EQUALS RESEARCH REPORT 2025

Evidence to Impact: Advancing Gender Empowerment in the Digital Age

KAIST

EQUALS GLOBAL PARTNERSHIP

REPORT BY EQUALS RESEARCH GROUP, LED BY KAIST

ABOUT KAIST

The Korea Advanced Institute of Science and Technology (KAIST), established in 1971 as the nation's first public research-oriented institution in science and engineering, has been at the forefront of Korea's scientific and technological advancement. Over the decades, KAIST has served as a driving force for innovation, entrepreneurship, and economic development, with its graduates playing pivotal roles in shaping Korea's transformation into a global technology leader. Looking ahead, KAIST has launched Vision 2031, a strategic development plan to mark its 60th anniversary. This vision reaffirms the university's founding mission and outlines its transformation into an institution that produces globally impactful knowledge and contributes to the betterment of humanity.

ABOUT KAIST STP

The Graduate School of Science and Technology Policy (STP) at KAIST is one of the largest and growing graduate programs in Asia dedicated to the intersection of science, technology, and policy. Home to a diverse community of multidisciplinary scholars, KAIST STP offers master's and doctoral degrees in STP, as well as a minor program for undergraduate students. STP's mission is to foster a diverse, democratic, and just society. Through a critical engagement with both quantitative data and qualitative narratives, KAIST STP seeks to humanize science, technology, and innovation, shaping them to better serve humanity.

ABOUT EQUALS

The EQUALS Global Partnership for Gender Equality in the Digital Age is a committed group of corporate leaders, governments, businesses, not-for-profit organizations, academic institutions, NGOs, and community groups around the world dedicated to promoting gender balance in the technology sector. EQUALS was founded in 2016 by five partners: the International Telecommunication Union, UN Women, the International Trade Centre, GSMA and the United Nations University. The EQUALS's mission is to empower women and girls to become key drivers and active participants in the digital economy and society. EQUALS envisions a future where digital transformation for social change, education, and business is driven by women and girls, bringing prosperity for all.

ABOUT EQUALS RESEARCH COALITION

The EQUALS Research Coalition co-led by KAIST and Georgia Tech is fundamental to EQUALS' emphasis on evidence-driven actions. Composed of experts in information gathering and analysis, EQUALS Research Coalition focuses on generating knowledge about the existence, causes and remedies for gender tech inequalities, and on motivating key stakeholder groups, including private sector companies, government departments, regulatory agencies, and academia, to collect and share gender-relevant data.

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FOREWORD BY DOREEN BOGDAN-MARTIN, THE SECRETARY-GENERAL OF THE INTERNATIONAL TELECOMMUNICATION UNION (ITU)

Rapid advancements in artificial intelligence and other emerging technologies are a double-edged sword for gender equality — one that offers opportunities for empowerment in areas from education to employment to entrepreneurship, on one hand, while carrying the risk of deepening existing inequalities on the other.

Navigating this rapidly shifting technological landscape requires fresh perspectives grounded in data and lived experiences.

The EQUALS Research Report 2025 aims to provide both.

Under the auspices of the EQUALS Global Partnership to bridge the gender digital divide, these pages are the result of efforts to advance the global conversation on digital gender equality through exploratory research, case studies, and evidence-based initiatives from EQUALS partners worldwide.

Guided by the KAIST Graduate School of Science and Technology Policy, this report offers a data-driven foundation to craft policies and inspire innovation for more prosperous, equitable, and accessible economies and societies that benefit all women and girls, no matter how fast technology transforms.

As a founding partner of the EQUALS Global Partnership, ITU is fully committed to bridging the global digital gender divide together with more than 100 partners from around the world. Our shared vision puts gender equality at the heart of digital transformation by opening more opportunities for more women and girls to lead and shape our shared digital future.

This report was made possible thanks to a dynamic, global, multi-stakeholder alliance of EQUALS Research Coalition partners, practitioners and researchers, to whom I am deeply grateful for having contributed to this work.

As you read, I encourage you to consider how your own activities and actions can advance our mission to empower women and girls everywhere to thrive as leaders and innovators in an increasingly digital world.

Doreen Bogdan-Martin

Secretary-General
International Telecommunication Union

TABLE OF CONTENTS

1 DIGITAL SKILLS

2 DIGITAL INCLUSION AND EDUCATION

3 DIGITAL ECONOMY

4 AI AND CYBERSECURITY

EDITORIAL FROM THE EDITOR IN CHIEF

MOON CHOI (KAIST)

The EQUALS Research Report 2025: From Evidence to Impact – Advancing Gender Empowerment in the Digital Age is the outcome of dedicated collaboration among EQUALS partners worldwide. Advancing gender empowerment is a continuous process, and I believe that every minute and hour devoted to developing this report contributes meaningfully to building solidarity and catalyzing action toward closing the global gender digital divide.

Since the publication of the inaugural report in 2019, six years have passed—years marked by a global pandemic and an unprecedented acceleration in digital transformation. Gender inequality in ICT has become an increasingly central and urgent issue within the broader context of *Sustainable Development Goal 5: Achieve Gender Equality and Empower All Women and Girls*. As digital technologies continue to play an increasingly significant role in all aspects of life, bridging the gender digital divide is more critical than ever.

The EQUALS Research Report 2025 is organized into four thematic sections aligned with the EQUALS mission and vision: (a) Digital Skills, (b) Digital Inclusion and Education, (c) Digital Economy, and (d) AI and Cybersecurity. While the inaugural 2019 report laid an in-depth conceptual foundation—particularly in Part One—this second report builds on that groundwork by emphasizing the practical application of key concepts and frameworks. It presents up-to-date evidence on effective interventions and addresses emerging challenges such as deepfakes and cyber-resilience. I am especially proud to highlight that this report features the contributions of 33 authors and 20 reviewers, many of whom bring valuable perspectives from the Global South. This report serves as a valuable resource for policymakers, researchers, and practitioners seeking the most up-to-date evidence and tools for closing the gender digital divide across multiple levels.

