)

C. Highlights of Elementary data

Initial investigation is done based on the keywords that extracted 105 different publications from 2004 to 2021 in women empowerment by engineering education. The number of articles published per year is shown in Table III. The analysis based on the number of articles published per year is shown in Figure 2. In 2019, most of the researchers published their work.

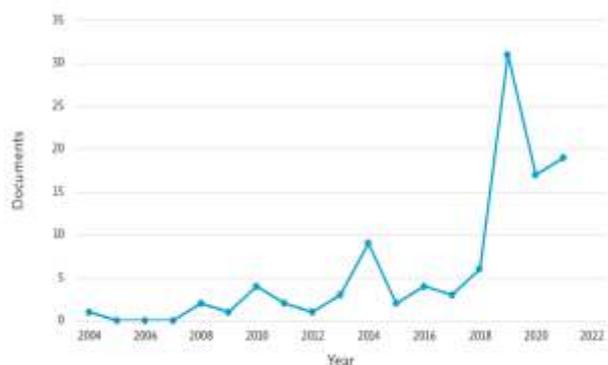


Fig. 2. Analysis of Publication by Year

Source: <http://www.scopus.com> (July 2021)

Table 3 : Number Of Publications Per Year

Year	Publication Count	Year	Publication Count
2021	19	2013	3
2020	17	2012	1
2019	31	2011	2
2018	6	2010	4
2017	3	2009	1
2016	4	2008	2
2015	2	2004	1
2014	9	Total	105

D. Geographical Region Analysis

The geographical regions of the published papers are shown in figure 3. The United States has a maximum number of publications in the field. Figures 3 and 4 show the contribution in publications by different countries.



Fig. 3 : Research on women empowerment in engineering education at different geographic locations
Source: <http://www.scopus.com> (July 2021)

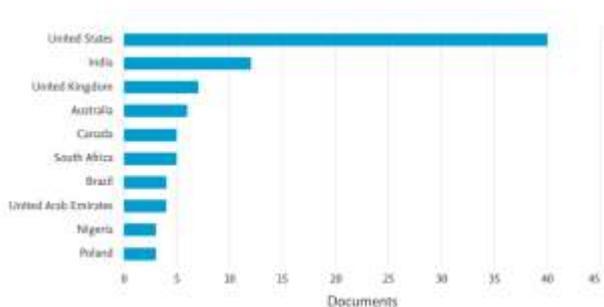


Fig. 4. Analysis by country /Region
Source: <http://www.scopus.com> (July 2021)

E. Analysis based on the subject area

The classification based on the subject area is shown in Figure 5. The analysis shows that in social sciences and engineering, followed by computer science, the number of research articles published is

the largest. The amount of research done in business management, economics, energy, environmental sciences, psychology, arts and humanities, and decision sciences is negligible.

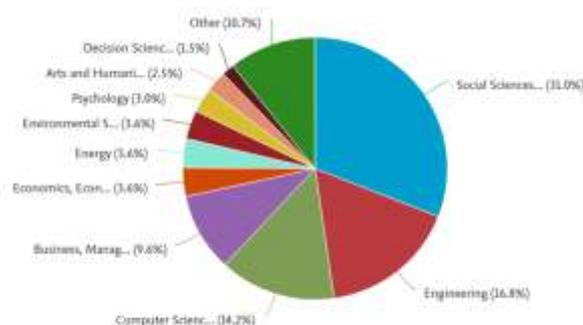


Fig. 5. Analysis of Publications by Subject Area
Source: <http://www.scopus.com> (July 2021)

F. Analysis based on affiliation

Figure 6 shows an analysis of different Universities worldwide that contributed to publishing research work in women empowerment through engineering education. Amrita University has made a significant contribution, as shown in the figure. The top ten universities publishing in this field have been revealed.

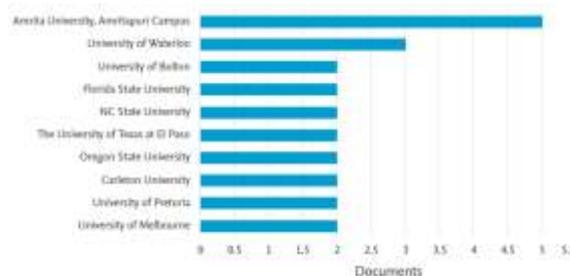


Fig. 6. Analysis based on affiliations for publications
Source: <http://www.scopus.com> (July 2021)

G. Analysis based on Sources

Figure 7 shows an analysis of documents by sources.

