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Review article

Bibliographic analysis: Research prospects for work-life balance of women workers in engineering

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ABSTRACT

Work-life balance is a significant issue today, especially for women workers, who often experience role conflict. Besides their professional roles, women also have responsibilities at home, making balancing work and life outside the workplace one of their primary challenges. This article aims to analyze scientific publications on work-life balance among female workers using bibliometric analysis to identify research opportunities in the field of engineering. The Scopus database was utilized for data mining, and data analysis was conducted using VOSviewer. A total of 123 documents were identified from the 2019–2024 period, with South Korea leading in publications (15 documents and 63 citations), followed by the United States, which had fewer publications (14 documents) but the highest number of citations (240 citations). The research subject areas were predominantly Medicine (27.8%), with only 4.7% focusing on Engineering. The majority of research subjects were healthcare workers (33%), while only 5% specialized in the industrial sector. The International Journal of Environmental Research and Public Health was the most frequently referenced source. Commonly discussed impacts of work-life balance influenced by gender include mental health, job satisfaction, and burnout. However, no studies specifically focus on female workers in the manufacturing industry to examine the effects of work shifts on work-life balance and their implications for occupational health and safety, work accidents, and musculoskeletal pain. Future research should address this gap by applying engineering studies to explore these challenges.

1. Introduction

In recent decades, the participation of women in the labor force has increased substantially [1]. PwC's Women in Work Index (WiW) highlights a rise in women's labor force participation across 33 Organisation for Economic Cooperation and Development (OECD) member countries in 2021. In Indonesia, data from the Indonesian Ministry of Manpower shows that women's workforce participation is at 54.27%, equivalent to 56.21 million people [2]. This number is expected to grow, as women now have equal access to education and employment opportunities compared to men.

Female workers often experience role conflict, as they are expected to fulfill responsibilities both at work and at home. This is particularly true in Eastern cultures with patriarchal norms that assign domestic roles predominantly to women, making household responsibilities closely tied to their identity [3]. At the same time, like men, women have professional commitments that demand their attention. This dual expectation often forces women to prioritize their role as homemakers within the family. Such conditions can make it challenging for women to balance their responsibilities at work and home, commonly referred to as work-life balance (WLB).

Research by the ILO states that one of the main challenges women faces is balancing work with life outside of work [4]. Additionally, women find it more difficult than men to manage the balance between personal and professional responsibilities [5]. Women with significant household and family duties often struggle to meet the demands of both their work and personal lives [6]. Addressing this issue requires cooperative and coordinated efforts from both employees and employers. Healthy communication and clear commitments involving all employees are essential to reducing stress and increasing satisfaction. This, in turn, creates added value for the employer [7], [8].

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Research on Work-Life Balance (WLB) has been widely researched since the 1990s, as it is an interesting topic to study. Many researchers are interested in examining work-life balance because it is important in a person's work, so research on this topic increases yearly. The author's initial search results on the Scopus engine on April 13, 2024, by inputting the keyword "work-life balance" brought up 10,168 documents from 1996 - 2024. For most researchers, countries from the United States have as many as 2,922 documents, followed by the UK with 1,327 documents and other countries. This means these countries have the greatest tendency to research this field. The field of Medicine is the most likely to conduct this discussion (22.4%), followed by Social Sciences (20.3%), while the field of Engineering is only 4.1%. In terms of keywords, the most common occupation was doctor (939 times), followed by medical education (743 times), medical student (552 times), female doctor (425 times), patient nurse (324 times), health worker (286 times), employee (248 times), nurse (242 times), surgeon (210 times), medical student (193 times), and others. The keywords also show that women (2,323 times) are discussed the most compared to men (1,934 times), this happens because gender affects the difference in WLB between women and men [9], [10], [11].

Research on WLB has mostly studied women workers in the health sector and only a few have studied workers in the industrial sector, if you look at the employment data in Indonesia in 2022, it shows that the type of industrial work is the 3rd largest labor-absorbing worker after the types of agricultural work and trade, where industrial work employs 15.18% of the female workforce while work in health services employs only 2.83% of the female workforce [2]. Judging from the type of work, industrial work is very different from work in the health sector. Women who work in the industrial sector have significant challenges in work-life balance, especially in the manufacturing industry. Jobs in the manufacturing sector often involve long and irregular work shifts, including night shifts, which can disrupt the rhythm of personal and family life [12]. Workers in the manufacturing sector also involve heavy and repetitive physical activity, which can lead to physical and mental fatigue [13], where workload is one of the main factors affecting work-life balance [14], [15], [16]. In addition, the manufacturing industry often focuses more on productivity and operational efficiency than worker welfare, so aspects of work-life balance are usually neglected [17], [18]. On the other hand, workers in the healthcare sector have more opportunities for flexibility in shift scheduling [19]. In some cases, healthcare workers can participate in shift rotation, which allows them to have days off at certain times or work different shifts in the work cycle, which can provide flexibility in organizing working time [20]. Work flexibility can assist workers in balancing work and family responsibilities [21]. Healthcare workers are also often involved in dynamic and complex situations that require quick problem-solving and adaptation to various conditions [22].