The preparation and publication of this report have been a long journey, involving numerous online meetings and extensive email correspondence. I extend my sincere appreciation to all authors, reviewers, and editorial board members for their invaluable contributions. The editorial board convened for an intensive workshop in Daejeon, South Korea—home to KAIST—to review hundreds of manuscripts in November 2024. My heartfelt thanks go to my colleagues (in alphabetical order): Loly Gaitan, Wan Hong, Dasom Lee, Javiera Macaya, and Araba Sey. A special note of gratitude goes to Ern Cher Khor, who has orchestrated the entire editorial process with exceptional commitment and skill as managing editor.

In solidarity and moving forward.

DIGITAL SKILLS

BRIDGING THE GENDER GAP IN DIGITAL SKILLS

DASOM LEE (KAIST)

Digital technologies increasingly shape every facet of our lives—from the smartphones in our hands to the data centers that underpin global communication networks. In this rapidly digitizing world, the ability to navigate and critically engage with digital technologies is not a luxury, it is a necessity. Although significant efforts have been made to expand access to digital devices and connectivity, disparities persist, not only in access, but also in how people use and benefit from these technologies. Among the most pressing and persistent of these disparities is the issue of gender equity in digital skills.

This section of the report focuses on how digital skills intersect with gender, highlighting both challenges and opportunities. It brings together three chapters and a case study, which collectively demonstrate that simply having access to the internet or digital tools is not enough. Social, cultural, and institutional factors continue to shape how individuals—especially women and girls—develop and apply digital competencies. The resulting inequities are compounded by concerns around safety, privacy, security, and sustainability, all of which interact in complex ways with structural gender inequalities.

The first chapter introduces the EQUALS Her Digital Skills Initiative, which argues that closing the gender digital divide begins with inclusive, context-sensitive digital skills training. The chapter outlines practical strategies for designing training programs that not only teach skills but also empower participants to challenge existing norms within the tech and ICT sectors. The second chapter provides empirical insights from India and Sri Lanka revealing that although internet access is relatively equal across genders, the use of the internet diverges significantly, with women and men navigating the digital world in distinct ways. The third chapter turns to a local after-school program that taught female students to become not just users, but creators—coders who could actively shape the digital tools they use. Finally, the case study in this section examines how targeted training and consistent support from mentors can significantly improve employment outcomes for participants, especially for women entering tech-adjacent fields.

Together, these contributions expose ongoing gender inequalities within digital systems while offering practical, hopeful pathways forward. They show that meaningful change is possible when initiatives are intentionally designed to empower those who have been historically excluded.

Looking ahead, we envision a world where digital skills are recognized as not merely technical proficiencies, but as tools for inclusion, expression, and social transformation. By investing in equitable digital education and support systems, we can help build a future where everyone, regardless of gender, can fully participate in and shape the digital society. The stories and programs shared here serve not only as evidence but also as inspiration for countries and communities seeking to create more just and inclusive digital futures.

1.1 GENDER TRANSFORMATIVE DIGITAL SKILLS EDUCATION

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ABSTRACT

Across the globe, women and girls benefit less from digital transformation than men and boys, due to power dynamics, educational disparities, marginalization, and other societal and social situations. Social and gender norms play a critical role in perpetuating the gender digital divide, hindering females from using technologies, accessing broadband services, and developing technologies. A "gender transformative" approach to digital skills education is needed, where education programs also address harmful gender norms, roles, and power dynamics through intentional design of content, instructional methods, locations, and types of skills.

Her Digital Skills: Towards a Gender Transformative Approach proposes an approach to the development and delivery of digital skills training and educational programs which addresses the social and gender norms inhibiting women and girls' involvement and use of digital technologies. Co-developed by a multi-disciplinary group of public and private sector organizations, the approach combines leading practices and perspectives from pedagogy, social change, economic development, and organizational leadership domains. This approach is not intended to address systemic root causes of the gender digital divide at a population level, but rather to provide tangible actions stakeholders can implement to address immediate gaps through grassroots efforts, adaptable to fit individual cultures and contexts.

This novel approach to addressing multiple aspects of the gender digital divide is still being refined in individual country and cultural contexts, incorporating feedback from learners, groups providing the training and learning programs, and communities in which sessions are held, as well as insights from similar, parallel programs.

KEY FINDINGS

Digital skills education programs must be:

- ***Gender transformative***, to address the discriminatory social and gender norms and power dynamics that perpetuate the gender digital divide.
- ***Inclusive***, so that digital skills programs do not exclude disadvantaged populations, making existing inequalities worse.
- ***Contextualized***, ensuring that learners' social, political, and economic contexts are considered in program design.
- ***Competency-based***, to equip learners with flexible, future-ready digital knowledge, skills, and attitudes that they will need for confident, critical, safe, and equal participation in a rapidly changing digital world.

GENDER TRANSFORMATIVE DIGITAL SKILLS EDUCATION

Across the globe, women and girls are benefiting less from the digital transformation than men and boys. The digital gender divide is not only pervasive but multifaceted, including substantial disparities in Internet access, mobile phone ownership, and digital literacy as well as the under-representation of women and girls in science, technology, engineering, and mathematics (STEM) fields, including Artificial Intelligence (AI).

Numerous studies have documented gender bias in STEM learning materials (UNICEF, 2021), including in text, imagery, videos, and case studies. Furthermore, gender biases in STEM materials often

intersect with additional biases. Many materials feature predominantly Caucasian, middle-class, urban, Westernized people, reflecting where the materials were created. These subtle but significant features suggest that women and individuals of different races, socioeconomic classes, educational backgrounds, or cultures and abilities are not welcome or not able to develop digital skills. It is imperative that examples, case studies, videos, and even discussions of digital and STEM topics become more inclusive and relatable to students and participants.

Despite the concerted efforts of member organizations of the *EQUALS Global Partnership for Gender Equality in the Digital Age*, and other leading private and public sector organizations, the digital gender divide continues to expand, as the demand for technical skills—given the pace of change—exceeds the number of people with the requisite skills.