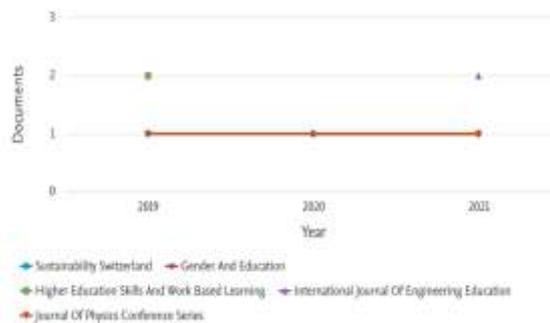


Fig. 7. Analysis of documents by sources
Source: <http://www.scopus.com> (July 2021)

Most of the research work was published in Sustainability Switzerland for women empowerment in engineering education.

H. Analysis based on Funding Sponsors

Figure 8 shows an analysis of documents by funding sponsors. National Science Foundation has given major funded sponsorship for the research in women empowerment in engineering education.

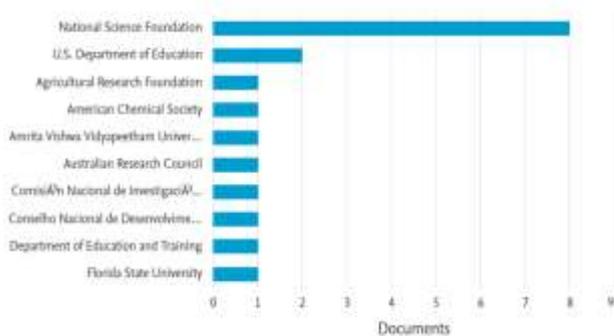


Fig. 8. Analysis of documents by funding Sponsor
Source: <http://www.scopus.com> (July 2021)

I. Analysis based on number of publications per author

Key authors contributing to the field of women empowerment through engineering education are depicted in figure 9. The first ten authors were considered from the available accessed data from the Scopus database.

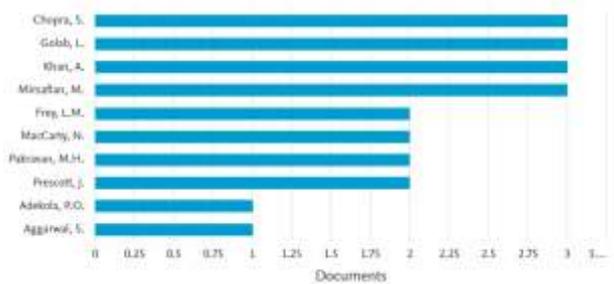


Fig. 9 : Analysis based on number of publications per author
Source: <http://www.scopus.com> (July 2021)

J. Citation Analysis

Table IV shows overall citations for publication per year in the area of women empowerment by engineering education. There are Five hundred twenty-three citations for 105 publications to date. The titles of the main articles and the citations received so far from the data extracted from this study are shown in Table V.

Table 4 : Citation Analysis Per Year in the Area of Women Empowerment In Engineering Education

Year	<2017	2017	2018	2019	2020	2021
No. Of Citations	112	43	45	68	152	103

Table 5 : A Citation Analysis of Top Publications in Women Empowerment in Engineering Education

Document Title	<2017	2017	2018	2019	2020	2021	Total
One less car: Bicycling and the politics of automobility	69	21	18	7	9	8	132
Mathematics - Critical Filter for STEM-Related Career Choices? A Longitudinal Examination among Australian and U.S. Adolescents	0	2	3	7	21	8	41
Gender diversity in STEM disciplines: A multiple factor problem	0	0	0	3	17	16	36
Unfamiliar technology: Reaction of international students to blended learning	0	0	1	8	17	5	31
"Girl Power": Gendered academic and workplace experiences of College Women in Engineering	0	0	0	8	8	7	23
In search of quality: measuring Higher Education Service Quality (HiEduQual)	0	0	1	2	11	8	22
Our bodies, our minds, our men: Working South Asian women	6	4	1	3	1	1	16
Exploring how parents in economically depressed communities access learning resources	3	3	1	6	1	1	15
Sustainability leadership in higher education institutions: An overview of challenges	0	0	0	0	4	9	13
Is 3D printing an inclusive innovation?: An examination of 3D printing in Brazil	0	0	0	2	8	3	13
Social and economic development through information and communications technologies: Italy	0	0	4	3	2	2	11
Minecraft and the building blocks of creative individuality	0	1	2	1	6	1	11
Business students' perspectives on employability skills post-internship experience: Lessons from the UAE	0	0	0	1	4	5	10
Survival Ethics in the Real World: The Research University and Sustainable Development	1	1	3	0	3	2	10
Professional men, professional women: The European professions from the nineteenth century until today	4	2	2	0	2	0	10

