Empowering African women with the skills required in the workplace in the Fourth Industrial Revolution (4IR)

by Gaelle Fitong Ketchiwou and Patrick Ngulube.

Gaelle Fitong Ketchiwou
ORCID ID: https://orcid.org/0000-0003-1793-2560 / Email: fitong@unisa.ac.za / gaellefit@gmail.com
School of Interdisciplinary Research and Graduate Studies, College of Graduate Studies,
University of South Africa.

Patrick Ngulube
ORCID ID: https://orcid.org/0000-0002-7676-3931 / Email: ngulup@unisa.ac.za
School of Interdisciplinary Research and Graduate Studies, College of Graduate Studies,
University of South Africa.

Abstract

Africa has been characterised by gender and social inequalities that have affected different dimensions of women's lives. Even in the modern era of the Fourth Industrial Revolution (4IR), most women do not have the right skills to secure and keep profitable employment. Grounded in human capital, postmodern feminism, and empowerment theories, this study unpacks how to empower African women with skills relevant in the 4IR. An integrative review approach is used. Out of 917 articles screened, 24 peer-reviewed articles (2018–2023) on 4IR, women, and Africa were retained and analysed using a manual content analysis method. Results reveal the need for a robust regulatory framework backed by government funding and support to address past inequalities and tackle the underdevelopment of 4IR and STEM (Science, Technology, Engineering, and Mathematics) skills in women. Firms, on their part, need to comply with regulatory frameworks and design programmes to empower women with 4IR skills while

offering them customised support. In this digital era, African women must actively cultivate a positive attitude toward technology and the development of 4IR skills. The unique contribution of this study is the proposed multi-stakeholder framework involving government, firms, and women to empower African women through targeted 4IR skills development.

Keywords: regulatory framework, fund skills development, support women, personal initiatives, STEM.

Introduction

Gender inequality has been persistent in Africa and globally and is being prioritized by the world's most influential organisations (International Labour Organization 2018; Lawson et al. 2022; World Economic Forum 2020). African nations are often fragmented based on race, class, and gender. Hence, the battle for equality and diversity has been a challenge, particularly for African women as they are regularly marginalized (Jeche 2023; Micheni et al. 2021). Poverty, underdevelopment, and other forms of inequalities characterize the unequal African society with devastating effects on women (Matotoka and Odeku 2021; Mahlatsi 2020). The unequal treatment and discrimination against women have excluded them from work and workplace opportunities for centuries (Mahlatsi 2020; World Economic Forum 2023a). Women are more vulnerable to job losses than men (United Nations 2022), occupy lower positions, and linger at the bottom of the organisational ladder (Basotia and Kothari 2020; Fitong Ketchiwou and Dzansi 2023; Micheni et al. 2021; Moalusi and Jones 2019). Although women constitute over half of the world's population, around two-thirds of the 175 million illiterates are youths and females (Potokri 2022). Youths and women are in the majority in developing countries, face abject poverty, high unemployment, and have limited professional skills that hinder their economic empowerment (Micheni et al. 2021). With Africa's history of persistent and significant inequalities, the continent is at risk of greater inequalities in the 4IR (Jeche 2023; Kayembe and Nel 2019).

Scholars argue that the continent is not yet ready for disruptive transformations of the 4IR (Chinyamunjiko, Simon, and Bhibhi 2022; Oke and Fernandes 2020; Masinde and Soux 2020), and several developing countries continue to struggle with previous revolutions (Moyo 2022; Saidi 2022; Uleanya and Ke 2019). Yet, the impact of the 4IR on Africa is significant with both positive and negative spins (Chinyamunjiko et al. 2022; Fitong Ketchiwou and Ngulube 2024; Moyo 2022). There is also a technological divide between women and men (Adams 2018; Mahlatsi 2020; World Economic Forum 2023b), and between rural and urban inhabitants (Jeche 2023; Moyo 2022). Even though the 4IR technologies can promote equality and inclusiveness (Chinyamunjiko, Simon, and Bhibhi 2022; Omonzejele and Agu 2023), access to technology and technological tools remains a challenge for many on the continent (Moyo 2022; Yingi, Hlungwani and Nyagadza 2022). Women are more prone to perform unskilled tasks that are now being automated and will likely be the most impacted by job losses (Barclay 2018; Christiaense and Demery 2018; Jeche 2023; Madgavkar et al. 2019). The use of technology and the development of technological skills continue to be a challenge (Fitong Ketchiwou and Ngulube 2023), particularly for women (Adams 2018; Kayembe and Nel 2019; Mahlatsi 2020). There is a gender gap in skills anticipated to grow in demand and importance in the future, such as technology skills, technological literacy, artificial intelligence, and big data (World Economic Forum 2023a; World Economic Forum 2023b). Many women lack the skills and competence to operate in the 4IR (Jeche 2023; Matotoka and Odeku 2021; Micheni et al. 2021; Naidoo and Potokri 2021). There is already a paucity of women in certain roles and in technology (Matotoka and Odeku 2021; World Economic Forum 2023b), and women are not prepared to keep up with the trends and developments of the 4IR era (Adams 2019; Mahlatsi 2020; Potokri 2022). Thus, there is a need for them to be empowered.

