Journal of Autonomous Intelligence (2024) Volume 7 Issue 3
doi: 10.32629/jai.v7i3.1394

REVIEW ARTICLE

Gender inequality in the sphere of artificial intelligence: Theoretical approach

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ABSTRACT

Artificial Intelligence (AI) sector, like the other sectors, is marked by the minority presence of women within these entities. According to the UNESCO, the percentage of technical employees in large enterprises of Machine Learning who are women is 20%, the percentage of researchers in artificial intelligence in the world who are women is 12%, and the percentage of professional software developers who are women is only 6%. In other words, the proportion of gender in the practice of the professions of the AI remains highly unequal. Therefore, it is now crucial to review the causes and consequences of these gender inequalities. This paper aims to develop a theoretical framework for managing human resources in the digital environment and artificial intelligence, aiming to identify the causes and consequences of gender inequality in the AI sector. The study will focus on the role of women in AI. Additionally, it will explore potential solutions to this issue, utilizing an analytical lens grounded in existing literature to gain a deeper understanding of gender disparities in the AI sphere. Nevertheless, this theoretical study has a limitation in its methodology, relying exclusively on a literature review. To better understand the depth of gender inequality within the sector of AI, more empirical case studies are needed for a more comprehensive understanding.

Keywords: women; gender; inequality; artificial intelligence

ARTICLE INFO

Received: 28 October 2023
Accepted: 15 December 2023
Available online: 18 January 2024

1. Introduction

In the field of Artificial Intelligence, the representation of women remains significantly low[1].This discrepancy persists despite the notable growth and progress[2] that machine learning and deep learning have witnessed in recent years. The rising inequality in many countries has become a major cause for concern[3], extending to the potentially negative impact of AI on women's economic empowerment and opportunities in the labor market.

Despite the growth and the progress of AI in recent years, particularly in the fields of machine learning and deep learning[2], rising inequality in many countries has become a major cause for concern[3]. This concern extends to the potentially negative impact of AI on women's economic empowerment and the opportunities on the labor market.

This issue can be illustrated by the introduction of artificial intelligence into the hiring process. Indeed, the algorithmic biases inherent in these AI systems can lead to discriminatory practices based on gender, race, color and personality traits. Studies along these lines, such as that by Chen in 2023, have confirmed these issues[4].

The purpose of this research is to identify the causes and consequences of gender inequality in the AI sector and to underscore the role played by women in this field. The study will also explore some potential solutions to this issue, utilizing an analytical lens grounded in existing literature to gain a deeper understanding of gender disparities in the AI sphere.

Firstly, we will present the different key concepts related to the topic of gender and AI to avoid all the different types of ambiguities than present the role of women in IA.

Moreover, we will describe the methodology employed in this study.

Afterward, we will explain various causes and consequences of gender inequality within the field of AI.

Furthermore, we will discuss the link between the presence of women in the high spheres of power and decision-making of the governing bodies of companies and their performance from the theory of the critical mass.

Finally, we will rely on the report "Gender Bias in Artificial Intelligence" by Collet, Isabelle, and the Laboratory of Equality to present the different steps to be taken into consideration to accelerate the mixing of women and men in AI and combat all forms of discrimination and sexual harassment.

Through a review of the literature around the theoretical foundations of the problem of "artificial intelligence" and the genre, we will try to inform "the black box".

2. Theoretical foundations

2.1. Definition of key concepts

Before delving into our topic, it seems very important to define the different key concepts related to our subject, these concepts include:

2.1.1. Equality

The 9th edition of Academy of the French Language dictionary distinguishes between two definitions of this term. The first definition of equality is the quality of what is equal in quantity and/or quality. In quantity, equality consists in distributing, dividing equally, in equal parts, by equal portions. In mathematics, equality expresses a relationship between two quantities that are exactly equivalent and can therefore be substituted. In quality, equality means treating individuals in the same way, without distinction. Thus, in law, the law provides all members of society with the same civic, economic, political and legal rights and obligations. The second definition of equality is the quality of that which does not vary, that which is constant, that which remains uniform without fluctuations or variations[5].

To further illuminate the concept of equality, it is crucial to closely explore the associated terms that enrich our understanding of this concept, such as:

Equality between women and men is to observe the same autonomy, accountability, participation and visibility of both sexes in all spheres of life, public and private[6].

