A BIBLIOMETRIC ANALYSIS OF THE RELATIONSHIP BETWEEN WORKFORCE DIVERSITY AND INNOVATION

Irina TĂRĂBAN [a], Alina Nicoleta BONCILICĂ [b*], Maria Andreea TILIBAȘA [c], Ovidiu DRANGA [d], Dorin Felician MARCHIȘ [e]

[a, b, c, d, e] Bucharest University of Economic Studies, Romania

ABSTRACT

The relationship between workforce diversity and innovation has recently come to the attention of researchers, numerous studies focusing on the causal relationship between the two terms, but none of them having investigated the specialized literature pertaining to this relationship from a bibliometric perspective. The aim of this paper is to use a bibliometric analysis in order to highlight the way the link between these two concepts evolves within the scientific field. In this sense, 366 Web of Science indexed publications on this topic were selected and analyzed with the help of two popular software - Biblioshiny and VOSviewer. The results highlighted the evolution of academic production on the link between workforce diversity and innovation, their territorial dissemination based on the most productive countries, the collaboration among three of the most influential channels (affiliations, authors, and sources), and the conceptual structure of the scientific production based on keyword co-occurrence analysis, as well as a longitudinal thematic analysis. This study can contribute to the literature through a map of the relationship between workforce diversity and innovation. Its conclusions have led to the idea that employee diversity (in terms of education, ethnicity, race, gender, equity, age) can create all the necessary premises (human capital, knowledge, productivity, cultural diversity, motivation, leadership) for an organization to be innovative and to achieve performance, thus leading to a competitive advantage.

KEYWORDS: *bibliometric analysis, Biblioshiny, innovation, VosViewer, workforce diversity.*

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1. INTRODUCTION

In an era dominated by technological breakthroughs (Mahardhani, 2023), global workforce migration (Jackson, 2023), and a continuously changing market environment (Michels & Murphy, 2021), organizations tend to resort to innovation as a key to gaining a sustained competitive advantage (Alawamleh et al., 2023). Innovation's transformational effect on organizations' ability to gain a competitive edge has been acknowledged by practitioners (Si et al., 2023) and academics (Alghamdi & Agag, 2024; Lappalainen et al., 2023), as well as by policy makers (Bogers et al., 2017). Concurrently, the employment arena is witnessing a complex transformation due to increased workforce heterogeneity (Buengeler et al., 2018; Lee & Waddell, 2021) in terms of nationality, ethnicity, race, gender, age, disability status, social status, marital status, religion, sexual orientation, personality traits, cultural values (Iqrahafeez et al., 2020), exterior aspect, demeanor, leisure habits, personal interests (Nafukho et al., 2011), educational level, comprehension capabilities, approach to learning, creative skills, ingenuity, problem-solving skills, and mental frameworks (Yeager &

* Corresponding author. E-mail address: *alina.dobre@man.ase.ro*

Nafukho, 2012). Besides the individual and team-level differences mentioned above, at the organizational level, inequalities in work experience such as task description, job categorization, seniority, labor union membership, authority level, as well as workplace location emerge (Nafukho et al., 2011). This multifariousness in the workplace, also known as workforce diversity, has constituted the focus of many legislators, researchers, and business specialists alike (Qabir & Kun, 2023). The association of the two concepts - workforce diversity and innovation - while not new, has been considered to lead to the competitive advantage of many organizations across a wide variety of industries (Bassett-Jones, 2005). Workforce diversity, in its complex display forms, has the ability to drive innovation through various processes, such as expanding the span of managerial experience related to critical thinking and problem-solving, heightening versatility, and boosting creativity, among others (Qabir & Kun, 2023). However, the link between workforce diversity and innovation is very subtle, complex, and often determined by various circumstantial factors, management, leadership styles, as well as by organizational culture (Guillaume et al., 2017). This intricate relationship raises the question: "How has the link between diversity and innovation been approached in the extant literature so far?" While many studies have attempted to answer this question in several ways (narrative literature reviews (Da Silva et al., 2022), qualitative (Krismadewi, 2017) and quantitative studies (Causadias et al., 2023) to the best of our knowledge, this is the first study to approach it from a bibliometric perspective. The bibliometric analysis will shed light on the way knowledge on this topic is created and disseminated, as well as on its impact within the realm of research focusing on the link between workforce diversity and innovation.

The purpose of this research is to outline how the relationship between workforce diversity and innovation is highlighted in literature, using a bibliometric analysis. Waltman et al. (2010) consider that bibliometric research is focused on analyzing networks of authors, documents, keywords through mapping and clustering techniques. Our bibliometric analysis offers an overview of the terms used for a deeper study of these two concepts, workforce diversity and innovation.

To answer the research question, the specialized literature (Breazu & Ștefan, 2022; Bunea, 2021; Marinaș et al., 2021; Popa & Gora, 2020) was studied and three main objectives were set, each with their sub-objective(s):

1. To establish the longitudinal and geographical distribution of academic production
   - To analyze the dispersal of research publications and their relevance based on the total number of citations
   - To identify the first publications highlighting the relationship between workforce diversity and innovation indexed by Web of Science
   - To determine the territorial dissemination of scientific production based on the most productive countries
2. To analyze the social structure of the scientific community focusing on the link between workforce diversity and innovation
   - To investigate the collaboration flows among three of the most influential channels (affiliations, authors, and sources)
3. To determine the conceptual structure of the scientific production
   - To highlight the research hotspots pertaining to the relationship between diversity and innovation
   - To understand the longitudinal thematic evolution of keywords related to the link between workforce diversity and innovation

The remainder of this paper is structured as follows: the next chapter will examine the state of knowledge on the researched topic, followed by an explanation of the proposed research method, the data collection, as well as data visualization. The research findings will then be introduced and discussed. In the end, the conclusions will be presented followed by the contributions, limitations as well as the suggestions for future directions.