> "There is still limited research on the 4IR in Africa *(Ebekozien and Aigbavboa 2021)*"

There is still limited research on the 4IR in Africa (Ebekozien and Aigbavboa 2021; Fitong Ketchiwou and Ngulube 2024; Oke and Fernandes 2020; Yingi et al. 2022). Surely the 4IR offers opportunities for skills development (Adeosun, Shittu, and Owolabi 2022; Oke and Fernandes 2020; Saidi 2022), can increase chances of employment in certain fields or professions (Ndagi and Salihu 2018; Omonzejele and Agu 2023), or create employment for women (Butler-Adams 2018; Fomunyam 2019; Potokri 2022). Yet, African research gives very little attention to women and the 4IR (Jeche 2023; Potokri 2022). Hence, this research seeks to unpack how to empower women with skills relevant in the 4IR.

The preceding section introduced the matter under investigation and identified the research problems, and research objective. The next section provides the theoretical anchor for this research and the methodology utilised in this research. Then, the researchers present a review of literature on the topic. The paper ends with research findings, implications, concluding remarks, as well as limitations and recommendations for further studies.

Theoretical background

This paper is grounded in the theory of human capital, postmodern feminist theory, and empowerment theory. The theory of human capital purports that investments in human development command returns in the labour market (Alnachef and Alhajjar 2017; Becker 1993; Hideg et al. 2018; Sweetland 1996). This implies that women with developed skills have a better chance of gaining and retaining employment at all levels, especially if these skills are related to the current industrial dispensation.

The postmodern feminism theory challenges gender boundaries that restrict women's growth and confine them to gender-based stereotypes, dichotomies, and essentialism (Basotia and Kothari 2020). It destabilizes the societal patriarchal norms entrenched in gender inequality (Mishra 2021). Women's experiences are deeply rooted in inequality and discrimination that limit their access to economic opportunities. This theory is used in this paper to show that addressing gender inequality and removing boundaries can give women better chances in the workplace.

The empowerment theory describes a psychological concept in which people, groups, and institutions feel in control, independent, and equipped with the power to change their status quo (Kalso 2019; Potokri 2022). Equipping women with vital 4IR skills can dismantle the gendered dichotomies and give women the power to make meaningful contributions to their careers, workplaces, and lives.

Literature review

In this section, we start by discussing gender inequalities, then the 4IR and skills of the 4IR, after which we review the role of 4IR in redressing past inequalities.

Gender inequalities

The World Economic Forum (2023b) defines the gender gap as the unfair difference between men and women and reveals that the gender gap is currently 68.6% closed and that it will take 131 years to arrive at full gender parity globally, 102 years for the Sub-Saharan Africa region, and 152 years for the Middle East and North Africa region to close the gender gap. This estimated time to parity is even higher than the one hundred years projected by the forum in 2020, thus indicating a worsening state for gender parity globally. Although women are re-entering the labour force at a higher rate than men, the overall gender gap remains wide in leadership, STEM occupations (Science, Technology, Engineering, and Mathematics), and artificial intelligence. As it stands, no country has full gender parity, and only one African country (Namibia) takes the eighth position in the top 9 countries with the best gender gap indexes, having at least 80% of its gender gap closed. The Sub-Saharan Africa region is the sixth out of eight regions with a 68.2% overall gender index. The region records a 67.2% gender gap for economic participation and opportunity, 97.2% for health and survival, a 22.6% gender gap for political empowerment, and an 86.0% for educational attainment. This ranking is followed by Southern Asia and the Middle East and North Africa region (World Economic Forum 2023b). Africa is deficient in skills relevant to the 4IR (Moyo 2022; Yingi et al. 2022). Skills gaps are most problematic in Sub-Saharan Africa and limit the transformation of 70% of companies (11 % points higher than the global mean) (World Economic Forum 2023a).