Parity means ensuring an equal numerical distribution between women and men in their representation within the responsibilities of social, professional and political life. Initially a notion of power sharing reserved solely for the political sphere with the law of 6 June 2000, parity, with the law of 23 July 2008, is now an integral part of the Constitution on a broader scope. Article 1 has been amended to read: "The law promotes equal access for women and men to electoral mandates and elective offices, as well as to professional and social responsibilities"[7].

Mixity mentioned in the dictionary in 1963, it means introducing representation of a gender where it is not yet represented: A group is said to be truly mixed when the under-represented category makes up at least 30% of the workforce[8–42].

2.1.2. Diversity

This concept refers to the conditions, modes of expression and experiences of different groups defined by age, level of education, sexual orientation, parenting status or responsibilities, immigration status, Aboriginal status, religion, disability status, language, "race", place of origin, ethnic origin, culture, socio-economic status and other attributes[9].

This concept is linked to a set of terms that need to be clarified in order to ensure a common understanding of any discussion related to it, such as:

Gender refers to the historically inherited, socially constructed, and normalized behaviors, characteristics and appearances which operate to define people as female or male[10]. Individuals and groups understand, experience and express gender in a wide variety of ways, through the roles they adopt, the expectations placed on them, their relationships with others and the complex ways in which gender is institutionalized in society[11].

Gender equality means equal rights, responsibilities and opportunities for women and men, girls and boys[12]. This does not mean equivalence in quantitative terms, in other words, equality between women and men does not mean that women and men are identical or substitutable, but that their rights, obligations, responsibilities and opportunities will not vary according to their sex, in the biological sense of the term[13].

Women denotes to female gender identity, specifically an adult person who identifies as female. This definition is based on the one proposed by renowned organizations such as the World Health Organization(WHO) and The United Nations Entity for Gender Equality and the Empowerment of Women (UN Women)[14].

2.1.3. Artificial intelligence (AI)

Artificial intelligence (AI) is a scientific, technical, economic, cultural and social revolution that is reshaping our lives. There are two main perspectives on artificial intelligence: On one hand, it is viewed as a tool that can enhance the prospects of individuals and communities, and on the other hand, it is seen as a force that requires critical analysis in light of the diverse threats stemming from its direct or indirect utilization[15]. Its significant impact on gender equality necessitates immediate awareness and action.

A formidable source of hope and concern, the artificial intelligence with which human beings are machines (computers, robots, etc.) is invading our daily lives: in everyday life (8 billion connected objects worldwide by 2020); in healthcare (pathology diagnosis, remote consultation, etc.), justice (crime prediction), security (face recognition), transport (autonomous cars)[16].

The concept of artificial intelligence is linked to a number of key terms, which need to be defined, such as:

Equity is a concept related to the objective of narrowing inequalities and to other notions such as justice, convergence, and fairness[17]. It is synonymous with justice, meaning that people, whatever their identity, are treated fairly. This means ensuring that resource allocation and decision-making mechanisms are fair to all, and do not discriminate on the basis of identity[9].

Gender equity means fairness in terms of treatment according to respective needs for women and men, in terms of equivalence of rights, benefits, obligations and opportunities. In the context of development, the objective of gender equity often requires the implementation of measures aimed at correcting the historical and social disadvantages of women[18].

The various keywords presented below have given us a clear idea of the different concepts that interest us in our theoretical research. We will now turn to a more in-depth exploration of the subject of gender inequality in the context of AI.

2.2. Women in IA

Despite the under-representation of women in the artificial intelligence sector[19], women are fighting their way into this sphere and even reaching top positions in the field[20].

The latest Women in the Workplace report from McKinsey, in partnership with LeanIn.Org. confirmed that women are more ambitious than ever, despite some hard-fought gains, women's representation is not keeping pace[20].

However, this lack of female representation in the field of artificial intelligence poses a major problem. This is made possible by the absence of strong ethical codes and regulatory frameworks within the sector[21].

Consequently, AI will not benefit from the role of women in its sphere. In fact, studies have shown that companies with gender-diverse teams are more innovative and produce better products[22].

A large body of theoretical and empirical work emphasizes the potential of women in AI in general, and more specifically in leadership positions including decision-making positions. Such as The British multinational company Deloitte has conducted surveys among women and men employed in the field of AI and machine learning, affirming that women play a pivotal role. This underscores the idea that an increased presence of women in this domain enhances the design and functionality of AI systems[23]. In the same line, having at least 30% of women in leadership positions, or the "C-suite", adds 6% to the net profit margin[24].This implies that women have a significant impact on performance.

