



TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering  
Vol. 65, Issue Special III, November, 2022

## BIBLIOMETRIC STUDY OF THE LITERATURE ON ERGONOMICS IN CONSTRUCTION

Elena MARICA, Adina SÂRB, Maria POPA

**Abstract:** Most employers are concerned about ergonomics, aiming to constantly improve working conditions in order to ensure that employees perform very well. Employees working in the construction industry are very exposed to accidents at work, therefore the focus is on both reducing workplace risks and on employee comfort. The purpose of the research is the bibliometric analysis of the construction ergonomics literature using the Scopus database and the VOSviewer software. The study analyzed 970 publications from more than 50 countries, published between 1971 and 2022, with the keywords ergonomics and construction as a common topic. The research results highlight the countries most concerned with providing the necessary conditions in the construction workplace, the period in which this topic was of major interest, and the field from which most researchers interested in ergonomics come.  
**Key words:** bibliometric analysis, VOSviewer, ergonomics, construction industry, safety and security risks.

### 1. INTRODUCTION

In general, in any organization, regardless the field of activity, employees are one of the most important tool because the quality of the output of the organization is strongly influenced by the quality of the people working therein. The output of an organization is very important, because it ensures a very strong competitive advantage in the market. To have a well-defined position in the market, top management plays an important role, because it will need to establish strategic decisions to improve the performance of the organization by improving the work conditions for the employees [1].

Ergonomics is a strategy that is focused to make the job easier for the workers by reducing the pain which is related to the job and which can decrease the work performance and the quality of the output [2]. At the same time, it considers the interaction of the human body with the working environment [3].

Going into details, it analyzes "human behavioral, psychological and physiological capabilities and limitations". Based on the studies of workers limitation and capabilities will result new work environments or changes of

the established work environments conditions. The job demands should not exceed people limitation and capabilities to ensure that they will not get stressed that can affect safety and health at work as well as the company's productivity [4]. Hence, the objective of the ergonomics is to ensure a safe and productive workplace to the people to achieve the goals and objectives of the company [4, 5]. Besides the creation of a safer and more healthful work environment, ergonomic implementation may offer other benefits, such as: "increased productivity, increased work quality, reduced turnover, reduced absenteeism, increased morale, reduce health insurance charges, reducing fatigue and discomfort that plague relatively sedentary workers" [6]. At the same time, due to its high importance, work environment is approached in other areas such as quality management, because the improvement of the work environment conditions represents one of the internal benefits resulted due to the implementation of a quality management system according to ISO 9001 standard [7].

These benefits make ergonomics a very important science in all fields of activity, with a high focus on industries where occupational

safety and security risks are much higher compared to other industries. One of this kind of industry is the construction industry. It is a very dangerous place to work because its physical processes involve complex ergonomic issues. Going into details, the construction industry is always risky because of the outdoor operations [8]. Also, construction workers are at high risk of work-related musculoskeletal disorders (WMSDs) because they are frequently exposed to awkward postures and motions, such as lifting, bending or twisting, sometimes for long periods of time [9-12]. WMSDs represent an important problem both for people, workplaces and society [13, 14].

At the same time, in the construction industry, worker activities are a very important resources with the highest impact on the outcomes of a project, including time, cost and quality. Worker activities are associated with construction productivity, which represents one of the most important performance indicators established by lots of organization from this field of activity [15, 16]. Productivity influences the compliance with the deadline of the project and the budget because low productivity means non-compliance with the schedule, cost increase and budget overrun. All these things have a negative impact on the construction company since it will lose the profit and it will reduce the competitiveness on the market in the construction industry [17]. Thus, ergonomics goal is to provide a very good fit between workers and their job, which can lead to the increase of maximizing worker's comfort, safety and health which will have a high impact on productivity and efficiency of the organization [18].

We will therefore highlight, through a bibliometric analysis, which countries have approached ergonomics in construction, respectively the period in which most papers have been published on this topic.

## 2. MATERIALS AND METHODS

To conduct this study, we used the Scopus database, respectively the VOSviewer software. Scopus is a database of abstracts and citations for articles in research-related publications. The database was created in 2004 by Elsevier

Publishing. Scopus is regularly updated and offers approximately 25,000 articles from over 5,000 international publishers, including: 16,500 peer-reviewed journals in scientific, technical, medical and social fields; 600 trade publications; 350 book editions; extensive global conference coverage with 3.5 million conference papers [17].

