Employee motivation: use of algorithms for its prediction and management

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ARTICLE INFO	ABSTRACT
	INTRODUCTION: The dynamics of organizations have led them to pay special attention to the motivation of workers to ensure good performance. Algorithms offer tools that allow organizational leaders to establish strategies based on the knowledge of the behavioural patterns of the work team. **OBJECTIVES:** Evaluate the prediction and management of worker motivation using algorithms. **METHODS:** A bibliometric analysis is performed for 2013-2023 with articles from the Scopus database and the VOSviewer program. **RESULTS:** Two clusters are derived from the analysis of the Co-occurrence - Author Keywords. The first cluster, identified with red, is related to work environment management and comprises the words Job Satisfaction, Machine Learning and Q-learning. The second cluster identified with green is related to job performance and comprises the words Motivation and Supply Chain Management. **CONCLUSION:** The worker performs their activities in a juxtaposition of internal aspects of organizations and external aspects that determine their skills. It is where algorithms play a fundamental role in the links between technological tools and human beings to positively impact worker motivation in different areas, such as training, development, health, well-being and integral development. **Keywords:** Motivation, Prediction, Leadership, Work environment management, Work performance, Bibliometric analysis.

1. Introduction

The dynamics of organizations have led them to pay special attention to the motivation of workers to ensure good performance (Abina et al., 2022; Ghanimi et al., 2023; Eslava-Zapata et al., 2023). Algorithms offer tools that allow organizational leaders to establish strategies based on the knowledge of the behavioural patterns of the work team (Malathi & Valli, 2023; Freire-Palacios et al., 2023; Del-Campo-Saltos, 2023)

Algorithms provide insight into employee satisfaction levels using open communication channels to map practical actions to address team dissatisfaction with work (Buitrago-Rodríguez, 2023; Ding, 2022; Cardeño-Portela et al., 2023). The idea is to transform the work environment so employees are engaged with the organization and all its processes (Albarracín-Vanoy, 2023; Guatemala-Mariano & Martínez-Prats, 2023; Silva-Sánchez et al., 2023).

As workers are more committed to the organization, they will be more productive, and therefore, there will be less employee turnover (Ibrahimi et al., 2023; Quiroz-Leal, 2019; Ardila-Otero, et al., 2023). However, engagement happens because internal communication improves, and algorithms provide training tools that foster skill development and team building (Arumugam et al., 2023; Quiroz-Leal & Eslava-Zapata, 2023;

Lizcano & Contreras, 2023). Algorithms allow the prediction of behaviours in order to establish actions that keep workers motivated (González-García et al., 2023; Hind et al., 2023; Shah et al., 2023).

Therefore, this research aimed to evaluate the prediction and management of employee motivation using algorithms. For this purpose, a bibliometric analysis was performed for 2013-2023 with articles from the Scopus database and the VOSviewer program.

2. Methods

The research is of a conclusive-descriptive type. Bibliometric techniques were used, and their contributions have made it possible to determine research trends in different areas of study (Rasheed et al., 2023; Olusegun-Oyetola, et al., 2023). The search filter considered titles, abstracts and keywords. The search filter was: (TITLE-ABS-KEY (motivation) AND TITLE-ABS-KEY (employee) AND TITLE-ABS-KEY (algorithms)) AND PUBYEAR > 2012 AND PUBYEAR < 2024 AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")))

The bibliometric study required a careful selection of published papers in English that explained the study's object. The Scopus database was used since it facilitated the search and accessibility of many papers, authors, and journals. In this sense, considering 2013-2023 as the study period, the results yielded 44 works, excluding papers and book chapters.

The bibliometric analysis was carried out systematically; firstly, the search filter was defined. Secondly, the papers were selected from the Scopus database, and thirdly, an analysis was made of the documents by year, documents by country, keywords and citations. The Visualization of Similarities (VOSviewer) program was used for this purpose.

3. Results

Table 1 shows the results of papers per year. It can be seen that the use of algorithms for the study of worker motivation is relatively new; this is evidenced by the scientific production of the last three years: 2023 (12), 2022 (6) and 2021 (7).

