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The Future of Knowledge Workers Studies: A Scientometric Analysis of Research Based on Web of Science Database During 1938-2021

Mahshid Pourhosein [1], Mehdi Sabokro [2,*], Saeid Saeida Ardekani [3], Masoud Charifi [4]

[1] *PhD Student in Management, Yazd University, Yazd, Iran. m.pourhossein@stu.yazd.ac.ir*
[2] *Associate Professor, Management, accounting and economics Department, Yazd University, Yazd, Iran.*
[3] *Professor, Management, accounting and economics Department, Yazd University, Yazd, Iran. dr.saeida@yazd.ac.ir*
[4] *Assistant Professor, Management, Psychology Department, Shahid Beheshti University, Tehran, Iran. m-charifi@sbu.ac.ir*

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ABSTRACT

This study aims to develop a comprehensive bibliometric overview of the publications on knowledge workers from the Web of Science database. The current research is of an applied type and has been carried out using scientometric methods and co-authorship and synonym analysis techniques. In this regard, 1609 scientific papers on knowledge workers were bibliometric analyzed in a descriptive-analytical study. A graphical mapping of the bibliometric material by using the visualization of similarities (VOS) viewer software has been developed in this work. The retrieved papers cover the years from 1938 to 2021. The results indicate an upward trend in the publication in the last ten years. This research demonstrated that keywords changed over time from focusing on key differences between knowledge workers and others to psychological factors related to employees and motivational factors. This study is one of the first attempts to summarize knowledge workers and suggest future research directions.

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***Corresponding Author: Mehdi Sabokro**
Email: msabokro@yazd.ac.ir
ORCID ID: 0000-0001-9837-6791

1. Introduction

The dynamics of the workplace are evolving rapidly. New methods of working and increased skill requirements are necessitated by the rise of digitalization and the potential consequences of artificial intelligence. Manyika and et al. (2017) cite research from McKinsey & Company that estimates as much as 30% of current employment could be automated by 2030, while 9% of the workforce will be in new roles. Another study found that by 2033, nearly half of all occupations in the United States will be threatened by automation (Lund and et al., 2020).

Knowledge workers already accounted for about a third of the workforce in the United States by 1958, according to Dovenport's estimates, and this percentage was expected to expand at a considerably higher rate than the whole workforce. About 40% of the working population in the United States and Canada was classified in the knowledge sector at the beginning of the 1970s, while in most OECD countries, this figure was still significantly lower. The knowledge worker population grew by an annual average of 1.9 million between 1980 and 2016 (Pyöriä, 2005).

The strong push for automation and the need for a workforce with advanced technical skills is accompanied by a simultaneous push to develop further "softer" abilities, including emotional intelligence, communication, and creativity (Gallup, 2019). At the same time, according to Gallup, employee participation is at its lowest level (van den Berg, 2020). Pfeffer goes even further by arguing that stress at work is at its highest level and is harmful to health (Pfeffer, 2018).

In recent centuries, one of the distinguishing aspects of work has been the change toward increasing the proportion of knowledge-oriented employees in organizations. Drucker (1969) suggested that knowledge-oriented employees could constitute 50% of employees in the future and emphasized the importance of increasing their productivity as the main management challenge of the 21st century (Morschheuser & Hamari, 2019).

There is no complete agreement on the definition of knowledge workers in the literature, but the literature analysis shows the emergence of several common patterns. The first person who used this term was Peter Drucker (Corò, 2021). According to Drucker, a knowledge worker has the following characteristics: He has valuable knowledge for the organization and is often the only person. He is a person who can use this knowledge for the organization. His knowledge is hidden and unconscious; sometimes, the employee is unaware of its importance and significance. Other employees of the organization have limited access to it and are unable (for various reasons, e.g., financial resources, time resources, knowledge workers more than other employees) to use their intellect, although this is not the rule. The same author has emphasized in many of his studies that scientists create value for the company's future. (Bartkowiak and et al., 2021)

Today, it is common to use scientific metric methods to review the development process of a scientific topic, draw a scientific map, review the research literature in this field of science, and identify the top countries and top researchers. Social network analysis is a systematic method that provides a sociological paradigm for keyword analysis. Moreover, it identifies scientific cooperation networks by analyzing network nodes and communication lines between them and determining the co-authorship of researchers and countries (Abrahams, Sitas & Esler, 2019).

A widespread method of map drawing is the Visualization of Similarities (VOS), implemented as a computer program called VOS viewer software (Van Eck & Waltman, 2010). This software illustrates bibliometric maps to emphasize different aspects of the literature produced. Furthermore, it uses a unified approach for mapping and clustering based on the co-occurrence matrix of normalized terms and a similarity measure that calculates the strength of association between terms. Puts terms very close to each

other into a cluster and displays each cluster with the same color. The proximity of terms can be interpreted as an indication of the similarity of the context in which they occur. In addition, the VOS viewer separates keywords by year by color and can display them with font size and bounding rectangles. Larger fonts and rectangles represent more frequent terms. Also, this software can draw networks of keywords, countries, institutions, co-authorship of authors, and citations (Subelj and et al, 2020).

