Now you see them, now you don't: will technological advancement erode the gains made by women entrepreneurship in Sub-Saharan Africa?

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Now you see them, now you don't: Will technological advancement erode the gains made by women entrepreneurship in Sub-Saharan Africa?

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Abstract

As global economic activity gains momentum post-COVID-19, assessing local economic recovery remains essential for shaping policies that foster inclusive growth. In countries such as South Africa, which contends with enduring unemployment and significant inequality, cultivating economic resilience—particularly among Previously Disadvantaged Individuals (PDIs) and female entrepreneurs—is essential. The pandemic highlighted the crucial importance of digital technology in business resilience, as digitally equipped enterprises adapted more efficiently. Currently, the focus on digital adoption is intensifying, highlighting the necessity for equal digital access to enable women entrepreneurs to fully engage and prosper in the digital economy. This study builds on the 'Advancement of Women in Technology (AWT) Framework' and the 'Adaptive Efficacy Model' (AEM) to explore the capacity and readiness of women entrepreneurs to integrate digital tools into their operations. Additionally, it investigates how engagement with STEM-related fields can be enhanced to support women's digital skills development and foster long-term adaptability. The findings reveal ongoing challenges: women entrepreneurs who lacked the digital skills to adapt quickly during the pandemic often became reliant on external support, sometimes losing control over essential functions such as financial management and, in some cases, their business ownership. For many women in Sub-Saharan Africa, digital adoption is still largely confined to social media marketing, limited by gaps in digital literacy, technological infrastructure, and support systems. This study emphasises the ongoing necessity of digital transformation for women entrepreneurs and the gender inequalities that persist in influencing digital access and proficiency.

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This research highlights the gendered obstacles to digital integration, emphasising the necessity of promoting UN Sustainable Development Goal 5 on gender equality and women's empowerment, thereby addressing the digital gender divide amid rapid technological advancement.

Résumé

Alors que l'activité économique mondiale prend de l'ampleur après le COVID-19, évaluer la récupération économique reste essentiel pour façonner des politiques qui favorisent une croissance inclusive. Dans des pays comme l'Afrique du Sud, qui fait face à un chômage persistant et à une inégalité significative, cultiver la résilience économique—particulièrement parmi les Individus Précédemment Désavantagés (IPD) et les femmes entrepreneurs—est essentiel. La pandémie a mis en évidence l'importance cruciale de la technologie numérique dans la résilience des entreprises, car les entreprises équipées numériquement se sont adaptées plus efficacement. Actuellement, l'accent mis sur l'adoption numérique s'intensifie, soulignant la nécessité d'un accès numérique égal pour permettre aux femmes entrepreneurs de s'engager pleinement et de prospérer dans le numérique économie. Cette étude s'appuie sur le 'Cadre de l'Avancement des Femmes dans la Technologie (AWT)' et le 'Modèle d'Efficacité Adaptative' (AEM) pour explorer la capacité et la préparation des femmes entrepreneurs à intégrer des outils numériques dans leurs opérations. De plus, elle examine comment l'engagement dans des domaines liés aux STEM peut être renforcé pour soutenir le développement des compétences numériques des femmes et favoriser l'adaptabilité à long terme. Les résultats révèlent des défis persistants: les femmes entrepreneurs qui manquaient de compétences numériques pour s'adapter rapidement pendant la pandémie sont souvent devenues dépendantes du soutien externe, parfois perdant le contrôle sur des fonctions essentielles telles que la gestion financière et, dans certains cas, leur propriété d'entreprise. Pour de nombreuses femmes en Afrique subsaharienne, l'adoption numérique est encore largement confinée au marketing sur les réseaux sociaux, limitée par des lacunes en matière de littératie numérique, d'infrastructure technologique, et de systèmes de soutien. Cette étude souligne la nécessité continue de la transformation numérique pour les femmes entrepreneurs et les inégalités de genre qui persistent à influencer l'accès numérique et la compétence. Cette recherche met en lumière les obstacles de genre à l'intégration numérique, soulignant le besoin de promouvoir l'Objectif de Développement Durable 5 des Nations Unies sur l'égalité des sexes et l'autonomisation, abordant ainsi le fossé numérique entre les sexes dans un contexte de rapide avancée technologique Technologie Numérique, Avancée Technologique, Écart de Genre, Femmes Entrepreneurs.

Summary highlights

Contributions of the Paper: This paper contributes to the discourse on digital adoption by women entrepreneurs in Sub-Saharan Africa, highlighting how technological advancement and digital transformation intersect with gender gaps and women's economic empowerment. It emphasises the importance of addressing the digital gender divide to support the achievement of SDG 5 on gender equality.

Research Questions/Purpose: This paper aimed to answer the following research questions: (a) will technological advancement exacerbate existing disparities between male and female-owned businesses? and (b) what are the implications of digital adoption and transformation on women's economic empowerment and SDG 5?

Methodology Used: The study employs Strauss's version of Grounded Theory Analysis, using structured coding processes (open, axial, and selective coding) to synthesize data collected through focus group discussions with 50 women entrepreneurs from seven Sub-Saharan African countries.

Database/Information: Data was collected via focus group discussions with women entrepreneurs from Nigeria, South Africa, Zambia, Ethiopia, Ghana, Malawi, and Tanzania. The sample included women actively running businesses during the COVID-19 pandemic, with diverse levels of exposure to STEM and digital tools.

Results/Findings: The findings showed that many women lacked digital skills, limiting their ability to integrate advanced technologies. Women relied heavily on mobile applications and social media for business survival and sustainability. Structural and cultural barriers, such as gendered expectations and limited training, hindered digital adoption. Urban women and those with higher education levels showed higher digital engagement compared to their rural counterparts.

Limitations: The study focuses on a small, purposive sample from seven Sub-Saharan African countries, which may limit generalizability. Language barriers and varying digital literacy levels also posed challenges during focus group discussions.

Scholarly/Theoretical Implications: The study integrates the Advancement of Women in Technology (AWT) and Adaptive Efficacy Model (AEM) frameworks to provide insights into the learning styles and self-efficacy of women entrepreneurs, contributing to gender-sensitive approaches in STEM education and digital transformation research.

Managerial and Practical Implications and Recommendations: Encourage community-based digital literacy programmes tailored for women entrepreneurs. Develop mentorship programmes led by successful women in technology to boost confidence and skills. Foster access to affordable digital tools and training resources.

Public Policy Implications: The study calls for a Digital Empowerment Policy Framework, emphasizing: (a) building digital confidence and self-efficacy through tailored programmes; (b) expanding digital infrastructure and subsidizing internet costs; and (c) supporting digital transformation through tax incentives and innovation hubs.

Recommendations for Further Research: Future studies should explore the long-term impact of digital transformation on women's business resilience and examine broader systemic barriers affecting women entrepreneurs across diverse socio-economic contexts.

Introduction

According to findings from the World Economic Forum (WEF) Global Gender Gap Report 2021, gender gaps are likely to continue in industries that call for *disruptive technical skills*. This phrase has gained popularity in the business world, especially in light of the COVID-19 crisis, as it requires innovative and creative thinking to appeal to growing new customer segments or markets (MindTools 2021). Women make up only 14% of the cloud computing workforce, 20% of engineers, and 32% of those working in data and artificial intelligence. Even though there is a strong demand for and influx of fresh talent because of the pandemic, these increases are insufficient to close the occupational gender gaps that existed before the pandemic. Women's participation in cloud computing barely increased by 0.2 percentage points to 14.2% in 2021, and data and AI positions only saw a 0.4 percentage point increase to 32.4% (ibid.). These persistent inequalities, according to recent study from the WEF and LinkedIn, are inhibiting women from making required or ambitious pivots that will ensure the sustainability of their businesses. Women's capacity to pursue better employment, grow in their careers, raise their income, launch a business or pivot their business models where technical skills are necessary have greatly been hampered by the COVID-19 situation.