VOSviewer version 1.6.18, released on 24 January 2022, was used. VOSviewer is a software tool for building and visualizing bibliometric networks. These networks can include, for example, journals, researchers or individual publications and can be built on citation, bibliographic linkage, co-citation or co-author relationships. VOSviewer also provides text extraction functionality that can be used to build and view co-occurrence networks of important terms extracted from a body of literature [20].

The study analyzed 970 publications from more than 50 countries, published between 1971 and 2022, which had the keywords ergonomics and construction as a common topic. The information about the 970 publications was downloaded on 30 April 2022 in csv format from the Scopus database and then loaded into the VOSviewer software.

## 3. RESULTS AND DISCUSSION

Of the 970 documents studied, 52.6% are scientific articles, 40.5% are conference papers and 4.4% are reviews. Only 0.1% of the papers considered are books. Most of the publications are written in English (937 of the publications), 11 of the articles are written in German and the remaining 22 publications are in French, Russian and Chinese.

Regarding the field of papers studied, 27.67% of them are from engineering, followed by social sciences with 339 papers and medicine with 16.8%. The National Institute for Occupational Safety and Health sponsored the most papers (40 papers), followed by the US Department of Health and Human Services and the Centers for Disease Control and Prevention, which sponsored between 30-36 papers. The results obtained using the VOSviewer software are shown in Figures 1 to 4.

### 3.1 Bibliometric analysis of the countries

Figure 1 presents the bibliometric analysis of countries interested in construction ergonomics.

The 29 items considered have been grouped into 6 clusters as follows:

- Cluster 1 is marked with red color and consists of nine countries (Brazil, Denmark, Germany, Italy, Lithuania, Norway, Portugal, Spain and Sudan);
- Cluster 2 is marked with green color and consists of Canada, Hong Kong, Saudi Arabia, South Korea, United States;
- Cluster 3 is marked with dark blue color and consists of 5 countries;
- Cluster 4 is marked with yellow color and consists of 4 countries;
- Cluster 5 is marked with purple color and consists of 3 countries;
- Cluster 6 marked with light blue color and consists of Nigeria, Poland and South Africa.

The size of the nodes represents the frequency of publications and the curves between the nodes represent the appearance in the same publication, therefore the United States published the most papers on construction ergonomics with over 300 publications, followed by the United Kingdom with 67 publications, Canada and Brazil which have between 59 - 65 publications and China ranks 5th with 50 appearances in the Scopus database.

Countries less interested in this topic are Estonia, Germany, Hungary, Pakistan, Serbia, Yugoslavia which have only one article published in the analyzed period.

Based on these results, we observe that the countries concerned with ergonomics research in construction, as evidenced by the large number of publications, belong to the category of developed countries with significant economies

### 3.2 Bibliometric analysis of the authors

Figure 2 illustrates the bibliometric analysis of the authors cited in the documents studied.

Out of the 2304 authors, only 48 authors were selected, thus respecting the condition that a minimum of 5 authors and a maximum of 25 authors per document should be mentioned.

According to the analysis, the most cited author is Buchholz, B. with 21 articles written on ergonomics, respectively with 777 citations, followed by Gibb A.G.F with 14 publications, respectively 698 citations, Gyi D.E. with 6 publications and 672 citations, and on the 6<sup>th</sup> position is Li, H. with 16 publications and 478 citations.

The bibliometric analysis of cited authors includes 47 items (authors) grouped into 5 clusters. The author Buchholz, B is part of cluster 5 marked with purple color and the author Li H is part of cluster 3 marked with blue color. The most cited articles were published between 2005 and 2010.

### 3.3 Bibliometric analysis of the keywords

Figure 3 reveals the result of the bibliometric analysis of the use of keywords by authors in the 970 publications studied. The size of the nodes represents the frequency of use of the words therefore the most used keywords are ergonomics, human, industry, construction, risk, but the first place is the keyword ergonomics, used about 884 times.

We consider that the frequent use of the keyword "ergonomics" in the publications analyzed is due to the complexity of the subject, which includes aspects such as risks, industry, employees etc.

### 3.4 Analysis of published documents according to the period of publication

During the review period 1971 to 2022, 970 publications were published that had ergonomics and construction as common topics. Figure 5 shows the increase in the number of publications over time. In 1971 only 1 article was registered in the Scopus database, while in 2021 40 publications were registered, respectively 5 articles in the period January - April 2022.