Drawing researchers' scientific and social structures in a scientific field provide valuable information about their position in the scientific body (Van Eck, 2018). The amount of scientific production indexed in the Web of Science database known as WOS is an important criterion for evaluating and determining the scientific ranking of countries, researchers, and universities (Verma and etal, 2020).

Some studies have investigated the process of science production in different fields of science in a bibliographic manner (Zancanaro, Todesco & Ramos, 2015). Based on the search of scientific sources in the field of knowledge workers, no bibliometric review of "knowledge workers" has been done in the Web of Science database. The present study was carried out with the aim of bibliometric analysis of scientific publications in the Web of Science database on knowledge workers and drawing a scientific map of the world. For this purpose, the world's top journals and researchers, the world's top countries and institutions, the most cited articles, the most frequent keywords, and the co-author status was discussed.

To achieve this goal, the present research has tried to answer the following questions:

1 (What is the distribution of the frequency of scientific productions and citations in the field of Knowledge Workers during the years 1938 to 2021 on the science website?

2 (Who are the top authors, institutions, and countries in scientific productions in the field of Knowledge Workers in terms of scientific participation?

3 (The results related to the co-authorship cluster analysis have led to the formation of what clusters in the partner countries in the scientific productions of the field of knowledge workers?

4) The results related to the analysis of keywords have led to the formation of what clusters and with what topics in the scientific productions of the field of knowledge workers, and what is the evolution of these keywords?

2. Literature Review

Three different ways to define "knowledge workers" have been put forward in the related literature. These approaches are conceptual, data-driven (industry) oriented, and job content-based. Conceptual approaches define a "knowledge worker" by how important the person is to the organization and how he uses his knowledge at work (Issahaka and Lines, 2020). People who work in organizations, institutions, and specific parts of the organization are considered knowledge workers. The approach based on job content considers knowledge workers as people who do a particular work (jobs) (Bussin & Brigman, 2019).

According to Reboul and colleagues (2006), knowledge work and knowledge workers are defined as follows:

- The primary work tool of knowledge workers is their brains. Therefore, when an organization loses its scholar, it loses its knowledge capital.
- A knowledge worker uses his knowledge in his work. He creates or shares explicit and tacit knowledge and uses it.
- The position and position of knowledge workers requires continuous learning and improvement.
- Knowledge workers change jobs and assign work. No two scientists do the same thing.
- It is challenging to measure the productivity and quality of knowledge workers.

Various definitions have been presented regarding knowledge workers, all of which emphasize that manual workers were the principal capital of the organization in the

past, but today it is the knowledge workers who are considered the primary and fundamental capital of the organization; people who have learned in systematic education (concepts, ideas, and theories) apply it better and more efficiently than bad employees.

Horowitz (2000) considers knowledge workers to be those who have education with high skills, technical literacy, cognitive power, and talent; the ability to make better decisions and provide more appropriate solutions for the organization, the ability to observe, combine, and interpret data, and have the information.

Davenport (2000) says that knowledge workers are people who create knowledge. He then expands on this idea by saying that knowledge workers are people with a lot of education, skills, and experience who create knowledge about distribution and application. Davenport's view is different from Drucker's. Drucker defines a knowledge worker as "someone who knows more about their job than anyone else in the organization." He believed that knowledgeable people often understand their work better than others. According to this definition, there is only one knowledge worker for each job, which is not a correct definition, according to Davenport. He ignored jobs with high knowledge content. Davenport's definition of knowledge workers differs from Drucker's: "Knowledge workers have a high level of expertise, training, and experience, and their main job is to create, distribute, and use knowledge" (Davenport, 2016).

Information visualization is a way to make it easy to understand how the structures and connections of thousands of documents work together. (Shah et al., 2019) VOSviewer is one of the tools that were made just for visualization and allow a large amount of information to be shown visually in a dynamic way. VOSviewer is free software used to create and visualize bibliometric networks, create maps based on network data, and visualize and explore these maps. This tool also lets you figure out how texts and data relate to each other, which can be used to build and show simultaneity networks. VOSviewer can receive information from many different sources, turn it into images that are easy to understand, and then process those images. To build the network, data can be taken from scientific bibliometric databases like Web of Science, Scopus Dimensions, and PubMed, as well as from resource management software. (Ding and Yang, 2020) You can give VOSviewer scientific references like EndNote and RefWorks.