With this phenomenon, the author is interested in knowing the research trends of work-life balance in female workers by looking at opportunities in Engineering research, so it is necessary to see the overall research model that discusses work-life balance in female workers. This research was conducted with bibliometric analysis in mapping the development of science, seeing opportunities in research, and supporting scientific research from current research trends [23]. VOSviewer software is used in this bibliometric analysis, which can create maps on publication network data and data visualization, including co-authorship and co-occurrence. This software can also map the network of scientific publications including authors, organizations, countries, and keywords so it is very helpful for researchers, librarians, and publication database managers to get the network map [23], [24], [25]. The advantage of VOSviewer software is that it can import bibliographic databases from Scopus, PubMed, or Web of Science [26]. The data obtained is presented as mapping to illustrate the relationship between nodes in the extended analysis [27].

2. Material and method

The authors used various scientific citation/literature databases as sources of information in obtaining research articles. The database chosen by the author in this research is Scopus because this database has comprehensive coverage, good quality and level of data accuracy, has various bibliometric analysis features, and is a verified and academically recognized data source [28], [29]. Falagas et al. compared the strengths and weaknesses of PubMed, Scopus, Web of Science, and Google Scholar. PubMed and Google Scholar are free; although PubMed is optimal for biomedical research, Google Scholar's accuracy is inconsistent. In contrast, Scopus offers 20% more coverage for citation analysis than Web of Science [30]. Sing et al. compared the Web of Science, Scopus, and Dimensions databases. Almost every journal in the Web of Science is reportedly available through Dimensions and Scopus. In contrast to Web of Science, Scopus has a 66.07% higher index of unique journals [31]. In the process, the author will delete articles that cannot be fully accessed in these databases. The year of publication is limited to publications of the last six years, namely from 2019 to 2024.

This study explores the search for research topics using several keywords with Boolean expressions in the Scopus database. The goal is to provide the most data information from keywords on research topics. In preliminary research, we conducted a topic search on April 8, 2024, using Boolean phrases in the Scopus database. The phrase search in Scopus uses double quotes ("), hash marks (*), and Boolean operators (OR, AND, NOT). The goal is to tell the Scopus search engine that there are words that must be combined with "loose phrases" for double quotes ("), while to expand or narrow the search parameters when using the Scopus

search engine, the hash mark replacement character (*) is used.

Fig. 1 shows the stages in conducting literature selection of publications that will be used as bibliographic studies by applying the PRISMA Flow Chart. The stages are as follows.

1. The first stage of searching from the Scopus database with a combination of keywords and operators is (TITLE-ABS-KEY ("work-life balance*" AND "female*") OR TITLE-ABS-KEY ("work-life balance*" AND "women*") AND NOT TITTLE-ABS-KEY ("covid" or "corona" or "pandemic"), which resulted in 2023 publications. The author does not review publications that discuss work-life balance in pandemic conditions (COVID-19) because pandemic conditions change working conditions, especially for women. Where when the Pandemic hit, women felt more emotional fatigue due to the disruption of personal life at work during the period of working from home [32].
2. The second stage is filtering for publications in the form of journal articles, which are English and accessible, regardless of the field of research focus, leaving 834 publications.
3. The third stage was carried out by reading the title, abstract content, and keywords. Here, only articles that discussed measuring work-life balance in female workers were selected. The election results left 149 publications considered appropriate enough to discuss work-life balance.
4. The fifth stage involved reading the publication's contents in detail. Only articles that measure work-life balance in female workers were selected. The selection results obtained 123 publications that will continue to be analyzed bibliographically.

The next step is to export the search results from the Scopus database into a Comma-Separated Value (CSV) file in Microsoft Excel, where all the information from the selected sources can be analyzed. Furthermore, VOSviewer version 1.6.17. was used to view the visualization and bibliometric construction of the selected documents. In the bibliographic analysis using VOSviewer 1.6.17 software, several attributes were selected: joint authorship, co-occurrence, citation, bibliographic merging, and co-citation of authors, organizations, and countries.