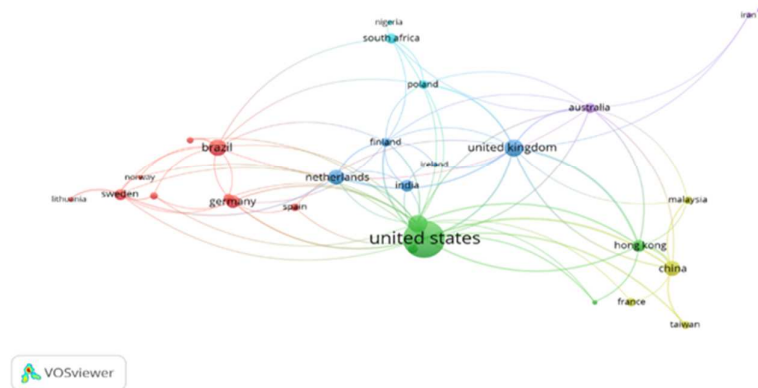


Fig. 1. Bibliographic analysis of authorship – countries.

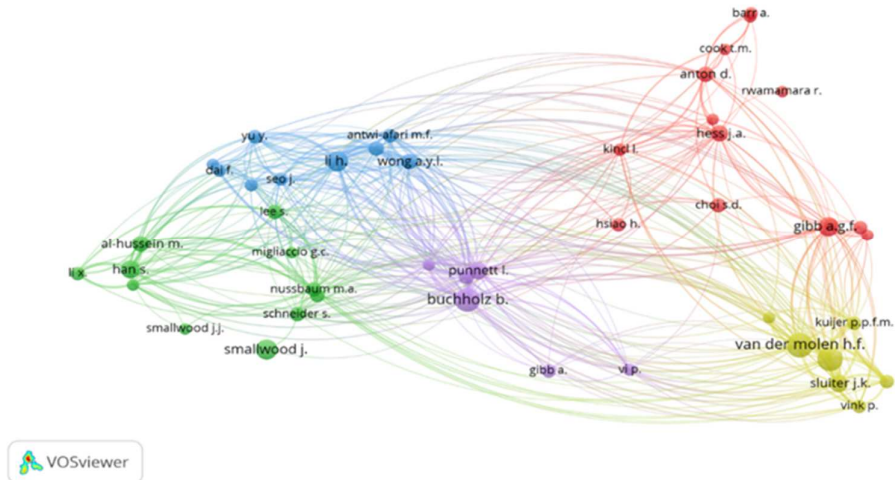


Fig. 2. Bibliographic analysis of citation – authors

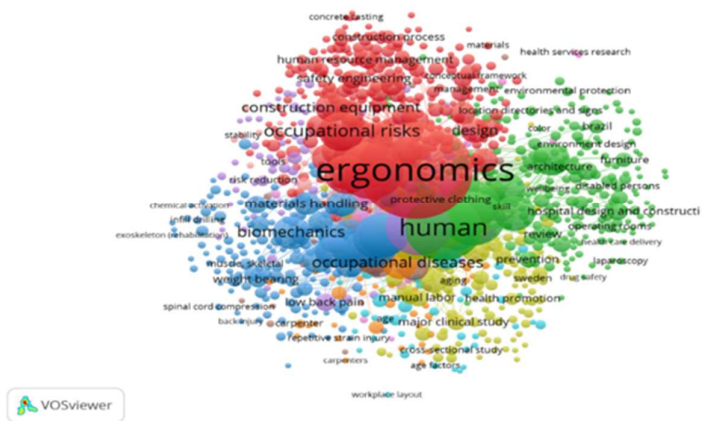
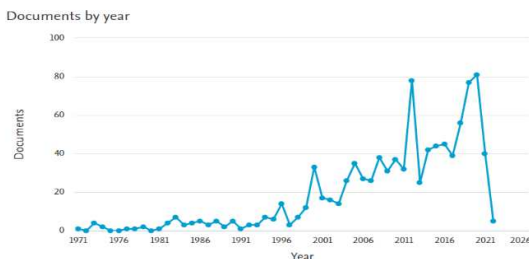


Fig. 3. Bibliometric analysis of keywords

The increase in interest in the topics analyzed has not been constant, for example in 2012, only 78 publications were registered and in the following year 53 fewer articles were published. The most prolific year in terms of publications

was 2020 with 81 publications, and the period 1971-1995 is the weakest, with an average of 2.91 articles published per year. The interest shown by researchers for the subject analyzed

increases by 80% considering the period analyzed.