WHAT IS EQUALS "HER DIGITAL SKILLS INITIATIVE"?

Four of the members of EQUALS' Skill Coalition came together to co-develop an approach to deliver digital skills education, as a learning pathway for young women and girls. This became *EQUALS Her Digital Skills Initiative* (HDS). Co-founders ITU, GSMA, EY, and W4 identified leading practices from each organization's experiences and approaches and combined them to create an integrated approach to learning digital skills. The training included mentoring and 1:1 coaching, and it focused on skills that are immediately commercial or can lead to commercial and business use. The program uses micro-accreditation approaches for learners to demonstrate their accomplishments.

After several years of actively delivering training, measuring results and outcomes from the sessions, and collecting feedback from learners, mentors, communities, and companies, the co-founders recognized that their success was due to the multi-disciplinary approach; they started to look for ways to sustain learners' progress over time. Reaching out to other EQUALS members and affiliated organizations, HDS was able to leverage research, insights, and practical examples from a select group of premier organizations: the World Bank, United Nations Development Programme (UNDP), United Nations International Children's Emergency Fund (UNICEF), Plan International, German Development Cooperation (GiZ), and the AIDS Healthcare Foundation. Through these contributions, a framework began to emerge to redefine what success in digital skills training should look like.

Her Digital Skills: Towards a Gender Transformative Approach proposed that digital skills training needs to address social and gender norms to reduce barriers women and girls may face in seeking to use technology or to work in technological roles. Too many women and girls who undergo digital skills trainings are unable to implement those skills in formal employment due to societal barriers. Some of these barriers are due to the social norms related to what skills and type of work are considered appropriate for women and girls. For example, helping family-owned farms get better prices for produce through online markets might be more acceptable than going to work in an office away from the farm itself.

Digital skills training also needs to focus on the practical use of technology, integrating examples, case studies, and role models that are tailored to the local context and culture rather than perpetuating stereotypes of technologists that are not relevant to the participants. Too often, the examples developed by training teams depict corporate environments or software development contexts that don't seem relevant to participants' lives. Cultural differences can also be a barrier, as urban environments are typically shown in examples instead of rural situations, leading participants to believe they are unable to use the knowledge presented.

Digital training that focuses on applicable skills (such as using devices, understanding how to be safe online, developing websites for small businesses or managing small businesses) gives participants the opportunity to start applying skills quickly, thus increasing retention. Competency-based approaches to assessment are also essential, as evidence of achievement can further challenge social norms regarding women's and girls' abilities.

Another important element for digital skills training to be considered gender transformative is careful planning for where and how the training is delivered. Broadband connectivity is not universally available, nor are the devices participants need for training. Providing training sessions in culturally acceptable locations is another key element for success. Libraries, schools, and faith or community centers are better choices than a corporate center. Locations and sites that are tied to the local community provide symbolic support to the use of technology and the skills needed to use the technology effectively. These locations also make travel to and from home or work site more manageable.

The impact of digital technologies on daily life is

expanding, and creating a level of digital literacy is essential to sustainable participation in the economy of the future. We are just beginning to see how much that future will be digitally enabled, possibly far beyond communities' expectations.

HDS members provide webinars and other knowledge-sharing opportunities for learners and alumni to continue to grow and develop their skills over time, developing leading practices in these areas. HDS believes this approach is best positioned for sustained change. It has pledged to design and provide access to free, gender-transformative digital skill training as well as capacity-building and mentoring opportunities for one million women and girls by 2026, as part of the Generation Equality Framework. (See Box 1.)

WHAT IS MEANT BY "DIGITAL LITERACY"?

In 2006, the European Parliament and Council of the European Union recommended eight key competencies for lifelong learning. One of these was 'digital competence' (European Parlliament and Council of the European Union, 2006), defined as "the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society" (EC JRC, 2022). This definition expands the discussion from technology-based skills (e.g., coding and programming) to the ability to use technology and devices. The ITU, in its Digital Skills Assessment Guidebook, notes that "digital skills include not only technical skills but also cognitive skills as well as non-cognitive soft skills such as interpersonal skills and communication skills" (ITU, 2020). For present purposes, digital literacy is the ability to effectively understand how to use technology, how to make decisions using technology, how to ensure one's safety and security while online, and communicate with others over technology-enabled channels or mechanisms. By measuring an individual's proficiency in different digital competence domains (see Figure 1), their level of digital literacy can be identified and measured.

BOX 1
GENERATION EQUALITY

Generation Equality is a 5-year action journey led by UN Women to catalyze progress in achieving the Sustainable Development Goals. The program will design and provide access to free gender transformative foundational IT skills training and e-mentoring for 1 million women and girls by 2026, via the **Her Digital Skills** initiative powered by the EQUALS Global Partnership for Gender Equality in the Digital Age.

Her Digital Skills powered by EQUALS includes:

- Basic introduction to the technical knowledge & education needed for careers in technology through hands on digital skills workshops.
- Access to free, adapted (gender transformative) foundational IT skills training through an EQUALS qualification ("the Digital Badge"), which will boost women's chances of pursuing further training/studies and access to formal employment in the ICT sector.
- An e-mentoring program connecting established companies in the tech and mobile industries to young women, to increase interest, involvement, and awareness of the overall role of industry in bridging the gender gap in leadership.

The overarching goal is to increase the talent pipeline of girls and young women in STEM (Science, Technology, Engineering, Math)/STEAM (Science, Technology, Engineering, Architecture, Math) leading to employment and/or internship opportunities.