The global technological environment is rapidly advancing and the participation of women in technology remains disproportionately low. Various initiatives have been undertaken to improve the participation of women and girls in the technology domain with scholars advocating for more empirical research to gain insights into this phenomenon. Thus, women's technological advancement as a discrete field of scholarship has both academic and political appeal, with a notable increase in the volume of research studies and a focus on the exploration of technological influence in the workplace/business from a decidedly gender lens. Humanity has developed various inventions and hypotheses in the pursuit of change and scientific development, a centrepiece of which have been waves of technological advances in recent decades. These advances have created and increased effectiveness and consequently, limited human involvement in business operations. Until now, the technologies developed allowed humans to be in control, guiding the machines and getting them to perform as desired. This was the motivation for the increasing focus on STEM education for women and girls that enabled them to access tech jobs, especially in areas that required human intelligence to control the machines (Hill et al. 2010; Katz et al. 2020; Idemudia and Onoshakpor 2023) However, the present wave of advancements brought about by the COVID-19 pandemic and the resultant lockdowns open the possibility of more sophisticated automation that requires large scale reduction of human contact/involvement while creating options for substantial augmentation of human capabilities. This has huge implications for women and heightens the challenges of educating and supporting women in tech-related fields.

This advanced technology provides the platform for new and emerging businesses to thrive and helps improve firm performance, by providing opportunities for entrepreneurs to build their businesses around the customers to create a truly connected and highly profitable enterprise (OECD 2017a, b; KPMG 2021). Customer

experience, operational efficiency, and competitive advantage are all improving as a result of new combinations of personnel and technology. Whether it is optimising operations, utilising data, or forming totally new business models, digital transformation ideally results in beneficial consequences. However, this extraordinary benefit and growth in connectivity have not been equally enjoyed by everyone, especially in sub-Saharan Africa. Differences in resources and in the ability to access and effectively utilise technology within and between countries, regions, sectors, and socio-economic groups have led to a digital gender divide, relegating women-owned businesses to a disadvantaged position (UN Women 2005).

Therefore, all types of social and systemic impediments need to be removed, and the educational levels and rates for both women and girls must be raised in order to ensure the survival of women entrepreneurship in the Global South. Governments and policy makers need to provide women entrepreneurs with enhanced access to the digital economy by 2025 through training, education, and low-cost finance in order to achieve these goals (Urooj et al. 2025; Assime and Ibourk 2025). Supporting women to lead the way towards sustainable, equitable and inclusive growth should be a priority for the Global South. Despite international efforts during the past two years to lessen the effects of the pandemic, women have been disproportionately affected negatively by COVID-19 (UN Women 2022) The UN predicted time it will take to close the worldwide gender gap in economic opportunity, politics, education, and health will increase by 36 years as a result of this, which threatens to reverse decades of progress towards achieving gender equity in the workplace and in business.

In the context of SSA, it must be noted that women entrepreneurs' use of technology is less about infrastructure and more about understanding the type of technology their businesses need and the tools for integrating digital technology into core business activities, which is aided by a defined digital strategy (Irene 2019). This research seeks to answer the following research questions:

1. Will technological advancement exacerbate existing disparities between male and female-owned businesses?
2. What are the implications of digital adoption and transformation on women's economic empowerment and the achievement of goal 5 of the SDGs?

It will seek to make recommendations on ways to close the gender gap and mitigate the current trajectories at various levels of business growth.

Literature review

Women empowerment and SDG 5

The pandemic has adversely affected the economic standing of women more significantly than that of males (Popović-Pantić et al. 2020). The aforementioned assertion, reiterated by several academics (Muñoz and Cohen 2018; Raman et al. 2022)

after the COVID-19 outbreak, seems to represent a situation that has undermined previous advancements achieved by women and threatens the United Nations' (UN Women 2022) advocacy for Gender Equality. Sustainable Development Goal (SDG) 5, which sets out clearly to promote women's rights to economic resources and the empowerment of all women and girls, is already behind target. As noted by Ewerling et al. (2020), women empowerment only happens when they believe that they can create a different life from what they are currently experiencing and are conscious of their ability to make such a decision to foster their desired change. However, the literature on empowerment presents a plethora of definitions, distinguishing between empowering processes and outcomes (Swift and Levin 1987). While no single standard can fully capture the meaning of empowerment in all contexts or populations, its conceptualisation from the various definitions generally refers to a deliberate ongoing process, centred in the local community, involving critical reflection, caring, and group participation, through which people lacking an equal share of valued resources gain greater access to and control over such resources (Cornell Empowerment Group 1989). This illustrates the fact that empowerment can be obtained from relevant activities, processes, and structures, resulting in empowering outcomes for individuals and communities.

To add to the eroding of gains in women's economic status through the pandemic Raman et al. (2022) argue that there is a lack of analysis of women's entrepreneurship research as a form of empowerment in relation to sustainable development, including the UN SDGs despite the fact that the UN strongly emphasises the potential women entrepreneurs have in nurturing sustainable solutions for various global challenges, such as poverty, hunger, education, reduced inequalities, and human rights (Agarwal and Lenka 2018; Warth and Koparanova 2012).

This research seeks to contribute to the discourse on women entrepreneurship and sustainable development in developing nations, as our findings can support the 2030 SDG 5 Agenda. The concept of empowerment is a key developmental construct premised on the understanding of individuals, organisations and communities (Zimmerman 1995) and, as it relates to this paper, this highlights technological advancement as a strategic factor in determining the level of empowerment for women in entrepreneurial activities.

The relevance of women in entrepreneurship transcends culture, language, race, or ethnicity as the impact of women entrepreneurs on their respective economies. Even though less than half of the population of women in the world own businesses compared to their male counterparts (Minniti 2009; Hossain et al. 2018), women entrepreneurship contributes more than 50 per cent to Gross Domestic Product (GDP) in both developed and less developed countries (Ayogu and Agu 2015). In the United States, women have outnumbered men in business (68 per cent) and they contribute significantly to the US economy (United States Department of Commerce 2011). Consequently, the importance of building on existing academic discussion on the conceptualisation of women empowerment in the face of increasing technological challenges as a step towards addressing the widening inequalities and gaps cannot be over emphasised. Within the context of this investigation, the concept of empowerment is not only perceived economically, but includes the ability of women to participate or engage with others to achieve their goals, access resources, and

enjoy an overall improvement in their quality of life. Given the unique role played by women entrepreneurs as agents of socio-economic and political change within the community, continuous development in information and communication technologies should provide opportunities for them to improve their entrepreneurship practices, to thrive in business and spread wealth impact on society (Zoltan et al. 2011).

The construct of psychological empowerment emphasises the importance of the development of personal resources through training and knowledge acquisition in relevant areas. This is particularly necessary to address inequalities faced by women entrepreneurs within the context of digital transformation (Zoltan et al. 2011). Ultimately, such empowerment not only equips but equally gives the individual access and control over the resources needed to interact and participate fully in entrepreneurship. Examples of psychological empowerment include adopting innovative technologies, IT training, support and mentorship, leadership development and problem-solving skills. Consequently, this could be regarded as the foundational layer of every empowerment process, including organisational or community-based empowerment.

Community-based empowerment includes ensuring that resources are accessible to all residents and opportunities are equally available for all. Consequently, community empowerment is a process which requires the participation of community members, various agencies, structures and governmental systems, providing the members the skills and resources needed to fully engage in activities to improve their community. Social inclusion may be utilised to harness a diverse set of skills and varied viewpoints to foster critical discourse among community members. Within the context of women entrepreneurship, an empowering community provides a platform for female entrepreneurs to access resources, facilities, and skills to fully engage in entrepreneurial activities. Some of the outcomes or results of community empowerment include health care services, recreational facilities such as parks and playgrounds as well as other general services such as training programmes and the provision of media resources (Zimmerman 2000). On the other hand, empowering processes provide access to participation in community and government leadership, involvement in decision-making and critical awareness amongst female community residents (Haneef et al. 2014). Such platforms tend to provide 'safe spaces' for women to share knowledge, skills, and best practices as they strive to develop themselves and excel within the entrepreneurial market. This research begins to build a case for economic empowerment through entrepreneurship and builds on an existing conceptual framework as seen in the next section.

Conceptual framework

This study will build on the 'Advancement of Women in Technology' (AWT) framework and 'The Adaptive Efficacy Model' (AEM) developed by Samuel et al. (2018) to explore women's ability and willingness to deploy technology in the

day-to-day operations of their businesses. The AWT framework focuses on the unique ways that women learn and acquire knowledge while the AEM framework explores issues of self-efficacy and self-confidence. The juxtaposition of these two frameworks in this study will aid in the understanding of the difficulty of training and challenges of promoting women in STEM and technological fields.