2. LITERATURE REVIEW

Workforce Diversity

Workforce diversity implies any category in which employees in an organization differ from one another or perceive themselves to be different from their colleagues (Guillaume et al., 2017). According to Qabir & Kun (2023), workforce diversity can arise both from differences and from similarities among employees. Since, in the beginning, the topic of workforce diversity became common in the US, most researchers focused on the racial and ethnic diversity (Singh et al., 2013). However, with the increase in the number of diverse workplaces around the world, the necessity to consider more attributions to workforce diversity has been raised (Chen et al., 2021). Thus, academics in the organizational behavior and psychology fields have developed various conceptualizations of the term (Roberson, 2019).

Yadav & Lenka (2020) divide workforce diversity into two main categories: relations-oriented workforce diversity (a social grouping) and task-oriented workforce diversity (an information-based categorization). The former type of workforce diversity tends to prevail in the extant literature (Webber & Donahue, 2001), due to them being more pronounced. Along the same lines, Harrison et al. (2002) as well as Hecht & Allen (2009) classified workforce diversity into surface-level diversity (pertaining to easily noticeable traits such as gender, age, ethnicity, and race) and deep-level diversity (individual beliefs, values, and cognition levels). Iqrahafeez et al. (2020) provide a detailed exemplification of workforce diversity types: nationality, ethnicity, race, gender, age, disability status, social status, marital status, religion, sexual orientation, personality traits, cultural values, which is complemented by Nafukho et al. (2011) with: exterior aspect, demeanor, leisure habits, personal interests – at the individual and team level – and inequalities in task description, job categorization, seniority, labor union membership, authority level, as well as workplace location – at organizational level –, to be completed by Yeager and Nafukho (2012), with: educational level, comprehension capabilities, approach to learning, creative skills, ingenuity, problem-solving skills, and mental frameworks. Despite this long, but not exhaustive, list of diversity types, employees tend to attach themselves to people who resemble their characteristics, thus forming ingroups, and leaving others who are different to belong to the outgroups (Iqrahafeez et al., 2020).

Workforce diversity could be an advantage for an organization, leading to creativity, innovation, or enhanced problem-solving capabilities (Maqsoom et al., 2023) on the one hand, and a disadvantage, causing conflict, discrimination, or stereotyping (Maqsoom et al, 2020), on the other hand. To minimize the conflicts and maximize the potential of workforce diversity, conflict management is an imperative in any diverse workplace (Kim & Lee, 2022).

Innovation

At the economic level, the concept of innovation implies the complex use of thought processes and ideas to create a set of superior products, services, processes, and technologies. This provides the key to the success of organizations in a competitive business environment (Chaudhry et al., 2021). Innovation produces changes in organizational growth and industrial structures, having a strong impact on performance, product quality, job satisfaction, knowledge management (Van Wijk et al., 2008). Therefore, human resources are a vital element for a competitive and effective organizational culture (Maier et al., 2014).

At the social level, innovation involves the development of innovative services and programs to meet social needs (European Commission, 2011). In this sense, social innovation involves social awareness and the generation of collective ideas by people or organizations with social goals to meet social needs (Alkan et al., 2022).

At the organizational level, the main condition for organizations to maintain their competitive advantage is innovation. Innovation is a factor underlying competitive strategy to achieve superior organizational performance. Some studies (Liang et al., 2014) showed that many organizations

occupied the last positions in the competitive market because they did not create innovative products and services. In a new digital environment, organizations should focus on innovative technologies that generate value. Among the components of innovation, marketing services that enable faster development by adding innovation to existing products in the company's portfolio (Snowball et al., 2022) have been identified as a key factor. However, Mohammadi et al. (2017) believe that radical innovation is possible through the help of employees with diverse disciplinary backgrounds.

Other researchers (Khan et al., 2021) consider that innovation is possible through three key elements: knowledge management, workforce diversity, and organizational learning culture. For current and future employees to become cross-culturally competent, it is necessary that educational institutes and business schools implement innovative teaching processes, knowledge management systems, and a learning culture. Given that innovation provides the opportunity to exchange and combine diverse knowledge, organizations should have the capability to adapt to a diverse workforce. For the introduction of radical innovation, the organization should provide diversity training that includes the knowledge and skills necessary for employees to perform their tasks (Mohammadi et al., 2017).

At the team level, the quality of communication and team performance can be influenced by education level diversity. Valls et al. (2016) show that the team communication quality depends on education level diversity and, together, they represent an essential condition for a team innovation climate. In this case, a climate characterized by diversity leads to stimulating creativity which is the main element for innovation. Pamfilie (2008) considered that management should involve all employees in the development of innovative ideas so that the innovation process that contributes to improving the image of the organization and creates a sustainable competitive advantage is set among their permanent activities.

The Link Between Diversity and Innovation

Innovation has long been considered one of the most important sources of competitive advantage (Porter, 1985; Popa et al., 2011). This statement is supported by Chaudhry et al. (2021), who contend that organizations with high levels of innovation outperform those less preoccupied with innovation. Therefore, the comprehension of the impact the relationship between workforce diversity and innovation could have on organizations is an imperative for businesspersons and lawmakers alike (Qabir & Kun, 2023), as well as for academics (Bae & Han, 2019; Bogers et al., 2018; Bolli et al., 2018; García-Martínez et al., 2017). Kemeny (2017) considers workforce diversity a source of organizational innovation. This affirmation is sustained by Bassett-Jones (2005), who takes it one step further, mentioning the fact that besides driving creativity and innovation, workforce diversity has the potential to become a competitive advantage for the organization.