3. Network Analysis

Network analysis can represent the correlation between the various entities. This analysis was carried out by using different tools like Gephi, Sciencscape. Both are free software available for everyone and used for clustering and manipulation of the available data. Keywords, source type, publication title, year of publication, affiliations, author are represented by nodes and edges. Combining different parameters from extracted data of Scopus is used to create the clusters shown in figures 10-17. Fruchterman Reingold layout was used along with manual adjustments for the structure while clustering.

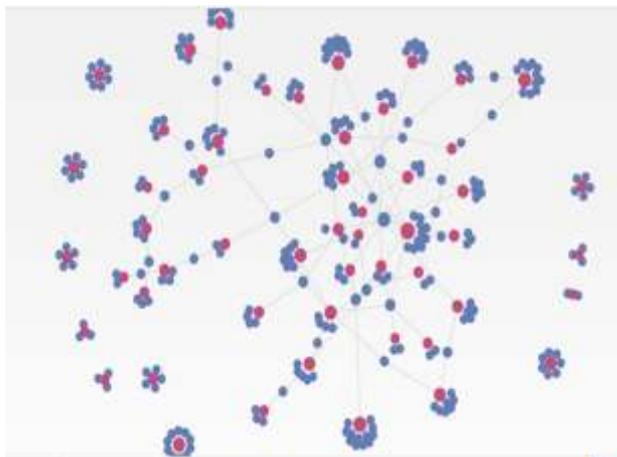


Fig. 10. The cluster of Author Keyword and Source Titles

Figure 10 shows an analysis of the authors' keywords and source title networks. 383 nodes and 386 edges are used to represent author keywords and source titles. Some nodes were removed by the sciencscape tool when they were disconnected from the network.

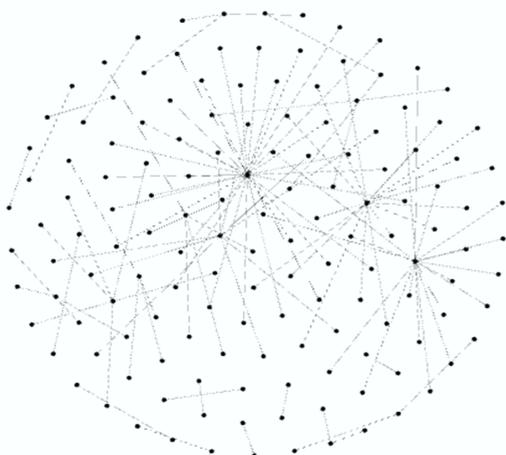


Fig.11: Analysis of Publication Title & Publication year

Figure 11 shows a set of publication titles and publication years. 145 nodes and 118 edges are used to represent the publication title and publication year.

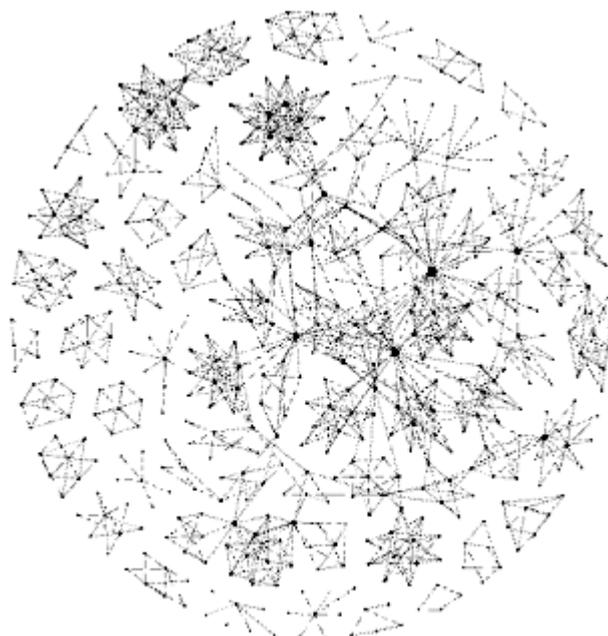


Fig. 12. The cluster of Authors and Keywords

A cluster of Authors and Keywords is shown in Figure 12. 530 Nodes and 1157 Edges are used to represent authors and keywords.