Conceptualising women's learning processing (AWT framework)

To understand women's involvement in STEM, it is necessary to explore how women learn. "Women as Learners" (1986) investigates the notion that people learn in different ways and it is not gender neutral. Gender differences and gender-sensitive learning have all been the subject of much research (Belenky et al. 1986; Brown and Gilligan 1992). Astur et al. (1998) highlighted the need to better understand underlying causes and implications for practice by demonstrating that even while the approaches to learning and knowledge acquisition vary, performance remains comparable in certain circumstances and differs in others. This is especially true in the STEM fields where there has been a concentrated effort on women's education. However, it is noteworthy that fewer educators and researchers have applied the concept of "women as learners." This gap may present an opportunity to learn more about how women learn. These differences in methods of knowledge acquisition and learning, however, do not imply that women's ways of knowing are less valuable than men's, nor do they imply that women's ways of knowledge acquisition are superior to men's (Hayes and Flannery 2000).

Without considering the social context in which learning occurred, women's learning cannot be understood. In addition to developing a deeper awareness of the social dimensions in formal learning environments, educators need to explore other contexts of learning where women, can gain deeper insights into themselves. This will help educators to better prepare women for their futures (Hayes and Flannery 2000). Personal experiences often impact on learning and this in turn impact their self-esteem. Women might be unaware of the ways in which culture and gender affect learning, or the impact these may have on their identities and self-esteem. The concept of "voice as identity" highlights how women's identity development and expression are crucial aspects of learning (Sweet and Parker 2019; Kleinerman 2010.). Women's ambition to obtain their individual and group power "through expression and affirmation of their interests, demands, and experiences" is reflected in the phrase "voice as power." Sweet and Parker 2019; Kleinerman 2010.). Educators must decide for themselves the discourse patterns and meanings of 'voice' that they wish to pay closer attention to when teaching in group settings. The phrases have taken on a variety of meanings in both specialized literature and women's narratives that includes global processing, subjective knowledge and intuition (Hayes and Flannery 2000).

The understanding of women's methods of knowledge acquisition can be used in adult education practices to make better-informed decisions on how to educate women and girls. The interrelated nature of women's learning can be explained by several factors, including physiological, psychological, sociological, and anthropological ones. The explanation of the physiological factors is intriguing as shown in

the findings of Carl Sagan's studies on the brain which found that women had a larger corpus callosum that connects the brain's two hemispheres. Neuroscientists are of the opinion that women use more parts of the brain simultaneously when performing an action or engaging in problem-solving activities, because there is a stronger connection between the two hemispheres (Samuel et al. 2018). According to Sagan (1998 p.1) while there is no concrete evidence, "the larger connector may also account for a woman's tendency to exhibit greater intuition." Therefore, he concluded that men "tend to be focusing hard on specific issues," whereas women "tend to be able to pursue numerous trains of thought." The anticipation is that by examining these many definitions of connectedness, researchers and educators might better understand how women learn and advance knowledge of the topic. This is not to claim that men and women have fundamentally different modes of knowledge acquisition; rather, previous research suggests that these variations may be due in part to the topics being discussed (Zhang et al. 2015; Astur et al.1998). Researchers and educators have enough reason from the results from past research to seek out a more detailed explanation of this impact (Samuel et al. 2018) and investigate how curriculum may be adjusted to accommodate gender variations in learning. Many current male-dominated areas would benefit immensely when educators begin to incorporate this knowledge and awareness into our teaching practice because more women will enter those fields bringing new views, value-added knowledge, and insights, with a fresh perspective. Even if it is very evident that this transformation is necessary, it still requires a collective effort to be made in order for it to happen (Watts 2015; Tomlinson 2014).

Finally, it is crucial to have an open dialogue on the underrepresentation of women in traditionally male-dominated industries. Research questions must be formulated and answered to address how this can be achieved. The COVID-19 pandemic and the resultant digitisation of business due to social distancing and lockdowns make this even more important. Increasing the participation of women in securing the STEM field especially in computer science, information systems, analytics, and artificial intelligence will demonstrate that everyone, regardless of gender, has equal access to education and support. The advantages of educating girls and women will become more obvious as women's participation in technology fields grows because they will improve the world through the dynamics of fairness, variety, and balance. Women entrepreneurs will also be ready for technological adoption in their businesses especially women in the formal and informal economy of SSA.

Conceptualising women's self-confidence and self-efficacy (AEM framework)

To encourage women to pursue school and careers in STEM fields, confidence and self-efficacy have been recognised as crucial elements (Hill et al. 2010; Howe-Walsh and Turnbull 2016). Students' academic progress has been linked closely to their level of confidence (Colbeck et al. 2001). Therefore, there is a need to understand the origins and precursors of self-confidence and efficacy (see Fig. 1).

Since self-efficacy is a key driver of behaviours, how experience and verbal stimuli are interpreted becomes crucial since it affects self-efficacy. Any effort to
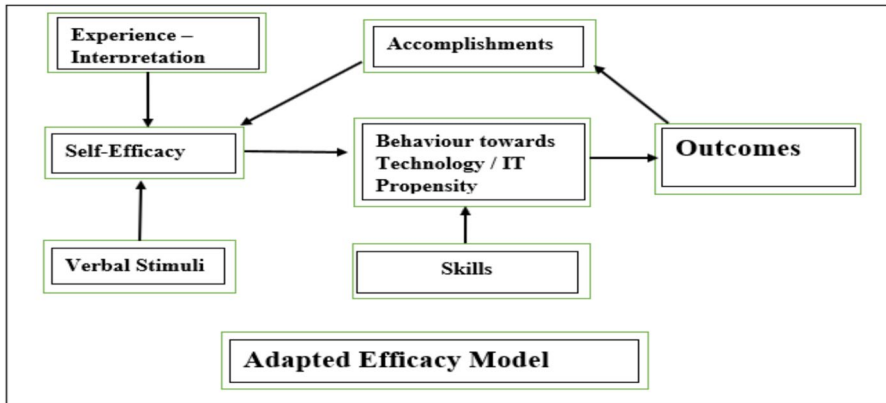
increase women's engagement and performance behaviours must take these two elements into consideration because verbal cues might be exogenous to the person, whereas experience interpretation is typically endogenous (Bandura and Adams 1977). Education enhances skills/abilities, which in turn affects behaviours and results and fosters a sense of success. Contrary to experiences, which are regarded from a subjective perspective, accomplishments are viewed as objective measures validated by external agents. They have a positive effect on self-efficacy. Although the "Adaptive Efficacy Model" (AEM) is basically gender neutral in its application, the model is gender-sensitive, emphasizing earlier research that suggests gender differences in self-efficacy regarding technology (Scherer and Siddiq 2015). Previous studies have shown that self-efficacy is influenced by a "psychological notion of masculinity," not by biological gender (Huffman et al. 2013). This has significant ramifications for gender-sensitive use of the elements that affect self-efficacy.

While the AWT framework and the AEM framework are two different frameworks, we have juxtaposed them to show the link between unique learnings styles and self-efficacy in women's behaviour towards STEM disciplines and technology adoption in Fig. 2.

This study will use the interpreted gendered construct revealed from the combination of the AWT and AEM framework to understand why despite the fact that the global technological environment is advancing rapidly, the participation of women in technology remains disproportionately low.