The 4IR

Moll (2021) critiques that we are not in the 4IR but only experiencing an extension of the third industrial

revolution (3IR), the reason being that it does not meet his criteria for revolution, being widespread technological innovation, transformation of the labour process, changing work relations with the competing interests of employers and workers, changing community and social relations, and international/global transformation. He contends that a revolution consists of fundamental societal transformations that go beyond technological innovation, to include socio-economic, cultural, and geopolitical changes. He also argues that the current era lacks a comprehensive societal overhaul, with deep transformation of the labour relations, labour process, social life, and the international socio-economic relations to qualify as a 4IR. The author further adds that the technologies often cited as evidence of a "4IR" (e.g., AI and the Internet of Things) are only accelerated developments of the Third Industrial Revolution (3IR). Moll (2022) insinuates that the 4IR rose because the information-driven, digitalised, international order is in trouble and not because another revolution has happened.

However, according to Schwab (2016), the 4IR has emerged as we witness the emergence of technological breakthroughs in a wide range of fields such as artificial intelligence, the internet of things, robotics, 3D printing, autonomous vehicles, nanotechnology, biotechnology, energy storage, materials science, and quantum computing. This exponential change occurs at a much greater scale, scope, and complexity (Mahlatsi 2020; Oke and Fernandes 2020; World Economic Forum 2023), affecting humanity, societies, businesses, as well as the environment and universe (Fitong Ketchiwou and Ngulube 2023; Omonzejele and Agu 2023; Schwab 2016). Also, Marwala (2020) attests that the interconnectivity of technologies through AI, automation, nanotechnology, communication technologies, and biotechnology blur the lines between the physical and digital, and biological spheres, which marks a clear difference from the previous revolutions. Anwar and Graham (2022) argue that less than two decades ago, there were more internet users in countries like France or Germany than in all of Africa, yet from 2018, a majority of the world is now connected to the internet. Workers can now apply for and work anywhere remotely. With a rise in digital outsourcing in the labour force, a new world of digital work emerged with several implications for the lives and livelihoods of African workers.

Masikane and Webster (2025) highlight the changes current digital technologies have brought to the labour market and hybrid worker organisations, resulting in collective unionised action and organisation. This has impacted workers' incomes, demands for better working conditions, work benefits, access to social security, social power, and job security. The rise of the gig economy led to a new social force that replaces the old one, evidence being the recent upsurge in labour struggles in the platform economy globally and in the global South. Again, Webster and Masikane (2021) argue that the disruption caused by the digital age and platform presents challenges and opportunities for workers in terms of fairness in pay, work conditions, contracts, management, and representation. On one end, there could be job creation, with most workers being stuck in low-wage drudgery without the protections or benefits of formal employment. On the other end, there could be a digital social compact created by workers and their organisations to create coherent national and global policies, unionisation, and legislation to protect workers. Hence, new technologies create platforms, work, and opportunities which are 'entry points' that facilitate access to social protection and support compliance with laws (Webster and Masikane 2021).

Anwar and Graham (2022) argue that the growth of digital technologies, increasing internet, and digital capitalism is bringing new jobs to Africa. Yet Africa has emerged as a major supplier of labour for digital and remote labour (with South Africa, Egypt, and Kenya leading) to meet the bulk of the demand for digital work in other countries. The business process outsourcing and remote gig economy create a global market for digital work and present an economic opportunity for African workers. However, African workers are challenged with structural constraints (cultural, social, political, and economic) that technology alone cannot transcend. The authors also argue that digital jobs are enabling 'digital Taylorism' that breaks down work into simple tasks to quantify worker performance and link wages to performance, thus using algorithms to control processes, workers, and the quality of jobs remotely. In low- and middle-income economies, the impact of digital Taylorism

on the quality of the job in digital work is greatly amplified due to poor socioeconomic backgrounds (e.g., lack of education) and political environment (e.g., high unemployment rates), inadequate social protection measures, legal protection, and workplace harassment. While new digital work activities bring employment opportunities for Africa, their job quality outcomes are varied (Anwar and Graham 2022). Despite ongoing debates on 4IR, recent literature cited above confirm widespread technological innovation, transformation of labour and its processes, changing work and social relations, at a global scale, which has been termed the 4IR. Thus, women need the relevant skills to leverage the opportunities that come with the 4IR.