The same author has identified a paradox in the relationship between workforce diversity and innovation, contending that while diversity has the potential to enhance creativity and boost innovation, it can also lead to misunderstandings, conflict, and reluctance in cooperation within the work environment, which could hamper innovation.

On the one hand, it is necessary to acknowledge the existence of misunderstandings, conflicts, and uncooperative behavior, since it can hinder communication and result in high employee turnover (Qabir & Kun, 2023). But, on the other hand, the advantages workforce diversity can bring in relation to fostering innovation must not be overlooked. It has been empirically proven that differences in ethnicity within the workplace can lead to a higher rate of patent applications (Parrotta et al., 2014). Besides, a collaborative-conducive diverse work environment leads to a corporate culture respectful of each individual's rights and decency (Qabir & Kun, 2023). Such culture also enables employees' identification and acknowledgement of positive traits as well as high qualifications in their colleagues (Park & Liang, 2020). The proper management of such a diverse workforce could lead to a complex structure of human capital which, in turn, can improve innovation processes and the overall organizational performance (Guillaume et al., 2017).

Therefore, more organizations are placing the employment of a diverse workforce among their top strategies towards becoming more innovative organizations (Qabir & Kun, 2023). To achieve this goal, organizations are required to design workplaces where employees with diverse backgrounds can feel included (del Mar Fuentes-Fuentes et al., 2023). An inclusive management of the diverse workforce can induce a perception of belongingness and fairness, as well acceptance and appreciation for uniqueness (Jones et al., 2021), which leads to motivation and achievement (Chaudhry et al., 2021) and further results in innovation (Jones et al., 2021).

3. METHODOLOGICAL FRAMEWORK, DATA COLLECTION AND DATA VISUALIZATION

Bibliometric analysis

Bibliometric analysis is a statistical approach to scientific publication metadata used to convey the development status and existing tendencies in a certain field (Li et al., 2021). It facilitates the longitudinal comparison of scientific output, the identification of prominent authors, institutions, topics, and sources, as well as the isolation of the most recent themes in a certain research area (De las Heras et al., 2021). Bibliometric analysis is also a broadly used tool in the attempt to emphasize emerging trends in various scientific fields, and to facilitate the comprehension of the relationships between them (Li et al., 2021).

Data Collection

The global literature on workforce diversity and innovation published between 1996-2023 was exported on October 24th, 2023, from the Web of Science database. The Web of Science Database was selected for the document search since it indexes the most significant journals and is referred to as the most extensive and academically trustworthy database (Olawumi & Chan, 2018; Tao et al., 2020). Only SCI-EXPANDED, SSCI, AHCI, CPCI-S, CPCI-SSH, and ESCI from the Web of Science Core Collection were selected for this study.

At first, the keywords "diversity" or "nationality" or "ethnicity" or "age" or "race" or "gender" or "disability" or "religion" or "sexual orientation" or "LGBTQ" were introduced in the 'Topic' field of Web of Science Core Collection, to which two more 'Topic' fields were added, both connected to the first 'topic' field with the boolean "and". In the second 'topic' field the keyword "workforce" was inserted, and in the third 'Topic' field, the terms "innovation" or "organizational innovation" or "team innovation" or "individual innovation" were added. The initial search resulted in 490 articles. The search was then refined, limiting the results to four types of publications (articles, proceeding papers, review articles, and early access articles), excluding book chapters and editorial materials, which turned up 473 documents. The data was further refined, allowing only English documents in the search, as most globally recognized academic research is conducted in English (Liu et al., 2022), resulting in 463 articles. A manual screening of documents followed, with close attention being paid to the titles, the keywords, and the abstracts of the articles, to make sure they meet the purpose of the study. As a result, ninety-seven documents were rejected since they did not pertain to the goals of the current research. The final database, containing 366 documents, was exported in a .ciw file format so that it can be uploaded into data analysis software for processing.

Data analysis and visualization

For the analysis and visualization of the data resulted from the exported database, besides Microsoft Excel, two popular software were used: Biblioshiny, within RStudio's Bibliometrix package (Aria & Cuccurullo, 2017) and VOSviewer (Van Eck & Waltman, 2023). Biblioshiny has a user-friendly interface, allowing an easy data import, modification, as well as interactive visualization; data can be visualized as graphs, line plots, three field plots, maps, and networks which facilitate the research undertaking (Gronthy et al., 2023). VOSviewer (Van Eck & Waltman, 2023), a computer software created by Nees Jan Van Eck and Ludo Waltman (Van Eck & Waltman, 2011), aids the creation,

visualization, and exploration of scientific maps in a bibliometric analysis (Van Eck & Waltman, 2010). The mapping technique used in the creation of keyword network visualization maps is called VOS (visualization and similarities) (Van Eck & Waltman, 2007).

4. FINDINGS AND DISCUSSIONS

4.1.1 Longitudinal distribution of scientific production and its relevance

To analyze the dispersal of research publications and their relevance based on the total number of citations, a graph was created (represented in Figure 1, below). It contains the annual total number of publications indexed between 1996 - when the earliest article addressing the concepts "workforce diversity" and "innovation" appeared - and the current year (2023) represented by the green bars, the mean total number of citations per article shown by the blue bars, as well as the mean total number of citations per year symbolized by the red line.
The left axis shows the total number of publications and mean total citations per article, while the right axis represents the mean total citations per year.