After concluding the scholarly mapping analysis, the final phase involved a qualitative discussion aimed at providing an overall evaluation of the scholarly contributions to work-life balance in women workers and looking at work-life balance in women workers research opportunities for the field of Engineering. This discussion entailed an in-depth exploration of the research gaps found in this study and locating potential further studies for future research on the work-life balance of female workers.

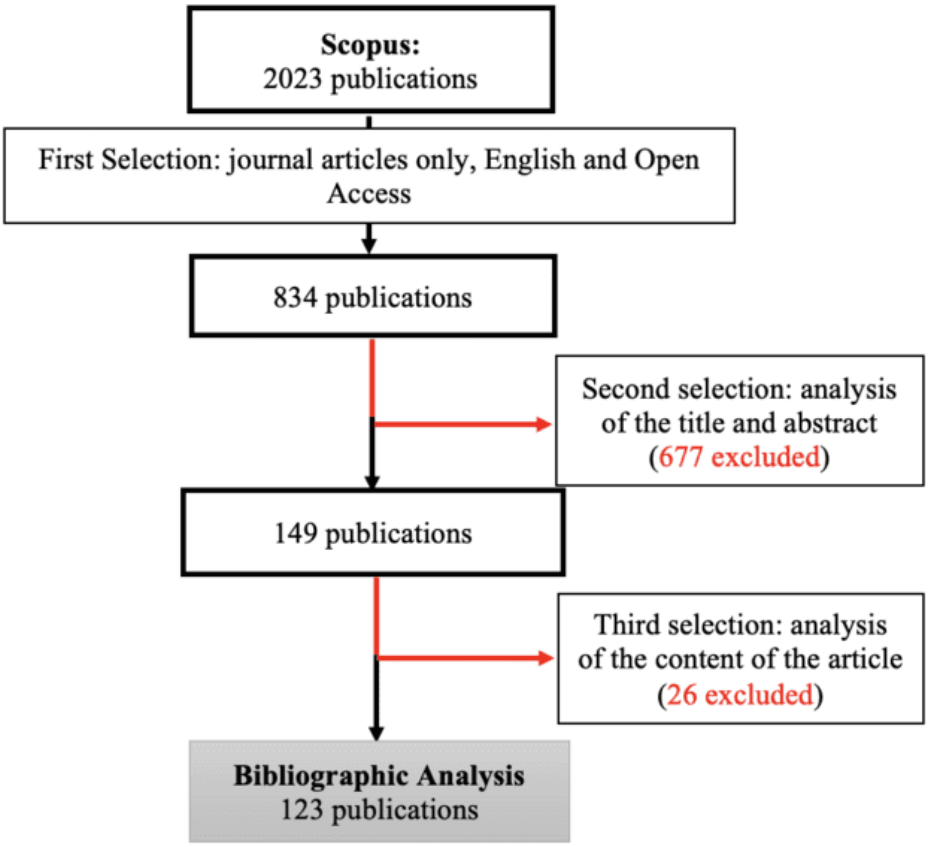

Figure 1. PRISMA research flow chart

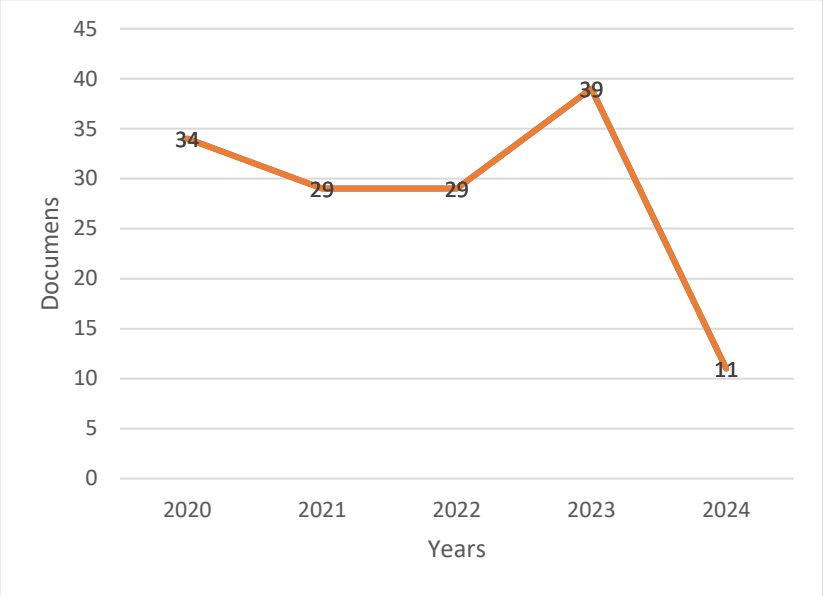

Figure 2. Number of Scopus documents from 2019-2024

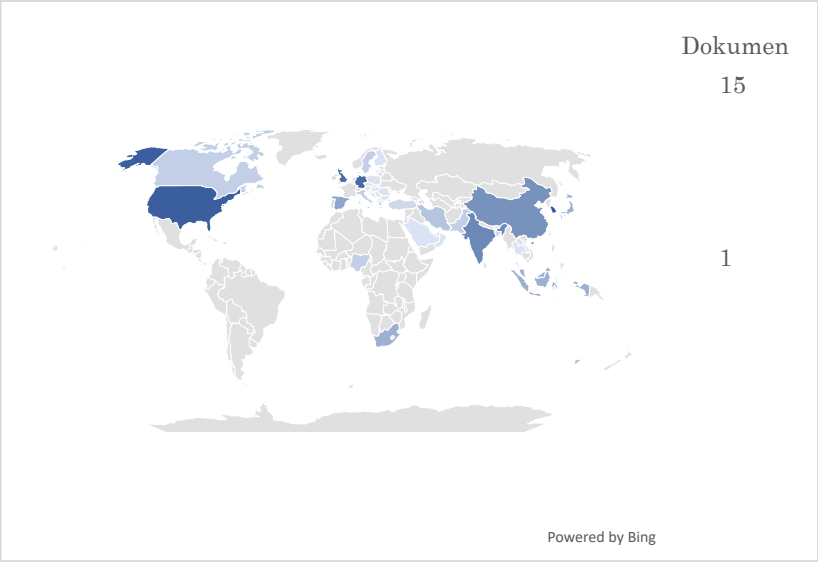

Figure 3. Distribution of documents by country

3. Results and discussions

3.1. Publication frequency

Fig. 2 shows the evolution of scientific publications from 2019 to 2024 on work-life balance in female workers. From the screening of articles, the most references were obtained in 2023, with 39 publications. Whereas in 2024 there were only 11 articles, this is due to the author's last access to Work-Life Balance (WLB) research in April 2024, so the possibility of research on this topic continues to increase until the end of 2024. The trend observed is that publications within the scope of women's work-life balance have been growing yearly. This increase aims to further research on work-life balance in female workers through studies, method development, and applications by the scientific community.

3.2. Contribution of countries