**Fig. 4.** Analysis of published documents according to the period of publication

#### 4. CONCLUSIONS

Considering the period analyzed, 1971-2022, and the small number of publications published in this period, we can appreciate that research in this field is in its infancy, but with a great potential for development considering the focus on health and safety of employees at work. In this context we highlight that among the 970 publications studied, which have ergonomics and construction as common topics, registered in the Scopus database, most articles, 81 to be precise, were published in 2020. Of the 970 publications, 310 articles were written by authors from the United States and 133 are published by authors from Brazil and Canada, thus the most active researchers studying construction ergonomics are from the United States, Brazil and Canada. The bibliometric analysis was based on the two keywords “ergonomics” and “construction”. The most used keywords in the 970 publications registered in the Scopus database that presented information on ergonomics in construction were ergonomics, human, industry, construction and risk. Of the keywords listed, the most used keyword in the articles analyzed is “ergonomics”, used 884 times.

In conclusion, the bibliometric analysis performed shows a gradual increase in the interest of researchers in ergonomics, and therefore comfort and safety at work, especially in the field of construction, are closely followed. Future research should be oriented on the the design and development of a ergonomics risk assessment tool (as presented by [21]) and on creating new ergonomic approaches for the

practical investigations and optimization through the knowledge transfer [22, 23].

#### 5. REFERENCES

- [1] Olabode, S.O., Adesanya, A.R., Bakare, A.A., *Ergonomics awareness and employee performance: an exploratory study*, Economic and Environmental Studies, 17(4), pp. 813-829, 2017.
- [2] Adnan, N.H., Ressang, A., *Ergonomics awareness on construction site*, 2022, available at: <http://civil.utm.my/wpcontent/uploads/2016/12/Ergonomics-Awarenesson-Construction-Site.pdf>, 2016.
- [3] Carreira, L.M., Azevedo, P., Dias, J., *The importance of ergonomics for dental medicine procedures in the triad position: the patient, the dentist and the surgical microscope*, ARC Journal of Dental Science, 1(4), pp. 12-18, 2016.
- [4] Jaffar, N., Abdul-Tharim, A.H., Mohd-Kamar, I.F., Lop, N.S., *A literature review of ergonomics risk factors in construction industry*, Procedia Engineering, vol. 20, pp. 89-97, 2011.
- [5] Kolgiri, S., Hiremath, R., Bansode, S., *Literature review on ergonomics risk aspects association to the power loom industry*, IOSR Journal of Mechanical and Civil Engineering, 13(1), pp. 56-64, 2016.
- [6] Khedkar, E.B., Pawar, P.Y., *Review of literature on organizational ergonomics*, International Journal of advance research in computer science and management studies, 3(4), pp. 454-458, 2015.
- [7] Sârb A., Glevitzky, I., Itul, L., Popa, M., *The improvement of quality management system in a porcelain factory*, MATEC Web of Conferences, vol. 290, 1-11, 2019.
- [8] Ajayi, O., Thwala, W.D., *Developing an integrated design model for construction ergonomics in Nigeria construction industry*, African Journal of applied research, 1(1), pp. 478-495, 2015.
- [9] Valero, E., Sivanathan, A., Bosché, F., Abdel-Wahab, M., *Musculoskeletal disorders in construction: A review and a novel system for activity tracking with body area network*, Applied Ergonomics, 54, pp. 120-130, 2016.
- [10] Gajšek, B., Draghici, A., Boatca, M. E., Gaureanu, A., Robescu, D., *Linking the Use of Ergonomics Methods to Workplace Social Sustainability: The Ovako Working Posture Assessment System and Rapid Entire Body Assessment Method*, Sustainability, 14(7), 4301, 2022.