This further motivated us to deepen our understanding of human resource management in the digital environment and artificial intelligence, in order to identify the causes and consequences of gender inequality in the AI sector, as well as the role played by women within it.

3. Methodology

In this section, we delve into the methodology employed in this research. In fact, the methodology served as the foundation for our investigation, providing a systematic approach to address our research objectives. The processes applied in the methodology are illustrated in **Figure 1**.

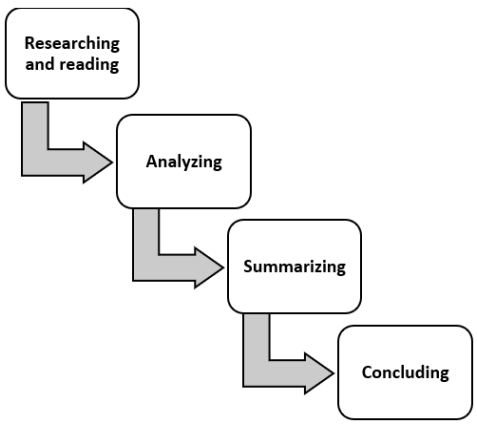

Figure 1. Methodology.

Firstly, in the researching phase, we conducted an extensive literature review to gather existing knowledge and theories related to women, gender equality, and diversity in artificial intelligence. We searched through academic articles, theses, reports, and other scholarly sources.

Next, we moved on to the reading stage, where we thoroughly analyzed the collected literature. This involved critically evaluating the sources, identifying key themes, theories, and empirical studies related to our research topic. We took careful note of the various perspectives and arguments presented within the literature.

After the reading phase, we proceeded to the analysis stage. In this phase, we employed both qualitative and quantitative research methods to examine the data and extract meaningful insights. We analyzed case studies, conducted interviews, surveys, and examined relevant statistical data to gain a comprehensive understanding of gender inequality in the field of artificial intelligence.

Upon completing the analysis, we moved to the summarizing phase. We synthesized the information gathered from the literature review and the data analysis, highlighting the key findings and patterns that emerged from our research. This allowed us to draw connections and identify significant themes within the data.

Finally, based on our comprehensive analysis and synthesis, we arrived at the concluding phase. We drew conclusions based on the evidence we gathered, addressing the research objectives and providing insights into gender inequality in the field of artificial intelligence.

It's important to note that our methodology aimed to ensure rigor and validity throughout the research process. We utilized a combination of qualitative and quantitative approaches, providing a holistic view of the topic. By employing these steps of researching, reading, analyzing, summarizing, and concluding, we have strived to create a robust and well-rounded research study.

4. Human resource management in the context of AI

Until the 21st century, women suffered from gender inequality. This issue of gender inequality is defined as the imbalance between men and women in terms of individual achievement. A major obstacle to human development, they have been measured since 2010 by the United Nations Development Programme (UNDP) through the Gender Inequality Index (GII). The GII takes into account three important aspects of human development. Among others, it includes an index of economic status expressed as labor market participation and measured by the labor force participation rate of women and men aged 15 and over[25].

In this context, evaluations carried out by the UNDP, aimed at assessing attitudes to the social roles of men and women in society, show that prejudices are still present, deeply rooted, and influence people's beliefs and actions. A recent UNDP report on the Social Gender Norms Index shows that prejudice remains unchanged[26]. This finding prompted us to identify the causes of this phenomenon and its consequences in the field of artificial intelligence, based on theoretical and empirical studies already carried out.

4.1. The causes of gender inequality in the AI sector

No one can deny that humans determine the uses, limitations and purposes of the applications they develop. In other words, the technology is neutral of all types of discrimination that exist within its sector. Human beings are rich in their diversity. This must be translated without bias at all levels of development, from the designer to the user. So now, the question is to determine the causes of gender inequalities in the AI sector.

To answer our question, we base ourselves on the report "Gender bias in artificial intelligence" made by COLLET, Isabelle & Equality Laboratory in 2018[27].

4.1.1. AI reproduces the existing inequalities between women and men in society[27]

The first cause is the way these devices learn. AI is made up of algorithms. These algorithms learn from a language that is fed by billions of data (texts, images, videos, etc.) imbued with our cultures.

When a system becomes sufficiently qualified to create a conversation and construct a language that appears natural, it is based mainly on accepted ideologies in the society in which it is interested.