The development of algorithms facilitates the generation of work environments that can predict worker performance and automate tasks (Laplagne-Sarmiento & Urnicia, 2023; Eslava-Zapata et al., 2022). Algorithms are now available to predict worker performance and skills, so organizational leaders can manage worker motivation through healthy labour relations and offering fair wages that allow them to lead a dignified life (Flórez-Márquez et al., 2023; Mejías et al., 2022).

Table 1. Documents by year

YEAR	DOCUMENTS
2023	12
2022	6
2021	7
2020	6
2019	3
2018	2
2016	4
2015	1
2014	1
2013	2
TOTAL	44

At the world level, scientific production is led by the United States with 10 papers, followed by the Russian Federation (9) and China (5) (Table 2).

Researchers are showing interest in including new algorithms in work environments, given that, with the introduction of new technologies, organizations are storing large amounts of information on the performance of tasks, the physical movements of workers and their feelings (Noguera-López, 2020; Zhang et al., 2021).

Table 2. Top 10 Documents by country

N°	COUNTRY	DOCUMENTS
1	United States	10
2	Russian Federation	9
3	China	5
4	India	5
5	Romania	2
6	Ukraine	2

7	Bangladesh	1
8	Canada	1
9	Italy	1
10	Kenya	1

The results of the subject area reveal that the top three places are occupied by business, management and accounting (15), computer science (13), and engineering (12) (Table 3).

The subject of employee motivation fits perfectly into the Business, Management and Accounting areas. Indeed, big data allows the use of large volumes of information and its analysis with algorithms that assess the result of the work and predict the behavioural patterns that must be corrected to achieve the proposed objectives (Shobhanam & Sumati, 2022; Kassens-Noor et al., 2021).

Table 3. Top 10 subject area

N°	SUBJECT AREA	DOCUMENTS
1	Business, Management and Accounting	15
2	Computer Science	13
3	Engineering	12
4	Social Sciences	9
5	Environmental Science	7
6	Decision Sciences	6
7	Economics, Econometrics and Finance	6
8	Energy	6
9	Mathematics	4
10	Psychology	4

The University of North Carolina at Chapel Hill (2), Saint Petersburg State University (2) and Kazan Federal University (2) are the leading institutions in academic production. It should be noted that the study of worker motivation using algorithms is a new field of study from which several lines of research can be derived to deepen work environments (Table 4).

More and more organizations rely on algorithms to redesign human resources departments and achieve positive impacts on employee development and the management of aspects such as health, equality, diversity, and team relationships (Raveendhran & Fast, 2021; Balajee & Jayanthi-Kannan, 2023). Therefore, although leaders may need to understand the magnitude of the impact of algorithms for prediction, it is recognized that organizations must adopt new technological tools to develop mechanisms for managing human capital and its performance (Lamola, 2022; Jackson, 2023).

Table 4. Top 10 documents by affiliation

N°	AFFILIATION	DOCUMENTS
1	The University of North Carolina at Chapel Hill	2
2	Saint Petersburg State University	2
3	Kazan Federal University	2
4	Chamber of Commerce and Industry	1
5	Sias International University	1
6	Hyperion University of Bucharest	1
7	Wildlife Conservation Trust	1
8	Academia Română	1
9	Univerza v Mariboru	1
10	Universitatea Titu Maiorescu	1

Two citations per document were taken as a criterion for the analysis of the Co-Citations. Only 3 citations met the criterion: Vroom V.H. (1964), Waytz A. et al. (2010) and Waytz A. et al. (2014) (Table 5). It confirms no relationship between the documents in this analysis since they have been cited independently.

Table 5. Top 3 de Co-Citations – cited references

N°	CITED REFERENCE	CITATIONS
1	Vroom V.H., work and motivation, (1964)	2
2	Waytz A. et al., who sees human? the stability and importance of individual differences in anthropomorphism, perspectives on psychological science, 5, 3, pp. 219-232, (2010)	2
3	Waytz A. et al., the mind in the machine: anthropomorphism increases trust in an autonomous vehicle, journal of experimental social psychology, 52, pp. 113-117, (2014)	2

As for the Co-Authorship Author-authors analysis, the criterion was one document per author and four citations per document; the results revealed that only 19 documents met the criterion.