Fig. 3 shows the bibliometric analysis by author's country of origin in the number of articles evaluated. The analysis shows that 47 countries conduct work-life balance research on female workers with at least one article and zero citations. However, of these 47 countries, only 32 countries are connected. Table 1 shows the top 10 countries with the highest number of publications. South Korea has the highest number of work-life balance publications on female workers, with 15 documents and 63 citations. However, its publications are not connected to other countries, so the number of links and total links is 0. The following country, the United States, is second for the number of work-life balance publications on female workers with 14 documents. However, it has the highest number of citations, with 240 citations with several links of 15 and a total link strength of 16.

Table 1.
Top 10 countries with the highest number of documents

Rank	Country	Cluster	Docs.	Citations	Link	Total Link Strength
1	South Korea	0	15	63	0	0
2	United States	10	14	240	15	16
3	Germany	4	13	170	16	18
4	United Kingdom	2	13	147	19	21
5	India	0	10	30	0	1
6	China	3	9	103	6	7
7	Spain	2	7	114	15	15
8	Indonesia	0	6	6	0	1
9	Japan	0	6	74	0	4
10	Malaysia	0	6	61	0	4

Table 2.
Source ranking with a minimum of 3 documents

No	Journal	Country	Docs.	Citations	h-index	SJR (2024)	Q
1	International Journal of Environmental Research and Public Health	Switzerland	9	162	198	0.575	Q2
2	Plos One	United States	5	27	435	0.84	Q1
3	Annals of Occupational and Environmental Medicine	United Kingdom	4	14	30	0.43	Q3
4	Sustainability	Switzerland	4	77	169	0.67	Q1
5	Administrative sciences	Switzerland	3	6	35	0.63	Q2
6	BMC women's health	United Kingdom	3	18	64	0.76	Q2
7	Frontiers in psychology	Switzerland	3	14	184	0.8	Q2