FIGURE 1

DIGITAL COMPETENCE DOMAIN DESCRIPTIONS

INFORMATION AND DATA LITERACY	1.1. Browsing, searching and filtering data, information and digital content 1.2. Evaluating data, information and digital content 1.3. Managing data, information and digital content
COMMUNICATION AND COLLABORATION	2.1. Interacting through digital technologies 2.2. Sharing information and content through digital technologies 2.3. Engaging in citizenship through digital technologies 2.4. Collaborating through digital technologies 2.5. Netiquette 2.6. Managing digital identity
DIGITAL CONTENT CREATION	3.1. Developing digital content 3.2. Integrating and re-elaborating digital content 3.3. Copyright and licences 3.4. Programming
SAFETY	4.1. Protecting devices 4.2. Protecting personal data and privacy 4.3. Protecting health and well-being 4.4. Protecting the environment
PROBLEM SOLVING	5.1. Solving technical problems 5.2. Identifying needs and technological responses 5.3. Creatively using digital technologies 5.4. Identifying digital competence gaps

Source: Her Digital Skills: Towards a Gender Transformative Approach, page 24.

WHAT DIGITAL SKILL DOMAINS ARE ESSENTIAL FOR DIGITAL LITERACY?

Many organizations and international agencies have developed digital competence frameworks to guide the design and evaluation of curricula, syllabi, and learning content for students, teachers, and institutions (ITU, 2020). These competence frameworks "provide a means of categorizing and organizing the complexity and range of digital skill sets, create a common language, and sometimes prescribe proficiency levels or learning outcomes" (ITU, 2018). A systematic review of more than a hundred frameworks identified some common digital competence areas or domains: use technology to communicate and collaborate; find, evaluate, and manage digital information and data; create and edit digital content, including computer code; protect one's privacy and data and safeguard against digital risks; acquire technical skills, including hardware and software essentials; and solve problems, as a cross-cutting digital competence.

While commercial curricula usually define learning outcomes in terms of knowledge and skill, digital competence frameworks such as *DigComp 2.2* go further by adding attitude-related outcomes. This

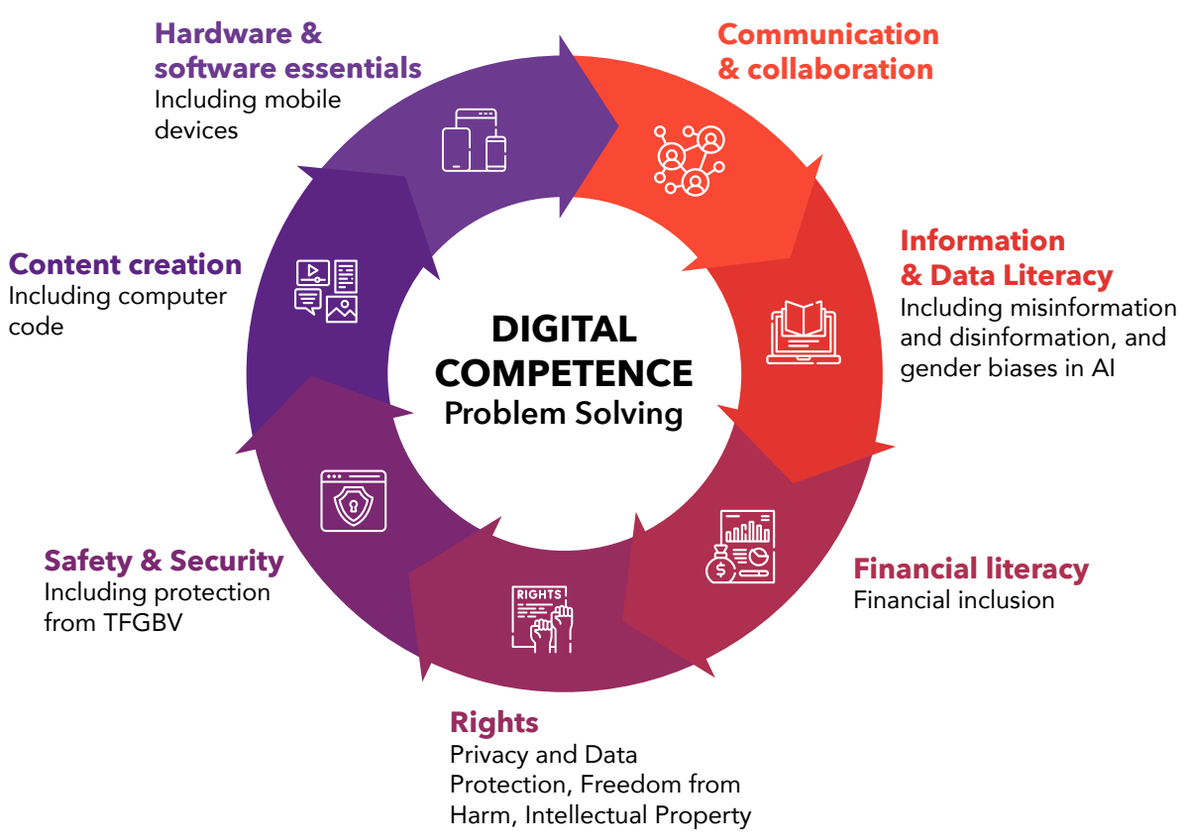
is essential for closing the digital gender divide, as gaining skills is not sufficient without actively using the skills and knowledge. Too often, after formal learning opportunities are completed, girls are not able to apply the new skills in formal employment or are discouraged from using these skills by their social networks. Attitude-related outcomes—metrics evaluating the learner's confidence in using skills or knowledge—are essential for learners to self-advocate and build their own sense of accomplishment.

Many syllabi already exist, and most are free to download. However, there is a lack of mobile skills curricula, and existing syllabi may need to be substantially modified to meet the learning needs of unconnected women and girls. There are also gender gaps, including a lack of syllabi on technology-focused gender-based violence as well as gender biases in Artificial Intelligence. We adapted the DigComp 2.2 framework to guide the design of gender transformative curricula and syllabi for digital skills education. The enhancements include an additional focus on *digital rights*, to include four main elements: the right to privacy and data protection; the right to freedom from harm; the right to anonymity and to be forgotten; and intellectual property rights. (See Figure 2.)