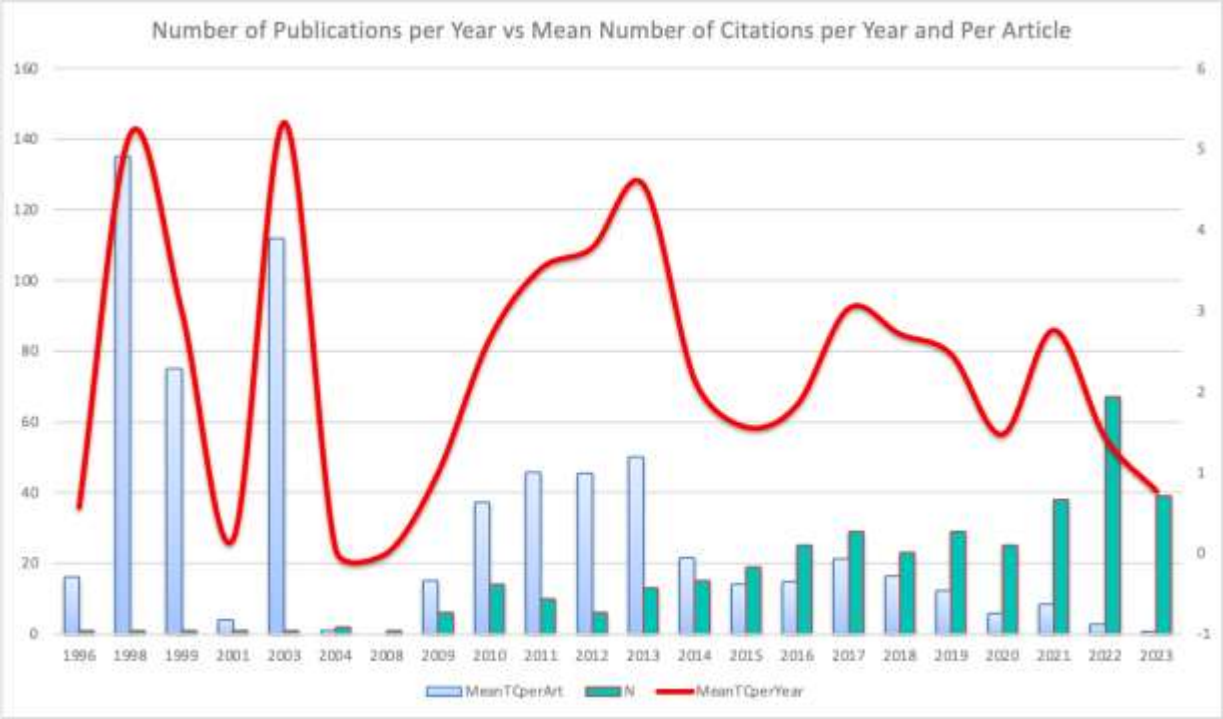

Figure 1. Academic production in 1996-2023
Source: created by authors with Excel after Web of Science

As can be observed in Figure 1, the amount of academic production on the link between workforce diversity and innovation was almost absent before 2009, but has significantly increased after this year, with the highest number of publications in 2022 reaching a total of sixty-seven. 2023 and 2021 were also very productive years regarding this topic with a number of thirty-nine and respectively thirty-eight papers per year, followed by 2017 and 2019 with an annual number of twenty-nine articles, and 2020 which produced around twenty-five papers per year.
The total mean number of citations per year averages around 3.5, with three exceptions - the peaks recorded in 1998 with 5.19 citations, in 2003 with 5.33 citations, and in 2013, with 4.56 citations. The fact that 1998, 2003, 2013 were the years when three of the most impactful publications on this topic, in that period, appeared could be an explanation for these three exceptions.

Regarding the mean total number of citations per article, the highest number was in 1998 with 135 citations, followed by 2003 with 112 citations. As in the previous paragraph, this can be explained by the fact that those articles may have been considered among the most important publications to mention the analyzed concepts which were still emerging at that time. The articles written between 2010 and 2013 also seem to enjoy a high number of citations (above 50) which can be justified by an increase in interest associated with the sudden rise in publication numbers on the researched topic. The lowest number of citations can be identified in the period between 1996-1997 -, because there were not enough papers on this topic at that time - and in 2023, because the latest publications have not yet been cited.

4.1.2 First publications on the topic

To identify the first publications highlighting the relationship between workforce diversity and innovation indexed by Web of Science, Table 1 was created.

Table 1. First publications indexed by Web of Science

Year	Authors	Title	Journal	Keywords	Country
1996	Stephenson, K; Lewin, D	Managing workforce diversity: Macro and micro level HR implications of network analysis	International Journal of Manpower	discrimination, employees, equal opportunities, network analysis, USA	UK
1998	O'Reilly, CA; Williams, KY; Barsade, S	Group demography and innovation: Does diversity help?	Research on Managing Groups and Teams	diversity, work group, innovation	USA
1999	Schneider, SK; Northcraft, GV	Three social dilemmas of workforce diversity in organizations: A social identity perspective	Human Relations	social identity; social dilemmas; diversity; group processes	USA
2001	Reingold, DA	The decentralization of manufacturing employment and the role of race: The case of the Lakeside Press	Journal of Urban Affairs	racial subordination, workforce integration, firm experience, technological innovation, outmigration	USA

Source: created by authors with WoS

The first article appeared in 1996 and studied workforce diversity regarding human resources and networks. It was published in the UK, but it analyzed the situation in the US, and had essential keywords like discrimination, equal opportunities, and network analysis.
The second article on our topic appeared two years later, in 1998, and analyzed the relationship between group demography and innovation. In 1999 and 2001 two other publications appeared, focusing their research on workforce diversity in organizations. Their importance is significant to our research because they represent the reference basis in this context.
Of the four articles identified, three were published in the US, and only one in the UK. Therefore, it can be concluded that the US represents a starting point for the emergence of the concepts of workforce diversity and innovation.