Methodology

This study uses Strauss's version of Grounded Theory Analysis, emphasising systematic comparison and questioning to analyse data through structured procedures (Strauss and Corbin 1997; Walker and Myrick 2006). This approach helped organize and synthesize data collected through focus group discussions with 50 women entrepreneurs from seven Sub-Saharan African (SSA) countries, allowing the research to reveal the
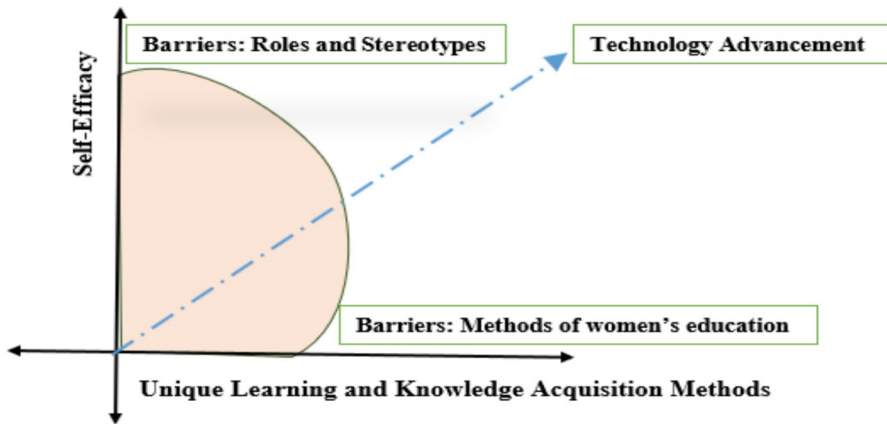
Fig. 2 The nexus between advancement of women in technology (AWT) framework and AEM model as adapted from Samuel et al. (2018)

complex learning and digital adoption challenges faced by women in STEM and technology fields. Grounded Theory also allows theory to emerge directly from the data, avoiding the need for pre-established hypotheses (Dey 1993). The study prioritised the following: (a) women entrepreneurs actively running businesses in one of the seven Sub-Saharan African countries included in the study; (b) women with diverse levels of exposure to STEM or digital tools in their business operations; (c) women aged 18 and above to ensure alignment with ethical research protocols; (d) businesses that were operational during the COVID-19 pandemic, providing insights into resilience and adaptation strategies and (e) women willing to engage in focus group discussions and share their experiences in adopting technology or digital tools. The study also excluded the following: (a) women not engaged in active business ventures and (b) women unable to complete the focus group discussion due to language barriers or other constraints.

Data collection and organization

We conducted focus groups with 50 women entrepreneurs across seven SSA countries. The discussions centred on learning processes and digital adoption challenges, with questions informed by AWT and AEM frameworks to explore women's unique experiences in technology. The data was thematically organized to identify prominent issues, including self-efficacy, stereotypes, and access to technology in entrepreneurial settings.

Coding Process in Grounded Theory

Based on Corbin and Strauss (1990), data analysis followed three coding phases—open, axial, and selective—facilitating a deeper understanding of the factors affecting digital adoption among women-owned businesses.

1. **Open Coding:** This process involved an initial breakdown of data to identify core concepts. It required the examination of the focus group transcripts to classify key concepts aligned with AWT and AEM frameworks. We created categories such as self-efficacy, learning styles, societal roles, and methods of technology use. Then we documented the dimensions and properties of each category and established foundational themes, highlighting women's learning patterns and challenges in digital adoption.

2. **Axial Coding:** The purpose was to reassemble the data to understand relationships between categories and subcategories. The process involved forming coding paradigms to link categories and subcategories. We considered contextual factors (e.g., economic and cultural influences), responses to these contexts, and outcomes of specific actions or inactions which revealed interconnections among themes, offering insights into barriers and facilitators in women's digital engagement.

3. **Selective Coding:** The purpose was to integrate the categories into a cohesive theory. The process involved identifying the central themes and aligning them with AWT and AEM frameworks to construct a narrative around the digital challenges women entrepreneurs face. This enabled the development of a grounded theory explaining barriers and enablers to digital adoption for women entrepreneurs in SSA.

Finally, this study focused on selective coding—a phase described by Strauss and Corbin (1998) as the "process of integrating and refining the theory" (p. 143). This stage allowed us to synthesize the data around a central theme that encapsulates key issues observed in the study. The core themes identified in this phase are:

The Two-Headed Phenomenon of Livelihood and Survival: This theme captures the dual pressures of sustaining a livelihood and ensuring survival, often intensifying women's drive to adopt technological tools.

Women's Technology Adoption: This focuses on the use of mobile applications and social media strategies as accessible tools for business sustainability in SSA.

Minding the Digital Divide – Leave No Woman Behind: Reflects the importance of inclusivity in technology access, underscoring the need for policies and support structures to bridge digital gaps.

Unique Learning and Knowledge Acquisition Methods: Highlights distinctive approaches to learning and knowledge-sharing common among women entrepreneurs in SSA countries, which are shaped by cultural, economic, and infrastructural factors.

Rationale for the chosen method

This method was chosen because grounded theory combines qualitative insights with the structure and rigor often found in quantitative approaches through systematic coding. The inductive nature of grounded theory allowed us to reflect on the authentic experiences of SSA women entrepreneurs without relying on preconceived assumptions.

The next section will present our results, discussing how these core themes interact with various subcategories to build a coherent framework based on the data (Strauss and Corbin 1990).

Findings

This study involved 50 women entrepreneurs from seven Sub-Saharan African (SSA) countries, with participants distributed as follows: Nigeria (20%), South Africa (20%), Zambia (10%), Ethiopia (10%), Ghana (10%), Malawi (10%), and Tanzania (10%) (Table 1). The findings reflect the varying contexts and experiences across these countries while highlighting overarching themes related to women's engagement with STEM and technology.

Gendered learning patterns and STEM engagement

Our data showed distinct gendered patterns in learning which confirms the studies of scholars such as Cohen (2007); and Kroess (2022) that suggests learning is not gender neutral. Women across the sample—representing Nigeria (70%), South Africa (60%), Zambia (70%), Ethiopia (60%), Ghana (80%), Malawi (80%), and Tanzania (80%)—demonstrated a preference for collaborative and applied learning. For many of them, hands-on experience and peer-based problem-solving were central to their skill development, which aligns with findings from the 1986 study of "Women as Learners." However, gendered societal expectations often affected participants' confidence in engaging with STEM, especially among those from more traditional backgrounds. A survey conducted by UNESCO in 2021 revealed that 68% of women learners in Sub-Saharan Africa preferred group-based problem-solving over individual assignments, compared to 45% of male learners. This highlights a broader trend in the importance of collaborative learning for women. In Ethiopia for instance, women participants in community-based training programmes showed a 40% higher retention rate when the training incorporated practical, applied tasks over theoretical lectures.

Our findings also showed that the Nigerian and South African participants were more likely to express interest in STEM careers when exposed to female mentors in the field, underscoring the need for visible representation. The intersectionality in learning patterns was also highlighted in the rural versus urban dichotomy. Our study found that women from urban areas such as Johannesburg (South Africa) and Lagos (Nigeria) reported a higher inclination towards using digital tools for learning (85%) compared to women in rural settings (40%), where access to technology was limited. Additionally, women with higher education levels demonstrated a stronger preference for hybrid learning models (online and face-to-face), while those with limited formal education leaned more heavily on peer-based learning in community spaces (Table 2).

Table 1 Demographic profile of participants (include table with demographic information of focus group participants)

Respondent demographics		Total (%)	Type of business	Total (N)
Marital status			Bookstore	3
Single	13	26	Interior decoration	5
Married	37	74	Advertising	1
Total	**50**	**100**	Quantity surveyor	1
Age of business			Ecommerce	2
0–5	14	28	Supermarket	13
6–10	28	56	Fashion and accessories	4
11–15	6	12	Hospitality	5
Above 15	2	4	Events management	2
Total	**50**	**100**	Personal hygiene	1
Country of participants			Financial services	1
Nigeria	15	20	Medical supplies	1
South Africa	10	20	Laundry services	1
Zambia	5	10	Bakery	2
Ethiopia	5	10	Beauty and cosmetics	5
Ghana	5	10	Freelancing	1
Malawi	5	10	Real estate	2
Tanzania	5	10		
Total	**50**	**100**		
Number of employees				
0–10	22	44		
11–20	28	56		
Total	**50**	**100**		
Level of education				
Bachelor's degree	40	80		
Master's degree	8	16		
PhD	2	4		
Total	**50**	**100**	**Total**	**50**

The role of confidence and self-efficacy in technology adoption

Confidence and self-efficacy were recognised as crucial elements affecting women entrepreneurs' capacity to accept and use digital technology into their company operations. In all seven nations, these psychological dimensions were intricately linked to exposure, experience, and perceived accessibility of technology. Women with elevated self-efficacy were more inclined to use sophisticated digital technologies, while those with diminished confidence mostly employed simple digital resources such as social media for marketing purposes.