Bibliometric review is an interdisciplinary field of knowledge that lets researchers' study and look into a specific research field, field, or topic by using quantitative analysis. This lets them learn about the development of a field or topic and how it has changed over time, which gives them useful information (Zupic & ater, 2015). Bibliometric research has been used in many disciplines and fields. It is a method that is often used in management and business studies, such as strategic management (Nerur et al., 2008), entrepreneurship (Schildt et al., 2006), innovation (Garcia-Manjon & Romero-Merino, 2012), and so on.

Bibliometric analysis is a type of scientific publication analysis that examines how our understanding of a particular topic has evolved over time, as well as the scientific quality and impact of works and resources (Donthu et al., 2021). The bibliometric analysis examines bibliographic materials from an objective and quantitative perspective, which helps organize information in a specific subject area. Also, bibliometric analysis is a useful tool for evaluating and analyzing the results of academic research. It prevents subjectivity and creates objectivity (2019, Della Corte et al.). The results of these methods are generally displayed using visualization software.

Performance analysis: To study the historical evolution of Knowledge workers research, both quantitative and qualitative indicators were used. For example, the total number of articles published is one of the most commonly used quantitative indicators in bibliometric studies. The number of citations is an important qualitative indicator that reflects the importance of the topic

under study. The h-index was also used. This composite index combines quantitative and qualitative measures. It is an easy-to-use relative value derived from the number of publications and the number of citations (Mas-Tur, Roig-Tierno, Sarin, Haon & et al., 2020).

Mapping analysis: Science mapping is a technique that provides a structured overview of relevant publications. One of the techniques used in science map drawing is the visualization of similarities (VOS), in which a computer software program called VOSviewer implements this technique (Pagan-Castaño & et al., 2022). With the graphic drawing of each scientific field, science maps have paved the way for the better and more accurate identification of that branch of human knowledge and the transformation of the abstract concept of the scientific field into a more objective concept. These maps are drawn with several techniques and methods. One of the purposes and applications of co-occurrence analysis is to draw the structure of science or draw scientific maps (Araujo, Carneiro, & Palha, 2020). Both techniques have been used in the present study. In this research, both the citation status and the frequency of articles have been investigated, and the knowledge map of articles in the field of knowledge workers has been presented. VOSviewer software was used to analyze and illustrate keywords and draw a science map.

Considering the necessity of a comprehensive and integrated review of past research, the aim of this research is the bibliometric analysis of research published in the knowledge worker's field.

3. Methodology

The current research is of an applied type and has been carried out using scientometric methods and co-authorship and synonym analysis techniques. this research intending to analyze the social network of scientific productions in the field of knowledge workers from the web of science data.

The search was conducted in August 2022 using the WoS Core Collection database search engine. The search was limited to all papers published from all years. Using the keyword "Knowledge workers" as the search string, 1,705 papers were identified. The analysis was restricted to articles. Next, following a bibliometric analysis approach, the search was restricted to articles, reviews, notes, and letters (Merig´o, Gil-Lafuente, & Yager, 2015; L´opez-Rubio, Roig-Tierno, & Mas-Verdú, 2022). As a result of these restrictions, the number of papers was reduced to 1,435. This restriction was set to guarantee that the analyzed documents had been peer-reviewed, thus ensuring their scientific quality (García, Rodríguez-S´anchez, & Fdez-Valdivia, 2017).

In this research, the keywords used by the authors of the articles were used for co-lexical analysis because experts in this field wrote these words, which gives a better understanding of the subject of the articles. The total number of keywords was 5000. In the VOSviewer software, the co-occurrence of 5 words was used, and finally, the number of selected keywords was 380. Co-occurrence 5 was selected because the higher the co-occurrence rate, the more important words and clusters are recognizable. Therefore, co-occurrence five was found to be appropriate by examining different co-occurrences.

4. Findings

Publication and citation structure

1) distribution of the frequency of scientific productions and citations in the field of Knowledge Workers during the years 1938 to 2021 in the science website:

Figure 1 shows a graphical representation of the number of articles from 2000 to 2022. During the first decade of the analysis, fewer than 53 articles were published each year. In contrast, from 2013 onwards, more than 50 articles were published each year. The data therefore show growth in the number of Knowledge workers publications each year over the last decade.

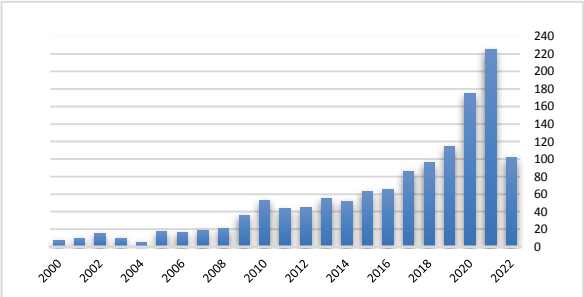

Figure 1. Number of articles over time.