- [11] Choong, S. W. J., Ng, P. K., Yeo, B. C., Draghici, A., Gaureanu, A., Ng, Y. J., ..., Selvan, H. K. T., *A Preliminary Study on Ergonomic Contribution to the Engineering Design Approach of a Wheel Loader Control Lever System*, Sustainability, 14(1), 122, 2021.
- [12] Dale, A.M., Jaegers, L., ..., *Evaluation of a participatory ergonomics intervention in small commercial construction firms*, American Journal of industrial medicine, vol. 59, pp. 465-475, 2016.
- [13] Dufour, C., Draghici, A., Ivascu, L., Sarfraz, M., *Occupational health and safety division of responsibility: A conceptual model for the implementation of the OHSAS 18001: 2007 standard*, Human Systems Management, 39(4), 549-563, 2020.
- [14] Draghici, A., Vaduva, R., Capotescu, S., Banaduc, G., Robescu, D., *Innovations for Tackling Post-Pandemic Related Challenges-A Collaborative Research to Discover New Solutions for Hybrid Work in The Context Of 15-Minute Cities*, Acta Technica Napocensis-Series: Applied Mathematics, Mechanics, and Engineering, 65(1S). 2022.
- [15] Brandt, M., Madeleine, P., Samani, A., Ajslev J.Z.N., Jakobsen, M.D., Sundstrup, E., Andersen, L.L., *Effects of a participatory ergonomics intervention with wearable technical measurements of physical workload in the construction industry: Cluster Randomized Controlled Trial*, Journal of Medical Internet Research, 20(12), 2018.
- [16] Golabchi, A., Guo, X., Liu, M., Han, S., Lee, S., Abourizk, S., *An integrated ergonomics framework for evaluation and design of construction operations*, Automation in Construction, 95(7), pp. 72-85, 2018.
- [17] Sumarningsih, T., Wibowo, M.A., Wardani, S.P.R., *Ergonomics in work method to improve construction labor productivity*, International Journal of Science and Engineering, 10(1), pp. 30-34, 2016.
- [18] Pawar, P.Y., Khedkar, E.B., *Review of ergonomics practices in different sectors*, International Research Journal of multidisciplinary studies, 2(9), pp. 1-4, 2016.
- [19] Koaha.org, *Scopus*, <https://koaha.org/wiki/Scopus> (base di dati), (baza de date).
- [20] VOSViewer, <https://www.vosviewer.com>.
- [21] Dragoi, G., Draghici, A., Rosu, S. M., Radovici, A., Cotet, C. E., *Professional risk assessment using virtual enterprise network support for knowledge bases development*, Proceedings of the International Conference on Enterprise Information Systems (pp. 168-177), Springer, Berlin, Heidelberg, ISBN978-3-642-16418-7, 2010.
- [22] Szabó, G., Balogh, Z., ..., *Introducing the ergonomics and human factors regional educational CEEPUS Network*, Acta Technica Napocensis-Series: Applied Mathematics, Mechanics, and Engineering, 64(1-S1), 2021.
- [23] Draghici, A., Baban, C. F., ..., *Key success factors for university–industry collaboration in open innovation*, Proceedings of the ICERI2015, ISBN: 978-84-608-2657-6, 7357-7365, IATED, 2015.

### Studiu bibliometric al literaturii privind ergonomia în construcții

**Rezumat :** Majoritatea angajatorilor sunt preocupați de ergonomie, urmărind să îmbunătățească în mod constant condițiile de muncă pentru a se asigura că angajații au radament foarte bun. Angajații care lucrează în industria construcțiilor sunt foarte expuși la accidente de muncă, de aceea accentul se pune atât pe reducerea riscurilor la locul de muncă, cât și pe confortul angajaților. Scopul cercetării este analiza bibliometrică a literaturii de specialitate privind ergonomia în construcții, utilizând baza de date Scopus și software-ul VOSviewer. Au fost analizate 970 de publicații din peste 50 de țări, publicate în perioada 1971 -2022, care au ca subiect comun cuvintele cheie ergonomie și construcții. Rezultatele cercetării evidențiază țările cele mai preocupate de asigurarea condițiilor necesare la locul de muncă în domeniul construcțiilor perioada în care acest subiect a prezentat un interes major și domeniul din care provin cei mai mulți cercetători interesați de ergonomia în construcții.

**Elena MARICA**, Eng., PhD Student., Lucian Blaga University of Sibiu, Doctoral School, Faculty of Engineering, Sibiu, România, [elenamarica93@yahoo.com](mailto:elenamarica93@yahoo.com)

**Adina SÂRB**, PhD, Quality Department, S.C. APULUM S.A., Alba Iulia, Romania, [sarb.adina92@yahoo.com](mailto:sarb.adina92@yahoo.com)

**Maria POPA**, PhD, Professor, 1 Decembrie 1918 University of Alba Iulia, Faculty of Economic Science, Alba Iulia, România, [pmpopamaria2010@gmail.com](mailto:pmpopamaria2010@gmail.com).