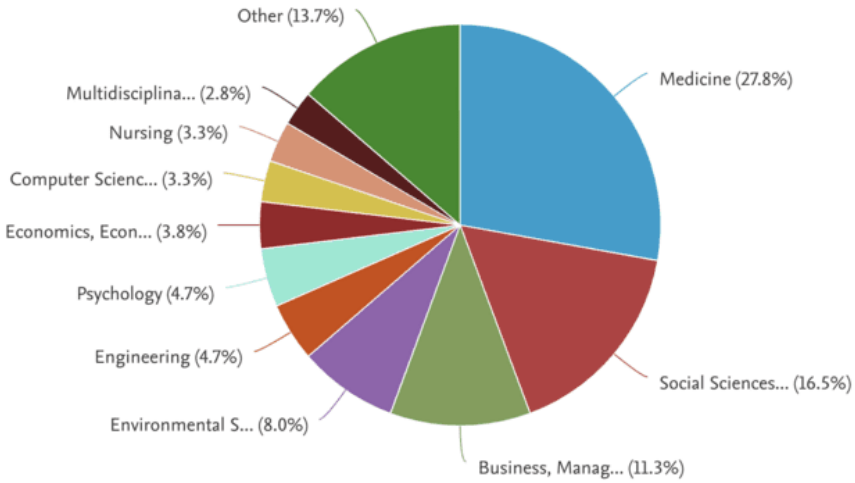

Figure 4. Distribution of documents by subject area

Germany and the United Kingdom are the third with the most documents (13 documents). Germany has the second-highest number of citations (170 citations), with links of 16 and a total link strength of 18. At the same time, the United Kingdom has the third highest number of citations (147 citations), but has the highest number of links, 19, and the highest total link strength, 21. This means that the United Kingdom collaborates with many other countries in work-life balance research on female workers. The United Kingdom and Spain are the two countries that most often collaborate in work-life balance research on female workers; the United Kingdom also collaborates with Ireland, Sweden, the United States, Germany, Switzerland, and several other countries.

3.3. Analysis of the source

The source analysis results using VOSviewer 1.6.17 software was extracted from 123 documents. The results showed that there were 88 publication sources, and the analysis was carried out from each publication source with at least one article and zero citations. Table 2 shows that the 'International Journal of Environmental Research and Public Health' was the top source (9 documents), followed by Plos One (5 documents), Annals of Occupational and Environmental Medicine (4 documents), Sustainability (Switzerland) (4 documents), Administrative sciences (3 documents), BMC women's health (3 documents), and Frontiers in psychology (3 documents).