Regarding the most representative publications, Table 1 shows the document title, authors, total citations, publication date, and citations per year of the 10 most cited papers on Knowledge workers. These most cited articles were published between 1997 and 2011, and all have at least 145 citations. The article by Drucker, PF (1999), entitled "Knowledge-worker productivity: The biggest challenge", leads the list of the 10 most cited Knowledge workers' articles, with 653 citations and 27.21 citations per year. According to Google Scholar, this paper has 50 citations. The second most cited article was authored by Lewis, W; Agarwal, R and Sambamurthy, V (2003). The article, "Sources of influence on beliefs about information technology use: An empirical study of knowledge workers", has received 527 citations in WoS and 1492 on Google Scholar.

Table 1. *The most influential articles in Knowledge workers*

R	TC	Title	Authors	PY	C/Y
1	653	Knowledge-worker productivity: The biggest challenge	Drucker, PF	1999	**27.21**
2	527	Sources of influence on beliefs about information technology use: An empirical study of knowledge workers	Lewis, W; Agarwal, R & Sambamurthy, V	2003	**26.35**
3	407	Knowledge and performance in knowledge-worker teams: A longitudinal study of transactive memory systems	Lewis, K	2004	**21.45**
4	294	Can they take it with them? The portability of star knowledge workers' performance	Groysberg, B; Lee, LE & Nanda, A	2008	**19.6**
5	228	Knowledge worker team effectiveness: The role of autonomy, interdependence, team development, and contextual support variables	Janz, BD; Colquitt, JA & Noe, RA	1997	**11.08**
6	218	When more is too much: Operationalizing technology overload and exploring its impact on knowledge worker productivity	Karr-Wisniewski, P & Lu, Y	2010	**16.77**
7	190	Knowledge worker communications and recipient availability: Toward a task closure explanation of media choice	Straub, D & Karahanna, E	1998	**7.6**
8	182	Science, capitalism, and the rise of the "knowledge worker": The changing structure of knowledge production in the United States	Kleinman, DL & Vallas, SP	2001	**8.27**
9	161	It's the Little Things That Matter: An Examination of Knowledge Workers' Energy Management	Fritz, C; Lam, CF & Spreitzer, GM	2011	**13.42**
10	145	Knowledge workers' creativity and the role of the physical work environment	Dul, J; Ceylan, C & Jaspers, F	2004	**12.08**

Notes: R = rank, TC = total citations, PY = publication year, C/Y cites per year

2) Top authors, institutions and countries in scientific productions in the field of Knowledge Workers in terms of scientific participation:

This subsection presents the main authors, institutions, and countries in relation to Knowledge workers. Table 2 lists the 8 authors who have contributed the most to Knowledge workers The results are ordered by number of publications and are based only on publications on Knowledge workers. The authors in this list have more than three articles and more than 20 citations. The list also provides information on affiliation, country, total citations, h-index, and total citations per article.

Table 2. *The most productive and influential authors in Knowledge workers*

R	Author	Affiliation	Country	TP	TC	h	C/P
1	Kaplan, Sigal	Teva Pharmaceutical Industries	ISRAEL	6	155	4	25.83
2	Lee, Jungwhan	China Europe International Business School	CHINA	6	42	4	7
3	Li, Yuan	National Institute of Development Administration	THAILAND	5	26	2	5.2
4	Riccò, Matteo	AUSLI RCCS Reggio Emilia	ITALY	5	54	3	10.8
5	Albertsen, Karen	TeamWorkingLife	DENMARK	4	56	3	14
6	Di Giuseppe, Gabriella	Universita della Campania Vanvitelli	ITALY	4	106	4	26.5
7	Garde, Anne Helene	University of Copenhagen	DENMARK	4	56	3	14
8	Rugulies, Reiner	National Research Centre for the Working Environment	DENMARK	4	56	3	14

Notes: R = rank, TP = total publications, TC = total cites, H = h index, C/P = cites per publication.

The continent with the highest contribution is Europe. The most representative country is the DENMARK. With 6 articles, the author with the highest number of Knowledge workers' publications is Sigal Kaplan of the Teva Pharmaceutical Industries in the Israel. Sigal Kaplan is followed by Jungwhan Lee of China Europe International Business School in the China and Yuan Li of National Institute of Development Administration in Thailand, with 6 and 5 articles, respectively. The h-index is a robust estimator of the impact of a scientist's contribution to a particular research area (Hirsch, 2005). That is, it reflects the quantity and visibility of the work by a given author (Bornmann & Daniel, 2007; Egghe & Rousseau, 2006). These 8 most cited authors each have more than 20 citations and an h-index ranging from 2 to 4. Gabriella Di Giuseppe, has the highest number of citations per article, with an h-index of 4, followed by Sigal Kaplan, with 4.