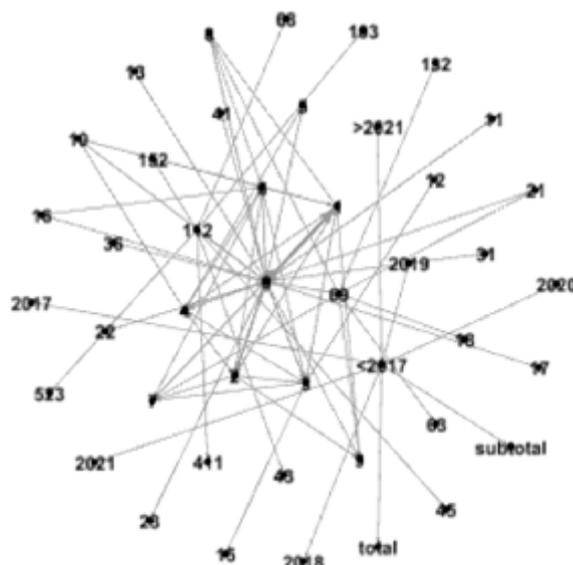


Fig. 13. Network of Citations Per Year

Figure 13 depicted a network of Citations per year. 44 Nodes and 84 Edges are used to represent citations per year.



Fig. 14: Cluster by Affiliation, Language & Source Type

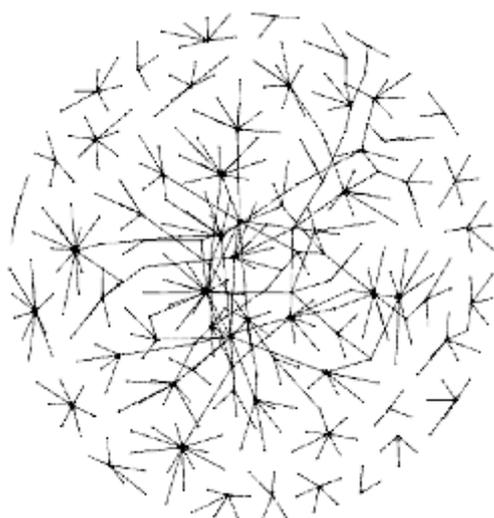
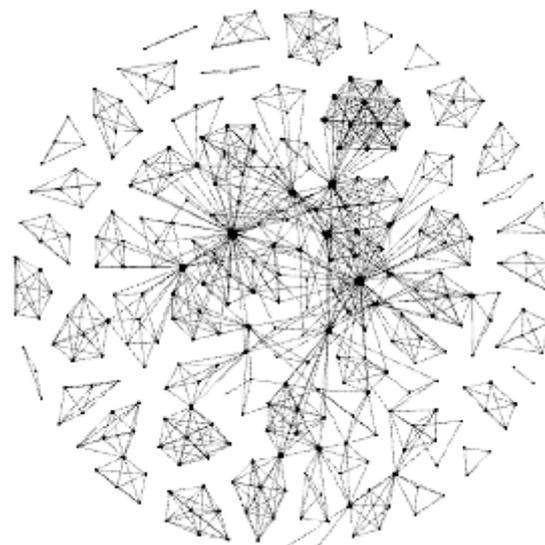


Fig. 15: Cluster by Source Title and Author's Keywords



Fig. 16: Network of Authors linked by Co-Publications

Figure 14 shows the groups categorized by affiliation, language, and source type. Figure 15 shows grouping by source title and author keywords. Figure 16 shows the author's network linked by CoPublications. Figure 17 shows the author's keyword network that appears in the same article.



**Fig. 17 : Network of Author Keywords
Appearing in Same Paper**

4. Limitations of Present Study

This bibliometric study considers just Scopus-based publications resulting in the blending of keywords used by the researcher. Many databases like PubMed, Web of Science, and Google Scholar for research publication are not analyzed during this bibliometric survey. Different databases give different statistics of citations for publication. In this study, citations for documents are also counted for the Scopus database only. And lastly, this research is limited to just the English language.

5. Conclusions

By analyzing this bibliometric study, it has been observed that only a few researchers are working in the domain of women empowerment in engineering education from 2004 to date. As women empowerment is a point of contention nowadays, most of the publications were after 2019. With the earlier information presented with the help of graphs, it is clear that many journals are publishing their work in this research domain. Nowadays, visual information is widely spreading across the globe. Hence, it is essential to check the truthfulness of such information due to which women's empowerment in

engineering education is the most valued field of research today.

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