Skills of the 4IR

The human capital theory emphasises the value of skills against commensurate results. Skills attributed to the 4IR include adaptability and flexibility, critical thinking, analytical thinking, problem-solving, judgment and decision-making, creativity and innovation, cognitive skills, automation, coding and programming, information and technology literacy, computer-based competencies, system thinking, data analysis, social media skills, resource management skills, active learning, communication, emotional intelligence, and teamwork (Adeosun, Shittu, and Owolabi 2022; Ayo-Ayinde 2022; Chaka 2020; Chopra and Purohit 2022; Naidoo and Potokri 2021; Potokri 2022; Reaves 2019; Schwab 2016; World Economic Forum 2023a). These skills are imperative to equip people for success in the 4IR era (Butler-Adam 2018; Chaka 2020; Fitong Ketchiwou and Ngulube 2024). Digital skills are required to use and implement new technologies such as artificial intelligence, cloud computing, quantum computing, robotics, machine learning, 3D printing, genetic engineering, big data, blockchains, process automation, biotechnology, nanotechnology, space technology, neuro-technology, autonomous vehicles, additive manufacturing, augmented reality, and digitization (Adeosun, Shittu and Owolabi 2022; Ayo-Ayinde 2022; Chinyamunjiko et al. 2022; Chopra and Purohit 2022; Kayembe and Nel 2019; Micheni et al. 2021; Omonzejele and Agu 2022; Saidi 2022; Schwab 2016; Venter et al. 2019; Yingi et al. 2022). Skills considered as skills of the 4IR train the mind to be flexible, agile, and innovative (Fitong Ketchiwou and Ngulube 2023). Increasing women's access to skill development opportunities prepares them to respond to the rapid changes in the skills demand in the labour market (Chopra and Purohit 2022; World Economic Forum 2023b).

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The role of the 4IR in redressing past inequalities

Africa has a history of gender-biased culture and religious norms that hinder women's employment, working conditions, and educational opportunities while men enjoy preferential employment, remuneration, and upward mobility (Mahlatsi 2020; Matotoka and Odeku 2021). The association of women with illiteracy and unskilled jobs reflects the gender and social injustice perpetuated against women (Chiweshe 2019). Also, the revealed gendered patterns in skilling have substantial

ramifications on economic progress, as they affect talent allocation, utilization, and innovation in a world with high demand for fast-evolving skills (World Economic Forum 2023b). Existing inequalities led to further occupational segregation, limited job opportunities for women, and talent scarcity in the 4IR. However, the 4IR has enormous opportunities for women (Chiweshe 2019; Fernandez-Stark et al. 2019; Owasanoye 2020). For example, increasing their employment chances (Jeche 2023; Ndagi and Salihu 2018; Omonzejele and Agu 2023) and their ability to create employment (Ajah and Chigozie-Okwu 2019; Butler-Adams 2018; Potokri 2022). This is in line with the empowerment theory as a tool to regress past gender inequalities.

The 4IR uses digital and smart technologies, automated systems, robots, and computerised heavy machinery that are easy to use by any gender. Thus, women can now access jobs that previously required physical strength and traditional male-dominated jobs (i.e., manufacturing, mining, and construction) (Fernandez-Stark et al. 2019; Jeche 2023). Agriculture is one of the sectors in which women excel, and technological advancement offers women opportunities to use automated machinery and smart farming methods to alleviate strenuous, rigorous, and hard labour. Advanced technologies also increase productivity, increase yields, lower costs, secure better financial gains, improve efficiency, and reduce environmental impact (Tanjea and Suraiya 2019; Jeche 2023), thereby breaking technical barriers and gender bias in the employment of women in male-dominated fields.

Likewise, women often do the bulk of unpaid female domestic work in patriarchal and dichotomised and stereotyped underdeveloped societies; hence, equipping them with 4IR skills can replace physical labour for financially rewarding employment (Jeche 2023). Employment can secure the financial empowerment of women (Kamberidou and Pascall 2020; Matotoka and Odeku 2021), and if the 4IR does not contribute towards this agenda, it may fail African women and perpetuate records of social exclusion (Jeche 2023; Micheni et al. 2021). As skills and employment levels augment in the continent, inequality gaps will reduce (Chinyamunjiko, Simon, and Bhibhi 2022; Yingi, Hlungwani, and Nyagadza 2022), resulting in lower poverty levels (Ebekozien and Aigbavboa 2021; Manda and Dhaou 2019).