The broad objective is not merely to mitigate the risk of technology-focused gender-based violence but also to reduce the incidence of these attacks. Increased levels of cyber-based or cyber-facilitated violence against women demand that attention be paid to this risk, including actions victims can take to address harassment and harm. Similarly, AI risks also expand, including gender biases in data, in algorithms, and in the interpretation of results; as the developed world continues to utilize the benefits of AI and large data modelling in a range of decisions, these biases will impact individuals across all aspects of life. The last two areas of focus are the digital financial skills and computational skills that women and girls need to participate in the digital economy, and a mobile-first approach in regions where household computer ownership remains minimal.

FIGURE 2

ADAPTED DIGCOMP 2.2 FRAMEWORK



Source: Her Digital Skills: Towards a Gender Transformative Approach, page 54.

Critically, the combination of digital competence-based assessments and attitude-related outcomes addresses two driving forces of the digital gender divide. 1) Fewer women and girls have digital skills, compared to men and boys. 2) Social and gender norms in many countries discourage women and girls from using technology in formal employment or even in daily activities.

Once the appropriate competency framework is selected, the content and syllabi for instruction can be developed (see Figure 3). Crucially, content creation must be participatory and iterative, involving key stakeholder groups and gender-intentional human-centered design methods, focusing on the needs of the participants and learners. The content used in the digital learning context needs to be relevant to the participants, reviewed for gender bias, and, most importantly, delivered in local languages. Word-for-word translation is not applicable here, as many of the terms used in digital training (developed in English) do not have accurate translations in other languages or dialects. The broader intention and meaning of curricula must be considered during the translation process.

FIGURE 3

MAPPING DIGITAL COMPETENCIES TO A CURRICULUM AND SYLLABUS

CONTENT CREATION COMPETENCIES

DEVELOPING DIGITAL CONTENT

To create and edit digital content in different formats, to express oneself through digital means.

INTEGRATING AND RE-ELABORATING DIGITAL CONTENT

To modify, refine and integrate new information and content into an existing body of knowledge and resources to create new, original and relevant content and knowledge.

PROGRAMMING

To plan and develop a sequence of understandable instructions for a computing system to solve a given problem or to perform a specific task.

CONTENT CREATION CURRICULUM

MAPPED BY ICDL TO DIGCOMP 2.2

- Presentations
- Spreadsheets
- Documents
- **IMAGE EDITING**
- Web editing
- 2D design
- 3D design
- Coding principles
- Computational thinking
- Data analytics

IMAGE EDITING SYLLABUS

CATEGORY	SKILL SET
IMAGING CONCEPTS	• Digital images • Colour concepts • Graphic formats
IMAGE CAPTURE	• Capturing images
USING THE APPLICATION	• Image creation • Enhancing productivity • Settings
WORKING WITH IMAGES	• Selection • Image manipulation • Layers • Text • Effects and filters
DRAWING AND PAINTING	• Drawing tools • Painting tools

Source: Her Digital Skills: Towards a Gender Transformative Approach, page 57.

Digital skills education programs typically have implementation strategies, curricula, and content portions. These may not be designed to be inclusive or gender transformative. For instance, implementation strategies need to address gender biases in educational institutions, as well as the normative barriers that women and girls face in attending out-of-school training programs and in consolidating their skills at home. Curricula need to be competency-based, focusing on digital knowledge, skills, and attitudes that are relevant to women's and girls' lives and not only on theory and vocabulary. Content should be free of unconscious bias and gender stereotypes and should adopt a social and behavior change communication (SBCC) approach to change attitudes and support normative change. (See Box 2.)

BOX 2
WHAT IS A SOCIAL AND BEHAVIOR CHANGE COMMUNICATION APPROACH (SBCC)?

Evidence from public health research suggests that informational communication approaches designed to increase knowledge and awareness rarely result in sustained behavior change (USAID, 2014). However, a substantial body of evidence from sectors such as public health, water, sanitation, disaster prevention, and education shows that social and behavior change communication (SBCC) can increase the impact of interventions (USAID, 2014). SBCC is the strategic use of communication approaches to positively influence knowledge, attitudes, social norms, and behaviors among individuals, institutions, and communities (Johns Hopkins University, n.d, 2023). SBCC engages communities and decision-makers at multiple levels (UNICEF, 2018)—not just with individuals but also with powerful people in their social networks—as well as supporting advocacy regarding policy and resources (Johns Hopkins University, n.d, 2023).

WHAT IS MEANT BY "GENDER TRANSFORMATIVE"?

A Gender Transformative Digital Skills Education program needs to understand and harness the factors that influence changes in norms and power dynamics, as foundational elements of its digital skills curriculum. Gender specialists have identified institutional, resource, social, and individual factors that influence social and gender norms and power dynamics. Researchers have also identified contextual, household, and individual factors, including social and gender norms that impact women's and girls' access to and use of digital technologies.

The framework and guide build on a 2021 report (Plan International et al., 2021) that argues that Gender Transformative Education removes barriers to education and promotes social changes. These changes include reducing gender-based violence and early marriage, increasing women's participation in the labor market, promoting gender equality, and supporting women's and girls' leadership in decision-making roles. The EQUALS Global Partnership Skills Coalition applied Plan International's definition of Gender Transformative Education to digital skills education, arriving at the following definition:

> *Gender Transformative Digital Skills Education (GTDSE) seeks to transform gender stereotypes, attitudes, norms, and unequal power relations to bridge the gender digital divide and foster gender equity and equality.*

This framework and guide recommend gender transformative approaches to the design of digital skills education programs, inside and outside the classroom. They adopt an inclusive, contextualized, competency-based approach to learning strategies, curricula, and content. And they recommend ways for stakeholders to intervene in the wider ecosystem, which is critical for change. The British Columbia Centre of Excellence for Women's Health identified a continuum of interventions ranging from gender unequal to gender transformative (Center of Excellence for Women's Health (CEWH), 2023).