In this regard, Shen X.N. et al. (73), Ravenelle A.J. (70) and Harms R. et al. (54) occupied the first three places in citations. It was also found that there is no relationship between citations. Therefore, these citations are independent (Table 6).

Table 6. Top 10 de Co-Authorship Author - Authors

N°	AUTHOR	YEAR	CITATIONS
1	Shen X.N. et al.	2018	73
2	Ravenelle A.J.	2019	70
3	Harms R. et al.	2014	54
4	Özbek N.S. et al.	2020	28
5	Raveendhran R. et al.	2021	25
6	Bigman Y.E. et al.	2022	23
7	Ning X. et al.	2021	22
8	Choi M.	2016	19
9	Canós-Darós L.	2013	12
10	Zhang Q. et al.	2021	12

In the Co-Authorship Author - Countries analysis, one document per country and two citations per country were taken as criteria. The results showed that only 16 countries met the criterion.
United States (10), Russian Federation (9), and India (5) lead the first three places in the number of documents produced; in terms of document citations, the first three places are occupied by the United States (206), China (86) and United Kingdom (73) (Table 7).
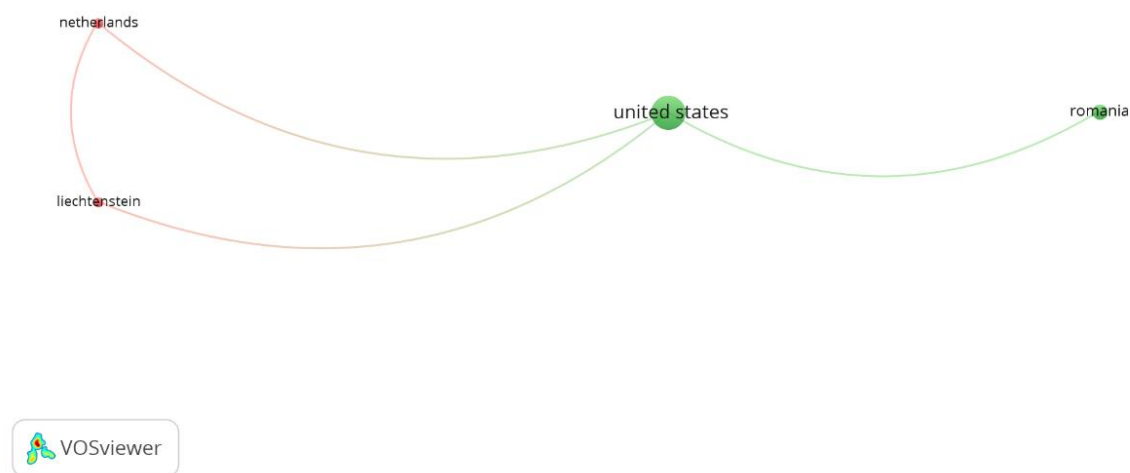
Table 7. Top 10 de Co-Authorship Author - Countries

N°	Country	documents	Country	citations
1	United States	10	United States	206
2	Russian Federation	9	China	86
3	India	5	United Kingdom	73
4	China	5	Liechtenstein	54
5	Romania	2	Netherlands	54
6	Italy	1	India	33
7	Pakistan	1	Turkey	28
8	Slovenia	1	South Korea	19
9	Qatar	1	Canada	12
10	Canada	1	Spain	12

Regarding collaboration between countries, it is evident that there is little collaboration, but this is justified because the research is incipient, and there are few studies that address the subject; however, the formation of two clusters was found (Figure 1).

The first cluster identified with the red colour comprises Liechtenstein and the Netherlands. In contrast, the second cluster identified with green comprises Romania and the United States.

The use of algorithms to improve worker's performance and productive capacity is one of the objectives of organizations. The incorporation of new technologies for the performance of routine work will allow workers to take advantage of time for the development of other activities in order to enhance skills and learning for problem solving in real time, which will give them confidence in their knowledge. therefore, it can be said that the foundations are currently being laid for the development of future research (Orlova, 2023).