Table 3. *The most productive and influential institutions in Knowledge workers*

R	Institution	Country	TP	TC	h	C/P
1	University of California	USA	30	351	11	11.7
2	University of Gondar	Ethiopia	22	234	7	10.34
3	Egyptian Knowledge Bank	Egypt	18	227	6	12.61
4	World Health Organisation	Switzerland	18	218	9	12.11
5	MINIST HLTH	Singapore	17	89	6	5.24
6	University of Ibadan	Nigeria	17	174	8	10.24
7	University of London	England	17	269	9	15.82
8	Centers for Disease Control and Prevention	USA	16	259	10	16.19
9	Harvard University	USA	16	421	7	26.31
10	University of Michigan	USA	16	448	11	28

Notes: R = rank, TP = total publications on the subject of Knowledge workers, TC = total cites, H = h index, C/P = cites per publication.

Table 3 shows the 10 main university affiliations of the authors who have published on Knowledge workers, classified by the total number of publications on the subject. University of California has the highest number of publications (30), the number of citations (351), the highest h-index (11), and the average number of citations per publication (11.7). However, the University of Michigan has the highest total cites (448). In general terms, the dominant universities in the subject are located in the USA (4). six countries also appear in the ranking: Ethiopia, Egypt, Switzerland, Singapore, Nigeria and England.

3) The results related to the co-authorship cluster analysis have led to the formation of what clusters in the partner countries in the scientific productions of the field of knowledge workers:

Figure 2 graphically shows the co-authorship network of authors publishing on Knowledge workers. This map was produced

with the data on the co-citations of the authors included in the analysis. The colors indicate the group to which each author should be assigned according to the application of the cluster technique. The clustering has a simple interpretation such that authors are related to each other in a visual way. This aspect is one of the main advantages of VOS viewer over other widely used tools such as SPSS and Pajek, where, for example, the overlapping of labels prevents a clear visualization.

The graph highlights two groups of interconnected co-authors. Red corresponds to group 1, consisting of Yimin Chen, Peter Decat, Ciyong Lu, Meile Minkauskiene, Eileen Moyer, Dirk Van Braeckel, Zhijin Wang, Jie Wu, Shizhong Wwu, Longchang Xu and Wei-hong Zhang. green corresponds to group 2, which is formed by Lin Li, Yan Li, Stanley Luchters, Marleen Temmerman and Ying Zhang.

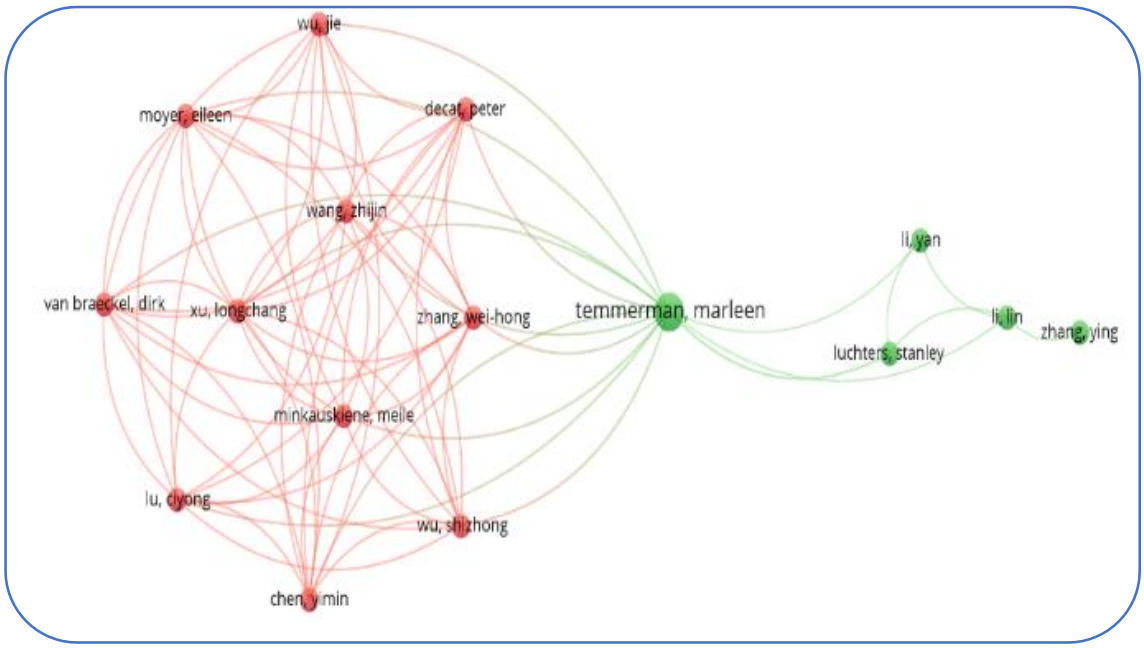

Figure 2. Co-authorship map of authors.
Notes: Minimum number of documents per author = 2; 16 of the 6,348 authors meet this condition.