Table 2 Categories and subcategories from coding process (include table describing relationships between identified categories and subcategories)

Coding paradigm	Reference points (**)						
	Nigeria	Ghana	South Africa	Zambia	Ethiopia	Tanzania	Malawi
Personal level							
Awareness of digitisation	14	6	9	8	6	2	1
Need or understanding of technology opportunities	13	4	5	10	10	2	2
Knowledge of how to implement technology	16	3	3	8	6	3	3
Availability of quality independent advice	15	6	3	8	5	8	2
Skills and competencies	21	16	12	17	13	3	3
ICT management skills	8	8	11	5	4	3	3
Experience in the use of technology systems	12	6	12	4	8	6	1
Availability of skilled personnel	9	6	4	3	2	1	1
Technology adoption strategies	12	7	6	2	2	2	1
Ability to source and utilise data	5	2	3	3	3	1	1
Cognition	6	3	6	8	5	2	2
Data protection	15	3	3	11	8	5	2
Exposure to internet fraud	3	5	4	8	2	2	2
Social media (backlash from negative reviews)	8	3	1	5	9	1	1
Aversity to innovative business practices	13	3	1	3	4	0	0
Organisational level							
Finance for technology adoption	9	3	6	5	2	1	1
Expenditure for the continued maintenance and upgrade of technology systems	13	3	8	3	2	1	1
Availability of employees with appropriate technical skills	6	3	3	2	2	1	1
Business survival	35	21	19	8	6	5	7
Infrastructure support	12	3	3	3	2	1	1
Diversification	15	3	3	11	8	5	2
Time and effort to acquire digital skills; lack of training for owners/staff	14	4	4	3	2	1	1

Table 2 (continued)

Coding paradigm	Reference points (**)						
	Nigeria	Ghana	South Africa	Zambia	Ethiopia	Tanzania	Malawi
Complexity: learning while adopting	22	18	28	15	13	12	12
Availability of inter-organisational ICT systems (for example, online supply chain systems)	21	14	12	19	11	6	3
Opportunity identification—digitisation	6	3	3	2	2	1	1
Challenges with digitisation	12	3	3	3	2	1	1
Opportunities of digitisation	14	4	4	3	2	1	1
Retraining and skills development	9	3	2	2	2	1	1

Notes: References indicate the number of mentions in the narratives, not the number of participants

High self-efficacy and adoption of advanced technology

The research uncovered significant variations in confidence levels across the seven nations. Participants from South Africa (60%) and Nigeria (50%) displayed the greatest self-efficacy, resulting in the proactive utilisation of sophisticated digital technologies, including customer management systems, e-commerce platforms, and digital accounting software.

- Nigerian participants articulated that their confidence was enhanced by engaging in local digital literacy training programmes and partaking in peer-to-peer mentoring initiatives.
- South African participants credited their increased confidence to enhanced internet infrastructure and governmental actions to help small enterprises during and after COVID-19.

These ladies indicated quantifiable enhancements in their enterprises, including heightened consumer involvement, optimised operations, and entry to new markets. A South African businesswoman emphasised that migrating to an e-commerce platform enabled her to increase her revenue in six months.

Low confidence and limited technology use

In contrast, individuals from Tanzania (10%), Malawi (10%), Ghana (20%), Ethiopia (30%), and Zambia (30%) had decreased levels of self-efficacy. A significant number of these women were deficient in exposure to digital tools and STEM education, hence limiting their interaction with technology to fundamental functions. Social media marketing became the predominant digital instrument among these participants. A Tanzanian entrepreneur stated:

> *"I utilise WhatsApp and Facebook for product sales, but anything more technical appears daunting, particularly as I don't have the skill for that" (P6).*

Barriers to confidence development

Structural and cultural barriers played a significant role in shaping these disparities. Participants from countries with lower self-efficacy reported challenges such as:

- Limited training opportunities: Only 15% of participants from Tanzania and Malawi reported access to digital literacy programmes tailored to women entrepreneurs.
- Gendered expectations: In Ethiopia and Zambia, societal norms often relegated women to traditional roles, hindering their confidence in pursuing STEM-related skills.
- Infrastructural deficits: Poor internet access and unreliable power supplies in rural areas compounded these issues, particularly in Ghana and Malawi.

The Influence of External Support Dependence on external parties for technology-related needs also contributed to lower confidence levels. Approximately 40% of participants from Ethiopia, Malawi, and Tanzania said that they depended on male relatives, acquaintances, or paid consultants to oversee the technical aspects of their enterprises. This dependence often resulted in a diminished control over essential activities, as one Malawian entrepreneur articulated:

> *"I had to request my nephew's assistance to establish my website. He now oversees all upgrades and has access to my bank details. I do not really understand its functionality of these technologies, which makes me feel marginalised inside my own business" (P3).*

Discussions

Given the objective of this research, factors that impeded women's motivation and ability to engage in technology-related fields were the central focus; therefore, gender differences in knowledge acquisition were explored as well as women's self-esteem; self-beliefs; control beliefs, self-efficacy; and self-confidence that reflected personal empowerment. To explore these, we asked the participants about additional challenges that COVID-19 posed and the resultant business model pivots. It was important that we understand how women made sense of their lived experiences and how they see the possible link (if any) to issues of self-esteem/self-belief because some studies have identified a confidence gap that inhibits women's potential and desire to compete with men in certain fields, especially in relation to technology adoption.

The participants in this study reported institutional and cultural challenges in managing their businesses during the COVID-19-induced lockdowns. The majority of the participants admitted that they struggled to make sense of the new direction of business during the lockdowns and the social distancing regulations that were put in place to limit the spread of the virus. Having never engaged in digital businesses, they needed help from the outside (some relied on family members while others employed skilled workers) which posed new challenges as some women almost lost their businesses. According to them, their situations became increasingly difficult as their incomes declined due to reduced business operations during the COVID-19 pandemic.

Women's economic empowerment: The embeddedness of the two-headed phenomenon of livelihood and survival

The United Nations SDG 5 is focused on empowering all women and girls and achieving gender equality. Huge advancements have been made since the Beijing conference 25 years ago, and women now have greater possibilities and access to

technology than ever before. Nevertheless, there is still a long way to go, as about 40% of girls and women worldwide (1.4 billion people) live in nations that are lagging on gender equality, while an additional 1.4 billion people reside in nations that "barely pass." This has a huge implication for the Women's Economic Empowerment (WEE) agenda the survival of women-owned businesses post-COVID-19 pandemic.

In analysing the two-headed phenomenon of livelihood and survival while also considering WEE, we find that both concepts are inseparable. According to Chambers and Conway (1992), the term "livelihood" refers to the capacity to support oneself financially. There has been an expanding body of research on women's survival tactics that draws on ideas and methodology from studies of rural poverty. Matriarchs struggling with poverty in SSA are turning more frequently to small-scale informal economic activity as a source of income. In general, people (women in particular) aim for a portfolio of both tangible and intangible assets in order to build sustainable lifestyles. Resources like physical investments and/or talents are examples of tangible assets, as are things like food or cash reserves. Conversely, intangible assets include things like rights of access to services and transfers from the government or other parties. Choosing how to employ their own portfolios is a decision made by households. Women striving for livelihood-focused outcomes described a deliberate approach to expanding their businesses, seeking financial stability, and fostering long-term growth through innovation and market expansion. According to a Nigerian participant, who transitioned her fashion business into PPE production during the pandemic:

> "It wasn't just about keeping the business alive; I wanted to show that we could innovate even in hard times. This wasn't only about surviving COVID—it was about showing my daughters what's possible when you think ahead" (P9).

Another from South African who adopted digital accounting software said:

> "With technology, I can now track my expenses, plan better, and invest more in my business. It's not just about today—it's about building something my children can inherit" (P17)

In contrast, many women described how their entrepreneurial activities were shaped by immediate survival needs, especially during economic disruptions. Their focus was on maintaining basic income and ensuring household sustenance. According to a Malawian woman participant:

> "When the lockdowns started, I lost most of my customers. I quickly shifted to selling dried goods because they could last longer and didn't require refrigeration. It was about putting food on the table for my family."

Similarly, an Ethiopian participant noted:

> "There were weeks when I made no sales, so I started selling smaller items—things people could afford even with little money. It was not about profit, just survival."