4.1.3 Territorial distribution of academic production

To determine the territorial dissemination of scientific production based on the most productive countries, a geographical map was created in Figure 2. It presents the number of publications distributed geographically, using distinct colors. Green represents the country with the largest number of publications, blue has been used to represent countries with a number of publications ranging around fifty, and pink for countries with the lowest number of publications. For intermediate nuances, in terms of blue tones, the darker the blue in the country color, the smaller the number of publications. The tints of purple and mulberry represent a gradual decrease in the number of publications from twenty downwards.

As can be observed on the map in figure 2, the USA is the most productive country with a number of 454 publications, followed by the UK with a number of fifty-five publications, Australia with fifty-two publications. Germany and Canada follow closely behind with forty and respectively thirty-eight publications, followed by Italy with twenty-seven publications, China with twenty-five, and India with nineteen. The Netherlands and South Korea have both published sixteen papers on the researched theme, France, New Zealand and Spain, twelve, Malaysia and South Africa have submitted eleven publications, and Switzerland, ten. The poorest countries regarding the number of publications are The Philippines, Uruguay, Serbia, Luxembourg, Ecuador, Estonia, etc. with only one publication about workforce diversity and innovation.

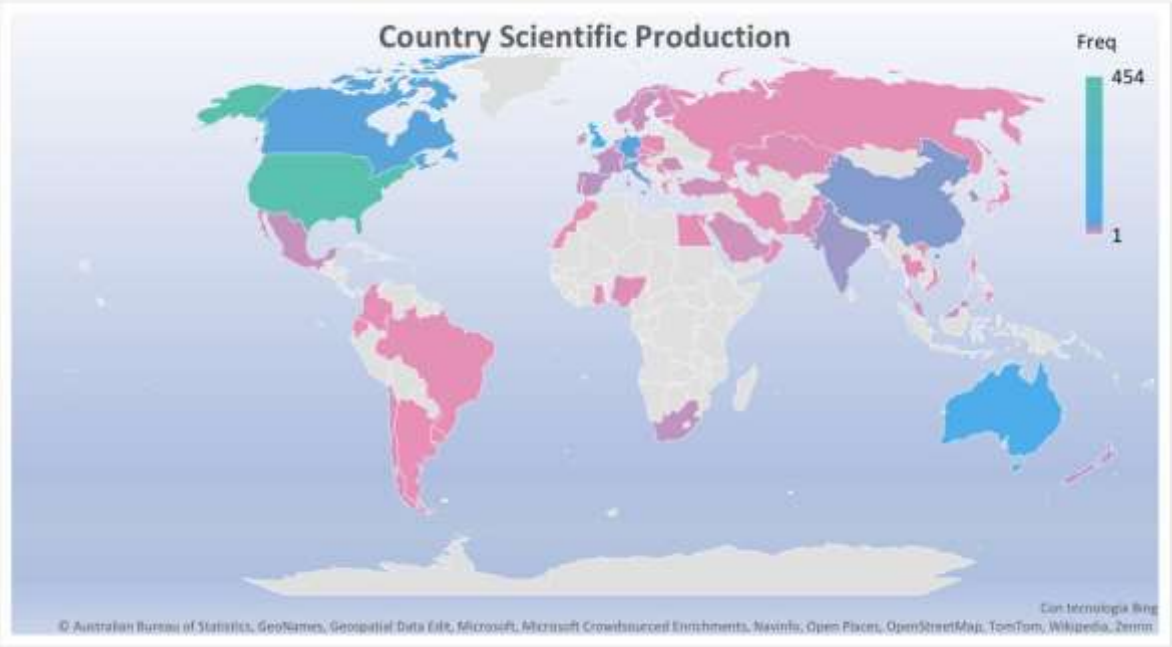

Figure 2. Country production map
Source: created by authors with Excel after Web of Science

As can be depicted from the color intensity on the map above, there is a substantial difference between the topmost academically productive country (the US, with 454 publications) and the second ranking country (the UK, with only fifty-five published papers). The reason why The United States sets itself apart from the other countries could be explained by the fact that it has been a pioneer in diversity, dealing both with race and ethnicity issues for more than half a century now, thus scientific interest in the topic as well as search for solutions to occurring issues may have been the natural path. A noteworthy point is the fact that the top three most productive countries are all English-speaking countries but from different continents; still, each of them has a diverse workforce and well-established policies to promote and protect diversity. Another point worth noticing is the fact that the top five most productive countries are all developed countries, four being English speaking countries and one of Germanic origin, the last two (Germany and Canada) having a long immigration history. The countries with the number of publications ranging between 30 and 10 - in a downward order- are truly diverse (4 Asian, 4 European, 1 Oceanic, and 1 African), all of them tackling either ethnic diversity within the local population or having witnessed global migration of workforce. The countries with the lowest number of publications present too many differences to allow the drawing of a common trait, but their interest in the link between workforce diversity and innovation must not be overlooked.

4.2.1 Social dynamic of the scientific community

In order to analyze the social structure of the scientific community focusing on the link between workforce diversity and innovation, the collaboration flows among three of the most influential channels (affiliations, authors, and sources) were investigated and presented in Figure 3.