4) The results related to the analysis of keywords have led to the formation of what clusters and with what topics in the scientific productions of the field of knowledge workers, and what is the evolution of these keywords:

Authors' keywords are very important because they are the main concepts used by the author to communicate with the audience. Circles or rectangles in figure 3, indicate the most frequent words. The bigger circle and bigger font in the image represent the words repeated more, and the smaller circle represents the less repeated words. The most used keywords include: Knowledge, management, performance, impact, behavior, and education. the most frequent words placed in seven color-coded clusters based on co-occurrence analysis.

A suitable title was given to the cluster based on the words repeated the most in each cluster. Titles and some more appropriate words are mentioned here.

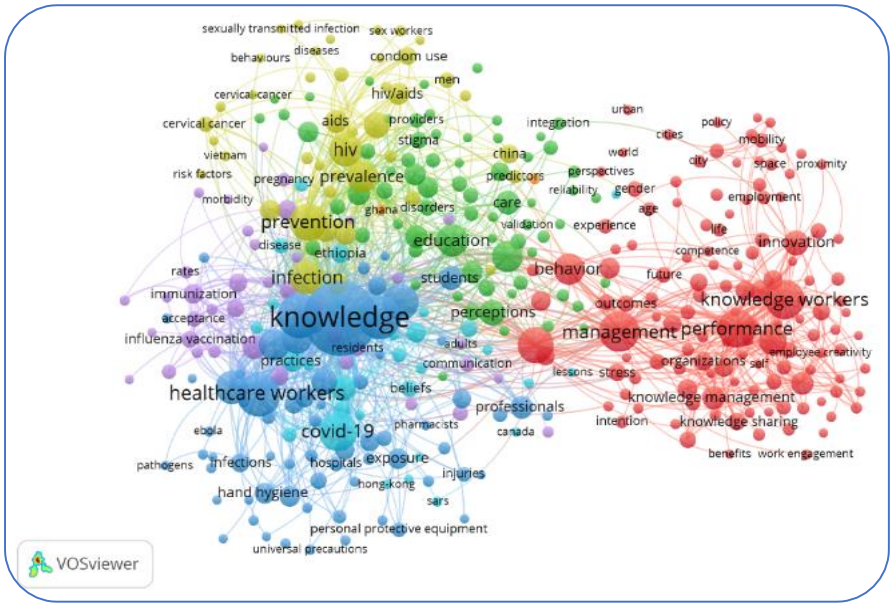

Figure 3. Key concepts in Knowledge workers. Notes: Minimum number of occurrences of keyword = 5; 380 of the 5,000 keywords meet this condition

Table 4. *Keyword clustering*

R	CN	Keyword
1	Job characteristics of knowledge workers	Ability-affective commitment benefits- burnout- career- conflict- climate- commitment- culture- impact-identity-job satisfaction- justice
2	Background factors of employees' work environment	Age- city-field- issues- place- urbane- time- social network- technology- economy
3	Job maintenance factors	awareness- burden- care worker- infants- mortality- acceptability- personnel- food safety
4	Features related to communication between knowledge workers	Access- adherence- population- community healthy work- facilities- intention- program-
5	Health of knowledge workers	Aids- ethics- experience- HIV- hospital- infection- disease
6	Career motivation factors of knowledge workers	Children- evaluation-fever- health care worker- knowledge level-
7	Knowledge management and general aspects of knowledge work	Attitude and practice- management of knowledge- primary healthcare- reliability- risk factor- screening-validity

Notes: R = rank, CN = Cluster name

Bibliometric analysis showed in figure 4 that the most frequent keywords of authors in the last decade have changed from the oldest ones in dark blue to the newest ones in red.