Figure 1. Co-Authorship Author - Countries

A minimum of two occurrences was considered for the Co-occurrence All Keywords analysis. The results revealed that 25 documents met the criterion. Two words unrelated to the study were eliminated, and two common words were joined with the thesaurus file.

Three clusters were formed (Figure 2). The first cluster identified with the colour red comprises the words Conceptual Framework, Employee Attrition, Health Program, Human, Leadership, Motivation, Organization, Personnel Management and Supply Chain Management.

The second cluster, identified with green colour, is integrated with the words Algorithm, Data Mining, Decision Trees, Job Satisfaction, Machine Learning, Optimization, Q-Learning Stakeholder, and Sustainability.
The third cluster, identified with blue colour, is integrated with the words Artificial Intelligence, Behavioral Research, Decision Making, Ethics, Fuzzy Logic, Fuzzy Sets, and Psychology.
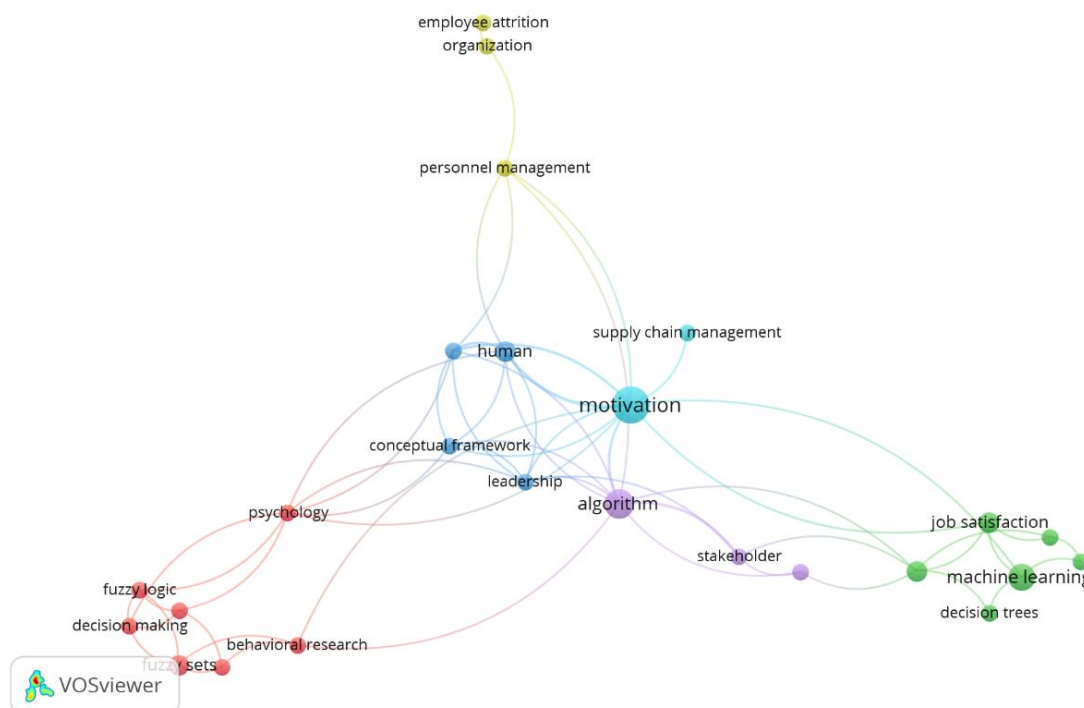
Figure 2. Co-ocurrence All Keywords

4. Discussion

A minimum occurrence of two was considered for the analysis of Co-occurrence - Author Keywords. Only 11 keywords met the criterion: Artificial Intelligence, Decision Making, Employee Attrition, Ethics, Fuzzy Logic, Job Satisfaction, Machine Learning, Motivation, Organization, Q-Learning and Supply Chain Management. Considering that this area of research is emerging, only two clusters were formed that relate only a few words (Figure 3).

The first cluster is identified with the red column and is related to the management of the work environment. It comprises the words Job Satisfaction, Machine Learning, and Q-learning. Managing the work environment is critical to the health and well-being of workers (Jafor et al., 2023). The more satisfied the employee feels, the more committed he/she will be to the organization. Job satisfaction can be reflected in working conditions, remuneration or work-life balance (Matloob et al., 2021).