It is undoubtedly that it reproduces historical, social and cultural representations that are ethically questionable. This is justified by the fact that the majority of programmers in the AI field are men, accounting for 90%, and exert influence on the development and feeding of algorithms, the foundations of AI. As a result, AI reflects a masculine worldview and "automatically" reproduces gender stereotypes, which it disseminates on a massive scale. What's more, it valorizes the masculine rather than the feminine gender in databases. These data often reflect past or present situations and opinions, frequently tainted by sexism and with little potential for change[16].

So, not only are virtual user assistance entities typically feminine, but this also reflects the fact that this profession is more often devolved to women. Since they use common conversational models as a reference, these virtual assistants can respond passively or positively to various harassing orders or sexual insults.

The Equality Lab is concerned about the spread and disregard of sexism, racism and homophobia by artificial intelligence algorithms.

4.1.2. Inequality in automatic decision aids[27]

The second risk arises when AI is used for decision-making. When machine learning is used, it relies on human-created databases from which the machines must make recommendations. However, to name just a few areas where AI decision support can be applied, what the machine will learn is:

a. For equivalent CVs (same academic and professional backgrounds), women are paid less than men[27];
b. For equivalent records, men are more likely to get business loans than women[27];
c. For equivalent careers, men are more likely to be promoted or called upon to occupy positions of influence than women[27];
d. For equivalent school transcripts, boys have a better chance of gaining easy access to engineering schools than girls[27];
e. In rape cases, the crime is often reclassified as sexual assault[27].

In a similar vein, in 2022, according to Collett, Neff, and Gomes, men are more likely to hold high-level professional positions in machine learning and engineering, while women tend to be in junior roles, such as data preparation or data mining[28].

This highlights significant discrimination against women, all the more so given that some women are more competent than men in the field of AI. For this reason, the Equality Laboratory has taken the initiative of questioning the automation of procedures which, by disempowering individuals, could amplify discrimination under the pretext of IT neutrality[27].

Finally, on this basis, these various causes will inevitably have discriminatory consequences for women. We will now take our exploration of the consequences of gender inequality in the field of AI a step further.

4.2. Consequences of gender inequalities in the AI sector

Artificial intelligence is a double-edged sword. On the one hand, it is seen as a source of hope, because it can be used to do many things, but on the other hand, it is seen as a source of concern, because it generates and amplifies racist and discriminatory practices.

a. Gender inequality in the AI sector

Firstly, the ratio of males to females in the AI sector is 90%, which says that the male gender is intensively present and valued than the female gender in databases. In other words, this shows that there is a reproduction of gender stereotypes not only in this sector, but in all sectors that use AI machines and software[16].

b. Inequality in automatic decision aids

Secondly, for companies using decision aids sometimes suffer from the existence of professional inequalities between men and women in terms of recruitment, pay, promotion and training. Especially when algorithmic decisions are based strictly on data where professional inequality between men and women is obvious[16]. This will destroy companies' image[16].

c. Gender inequality in websites

Thirdly, sites dealing with women's subjects and biographies are less popular than those dealing with men[16].This means that databases concerning the male gender are more present and valued than those concerning the female gender[16]. In other words, AI is changeable, depending on algorithmic data.

To make our work more concrete, we are going to illustrate the discriminatory effects of AI in the private sector with real-life examples taken from the Equality Lab's "Pact for Gender-Equal Artificial Intelligence".

a. Gender inequality in the British Medical School

The initial example concerns the British Medical School, which has shown that the AI system can cause discrimination due to a bias present in its training data[29].

b. Gender inequality in the Amazon company

The subsequent example concerns the retail company Amazon, which has reportedly abandoned an AI system for recruiting its staff due to an unfavorable bias against women. According to Reuters, the company reportedly realized that its new system was not evaluating applicants for IT and other technical jobs in a gender-neutral way. Historical data had taught Amazon's system that applicants were preferable to female candidates[29].

c. Gender inequality on the Wikipedia Website

The next illustration is in relation to searches for detailed information about women, such as Wikipedia, which contains only 20% of biographies of the female gender. So all the sexist stereotypes present in society are reproduced by AI[21].

From all this, we can deduce that women are under-represented and poorly treated, despite having undergone the same training, attained the same levels of education as men and possessing the same skills.

That is why it is crucial to explore and implement some of the solutions proposed by theories, authors, practitioners, international bodies, etc., in the AI context, in order to combat all forms of discrimination against women.