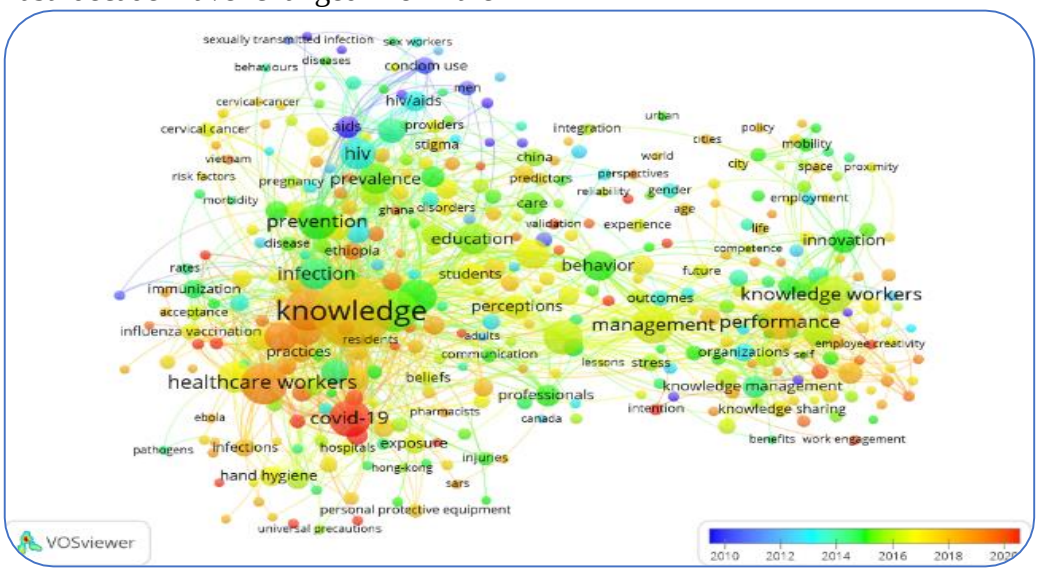

Figure 4. Distribute repetitive keywords per time period, Notes: Minimum number of occurrences of keyword = 5; 380 of the 5,000 keywords meet this condition.

Table 5. *The process of transformation of the most frequent words based on time period*

R	Color	keyword
1	Dark blue	Organization, Information, Field, Hospital worker, long term care, promotion
2	blue	Behavior, Adherence, Service, Social Worker, Motivation, Professional, Culture, Recruitment
3	green	Risk, Risk factor, Health knowledge, Health personnel, health workers, prevalence
4	yellow	Adoption, autonomy, Challenges, Intervention, community health worker, skill, Coverage
5	orange	Psychological capital, Perspective, post exposure prophylaxis, Self-determination theory
6	red	Covid19, Corona virus disease 2019, Knowledge management process

The trend of changing the most frequent keywords in Table 5, red and orange keywords should be placed in a category in the topic "Knowledge management and factors affecting the physical health" and yellow and green keywords in the topic "Psychological aspects of knowledge work". and the blue are considered in "General topics and key factors in knowledge work".

5. Discussion

In this research, an attempt was made to present a general picture of the world situation in the field of knowledge-oriented employees. The results indicate that researchers worldwide started publishing ISI articles on this topic 24 years ago, and the number of articles in this field is still developing. Regarding the scientific production process, generally, the number of articles was less than 20 before 1993 and gradually showed an upward growth, as seen in Figure 1. The greatest growth and intensity of the increase in the number of articles was shown from 2010 onwards. Since the search and data retrieval was done in the middle of the first month of 2021, it is possible that some unindexed WoS articles published in 2020 were still in the database. The downward trend seen in 2021 is because this research only covered the information of articles from 2021 that were indexed in the database until February 12, 2021.

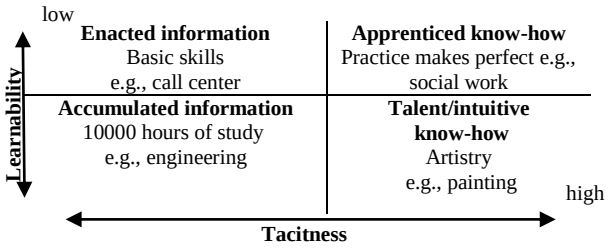

Figure 6. Classification of articles for knowledge work

Regarding the number of citations to articles per year, an upward trend was observed, with a lower slope before 2007 and a higher slope in the last decade.

Regarding the development process of frequently used keywords in Table 9, if the red and orange keywords are placed in a category in the subject of "general topics and key factors in scientific work,"; And the keywords of the yellow and green spectrum should be considered in the subject of "psychological aspects of knowledge work" and the blue spectrum in the subject of "knowledge management and factors affecting the physical health of employees"; It can be concluded that the process of scientific development in the subject of knowledge workers has changed from before 2011, from focusing on the main factors of the difference between knowledge workers and other workers in the years 2011 to 2013, and in the last few years from 2013 until now, towards the psychological factors related to Employees and motivational factors to keep these employees have changed. This development process is shown in the form of figure 5 in summary form.

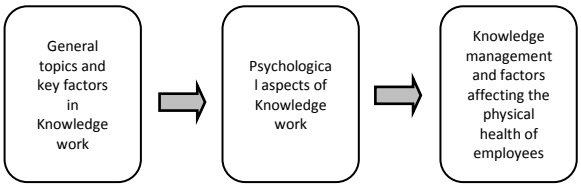

Figure 5. Keyword transformation paradigm

6. Conclusion

With the introduction of knowledge work, scientific sources have first expressed the differences between knowledge work and manual work. Most of the literature focuses on intellectual work as a representative of knowledge-based work. Various articles proposed the classification of expertise. A basic classification in these articles for scientific work is drawn as a diagram below:

The entry of psychology into the ups and downs of management led to the explanation of the individual's personality and behavior in the organization by using different schools

and theories of psychology and establishing human relationships. Due to the special importance of knowledge workers and the competitive advantage they create for the organization, much attention has been paid to their motivation and retention, in such a way that most of the articles in this field have examined the psychological components and mental health characteristics of these people in the organization.