Technologies, digital apps, digital platforms, digital trade, e-commerce, and artificial intelligence (AI) will result in substantial labour market disruptions and job displacements (World Economic Forum 2023a). Automation and robotics in an unskilled workforce will result in significant job losses (Butler-Adam 2018; Oke and Fernandes 2020). This will cause the gradual disappearance of jobs in traditional trades, professions, industries, and sectors (Akparobore, Omosekejimi, and Nweke 2020; Yingi, Hlungwani, and Nyagadza 2022). Research shows that women are more likely to perform unskilled jobs that will be automated (Christiaense and Demery 2018; Madgavkar et al. 2019). The fastest-growing roles are driven by technology, digitalization, and sustainability, while the fastest-declining roles are clerical or secretarial, postal service clerks, bank tellers and associated clerks, cashiers, data entry clerks, and ticket clerks (World Economic Forum 2023a). Unfortunately, these declining roles also fall under unskilled jobs often held by women. Skill gaps will disrupt labour markets across economies (Chamola et al. 2020; Schwab 2016; Soh and Connolly 2020) and broaden the gap between the rich and the poor (Chinyamunjiko, Simon, and Bhibhi 2022; Moyo 2022; Ndagi and Salihu 2018; Omonzejele and Agu 2023). Therefore, given the multifaceted inequalities on the continent, the 4IR could perpetuate and further marginalize the poor majority (Kayembe and Nel 2019; Fomunyam 2019; Mahlatsi 2020), thereby increasing women's vulnerability to accentuate unemployment and poverty (Barclay 2018; Micheni et al. 2021; Potokri 2022). Without social inclusiveness, the 4IR will not benefit women, thereby perpetuating male dominance in many ways, especially in Africa. Equipping women with the skills necessary to operate efficiently in the digital world can enhance their chances of achieving meaningful and executive employment (Matotoka and Odeku 2021; Micheni et al. 2021). Developing women's skills can also eradicate gender inequality, reduce poverty, and fast-track development (Jeche 2023; Oke and Fernandes 2020). Thus, empowering women with relevant skills for the 4IR is vital to redressing existing inequalities and securing their employability.

Methodology

This research used a qualitative approach because it allowed the researchers to source rich content

that enabled them to explore how women in Africa can be empowered with skills for the 4IR, within a limited timeframe (Creswell and Creswell 2018; Marshal, Rossman, and Blanco 2022). The researchers used an integrative review approach (Snyder 2019; Kutcher and LeBaron 2022).

Researchers used Google Scholar to source literature on the 4IR and women. Google Scholar was chosen because it is a reliable and free open-access academic search engine that gives access to interdisciplinary publications, indexing both peer-reviewed articles and grey literature, which might not be fully captured by other databases. The careful search strategy and cross-checks were added to ensure comprehensive coverage of relevant literature for this research and the replicability of the study. We used the review process proposed by Kutcher and LeBaron (2022), which includes: select a topic, determine the aim of the study (refer to the introduction), conduct the literature search (refer to methodology section), organise and evaluate literature, analyse and synthesise results (refer to section on findings) summarise findings and conclude, disseminate findings (refer to the conclusion).

Key search string used to search articles included *Women* OR *female* and "fourth industrial revolution* or *industry 4.0* or *4IR* and *Africa* or *developing country*, and *skills* or *competencies* or *ability*. Only peer-reviewed journals written in English between 2018 and 2023 were considered in this study. Articles that did not meet these criteria were excluded. The initial search resulted in 917 articles. The titles, abstracts, and content of these articles were examined to decide if they were relevant in helping us meet the research objectives. In a few cases, relevant articles cited in the consulted literature were used to support the literature. This resulted in 24 articles, which were evaluated in full using the reviewer approach suggested by Kutcher and LeBaron (2022), where the 2 authors reviewed the evaluation independently, based on predetermined criteria stipulated in the inclusion and exclusion criteria and in line with the research objective.

A manual content analysis approach was used to analyse data (Neuman 2014). The first step consisted of scanning through articles to ensure they met the selection criteria and to ascertain the relevance of each article for the study. The researchers then read the selected articles thoroughly and analysed them in-depth as guided by the research objective and research question independently. Common themes were identified, organised as discussed in the next section, and later presented in Figure 1.

Findings: Empowering women with skills for the 4IR

Empowering African women to be skilled for 4IR will require the state, employers, and women assuming their share of responsibility.

Responsibilities of governments

Despite the male dominance in sciences and digitization, having the right measures can propel women to be on par with men and take the lead (Kayembe and Nel 2019; Potokri 2022). Matotoka and Odeku (2021) and Micheni et al. (2021) confirm that confronting the low level of digital skills that sideline women will require drafting, recalibrating, or revising targeted policies, legal framework, guidelines, and practices around social justice, equity, and diversity. Women should be part of the process involved in designing these frameworks. This regulatory framework should aim at skilling women, facilitating their employment and promotion in critical economic sectors in the 4IR. Some counties have made remarkable progress in promoting gender equality. Iceland, Norway, Finland, New Zealand, Sweden, and Germany are the top 6 countries that have nearly closed their gender gap (World Economic Forum 2023b) through their legislation, policy incentives, and resource allocation.