5. Recommendations

At present, companies are using AI software to recruit new talent. Indeed, the majority of decision-making positions are open to men[20]. This shows that this is because AI software does not respect morality.

As mentioned in the previous section dealing with the causes and consequences of gender inequalities within the AI sector, AI can not only generate and amplify racist and discriminatory practices, it can also have a negative impact on a company's image and performance.

However, if all jobs are open to women and men in the same way, this will create a real technological, economic, social and societal challenge. Therefore, everything depends on the type of relationship built between human and machine, in other words, whether it is based on universal values, norms and ethical principles.

Before answering our main question, which concerns how we can accelerate the gender mix in all teams working on AI by combating the stereotypes that prevent women from choosing and accessing AI and digital professions, we are supposed to focus on a very important point that most sectors, including the AI sector, neglect: the impact of the presence of women in decision-making positions on company performance.

5.1. The role of women in decision-making positions: "critical mass"

The concept of critical mass is borrowed from physics. In the literature, a body of work is based on the theory of critical mass. Among the first works to have had a significant impact on the evolution of this theory is that of Kanter in 1977[30], who states that company performance is linked to the proportion of women in decision-making and management positions. The higher this proportion, the greater the impact on corporate performance.

The term "critical mass" was coined in 2006 by Kramer et al.[20] to complement and extend previous research on women's contribution to performance and the influence of numbers on this contribution[31]. Indeed, Kramer et al.'s research, based on 50 interviews with senior executives, aims to demonstrate that a critical mass of three or more women can bring about radical change within the boardroom and contribute to improved corporate governance and performance[32].

The study by Kramer et al.[20] deduced that the presence of three or more women in a decision-making body together becomes normal; they are no longer seen as a curiosity. They are part of the group and no longer considered "outsiders"[32].

No longer an isolated female perspective, women begin to be treated as influential members, with different personalities, different concerns, different perspectives[32].

Thus, the presence of three or more women on a decision-making body creates a critical mass where women are no longer considered as "tokens"[32].

The results of the interviews conducted by Kramer et al identified three main advantages to this situation[32]:

a. Women implement a collaborative management style that benefits team dynamics and organizational functioning. They foster a quality of listening, support and effective problem solving that significantly influences group interactions and decisions;
b. Women are more likely than men to ask difficult questions and demand direct, detailed answers;
c. Women take into account the ideas and concerns of different stakeholders, thus helping to broaden the content of boardroom discussions and pave the way for new issues and perspectives.

Again, several empirical studies of the -longitudinal- type such as (in 1999 by Welbourne, in 2001 by Adler, in 2004 by Catalyst and in 2005 by Smith et al.) and others of the -sample study- type like (in 1997 by Sharder et al., in 2009 by Belghiti-Mahut and Lafond.) agreed on the positive influence of women's presence in management bodies on company performance, except that they do not specify the threshold of women's representativeness for their impact to be significant[32].

Through these scientific studies, major companies around the world have encouraged women to take up senior management positions and sit on boards of directors. Corporations, including Canada's largest public companies, have emphasized that maintaining a gender balance on boards and in the senior management team has become an economic imperative to boost corporate economic performance[33].

These findings are based on a report published in 2019 by Catalyst, a global non-profit organization working with leading companies to create women-friendly work environments, and Canada's 30% Club, a global campaign encouraging greater representation of women on corporate boards and in senior management. The report provides an overview of the progress made by Canada's largest public companies between 2015 and 2019, using the S&P/TSX Composite Index, widely regarded as a barometer of the Canadian economy. All data has been provided by Market Intel Works, a research and data analysis company focused on gender diversity, and is based on a review of 234 companies in the S&P/TSX Composite Index[33].

From this, we can deduce that the presence of women in decision-making spheres has a positive impact on the company. Therefore, we need to ensure that we implement an ethical artificial intelligence system that

allows equal access for all too decision-making positions and fights against all forms of discrimination and sexual harassment[1].

5.2. Measures to be taken to tackle the various stereotypes that prevent women from choosing and accessing AI and digital professions

Finally, for the measures and procedures to be taken to accelerate the gender mix in the AI sector and combat the stereotypes that prevent women from choosing and accessing AI and digital professions, we present to you the major ethical principles presented in 2018, in Quebec (Canada) on the occasion of the launch of the International Observatory on the Societal Impacts of Artificial Intelligence and Digital Technology by The Montreal Declaration AI[34]:

a. Respect for user autonomy[34];
b. Protection of intimacy and privacy[34];
c. Caution in the development of new tools[34];
d. Human responsibility in decision-making[34];
e. etc.