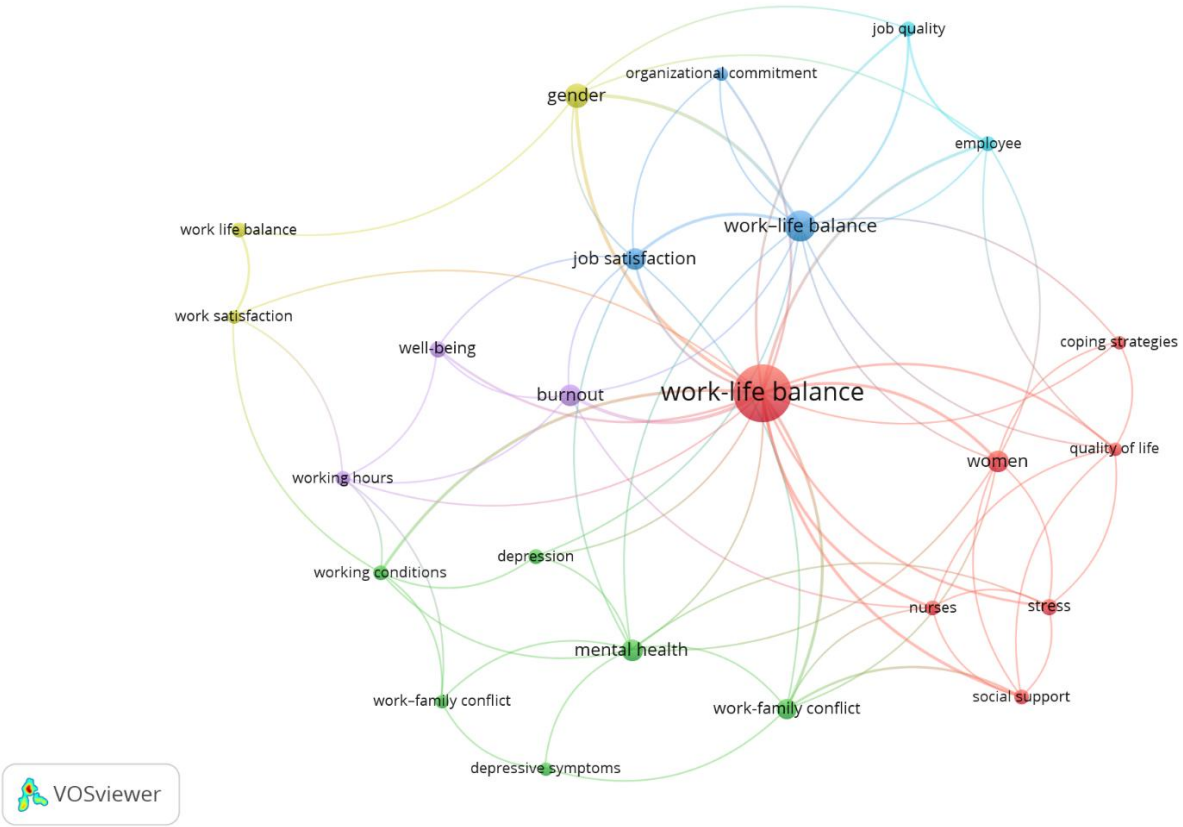

Figure 5. Overlay visualization map of author keywords

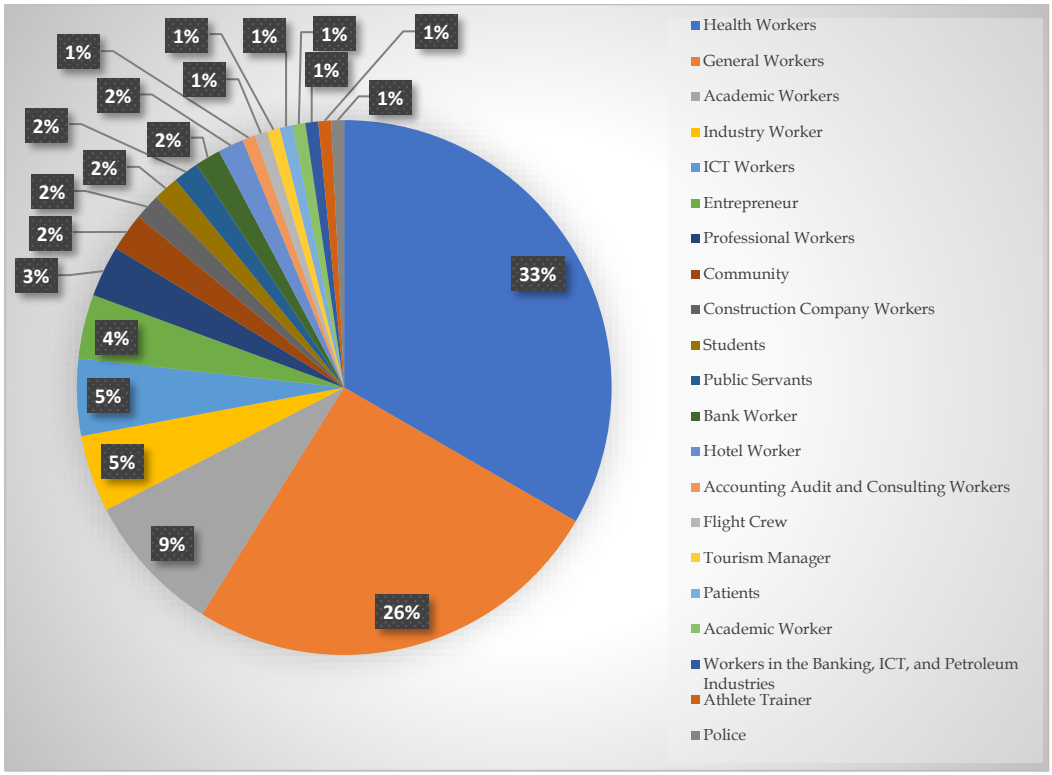

Figure 6. Distribution of documents by object studies

Table 3.
Grouping of author keyword visualization overlays

Category	Keyword	Cluster	Co-Occurrences	Link	Total Link Strength	Avg. Pub. Year.
Research subjects	employee	6	4	6	9	2021.50
	nurses	1	4	6	8	2021.50
Variable X	gender	4	10	6	12	2021.50
	social support	1	4	6	9	2020.75
	working conditions	2	4	6	8	2020.75
	working hours	5	4	6	6	2021.25
	coping strategies	1	3	4	4	2021.00
	organizational commitment	3	3	3	4	2022.33
Variable Y	mental health	2	8	10	10	2021.62
	job satisfaction	3	8	8	11	2020.88
	burnout	5	8	6	9	2021.75
	work-family conflict	2	7	7	10	2021.43
	stress	1	5	6	7	2021.00
	well-being	5	5	4	5	2019.80
	depression	2	4	4	4	2020.75
	job quality	6	4	4	7	2020.50
	depressive symptoms	2	3	3	3	2020.67
	quality of life	1	3	7	8	2021.00
	work satisfaction	4	3	4	5	2021.67
WLB and Women	work-life balance	1	57	19	43	2021.58
	women	1	8	8	10	2021.62

3.4. Analysis of the subject area

Publications on the work-life balance of female workers come from a multidisciplinary approach, this can be seen from the subject area analysis, as shown in Fig. 4. The analysis showed that the most significant number of publications came from medicine (27.8%); social sciences (16.5%); business, management, and accounting (11.3%); environmental science (8%); psychology (4.7%); engineering (4.7%); economics, econometrics and finance (3.8%); nursing (3.3%); computer science (3.3%); multidisciplinary science (2.8%) and other fields (13.7%). These percentages are determined from the number of each publication from the subject area based on the total publications in the bibliography.

3.5. Analysis of the keyword

The analysis of author keywords aims to find correlations between keywords and article topics, making it easier for readers to find various dimensions of the themes studied. The analysis of author keywords in this study uses VOSviewer software by inputting the minimum number of occurrences of a keyword as 3, then there are 24 words of keywords out of a total of 378 keywords with 6 clusters, 75 links and 108 total link strength as shown in Fig. 5.

The keyword 'work-life balance' is the most frequently used keyword by authors, with 57 co-occurrences linked to 19 other authors' keywords and a total link strength of 43, found in cluster 1 with an average year of publication of 2021.58, which means it is most frequently used in documents published around mid-2021. The following keyword is 'gender' with ten co-occurrences connected to 6 other authors' keywords and a total link strength of 12, found in cluster 4 with an average publication year of 2021.50, which means the keyword is also frequently used in documents published around mid-2021. The third keyword is 'job satisfaction' with eight co-occurrences connected to 10 other authors' keywords and a total link strength of 10, found in cluster 3 with an average year of publication of 2020.88, which means the keyword is most frequently used in documents published in late 2020.