The findings from the study showed that women in SSA, rely on a mix of economic activities, some of which may overlap with "informal" sector activities, to support their livelihoods rather than a single paying job or formal enterprise. The data showed that 80% of the participants had businesses that cut across sectors which helped them to maintain their standard of living in the face of the pandemic. Their engagement in multi-sectoral businesses acted as both long-term adaptation mechanisms and short-term coping mechanisms. According to Lui and Wall (2006), communities use local knowledge by merging historical and contemporary resources, long-standing social relationships, and recently established networks that extend outside the community in order to sustain livelihood. It should be noted that in line with earlier research from Dahles and Susilowati (2015) and Steel (2021), the results of this study showed that subsistence strategies, such as petty trading, agriculture, fishery, and household industries, dominated the livelihood discourse and left no room for business and enterprise. The participants also revealed that their businesses were a livelihood strategy, therefore the survival of the businesses through the COVID-19 pandemic and beyond was vital. Although some of the participants, pre-COVID-19 pandemic, were engaged in singular economic activities, the pandemic highlighted the need for multiple streams of income. Therefore, the women found themselves delving into different economic activities further underscoring the concept of embeddedness in the local economy.

The interplay between livelihood and survival

The study highlights that these two approaches are not mutually exclusive but often co-exist, particularly in the context of Sub-Saharan Africa's economic and infrastructural challenges. Many women expressed how they alternated between these modes depending on external pressures, such as the pandemic, market demand, or access to resources. According to some participants:

> *"Some months are good, and I can think about hiring more people or expanding my product line. But when sales are low, I go back to just making sure we survive—keeping my regular customers happy and cutting costs" (Retailer, Tanzania).*
> *"I reinvest in my business when I can, but there are times when all my profit goes into buying food or paying school fees. It's hard to think long-term when survival takes priority" (Retailer, Zambia).*

Structural factors reinforcing the phenomenon

The data also revealed structural barriers that reinforced the need for women to operate in this dual mode:

- **Access to Credit:** Many women mentioned being unable to secure loans, limiting their ability to scale operations and forcing them into survival mode during crises. According to one participant:

"I applied for loans several times, but they only approve men. We are left to figure out how to survive on our own" (Ghanaian Participant)

- **Digital Adoption and Support:** Women who lacked digital skills or access to technology found it particularly difficult to transition from survival to livelihood. According to one participant:

    "I only use social media because that's what I know. Other women in my community use apps to track their stock, but I don't even know where to start" (Ethiopian Participant)

Women's technology adoption: Mobile applications and social media strategies for business sustainability

Sustainability in entrepreneurship is a crucial component of business and plays a crucial role in most economies being a major factor in the growth of the national economies (Xiong and Qureshi 2013). Businesses need flexibility and innovation to be profitable. For women entrepreneurs, studies have shown that they have a higher failure rate than their male counterpart's pre-pandemic. Thus, it was no surprise that for the participants in this study, sustainability is one of the major problems that they faced during the epidemic. For business owners looking to retain their viability during the lockout, technology adoption became essential. To survive the crisis, most participants (80%) said they had to immediately adapt and change their business strategies. According to Yoon et al. (2019), sustainability in entrepreneurship can be conceptualised as "any activity that promotes the sustained growth and advantage relative to competitors" (p. 2). The adoption of new technologies helps businesses remain sustainable because it impacts people's live, work, and business, which affects both the economy and society. To this end, Bhagat and Sambargi (2019); Chatterjee et al. (2021) claim that most entrepreneurs are embracing technology and turning away from conventional business models. Technology can empower female entrepreneurs on both an economic and social level if it is used appropriately. It can offer useful tools to help women engage in sustainable entrepreneurial activities. Women entrepreneurs are crucial to the advancement of any country's economy given their crucial role in revenue generation, job creation, and poverty alleviation (Irene et al. 2021).

Our study showed that mobile applications and social media platforms were central to the technology adoption strategies of women entrepreneurs in Sub-Saharan Africa. These tools enabled women to sustain their businesses by improving customer engagement, expanding market reach, and streamlining operations. However, the extent of adoption varied significantly across countries, influenced by digital literacy, infrastructure, and financial access. All the participants stated that they utilised their mobile phones to compare market prices, do client searches, and choose the most effective distribution method for various products. Mobile applications were predominantly used for tasks like inventory management, financial tracking,

and communication with suppliers. While these tools improved operational efficiency, adoption was largely confined to women with prior exposure to technology or support networks. According to some of the participants:

"I used to keep all my records on paper, but it was messy and hard to follow. Now, with the app, I know exactly how much I make and spend each day. It has saved me a lot of time and stress" (Retailer, South Africa).

In contrast, according to a Zambian participant:

"I've heard about apps for stockkeeping, but I haven't tried them. They seem complicated, and I don't have anyone to teach me how to use them (Retailer)"

The acceptance of mobile applications can assist female business owners in growing their revenue, increasing customer loyalty, expanding their networks of contacts, improving their public relations, and marketing their goods to a wider market. Mobile application adoption is appropriate for women in the SSA because it is inexpensive, has simpler technological needs, and is significantly simpler to learn how to use. For them, using mobile applications is a quick and affordable way to build large business networks, connect with potential clients, and hear what their clients have to say. 68% of interviewees said they could only handle one aspect of digitisation because they weren't sure they could handle adopting more complex technologies. All participants, however, concur that in order for their enterprises to remain viable they must adopt mobile applications, which is in line with findings from other studies. This study and prior research also show that mobile applications are widely accepted in SSA as the primary enabler of sustainability for many SMMEs, particularly those run by women. Consequently, the use of mobile applications in the business models of start-ups is crucial to their sustainability and performance (Abed 2021a, b).

Although mobile usage is widely accepted in SSA, there are still some difficulties. Due to a lack of digitisation skills, 62% of the participants had trouble integrating this technology into their businesses. Previous research has looked at how women company entrepreneurs in SSA use their human skills. The results of this study demonstrated that mobile phone adoption was simple for the South African and Zambian participants due to the availability of the required infrastructure, but that the cost of adoption was exorbitant and out of reach for most women. Participants from Tanzania who encounter high costs, adoption distance, and subpar infrastructure expressed the same (especially in the North). Infrastructure, high costs, and reliability proved to be obstacles for the Nigerian participants, whereas mobile adoption by women entrepreneurs in Ghana was high and pervasive. Like the Malawian participants, the Ethiopian participants find adoption to be relatively simple in urban areas but challenging due to inadequate infrastructure in rural areas.

Previous research has looked at factors that affect the adoption of mobile technology, such as female entrepreneurs' behaviour intentions regarding embracing technology and open innovations for the long-term viability of their businesses. The human capabilities of women entrepreneurs have been the focus of such studies. The ability to use digital technology (which is occasionally hampered

literacy challenges in rural areas) and the sense that these technologies are not pertinent to their lives are some of the challenges faced by women. Some women choose not to use mobile devices or the internet due to worries about their safety and security, both offline and online. The findings from this study revealed that women adopted mobile devices mostly for social media integration into eCommerce, advertising, and company operations. Women-owned businesses in the SSA have a lot of potential for growth and success thanks to digital technology and social media, but they are not currently taking advantage of these platforms. One of the most popular channels for business owners to introduce their new goods or services to online consumers is social media. Social media emerged as the most widely used digital tool for women in this study, with platforms like Facebook, Instagram, and WhatsApp being leveraged to market products, connect with customers, and generate sales. Women cited affordability and ease of use as key reasons for its popularity. According to some participant using Instagram for her fashion business:

> *"I post pictures of my designs on Instagram every week. Customers see them and message me directly to place orders. It's like having a shop without paying rent" (Dressmaker, Nigeria).*
> *"WhatsApp is my main platform. I create groups for my customers and send them pictures of new products. It's quick and doesn't cost much" (Boutique owner, Tanzania).*

However, some women expressed concerns about the limitations of social media marketing:

> *"Social media is good, but I can only reach customers who have smartphones and data. Many of my target customers don't" (Retailer, Malawi).*