The development of algorithms makes it possible to predict employee feelings through computer systems and in different formats: visual, auditory or textual. One of the tools is machine learning, in which algorithms learn from some initial data and can make predictions from other data (Bigman, 2023). There is also Natural Language Processing (NLP), which decomposes texts in order to identify emotions. However, algorithms also make it possible to process large volumes of structured information, images, videos and audio to identify emotions. Algorithms are opening up various opportunities for organizations to apply the tools in the workplace. The qualitative and quantitative analyses that can be performed are diverse, using the results of surveys, e-mails, video calls, chats, social networks, and forums as a basis (Glackin & Adivar, 2023).

Algorithms also make it possible to delve deeper into employee sentiments and identify areas for improvement (Bossi et al., 2022). Organizations must approach the studies they conduct with ethics, ensuring the privacy of the information at all times. It should be noted that algorithms help to identify behavioural patterns that may require specific strategies to help enhance job satisfaction. (Florea et al., 2023).

The second cluster identified with green is related to job performance and comprises the words Motivation and Supply Chain Management. The algorithms facilitate the automation of activities, the maximization of worker performance, the management of idle time and the optimization of resource allocation.

Algorithm-generated analytics are driving continuous improvement of the work environment to achieve greater engagement and ownership of the organization. Information on employee performance emphasizes areas for improvement in order to make better decisions (Babkin et al., 2023).

Current research shows a trend in work related to job satisfaction, q-learning and machine learning (Figure 4).
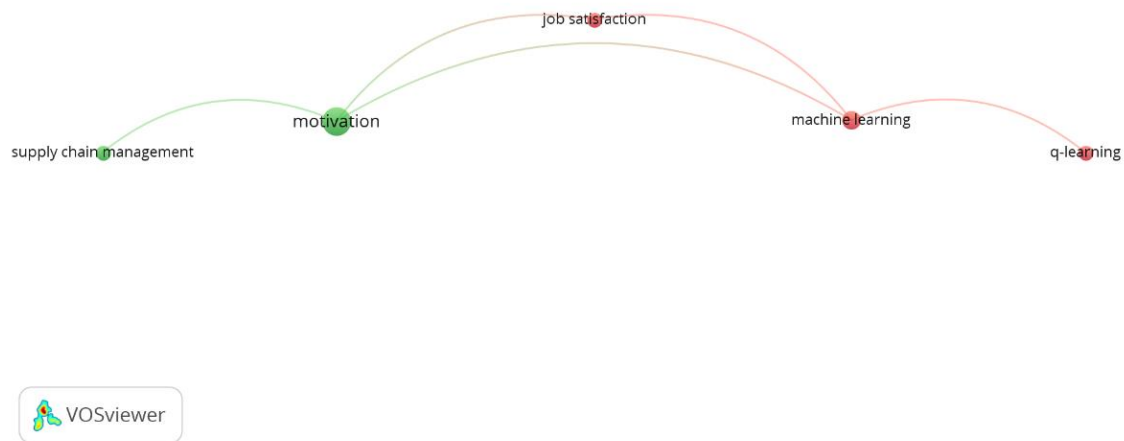
Figure 3. Co-ocurrence – Author Keywords

Figure 4. Overley of Co-ocurrence - Author Keywords

5. Conclusions

Algorithms can perform tasks in various activities more efficiently than workers, optimizing productivity and reducing operational costs. Public and private organizations use algorithms with different functions, especially in hiring workers, performance evaluation, sentiment measurement, and behaviour prediction.
One of the issues that should occupy the attention of organizations is the worker's motivation, especially in the labour relations between the parties involved, to establish objective criteria in using algorithms in the management of the work environment.

The worker performs his activities in a juxtaposition of internal organizational aspects and external aspects of the environment that determine his competencies. It is there where algorithms play a fundamental role in the

links between technological tools and human beings in order to generate positive impacts on the worker's motivation in different areas, such as training, development, health, well-being and integral development.

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