The author's keyword analysis grouped by research subject and research variable is shown in Table 3. Grouping the keyword categories of publications shows that the subjects in measuring work-life balance in women are employees and nurses. The most variables related to work-life balance are gender, social support, working conditions, working hours, coping strategies, and organizational commitment. The variables resulting from work-life balance are burnout, job satisfaction, mental health, work-family conflict, stress, well-being, depression, job quality, depressive symptoms, quality of life, and work satisfaction.

3.6. Systematic review

Fig. 6 shows that from the literature review, it can be seen that the most studied object groups in the discussion of women's work-life balance are the group of health workers (33%), general worker (26%), the group of academic workers (9%), industry workers (5%), workers in ICT (5%), entrepreneurs (4%), professional workers (3%), for the community, construction company workers, students, civil servants, bank workers and hotel workers (2%) and for police, flight crew, athlete coaches, academic workers, tourism managers (1%).

The field of research focus of the articles reviewed by the authors appears that the most studied is on health workers, namely nurses, doctors, hospital

employees, or laboratory workers. The study [33] researched 397 nurses working in community hospitals in the Northeast United States, and research [34] was conducted on 205 neurosurgeons in Europe. The following field of study is in the category of general workers, where the object of research is carried out on all categories of employees without explaining the field of work. Research by D.-W. Lee et al. where the object of study was 1,386 female employees in Korea who were grouped into white-collar jobs and blue-collar jobs [35], as well as research by N. Matilla-Santander et al. conducted on 13,683 workers in Europe consisting of employees, permanent workers, workers with permanent employment contracts [36]. The field of study of workers in the academic world is the third most researched. In contrast, the research subjects in this section are University workers, academic staff, lecturers, and even library staff. Research [37] was conducted on 1090 lecturers of the Faculty of Pharmacy in the US, and research [38] was conducted on 148 male and female employees working at private universities in Lebanon. The fourth field of study is industrial employees, as in the study [39] conducted on 150 participants working in Tamilnadu factories working in shifts, or the study [40] conducted on 800 participants working in four Chennai Sal Comp factory buildings, or the study [41] on 14,097 employees working in various industries in 22 European countries.