Thus, competition is getting stiffer for women entrepreneurs, and they need to be innovative to succeed and remain relevant in the digital economy (Anisiobi et al. 2014; Victoria et al. 2019). The participants in this study report that they spend more time talking, sending texts, and accessing social networking sites when using mobile devices. As a result, when it comes to commercial operations, women fall behind men in terms of having access to, using, and owning digital technologies, which results in missed opportunities. The study's participants think that systematic gender-based obstacles to information and networks make it challenging for them to incorporate digital and social media into their business operations. According to some participants:

> *"I believe women are making strides in the world of social media. We are learning how to blog, utilise Instagram, and use Pinterest. Social media supports women. We are at ease working with businesses that provide services, marketing, and communications. Social media is a marketing technology, one that does not need complex skills and knowledge to manipulate" (Beautician, Nigeria).*
> *"Locally, here in Zambia, some women, especially, that do hair business, you know, this hair from China, this extensions, and clothes. A lot of them are now*

selling online. You now see that they're more on Instagram, more on Face-book. And if they don't have delivery services, if they don't have a personal car, there's now been businesses where people are – like, they buy a small motorcycle and they do the delivery" (Business Consultant, South Africa).
"I had to go online and start a Facebook page, to try and start educating my clients about my business and how to take care of their hair and their skin. And that way creating cloud so that once I'm able to access my raw materials I already have a clientele base to buy what I'm selling" (Beautician, Zambia)

For SSA women entrepreneurs who desire to engage in e-commerce, there are additional external factors that poses difficulties to doing business online besides the constraints preventing women from digital adoptions. Inadequate logistics infrastructure for delivering goods to customers, a lack of demand due to customers' varying levels of apprehension about or lack of trust in e-commerce, and a lack of digital payment systems that would allow seamless payments are all factors that limit e-commerce activity to a large extent in SSA. Where digital payment systems are available, women could have trouble using them since they lack the proper identification that is necessary for KYC (know your customer) procedures. This problem featured a lot in the narratives of the Nigeria, Ethiopian, and Malawian participants. In the words of one participant:

"People are afraid to buy anything online because they don't even trust you will deliver their packages. Some customers are not even comfortable paying online for goods and services because some websites stop working after payments are made and the Nigerian banks are not helping people to recover their money like they do abroad. So, until the issue of trust is addressed, we will continue to struggle" (Retailer, Nigeria)

Despite the benefits, women faced challenges in integrating technology into their businesses. These included a lack of digital skills, unreliable internet connectivity, and financial constraints. According to some participants:

"I know there are tools that can help me manage my business better, but I can't afford the internet costs to keep them running" (Interior Designer, Ghana)
"I only know how to use Facebook. Apps like accounting software are too advanced for me. I need training to understand them" (P31, Zambia).

Similar to the findings of Oser and Riding (2018) and Abed (2021a, b), the challenges to women's technology adoption highlighted from this study are grouped under the following: (a) personal barriers linked to the AEM model in our conceptual framework (the "Conceptualising Women's Self-Confidence and Self-Efficacy (AEM Framework)" section) which include self-efficacy and self-confidence, as well as the AWT framework (the "Conceptualising Women's Learning Processing (AWT Framework)" section) which includes learning, knowledge acquisition, and skills; (b) performance expectancy which includes various conflicting benchmarks; (c) structural factors which include facilitating conditions (d) social influence including social capital, networks, and affiliations; and (e) behavioural intentions (resulting from the juxtaposition of the AWT and AEM models). The antecedents
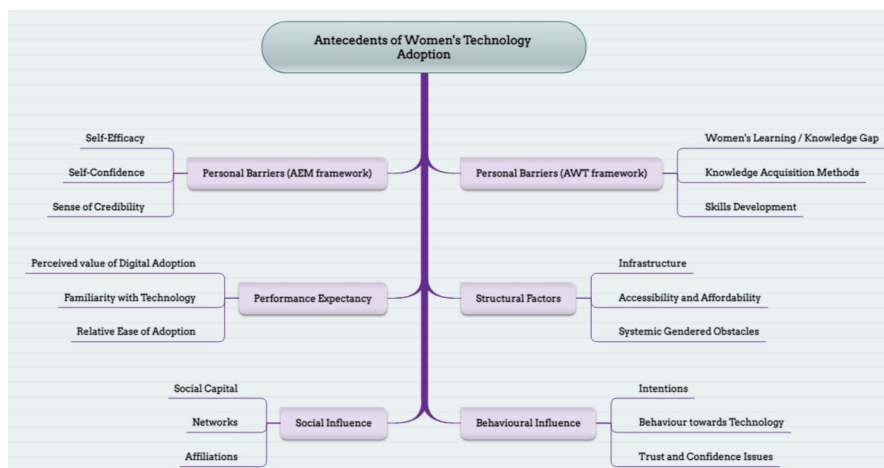
Fig. 3 Antecedents of women's technology adoption developed from the study

of women's technology adoption are shown in Fig. 3. The findings from this study shows that the use of technology, such as mobile applications, to foster business sustainability is linked to the performance and survival of women-owned SMMEs during and post-COVID-19 pandemic.

Minding the digital divide: Leave no woman behind

More than 55% of the world's population—4 billion people—does not use the internet, despite the United Nations' declaration that access to the internet is a fundamental human right. The difference between people who have access to contemporary information and communications technology and those who do not is known as the "digital divide" on a global scale. Lack of infrastructure and inability to buy smart devices are some of the causes. Governments in certain nations also limit citizens' access to the internet. Since women make up the majority of individuals without internet access, they are already at a disadvantage in terms of fully taking benefit of globalisation.

Internet usage is increasing overall, but it is still far more prevalent in the global north compared to the global south. Internet penetration is 81% in industrialised nations, 40% in developing countries, and 15% in least developed countries (LDCs), according to the International Telecommunication Union of the UN. In addition to these regional variations, gender discrepancies exist. Beyond challenges with technological infrastructure, gender norms that are socially and culturally formed define and restrict the ability of women and men to participate on equal terms. These limitations hinder women's access to digitisation as they frequently lack the financial means, educational background, and equal access to ICT products and services. The internet is a crucial facilitator of the corporate adoption of digital technology for SMMEs, providing new chances for women entrepreneurs in the SSA to enter the digital era. The use of ICTs by women entrepreneurs can contribute to sustainable

businesses that are essential for reducing rural poverty. Women are essential to the production and distribution of food in the SSA. Thus, the potential of wealth increase and economic development may arise from providing women with access to price and product information, supply chain alternatives, and knowledge that helps them generate revenue and competitiveness in the market.

Previous studies have highlighted the need to facilitate conditions for women's digital adoption by providing the necessary technical infrastructure. To develop and integrate IT systems into their businesses, the participants in this study talked about the necessity of establishing solid digitisation processes at the beginning of the business. Some of the challenges they encounter includes inability to find affordable skilled workers and limited access to qualified IT networkers, and some IT network members acted patronisingly towards women. Perceptions of gender bias in business support services, where the commercialization of IT is favoured above programming to assist IT adoption, were among the external factors (specified as training intervention, supplier expectations, industry norms or standards). On the other hand, services geared at women in business were observed to place more of an emphasis on personal needs than technical (IT assistance) needs.

In summary, mobile applications and social media strategies have become indispensable tools for women entrepreneurs in SSA. While they offer significant benefits, their adoption is hindered by digital literacy gaps, infrastructural challenges, and financial barriers. These findings underscore the need for targeted interventions to equip women with the skills and resources needed to harness the full potential of digital technologies.

Conclusions

Digital adoption is a useful tool that can help women business owners in SSA remain viable and competitive post-COVID-19 pandemic. It has also created opportunities for technology-based start-ups. Women entrepreneurs need efficient access to technology in order to engage in e-commerce and benefit from the advantages that digital technology offers. Mobile adoptions are the starting point for SMME owners, but they also need the infrastructure for efficient use, such as dependable network coverage and electricity.

The Women's Economic Empowerment (WEE) has been impacted negatively by COVID-19 epidemic and the gender equality gap has increased. More women than men had temporarily or permanently closed down their enterprises as a result of the pandemic (OECD 2020). Additionally, they have a higher likelihood of having reduced business operations, as well as lower sales, revenues, and consumer demand. Services, hospitality, and retail trade, industries where women-led enterprises are more likely to be concentrated, have been the sectors that have been most badly impacted globally. The following factors are largely to blame for these gender disparities: (1) governmental restrictions and lockdown measures; (2) industries and business sectors; (3) time spent on domestic duties; (4) access to social protections; (5) access to financing; and (6) technological disruptions and digital skills capabilities (ILO et al. 2019; OECD 2019; Azcona et al. 2020; Goldstein et al.