African governments need to implement industrialisation programmes to promote women's advancement using affirmative action initiatives across the different sectors (Jeche 2023). Such programmes need to be adequately customised to address the challenges women face in each sector and promote social inclusion in the development of STEM skills and the 4IR skills. Sectoral targets could be added to fast-track gender equity in the different sectors. Governments should also break down the myths about gendered skills in some fields and promote the ideology of equal intellectual capabilities for all at an early age. They also need to break stereotypes, promote parental influence, create

employment and entrepreneurial opportunities, and develop role models for girls and women (Abe and Chikoko 2020; Kibirige and Modjadji 2022; Makola and Tabane 2023). For example, having pictures of female professionals exercising in male-dominated fields like engineering and medicine in primary and secondary schools. This can create a mental stimulus for girls and the desire to pursue their education and career in those fields. Giving motivational talks to pupils and encouraging them to choose STEM-related subjects can also help. Above all, governments can create platforms to support girls who are willing to do STEM subjects, girls who struggle to pass STEM subjects, and not only focus on girls who are doing well in those subjects. Funded community or school tutors could also assist in improving performance in STEM subjects. Education funding should prioritize funding and supporting the education of females (Mahlatsi 2020).

To meet the rapidly evolving demand for skills, governments need focused financial investments in adult education, training, and lifelong learning, in line with sustainable development goals (World Economic Forum 2023b). For example, waiving age limits and excellent previous academic performance in scholarships for women who assume multiple family responsibilities and who come from underprivileged backgrounds. Such scholarships could be granted for a year, renewable subject to a certain level of performance. This can give women a chance to further their education and pursue their careers in the STEM field despite previous limitations.

With the gender digital divide being a challenge in Africa, governments should have initiatives to resolve the digital inequality paradox to ensure that women are not sidelined by the inevitable technological developments (Jeche 2023; Mahlatsi 2020). The overall purpose of such initiatives should be to protect women, strengthen their economic status, promote social autonomy, offer them security, and support resilience (Mahlatsi 2020; World Economic Forum 2022). Education for women should be used as a powerful tool to proactively tackle the root causes of gender inequity and barriers that keep women out of educational systems (Micheni et al. 2021; Walker et al. 2019).

The government is responsible for providing a relevant talent pool for companies by funding skills development that connects talent to employment (World Economic Forum 2023a). States should eliminate barriers and increase access to innovative technologies for women (Kamberidou and Pascall 2020; Micheni et al. 2021). The government can also increase the pool of skills for the 4IR by harnessing the unemployed and those already in the workforce to create resilient innovation opportunities (Alexander 2021).

Responsibilities of corporates

Corporations are responsible for identifying employees' training needs and supporting their development. A report of a global survey conducted by the World Economic Forum (2023a) states that six in every ten workers will need training before 2027, yet only half of workers seem to have access to adequate training opportunities. More so, two-thirds of companies anticipate a return on their investment in skills training within a year (World Economic Forum 2023a), which provides a business case for companies' investments in developing women. Targeted development that equips women for the technological world has become essential (Chopra and Purohit 2022; Jeche 2023; Mahlatsi 2020).

> "Maintaining women in jobs has been costly due to the current fragmented work arrangements and high competition for employment, which has made women lose some work-related advantages like paid maternity leave *(Micheni et al. 2021).*"

Maintaining women in jobs has been costly due to the current fragmented work arrangements and high competition for employment, which has made women lose some work-related advantages like paid maternity leave (Micheni et al. 2021). Although it is more financially profitable and less challenging to employ men, laws require organisations to employ and include women. It is therefore vital for companies to comply with existing gender laws and ensure that training and associated promotion opportunities do not exclude women (Fitong Ketchiwou et al. 2022; Matotoka and Odeku 2021). Hence, companies need adequate structures and initiatives to empower women with skills of the 4IR that will enable them to participate in the workplace equally and profitably. Gender-friendly policies and practices, enhanced work experience, mentorship, work involvement, training, and bursary programmes would be beneficial (Barclay 2018; Fitong Ketchiwou and Dzansi 2023; Wright 2018). Organisations should design personalised initiatives to mitigate the effects of gender experiences that limit women's careers. Such initiatives could consider the stage of the woman, in both the family life cycle and career life cycle. This approach will help to unlock her potential through self-awareness, goal setting, and 4IR skills building. For example, a mid-career woman who is in her childbearing years may want to balance her family and career to take care of her young children. Thus, she may need flexible development programmes that equip her with relevant skills for the contemporary era.

Globally, most employers ranked women as the most prioritised group for diversity, equity, and inclusion programmes in all industries worldwide, with 78% indicating that they will prioritize women, 68% will prioritize youth under 25 years, and 51% will prioritize people with disabilities (World Economic Forum 2023a). Hence, the current technological emergence presents opportunities for the corporate sector to reflect on the training and development needs of women and empower them with skills to achieve equity and diversity in this current dispensation.