FIGURE 4

THE CONTINUUM OF GENDER UNEQUAL TO GENDER TRANSFORMATIVE

APPROACHES	GENDER UNEQUAL	GENDER BLIND	GENDER SENSITIVE	GENDER SPECIFIC	GENDER TRANSFORMATIVE
FEATURES	Perpetuates gender inequalities	Ignores gender norms	Acknowledges but does not address gender inequalities	Acknowledges gender norms and considers women's and men's specific needs	Addresses the causes of gender-based digital inequalities and works to transform harmful gender roles, norms and relations

GENDER INEQUITY ▸ EXPLOIT ▸ ACCOMMODATE ▸ TRANSFORM ▸ **GENDER EQUITY**

Source: Her Digital Skills: Towards a Gender Transformative Approach, page 19.

Programs that seek to advance gender equality and/or women's empowerment by changing harmful gender norms, roles and power relations are described as 'gender transformative' (UNFPA, 2023). Gender transformation is a 'relative concept' that seeks to shift gender roles and relations closer to gender equity in any given context (Center of Excellence for Women's Health (CEWH), 2023).

Multiple stakeholders are needed to act in a concerted and coordinated way to create the types of changes that are essential to the long-term success of gender transformative digital skills education. These can be categorized into three main groups:

1. Practitioners in governments, educational institutions, civil society organizations, and the private sector.
2. Policymakers and those involved in advocacy work at the state, national, regional, and international levels.
3. Other stakeholders in the wider ecosystem, including employers, mass media institutions, and social media platform providers.

Each of these stakeholders can act independently and achieve success in establishing new narratives or perspectives, increasing the number of learning programs or even expanding the number of open positions for technology roles. Only when all three are working in concert, however, will holistic change be accomplished.

PUTTING THEORY INTO PRACTICE

The first step in creating a truly gender transformative approach is to fully recognize and understand the challenges faced by participating women and girls. Gender analysis involves identifying the types of barriers women and girls face in gaining access to technology, using technology, and working with technology. Next, identify which groups of girls or women are most affected by these various barriers, and how the barriers affect and could be reinforced by interactions with the women and girls.

Another key element in addressing social and gender norms is to ensure that educational programs do not isolate genders. Educators and instructors need training to deliver gender transformative digital skills education to all students regardless of gender. This should include raising educators' awareness of the normative barriers that prevent women and girls from increasing their digital knowledge and skill, as well as guidance on how to avoid reproducing gender stereotypes both inside classrooms and in other digital skills training programs. Additionally, training in digital safety, security, and well-being would help educators to consider the risks associated with digital use and to create a safe and supportive learning environment.

It is also critical that more women educators are hired to teach digital competencies inside and outside classrooms as well as STEM subjects in schools

(UNESCO and EQUALS Coalition, 2019). Multiple studies indicate that female students are more likely to apply for and graduate in a STEM subject at university level if they had female mathematics and science teachers at secondary school (World Bank, 2022). By having more women in STEM teaching positions – inside and outside classrooms – institutions can start the process of changing perceptions about who can be digitally savvy while providing women and girls with positive role models.

However, even in cultures where mixed-gender education is common and accepted, researchers have found that women do well in secure, moderated, women-only environments, where they tend to ask more questions and discuss problems and concerns more readily (UNESCO and EQUALS Coalition, 2019).

A digital skills program that only engages learners as individuals is unlikely to succeed, because peer learning and discussion in groups is key to changing attitudes and supporting norm change. Content should act as a stimulus for group discussion, by including questions and discussion prompts and by training educators on leading discussion in groups. The content should also aim to foster discussion with power holders in the students' social networks, for example with husbands and parents.

The HDS-led programs and other good practices show that women and girls participating in small group networking activities, or engaged in other communal discussions, were more likely to continue to learn and apply skills in daily and formal employment activities. The impact of collectiveness as part of the change process for social and gender norms should not be underestimated.

Content needs to feature relatable role models, i.e., women and/or girls from backgrounds similar to the learners', and "alumnae" who have achieved some level of digital literacy and benefited as a result. Role models might include (for example) marginalized women who used their digital skills to increase their farming income and are now active in women's collectives, as well as young women who graduated from tertiary STEM education and are now on a leadership track in a STEM career.

The benefits of digital skills as promoted in key messaging need to be relevant and compelling to women and girls, and also to those who hold cultural power in their families and communities. Learners need to believe that they, too, could achieve what the role models have achieved, and recognize a version of themselves in the imagery. For example, digital learning content that features Westernized, middle-class adolescents using expensive devices for luxury entertainment in urban environments may be aspirational to adolescent girls from low-literate, low-income rural communities, but it may also communicate that technology is beyond their reach. This kind of imagery may also alienate their parents.

The communications approach should address harmful stereotypes about femininity and provide alternative language, images, and examples to counter social norms. For example, it should model indicators of women's empowerment, such as mobility, control over resources, financial decision-making, participation in public life, and political participation. It should also model positive masculinity: for example, a husband who shares the burden of household chores and child-caring responsibilities, and who supports his wife working outside the home; and fathers who encourage their daughters to pursue further education and careers, including in STEM fields.

At the local level, practitioners (educators, program leaders) can: identify and incentivize digital champions in the community to act as local peer change agents, role models, and mentors; engage with power holders at home and in the community for conversations about women's and girls' use of technology and their concerns; prioritize group-based learning in trusted social networks; create opportunities for networking and establish connections among women and girls from different backgrounds; and deliver content and exercises in smaller portions (or "bite-sized") in recognition of women's and girls' time constraints.

Women and girls are often expected to do more household chores and activities to support their families than men and boys (in terms of total hours in unpaid work). As such, women and girls are time constrained in preparing for or reviewing classroom sessions; they need training sessions to be delivered in time blocks that allow for the limited available time. Locate training in socially acceptable spaces where women and girls feel safe and comfortable, such as community centers, schools, or markets where women and girls can gather and learn within cultural expectations.

WHAT ARE THE NEXT STEPS?