2020). Essentially, the pandemic has had a disproportionately detrimental effect on women-owned businesses in the SSA, especially in terms of the support provided to help SMEs weather the crisis. Recent studies emphasise the importance of support strategies that women-owned businesses need the most to survive and remain viable. In addition to private sector capital and financing, digitisation and digital adoption activities need to be accessible and affordable for women. They also need programmes and trainings to improve digital and entrepreneurial skills.

To conclude, the pandemic is predicted to have long-lasting effects on women-owned businesses, potentially eroding historic progress towards gender equality and forcing millions of women into abject poverty if steps are taken to mitigate the effects (Azcona et al. 2020; Madgavkar et al. 2020). Women-owned businesses provide significant contributions to the national economies, particularly in SSA, where it is estimated that SMEs account for 40% of economic growth and 70% of jobs created (Schnabel and Keenan 2020). According to estimates, eliminating the gender gap in entrepreneurship may increase global GDP by $5 trillion (Unnikrishnan and Blair 2019) (Tables 3 and 4).

Contribution

This study contributes to the ongoing discourse on the digital gender divide in SSA and the importance of providing the necessary support for the growth of women's entrepreneurship. The novelty of this study lies in its focus on digital adoption and transformation, highlighting the widening gender gap which can impact the achievement of the UN SDG number 5 on gender equality and empowerment of women and girls.

Implications for practice

The study of women's technological advancement has both academic and political appeal. This study focused on the gap and impact evaluation of digital adoption on women's businesses. This has implications for praxis as the findings of this study reiterate the importance of ensuring that more women engage in STEM education. Furthermore, providers of training and organisations involved in women's empowerment could introduce an adapted model of STEM education that are gender-sensitive and emphasises digital transformation for SMMEs to help SSA women develop the competencies required for the immediate survival of their enterprises.

Implications for policy

The study also has implications for policymakers as the ICT policy landscape is brimming with opportunities for educational research. We propose a policy-oriented and innovative approach through the development of a Digital Empowerment

Table 3 Reference points for empowerment, survival, and livelihood

Empowerment			Direct quotes
Nodes	Source number*	Reference point**	
Personal and business survival	38	31	"As I said, for us, April was the worst month because we didn't know whether we were going to shut down, so we were not being as aggressive as we should be. And I remember we were just broke having just enough to pay our workers. But I think after that realization that the economy is not shutting down and we need to get back on track, that was when we had to come up with new business idea to survive" (Real Estate Agent)
			"All of that was just happening in my head. But it took me a while. So after, like, two months, I began to realize that this is the new normal and I needed to survive. "Chioma, you need to survive, so think, think. How are you going to survive?" And that's when I began to research and started thinking of what business I can start or fund and that's how I started the online business" (Hairdresser)
			I was a bit apprehensive in thinking, "Oh, okay, what we're being told by the numbers, if that's really real, then that's a scary thing that's coming." And especially, obviously, because I'm not employed but I'm a businesswoman who's doing business for my survival and everything. So I was thinking, how will this impact my business and the different things
Diversification and mix of activities	46	48	"Because some other things we do at church are maybe time management courses, how to be a better public speaker. Those are the kind of things we also do as part of our church training. So, it just ramped up. And, honestly speaking, it felt like I was in another bubble. So, what I was hearing outside wasn't really now affecting me as much. So, I would say I had that sort of support from the people that I have around me from church" (PR consultant)
			"We all had to stay locked down, so there was no money coming in. For my husband too, it wasn't easy. So, I hold the family. In Nigeria now, most women are really carrying their homes. I was sewing PPEs and selling groceries. Sometimes I also cooked food. We needed to have multiple sources of income to survive" (Dressmaker)
			"So quickly I changed and then started making hospital scraps so that they can make money to feed their families, and then I started making nose masks. And anything that was related to COVID we started doing that just to stay in business" (Interior Decorator)

Table 3 (continued)

Empowerment

Nodes	Source number*	Reference point**	Direct quotes
Personal development	34	35	"On my side, I think COVID, at first, the fear, but there are a lot of opportunities that it exposed, so, so much, time for personal development which is important for my survival as well as my business survival" (Interior decorator) "And my weaknesses are my lack of formal business training" (Wholesaler) "I'm currently studying cosmetology just to help understand how best I can grow my business as my new business is in the beauty industry" (Beautician) "Us women, we mostly start our businesses without any training or skills to run a business. Women are opening a lot of businesses and employing a lot of people, but they are also struggling due to a lack of knowledge. The government should step in and provide the opportunity for us to develop our skills and compete with men on the same level" (Restauranteur)
Total	118	114	

Notes: * indicates the responses, ** indicates the number of related quotes found in the data. Participants may have made more than one statement that could be associated with the nodes

Table 4 Reference points for gender gap in technology adoption

Empowerment			Direct quotes
Nodes	Source number*	Reference point**	
Perceived values and barriers of adoption	38	31	"I believe that for women, the barriers to digital adoption are more severe. Women are underrepresented in technology. Unlike men, women find it difficult to understand and use technology." (Retailer)
			"The issue is that women's goals for success and growth are not met by existing technological support programmes, particularly those that provide access to funding. People want quick returns and the returns on digitisation are not immediate even though is sustained" (Event planner)
			"Women are too preoccupied with stuff to bother technology adoption. They don't prioritise technology and they are often unaware of how much simpler and more efficient their business will be, they do not know the impact it can have on their business performance" (Wholesaler)
Self-confidence and perceived ease of use / familiarity with technology	46	48	"Technology is not something that the younger generation shy away from. But with so many women entrepreneurs in their 40 s and 50 s engaging in new venture creation, this is out of their comfort zone" (Hairdresser)
			"Women frequently rely on the opinions of friends or partners, which might lead to the adoption of inappropriate technologies. As the business expands, the unfit technologies become problematic" (Grocer)
			"The biggest hindrance is that traditionally, women have not been involved in technology, therefore they lack the basic knowledge and are uncomfortable with it. They are more likely to accept advice from others about their needs. And 90% of the time, they turn to men for guidance because they lack the knowledge of the different technologies that are fit for their kinds of business" (Boutique owner)
			"Since women have fewer skills than males, learning about technology is lower on the list of difficulties faced while beginning a small business" (Hairdresser)

Table 4 (continued)

Empowerment			Direct quotes
Nodes	Source number*	Reference point**	
Accessibility and affordability	34	35	"The smaller the business, the more difficult it is to obtain technology. The bigger the company, the higher the revenue stream, making it easy for digital adoption. For small business owners like me, digitisation is not for us." (Interior decorator) "Access to finance have always been a problem for women and it makes it hard for them to ask for the capital needed for digital adoption. Therefore, the cost of technology puts them off. They do not believe they can raise the finance needed, so why bother" (Dressmaker)
Total	118	114	

Notes: * indicates the responses, ** indicates the number of related quotes found in the data. Participants may have made more than one statement that could be associated with the nodes

Policy Framework, which draws on the findings and insights from our study. This three-pronged approach should be designed to support women's digital adoption and economic empowerment building on our empirical findings and grounded in the Advancement of Women in Technology (AWT) and Adaptive Efficacy Model (AEM) frameworks:

a) The Foundation: Building Digital Confidence and Self-Efficacy: There is need for investments in community-based digital literacy programmes tailored to women, focusing on confidence-building and practical applications in business. Such actions should include mentorship programmes led by successful women entrepreneurs who have embraced technology.
b) Building Access: Bridging the Digital Divide: Policy actions could include subsidize internet and mobile data costs to improve affordability; expand digital infrastructure, especially in rural areas, to ensure reliable internet access; and provide grants or low-interest loans to women entrepreneurs for purchasing digital tools and devices.
c) Ensuring Sustainability: Advancing Digital Transformation for Business Resilience—Policy action could include Introducing tax incentives for businesses that invest in digital transformation training for women entrepreneurs; and establishment of innovation hubs where women can learn, collaborate, and experiment with new technologies.

The ability to address these concerns will enhance the potential of achieving the UN SDG number 5.

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