Therefore, to prevent gender inequalities within the AI sector, the human being must remain a priority and remain at the center of decision-making, and it must leave technology neutral to all immoral forms.

In the same vein, the report "Gender Bias in Artificial Intelligence" by the laboratory of equality sees to the control of AI, because without control AI only reproduces our own prejudices. The report sets out concrete and urgent measures to be considered for ethical and equal AI[27]:

a. The right to explanation

The European Union is currently working on this principle "right to explanation", the aim of which is to explain the decision made by corporate decision-making algorithms, even when "deep learning" (whose operation is opaque) is used[27].

b. Controlling the conversational content

The measure aims to control the conversational content produced, in particular for cases of sexual harassment, discriminatory manifestations towards virtual assistants[27].

c. Controlling the production of decision aids

A serious checks are carried out on the databases supplied upstream of machine learning, with the aim of making equality an essential criterion in the production of decision aids[27].

d. Creating diversity in AI

The measure aims to create real diversity of personnel in the AI professions, in both technical and decision-making positions[27].

e. Reinforcing gender equality in AI

This point is based on the reinforcement of all actions contributing to gender equality and the fight against sexism in the digital sector, in order to delegitimize a minority who allow themselves sexist and homophobic practices in the name of a so-called geek culture[27].

f. Encouraging Women in AI

Another way to tackle the various stereotypes that prevent women from choosing and accessing AI and digital professions, is to encourage women who have added significant, profitable and visible value to their sphere of IA[27].

For example, in 2019, IBM (International Business Machines Corporation) launched a program called "Women Leaders in AI" with the aim of rewarding women who have succeeded in their work in artificial intelligence and who have contributed to the evolution of their companies in various sectors around the world, in other words, those who are leaders in AI within their workplaces. Between 2019 and 2021, IBM has rewarded 115 women from 25 countries, working in 31 different industries[35].

6. Conclusion

In 2023, the World Economic Forum declares that it will take another 131 years for the world to achieve gender equality in general[36]. Specifically, despite the efforts in the international ethical development of artificial intelligence and the higher levels of university education among women compared to men across all sectors within the field of data science artificial intelligence (AI)[37] there is gender inequality in the sphere of IA.

In the same context, the ratio of women within the AI leadership includes roles such as decision-making positions, remains very low. In fact, men are found to dominate these high-level professional positions in machine learning and engineering (e.g., design and programming), while women tend to be in junior positions, such as data preparation or data mining[38].

This weakness has a negative impact not only on the image of companies in the AI sector and the users of digital technologies but also on compliance with norms and institutional rules. Furthermore, it adversely affects performance and creates a crisis within the AI industry[39].

To address this situation, it is crucial:

a. To raise awareness among all AI stakeholders, including governments, institutions and businesses, about the importance of actively engaging in reducing gender inequalities, rather than perpetuating them or worsening their consequences[40].This involves adopting an ethical and gender-neutral approach at all levels of AI implementation.;
b. To apply the recommendations put forward by UNESCO, which has drawn up an international standard-setting instrument on the ethics of artificial intelligence in the form of a recommendation. The latter was unanimously adopted by the 193 member states in November 2021. It is seen as a concrete roadmap for states in developing their AI policies, providing for a gendered approach to all aspects of artificial intelligence. This means that UNESCO encourages special consideration of gender issues in the development, application and use of AI[41,42];
c. To use the Women4Ethical AI platform, designed to expedite the implementation of the Recommendation on the Ethics of Artificial Intelligence, -UNESCO has established a collaborative initiative. Operating under the name Women4Ethical AI, the platform is aimed at supporting governments and companies. The primary objective of this platform is to share research and contribute to a repository of best practices. Additionally, the platform will play a pivotal role in advancing non-discriminatory algorithms and data sources, while also incentivizing the participation of girls, women, and under-represented groups in the field of AI[1];
d. To emphasize the positive influence of women's presence in executive management on business performance, while considering the application of 'the theory of the critical mass'[31].

However, this theoretical study has a limitation concerning the methodology used to examine the gender inequality in the context of AI, as it depends exclusively on a literature review. To better understand the depth of gender inequality within the sector of AI, more empirical case studies are needed for a more comprehensive understanding.

Conflict of interest

The authors declare no conflict of interest.

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