The wide-ranging improvements in digital skills training implementation, content, curricula, and measurement have introduced some good practice examples and promising practice approaches. Announced at the UN Commission on the Status of Women in March 2024, pilot programs are in development for private sector organizations that provide digital skills training or funding for digital skills. An

initial *checklist approach for stakeholders* is available on the EQUALS website.

One pilot, led by HDS co-founder GSMA, is working with leading telecommunications companies to assess how well the framework resonates with their own work and impact on the ground; it identifies early adopters/leaders in delivering programming aligned to the framework as well as best practices and areas for improvement in using the self-assessment checklist. The telecommunications companies working with GSMA are also collectively building good practice examples based on their organization's efforts to adapt their STEM and/or digital skills programming based on the framework's recommendations; they are reviewing the results and producing case studies, with a view to showcasing best practices and lessons learned, and they are further developing resources to assess and benchmark their programs to be gender transformative. HDS is also developing an approach (available in 2025) to evaluate progress in achieving a gender transformative approach, for organizations seeking to adopt these guidelines and practices.

In addition, leading efforts are using different approaches, including researching individual attitudes as well as expectations of others' attitudes and normative views (Learning Collaborative to Advance Normative Change (LCANC), 2017). Substantial evidence supports the need for mixed methods approaches that combine quantitative and qualitative methods; these approaches can effectively capture perceptions and reality, intensity, and scope, as well as complexity and nuance. Such approaches are essential for understanding causation in intricate systems and provide more rigorous and actionable information (UN Women, 2023; Learning Collaborative to Advance Normative Change (LCANC), 2017).

Evaluating gender transformative digital skills education programs goes beyond measuring changes in learners' digital competence. Fundamentally, evaluators need to assess whether programs have contributed to women's and girls' empowerment outcomes and/or gender equality as a primary outcome. Evaluators also need to assess progress towards secondary outcomes, including changes in the personal attitudes and normative beliefs of learners and of powerful people in their social networks. This can present a challenge, as no global standard exists for identifying and measuring social norm change beyond individual attitudes and behaviors. Behaviors can be influenced by factors other than norms, and a community is more than the aggregate of individuals' attitudes (UN Women, 2023; Learning Collaborative to Advance Normative Change (LCANC), 2017).

Examples of good or promising practices are constantly reviewed and shared in the live document version. To submit additional examples, please contact EQUALS at equals@itu.int.

WHAT CAN WE DO TO FURTHER ADOPT GENDER TRANSFORMATIVE DIGITAL SKILLS TRAINING?

Closing the digital gender divide, and ensuring gender equality and equity in digital transformation, will require sustained effort by many stakeholders. Without the active involvement of multiple stakeholders, collectively working across functions and silos, progress will not be made and sustained.

Support the improvement or enactment of legislation for women's economic inclusion. A concerted effort is needed to develop and implement laws that support women's economic inclusion and investment in better paid, flexible livelihood opportunities for women. Digital skills are essential for formal employment in all areas of the economy and in all locations. This underlines the need to address financial barriers in purchasing devices and accessing broadband capabilities through policy changes, micro financing, and pricing for universal connectivity.

Public and private sector actors need to continue to invest in changing public opinion about women's and girls' use of technology. Public service advertising campaigns need to be designed and implemented to help change the regressive normative beliefs that are preventing women and girls from participating fully in digital environments. Public-private partnerships should also consider the development of mentorships and pathways for formal employment for women and girls in technology.

Citizens, residents and leaders need to champion the mainstreaming of gender in digital skills education. Smart educational policies should be implemented to mainstream gender transformative approaches in digital skills education, for all genders. These need to be backed up with investments as well as clear metrics to track progress. Equally essential is building the capacity of educators to deliver gender transformative digital skills education to reduce gender biases in digital skills education, inside and outside classrooms, and to safeguard learners.

Finally, it is critical to ***legislate more effectively against technology-facilitated gender-based violence.***

Policy makers need to develop and implement more effective legislation against attacks. For example, Very Large Online Platforms should be made responsible for illegal content on their platforms, as the Digital Services Act (DSA) in the EU has done.

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1.2

GENDER GAPS IN INTERNET ACCESS AND DIGITAL SKILLS IN INDIA AND SRI LANKA

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ABSTRACT

Women have consistently lagged behind men in adopting and using technology, across time, geography, and various forms of technology. This gap is evident in mobile phone adoption, internet use, social media engagement, and digital skills. Such disparities hinder women from fully benefiting from technology, affecting their access to networks, resources, and livelihood opportunities as well as their agency. The disparity extends beyond individuals to society as a whole, and addressing this gap will be crucial to achieve the Sustainable Development Goals in a digital world.

Disconnected women face dual exclusion—not only from digital services but also from critical services such as government programs, e-commerce, and employment opportunities. While South Asia has made notable progress in digital connectivity, access alone is insufficient to empower women. Women need knowledge, skills, and agency across all societal segments to leverage technology meaningfully.

Using nationally representative data from LIRNEasia's 2021 surveys, this paper explores two questions: does gender intrinsically influence an individual's likelihood of being online; and does it affect their digital skill capabilities. Statistical models provide insights into these dynamics.

This research sheds light on the factors driving the gender digital divide in access and skills in India and Sri Lanka. It offers valuable insights for designing policies and interventions to bridge this gap and to promote gender equity in the digital sphere.

KEY FINDINGS

- When socioeconomic differences are controlled for, women in Sri Lanka are as likely to use the internet as men; in India, however, women are 35 percent less likely to use the internet.
- Gender does not significantly affect digital skills capabilities among Sri Lankan internet users, while gender does emerge as a significant contribution to digital skills capabilities in India: women in India have a considerably lower likelihood of being able to perform at least one digital task.
- Gender effects are highest for posting information online, making payments/transactions, and creating login details.
- Device ownership, age, and education are also key factors affecting digital skills in India and Sri Lanka.