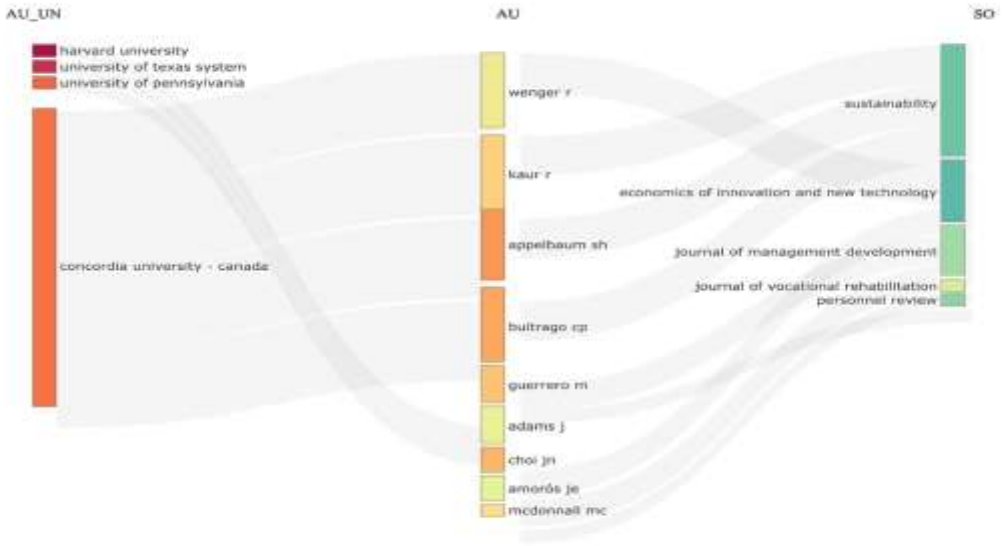

Figure 3. Three field plots of top affiliations, authors, sources
Source: created by authors with Biblioshiny

In Figure 3, a three-field plot based on a Sankey diagram can be observed. Sankey diagrams are utilized in the analysis of data flows since they allow a simultaneous depiction of the link among three or more selected elements in one single visual (Kumar et al., 2021). In Biblioshiny, the elements represent countries, journals, authors, or their affiliated institutions, cited sources, and paper keywords. The gray flows among the three elements symbolize their connection (Kumar et al., 2021). The three-field plot differentiates each element by color, illustrating the value of each rectangle (representing a node) within the same element through different intensities of the same color. The relationship between the elements can be identified in the size of the rectangle, which is proportional to the number of relationships occurring between the two elements (Janik et al., 2020). The three-field plot above depicts the proportionality among the main affiliations (left), the most important authors (middle) and the most important sources pertaining to the link between workforce diversity and innovation (right).

The most prolific university, with twenty-four papers published on our topic is Concordia University, in Canada. Four authors were affiliated with this university: Buitrago, Kaur, Appelbaum, and Wenger, each with six papers. Out of these four authors, the first three, published three papers each in 'Sustainability', while the fourth, Wenger, published in 'Economics of Innovation and New Technology'. While not associated with any of the top universities selected for this study, another author who published one paper in 'Economics of Innovation and New Technology' is Choi. The next author of interest is Adams, who gained attention having three affiliations - Harvard University, University of Texas System, and University of Pennsylvania, but who published in other sources than the top sources selected for this research. The three remaining authors of interest for our research are Guerrero with three papers, two published in 'Journal of Management Development' and one in 'Personnel Review'; Amoros, with one paper published in 'Journal of Management Development,

and Mcdonnall, with one paper published in 'Journal of Vocational Rehabilitation'. It is also worth observing Concordia University's tendency to publish mainly in 'Sustainability'. Another noteworthy point is the countries representing the affiliations, authors, and journals. While the affiliations are all located in North America (three in the US and one in Canada), the publication sources were all based in Europe (Switzerland, The UK, and The Netherlands); most authors originated from English speaking countries (4 from Canada, 2 from the US - though one has a Spanish origin -, one from Australia), one was from South Korea, and another one originated from Mexico. Thus, it can be concluded that scientific workforce diversity can contribute to collaboration within the academic community which further leads to innovation - the production of new scientific materials.

4.3.1 Keyword network visualization

To highlight the research hotspots pertaining to the relationship between diversity and innovation a keyword network map was created based on bibliographic data with the help of VOSviewer (Van Eck & Waltman, 2023). The *co-occurrence analysis* was selected from a list of types of analyses and *all keywords* were selected from units of analysis to create the keyword network map which is presented in Figure 4.