In all these resources in management, psychological strategies such as recognizing individual differences, talents, motivational factors, establishing human relations, how to encourage and punish, help managers to connect more with knowledge workers and their peers and realize The methods of influencing and communicating constructively and their leadership styles go from a dry and soulless state of management to lively and dynamic management with passion, motivation, calmness, dynamism, innovation, change and transformation in the entire organization under their cover and finally raising the quality and driving productivity.

Psychological research and surveys show that the physical conditions of the work environment have many effects on the mental health of the employees of organizations. Psychological studies show that if the physical conditions in the work environment are suitable, it will improve the productivity and quality of the employees' work. In recent scientific sources, different criteria have been used to study the effects of working conditions on people. The three main criteria are physiological, psychological, and production criteria. The choice of the most appropriate criterion is naturally dependent on the situation.

•Physiological standards of human work are done with the intervention of some physiological processes. When a person works, especially if it is physical work, there are many varied changes in their physiological state.

•Psychological criteria, in addition to normal physiological changes, such as physical fatigue, some psychological changes also occur during work or when a person is in a certain situation.

•Production: The third criterion for analyzing the effects of different work conditions on employees is production or any valid indicator of work results. In some studies, work reduction is considered.

By examining the physical factors of work and their great impact on the productivity of employees and even their mental health, as well as the spread of epidemic diseases and their impact on the health of employees, these issues have become the main focus of studies in recent years.

The topic investigated in this study was knowledge-oriented employees. It was observed that in some retrieved sources, the term "knowledge-oriented employee" is also used; Therefore, it is suggested that in future studies, the association of these two topics and related keywords should be investigated to obtain more comprehensive results. In addition, this study analyzed the web of science bibliometric analysis only in the database of published sources; It is recommended to examine the sources published in Science Direct and Scopus databases in future studies. In general, since the topic of knowledge-oriented employees has been widely considered in the countries of the world, it seems necessary to provide relevant training programs to empower employees in order to transform them into knowledge workers.

After analyzing the studies and articles published in Web of Science databases from 1938 to 2021, we find that the activity of knowledge workers has moved towards creating more specialized knowledge.

However, training programs for employees still focus on acquiring knowledge and not how to use the knowledge they have learned. Teaching efforts are still towards explicit knowledge, although tacit knowledge is considered a competitive advantage in the current economy. Most of the research in this field today has focused on this tacit knowledge.

Based on the conducted research, it can be said that creating knowledge is not enough due to the complexity and uncertainty of the current business environment. As a result, economic and business higher education should not only deal with the management and dissemination of basic knowledge about economic phenomena and specialized knowledge; It should also develop a series of more specialized skills and abilities. The skills and abilities suggested for training knowledge workers and researchers by examining the research process are presented in the table below.

Table 6. *Skills and abilities suggested for the future of Knowledge workers' studies*

Example of a cited article	Skill
Dunne, E. et. al. (1997)	Communication skills, study skills, problem solving, political and economic literacy, use of ICT, networking, Dealing with Uncertainty
Hargreaves, D.H. (1999)	Flexibility, networking, creativity, learning skills
Jenks, C.L. (2004)	Critical thinking, creativity, sensitivity, attention, examining each other's views, interaction and joint and productive cooperation with others
Johnson, D. (2006)	Technological skills (using information and communication technology to collaborate, learn, solve problems, make decisions, build models, produce creative works, and interact with peers, experts, and other audiences), information problem solving skills, and higher order thinking skills. searching for information, using information creatively, representing, interpreting, analyzing, comparing, estimating), conceptual skills (seeing the big picture, integrating information, empathy).
Brătianu, C, Shook, C.L. (2006)	Critical thinking, strategic analysis
Lindberg, M.E. (2008)	Risk taking, teamwork skills, flexibility, strategic analysis
Uluorta, H. Quill, L. (2009)	Flexibility, risk taking, innovation, learning skills
Sahlberg, P. Bce, E. (2010)	Extensive cognitive learning, communication and cooperation skills, risk-taking, creativity, innovation
Rothberg, H. N., & Erickson, G. S. (2017).	Strategic thinking, information search skills, collecting information from big data
Wipawayangkool, K., & Teng, J. T. (2019)	Knowledge sharing, personalization, computer technologies
De Srdi J., etal. (2021)	Learning analytical knowledge, learning applied knowledge, learning teamwork, adapting to the work environment

Future work

In this research, the bibliographic data of the Web of Science database is considered as the output of academic staff. Deeper researches are needed to expand the concept of knowledge workers.

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