Personal responsibility

Workforce development is usually the responsibility of companies and employees (Ayo-Ayinde 2022; World Economic Forum 2023a). For African women to harness opportunities associated with the 4IR, personal investment in developing relevant skills is required of them (Oke and Fernandes 2020; Walker et al. 2019). Women also need to develop mental bravery, self-motivation, optimism, self-confidence (Fitong and van der Walt 2023; Mahlatsi 2020; Potokri 2022), self-determination, and anticipated value (Abe and Chikoko 2020; Kibirige and Modjadji 2022). This is vital for women to enter the workplace and succeed in the 4IR, especially in male-dominated fields. Women need to develop a flair and positive attitude toward technology and innovation to be able to effectively use, develop, and empower themselves with skills for the 4IR and to strategically position themselves in line with the demands of the 4IR (Adeosun, Shittu, and Owolabi 2022; Akparobore, Omosekejimi, and Nweke 2020). Government interventions and company initiatives may not yield expected results unless there is personal commitment from women.

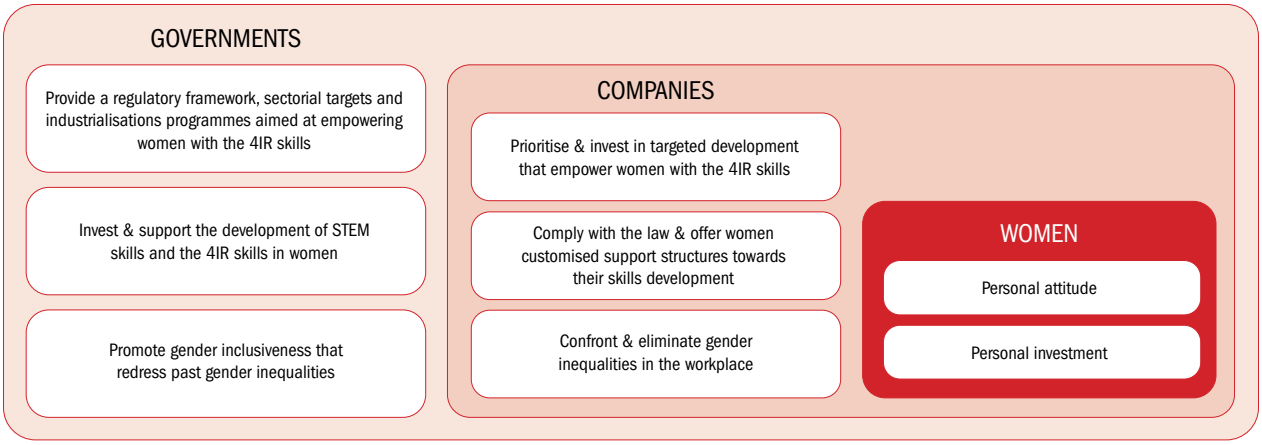

Figure 1. A model for empowering African women with skills required in the era of the 4IR.

Findings reveal that empowering African women with skills relevant in the 4IR era will require an appropriate state regulatory framework with legislation, policies, guidelines, funding schemes, and support mechanisms that promote the development of 4IR skills for women and redress past gender inequalities across different sectors and industries. Companies need to prioritize investing in empowering women with 4IR skills, comply with the law, institutionalize personalized support structures for women, and strive towards gender friendly workplaces. Lastly, women need to invest in themselves and have the right attitude towards their development for empowerment initiatives to be successful.

Practical and policy implications of the study

This research proposes a multi-stakeholder framework involving government, firms, and women, with each having a key role to play in empowering African women with 4IR skills. Policy makers can use findings from this study to promote the development of 4IR skills in women. Some lessons should be learnt from Luxembourg and Iceland with the highest percentages of women working in tech and tech-related jobs in Europe (AIPRM 2025). In Africa, Nigeria, South Africa, and Kenya fund and support the development of technological skills and tech startups formation for women, thus giving them access to tech-related employment (Veriv Africa 2025). A few practical examples provided in the next paragraphs can be replicated in African countries.

In Luxembourg, the Girls in Digital (GID) is an initiative designed in 2004 by WIDE (Women in Digital Empowerment) and the Luxembourgish Ministry of Equality. This online database aims to support youths, especially girls, to leverage digital opportunities through numerous resources in key disciplines for the future (such as STEM, AI, coding, and programming). GID offers a variety of online courses, fun workshops, games, and other content to educate on technology and improve skills in courses such as data science, programming, and cybersecurity. Some of the resources on the platform include STEM-focused quizzes to access digital knowledge and teach learners about STEM. Another resource includes Math and Science Tutor, where girls and women can acquire knowledge on problem-solving techniques, access instructional videos on STEM fields, and receive step-by-step guidance. They also have a program called Brilliant, where there is an immersive and highly engaged learning experience for participants to learn how to solve problems in a very interactive way (Petit 2024).