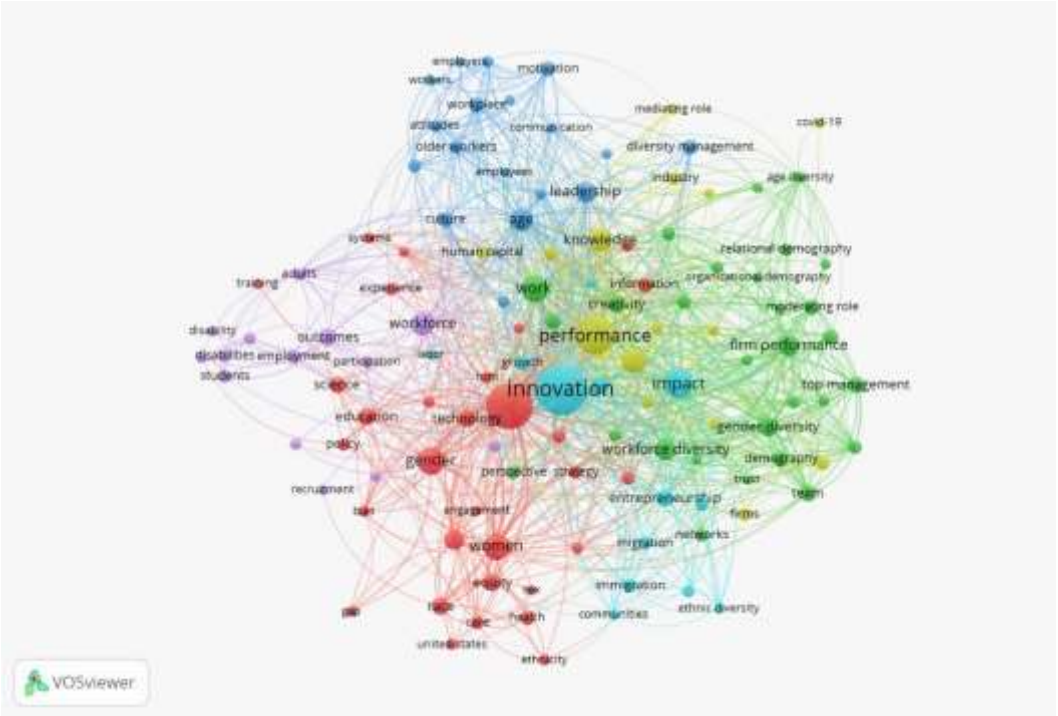

Figure 4. Keywords co-occurrence
Source: authors with VosViewer

For this analysis 1831 keywords were identified, but only 120 met the threshold. These were grouped in six clusters and created a total of 1917 links. The first cluster contains the keyword *diversity* as the central keyword with 105 links, and its cluster includes keywords like: ethnicity, race, gender, women, equity, acceptance, education, inclusion, information etc. This is the biggest cluster with thirty-one items, and it shows that the concept of diversity and its derivatives are frequently used in academic and organizational environments.

The second cluster is built around the keyword *work* and comprises twenty-nine items such as: human-resource management, job-satisfaction, networks, team diversity, top management, organizational demography, work group diversity, firm performance. This cluster includes keywords related to organizations. The most frequently used keyword in the third cluster is *age,* besides others

like older workers, culture, motivation, leadership, perceptions. The fourth cluster is centered around the word *performance* and includes keywords like human capital, knowledge, industry, firms.
The fifth cluster is built around the word *workforce* and contains fourteen items such as: employment, outcomes, recruitment, students, transition. The last cluster includes keywords related to *innovation*, like productivity, labor, cultural diversity, impact.
As a result, this clustering shows the main elements that highlight the relationship between *workforce diversity* and *innovation* and it might be said that the diversity of employees (in terms of education, ethnicity, race, gender, equity, age) can bring about all necessary premises (human capital, knowledge, productivity, cultural diversity, motivation, leadership) for an organization to be innovative and to achieve performance.
According to Popa & Gora (2020) a strong relationship between two keywords is indicated by their closeness. So, in our case, the closest keywords are *innovation* and *diversity* (link strength: 36) which shows that their connection was studied by numerous researchers. The other pairs with strong relatedness are *performance-innovation* (link strength: 29) and *performance-diversity* (link strength: 24), that leads to the idea that those two concepts -*innovation* and *diversity*- have an impact on performance. Also, a short distance represented on the map can be identified between *workforce diversity* and *innovation* (link strength: 12) which highlighted a powerful connection between these two keywords.

4.3.2 Longitudinal thematic evolution

The last step in our analysis was to highlight the keywords' evolution over time with the help of the Biblioshiny software. The resulting graph is presented in Figure 5.