3.7. Discussions

The results of the bibliometric analysis show that publications on work-life balance in female workers for 2019 to April 2024 are mainly carried out in the field of 'Medicine' followed by the fields of 'Social Sciences', 'Business, Management and Accounting', and environmental sciences' while for the field of Engineering there are still few. This assessment is obtained from the results of a bibliometric analysis of 123 publications on work-life balance in female workers indexed by Scopus, which can identify only 4.7% that discuss the field of 'Engineering'.

The study of objects measured in this bibliometric analysis was mainly done on health workers (33%), such as nurses, doctors, hospital employees, or laboratory workers. Furthermore, in the category of general workers without specifying the type of work (26%), next in academic workers (9%) such as lecturers, academic staff, or library staff, and only 5% conducted studies on industrial workers. The source analysis results evidence that the 'International Journal of Environmental Research and Public Health' is the source with the most citations regarding the work-life balance articles of female workers. In contrast, this journal is a journal of health research.

The field of Engineering studies that discusses work-life balance in female workers is looking at differences in work-life balance between female and male workers in industrial workers in India [42] and in workers in Lutiania [43], which this research was also carried out in other fields, namely comparing work-life balance between male and female neurosurgeons [10], [34], [44] or in the male and female oncology workforce [45], [46]. All research results show differences in work-life balance between men and women, where men have a better work-life balance than women. Workers who are married and have children find difficulties in work-life balance [47]. This occurs due to cultural gender prejudices that result in misconceptions about women's responsibilities in the family and household, especially in Eastern cultures, where patriarchal cultures place women in household responsibilities [3].

Engineering studies also discuss the effect of work-life balance on depressive symptoms, which are associated with Work-Family Conflict (WFC) and cause anxiety and risk of mental health problems in female workers in Korea [35], [48]. The same research was also conducted in other fields, namely work-life balance is related to depressive symptoms in healthcare workers in the United States [49], [50] and in women working at Birjand University of Medical Sciences [51], so a flexible standard work schedule is needed to get a better work-life balance [52].

In the field of Engineering studies, it was also found that work-life balance significantly influences health, time management, and busyness at work, so work-life balance strategies are needed to improve life well-being and encourage continued participation in work in female entrepreneurs [53], [54]. The same thing is also done in other research fields, namely work-life balance, which is related to physical and mental health in dermatologists in Texas [55]. However, studies on work-life balance that affect occupational health and safety have only been conducted by [56] on workers in the construction industry. Likewise, the study of work-life balance that affects occupational injuries and musculoskeletal pain was only conducted by [57] on workers in Korea.

The results of the bibliometric analysis also showed that of all the studies only one study was conducted on female workers in the manufacturing industry, namely the clothing manufacturing industry in India [47]. The results showed that higher age, family status, and having children experienced difficulties in work-life balance. However, no research has been found on the effect of work shifts directly on work-life balance in female workers in the manufacturing industry, where jobs in the manufacturing sector often involve long and irregular work shifts, including night shifts, which can disrupt daily routines and rest time [12]. The results of other studies show that work shifts have a significant effect on work-life balance in hotel employees [58] and in nurses in hospitals [59].

4. Conclusions

Research on work-life balance in female workers has grown considerably over the years. This topic studies work-life balance from its causes, factors related to causes, and prevention. This topic is mainly conducted in 'medicine' and 'social sciences', and the study of engineering is an excellent opportunity for further

research. There has been no work-life balance research explicitly conducted on female workers in the Manufacturing Industry to see the effect on occupational health and safety and the effect on occupational injuries and musculoskeletal pain. Likewise, research has yet to be found on the effect of work shifts directly on work-life balance in female workers in the manufacturing industry, where workers in the manufacturing industry often involve long and irregular work shifts. At the same time, this study was conducted on other subjects, such as hospital nurses and hotel employees. The challenge for future research is to apply engineering studies to assess work-life balance, especially for female workers in the manufacturing industry.

Declaration statement

Sri Zetli: **Methodology, Project administration, Resources, Software, Visualisation, Writing - original draft, Writing - review and editing**. Lusi Susanti: **Conceptualisation, Data curation, Formal analysis, Supervision and Validation**. Desto Jumeno: **Conceptualisation, Data curation, Formal analysis, Supervision and Validation**.

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Disclosure statement

The authors report there are no competing interests to declare.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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