> “In South Africa, the TechnoGirl Trust is a successful program designed by UWESO Consulting in collaboration with UNICEF and the Department of Basic Education, for girls and young women interested in STEM.”

In Nigeria, the Gina Mata, Gina Al-Umma’ program, translated from Hausa as “Building Women, Empowering Communities,” was launched in 2023 by the World Bank (Lawal and Robinson 2025). It aims to train girls and young women in Northern Nigeria in market-driven digital skills to help them access employment and economic opportunities. The program focuses on females from under-represented communities and vulnerable groups, such as those in internally displaced camps, young women facing economic hardship, and survivors of gender-based violence. The curriculum covers social media marketing, content marketing, online safety, financial literacy, STEM subjects, and remote work for the virtual economy supported by socio-

emotional skills, mentorship, financing earnings, and a practical career pathway. The success of this program informed the World Bank's Adolescent Girls Initiative for Learning and Empowerment (AGILE) project, aimed at improving secondary education for girls aged between 10 and 20. This is done by integrating training in digital skills in school curricula, providing computer labs, and equipping teachers.

In South Africa, the TechnoGirl Trust is a successful program designed by UWESO Consulting in collaboration with UNICEF and the Department of Basic Education, for girls and young women interested in STEM. The strategic purpose is to promote STEM careers among females through job shadowing and alumni empowerment for girls in school, as well as digital and 4IR training for unemployed females. The institution collaborates with corporates to expose and motivate girls to take up STEM careers where women are under-represented, to address the gender discrepancy in opportunities and the cycle of poverty for girls that impede social and economic transformation (TechnoGirl Trust 2025).

Again, in South Africa, the Department of Science, Technology, and Innovation (2025) launched the Women in Technology and Innovation Program in 2025. This pioneering initiative aims to address the systemic challenges women innovators and entrepreneurs face in the country and foster inclusive national innovation. It focuses on empowering women entrepreneurs through access to funding, mentorship, and creating an enabling environment for innovation to accelerate women's contributions in shaping South Africa's technological advancements and economic growth.

There are also company initiatives, such as the one in which the ABSA group collaborates with Women in Tech, an international non-profit organisation with the mission of closing the gender gap and supporting women pursuing careers in technology (ABSA 2023). The organisation drives women's empowerment through education, business, digital inclusion, self-confidence development, mentorship, and advocacy. Thanks to this program, women in the information and communications technology (ICT) sector across Africa and the globe can connect. Thus, allowing them to converse on the gender gap and related issues, access critical skills and mentorship, create jobs, increase female representation, provide opportunities for women to advance, champion women at work, and empower women and girls for leading roles in technology. This is achieved through initiatives such as workshops, summits and the Women in Tech Africa Awards. The Women in Tech Africa Awards celebrate innovation, highlight women's achievements and their contribution to the technology sector, and increase the visibility of women making the mark in the industry. Hence, other women can learn, connect, collaborate, and grow. In addition to this program, ABSA is involved in other initiatives focusing on the development of skills of the future and the upliftment of women.

Conclusion

This study has explored how to empower women with the 4IR skills using the theory of human capital, the postmodern feminism theory, and the empowerment theory. We conclude that the responsibility to empower women in the 4IR relies on the government, corporates, and women. African governments need to provide a robust regulatory framework, funding, and support structures that will address past gender inequalities and facilitate the empowerment of women with skills relevant to the 4IR. Firms also need to invest resources in the development of women, specifically targeting the development of skills relevant to the 4IR workplace. However, for government and company initiatives to be successful, the commitment and investment of women in their personal development is imperative.

The new working arrangements and frontier technologies of the 4IR dispensation require a different type of education and skills development. Women have been disadvantaged in the past, and gender inequality persists even in this technological era. Hence, women need to be empowered for equal employment, productivity, and wage parity. Accelerating progress towards gender parity, igniting renewed growth, and increasing resilience in this dispensation of disruptive technologies requires collective and coordinated actions by the government, private sector, and women. The successful examples provided in the preceding section could be replicated within the African countries. The dissemination of this research, through publication, provides an input for policymakers, governments, companies, and women to strategize on how to empower women with relevant skills for the 4IR.

Limitations and recommendations for future studies

The search was done on Google Scholar using selected keywords. Future research could consider other databases and keywords. This paper broadly discusses Africa without taking into consideration the different contexts, such as urban and rural, North and Sub-Saharan Africa, which may weaken its applicability to specific regions or countries. Future studies should consider diversity and conduct quantitative or qualitative studies on the topic. Also, more country-specific research is recommended in the future.

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