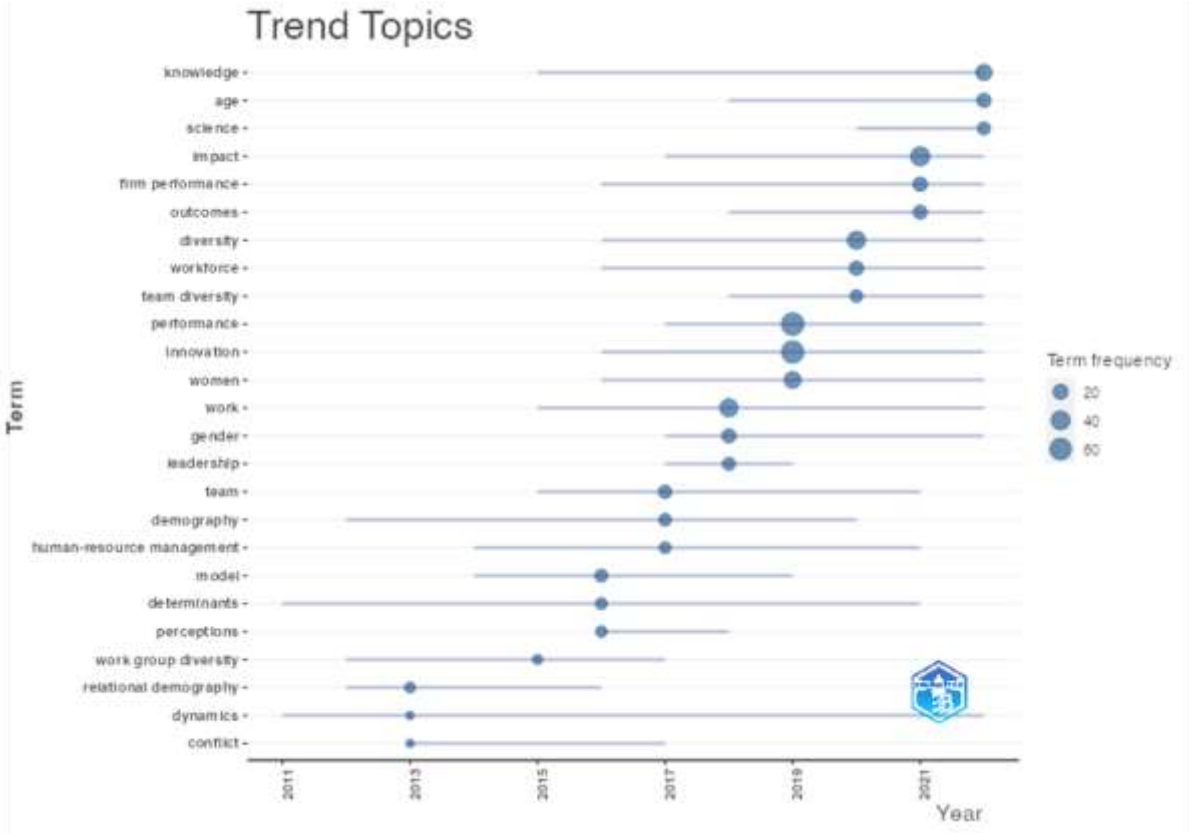

Figure 5. Trend topics
Source: authors with Biblioshiny

The oldest keywords used in this field were *conflict*, *dynamics*, *relational demographics,* and they had been used until around 2013-2015. In 2015, a new term frequently used at that time - *work group diversity* - appeared, which led to the idea that people started to form diverse teams in the workplace. Two years later, in 2017, this term led to other keywords such as *perceptions*, *human-resource management, team, leadership,* which highlights the importance of the workforce and its management at that time. With the advance of technology, the emergence of globalization and of social equality, new keywords started being used: *gender, women, innovation, performance*. Besides, an impactful event like the COVID-19 pandemic has changed human perceptions, with the period between 2020 and 2023 bringing new keywords to researchers' attention, keywords such as *diversity, workforce, impact, firm performance, science, knowledge*. The expansion of remote work provided the context for employing a diverse workforce and implementing innovative processes to achieve superior performance.

5. CONCLUSIONS

Our paper aimed to study the relationship between workforce diversity and innovation using a bibliometric analysis to analyze a document dataset extracted from the Web of Science on these subjects. The results of the bibliometric analysis firstly showed that an important amount of academic production on the link between workforce diversity and innovation has significantly increased after 2009 and the highest number of publications was in 2022. Regarding the mean total number citations per article, the lowest number of citations was in the period 1996-1997, because then there were not enough papers on this topic and in 2023 because the latest publications have not yet been cited. In terms of the mean total annual citations, they averaged around 3.5 per year, with three exceptions - 1998, 2003, and 2013 when the number of citations peaked above 4.5 as those were the years with three of the most impactful publications at that time. Our findings, then, focused on the list of the first articles indexed by WoS on our topic. We discovered that among the first four articles which appeared between 1996 and 2001, three were published in the US and only one (1996) was published in the UK, but its subjects pertained to the situation in the US. For a deeper analysis of the scientific production, we built a geographical map, which showed that the most productive country with 454 publications is the US, followed by the UK, Australia, Germany, and Canada, all of which are developed countries, four being English speaking ones on three different continents. It also shows that the poorest countries in the number of publications on these subjects were The Philippines, Uruguay, Serbia, Luxembourg, etc. with only one publication, but the differences among these countries were too big to draw a common trait.

To meet the second objective of our research, a three-field plot was built with Biblioshiny, which highlighted the collaboration flows among three of the most influential channels (affiliations, authors, and sources). Through the three-field plot, we were able to identify the most productive institution, Concordia University in Canada (with twenty-four publications on the researched theme), which collaborated with four or the most prolific authors (each with six papers), who published mainly in 'Sustainability'. The second important journal revealed by our fundings was 'Economics of Innovation and New Technology'. While most authors represented English-speaking countries, they presented more diversity than their affiliations which were all located in North America. They were also more diverse than the sources they published in, which were all located in Europe.

The last part of our research focused on the conceptual structure of the scientific production, through a keyword analysis and a longitudinal thematic analysis. The keyword analysis clustering showed the main six elements (*diversity, work, age, performance, workforce and innovation*) that highlight the relationship between *workforce diversity* and *innovation,* and it could be stated that employee diversity (in terms of education, ethnicity, race, gender, equity, age) can create all the necessary premises (human capital, knowledge, productivity, cultural diversity, motivation, leadership) for an

organization to be innovative and to achieve performance. The longitudinal thematic analysis highlighted the transition from keywords like *conflict, dynamics* and *relational demographics* - which appeared two decades ago – towards words like *diversity, workforce, impact, firm performance, science, knowledge* etc., after 2020, which could suggest the realization of the impact a diverse workforce could have on knowledge, besides innovation and firm performance, a link which could become an emerging trend worth studying in the future.
Therefore, we can conclude that a strong relationship exists between workforce diversity and innovation, and it is a trendy topic within the specialized literature, especially in the USA, with an ascendent trend in the future.

6. CONTRIBUTIONS, LIMITATIONS AND FUTURE DIRECTIONS

Being the first bibliometric study on the relationship between workforce diversity and innovation, this research is potentially a trend setter in this type of analysis on the subject. Besides providing an overview of the scientific production on researched topics, the findings presented in this paper could also help future researchers as well as business practitioners identify key areas to focus on within the studied concepts.
The scope of this research was limited to one database - Web of Science -, within which there were limitations related to the document format (journals, conference papers, reviews, and early access), to the subject depth (since only surface-level workforce diversity related keywords were introduced into the search field), as well as to the language coverage (as only English documents were considered in this paper).
While we acknowledge the limitations, we recommend future researchers to conduct an analysis collecting data from several databases such as Scopus, Science Direct, Ebsco, PubMed, etc. Future studies might also be interested in using an extended workforce diversity related keyword range, focusing on task related diversity, with an eye on diversity training and diversity management, as well as on the relationship between workforce diversity and knowledge.

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