INTRODUCTION

Compared to two decades ago, digital access gaps today are receiving increasing attention from researchers, governments, and industry. Women consistently lag behind men in technology adoption and use. This has been seen, for example, in mobile phone adoption, internet use, social media use, and digital skills (GSMA, 2021; ITU, 2021; ITU, 2017; LIRNEasia, 2019; United Nations Division for the Advancement of Women, ITU & UN ICT Task Force Secretariat, 2002; World Bank, 2016; World Wide Web Foundation, 2020; Zainudeen, Iqbal & Samarajiva, 2010).

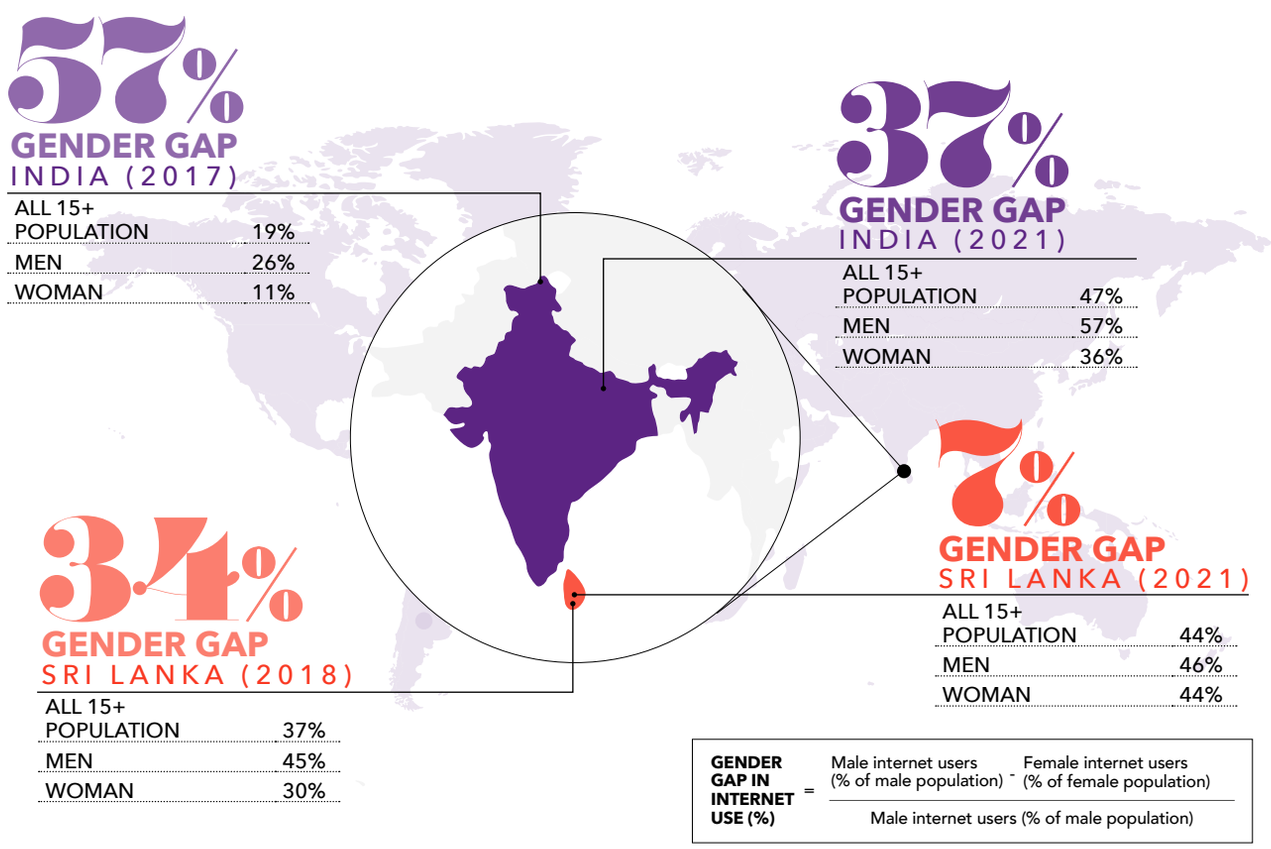
Disparities in women's access to digital technology limit women's ability to benefit from and be empowered by technology. This can include access to networks, resources, and livelihood opportunities as well as exercising voice and agency (GSMA, 2021; Broadband Commission, 2017; Scott, Balasubramanian & Ehrke, 2017; World Wide Web

Foundation, 2016 UNCTAD & ILO, 2014; Moyo & Deen-Swarray, 2013, September). These benefits have impact not only at the individual level but also at a society level also, such as fostering better health and education outcomes for children. Achieving the SDGs in many cases is tied to connectivity in an increasingly digitized world, requiring women — of all walks and circumstances — to be meaningfully connected.

With technology becoming increasingly central to all spheres of life, women who are not able to take advantage of its benefits will risk being doubly excluded: from the digital services themselves, but also from certain government services, ecommerce, and earning opportunities, among other functions that rely on digital access. Research suggests that they could even face bigger difficulties in managing their lives than in a pre-digital era (Scott et al., 2017; Cummings & O'Neil, 2015; Galperin Mariscal & Barrantes, 2014; Broadband Commission, 2013).

The South Asia region has seen significant improvements in internet connectivity in the past decade. Between 2018 and 2021, India saw the percentage of its population online more than double, from 19 percent (age 15–65) to 47 percent (age 15+), according to LIRNEasia's nationally representative surveys (LIRNEasia, 2019; LIRNEasia, 2021). Sri Lanka's growth between the same period was less dramatic, from 37 percent to 44 percent for those age groups. Significant growth can be attributed to the Covid-19 pandemic: 43 percent of new internet users in India and 31 percent in Sri Lanka indicated they had come online for reasons related to the pandemic. Along with this growth, gender gaps in access have also seen improvements. The gender gap in internet use dropped from 57 percent to 37 percent in India and from 34 percent to 7 percent in Sri Lanka by 2021 (Figure 1). The first research question addressed by this paper is: how does gender affect individuals' access to online platforms?

FIGURE 1
INTERNET USE IN INDIA AND SRI LANKA (2017-2021)



Note: 2017 and 2018 surveys pertain to the age group 15 to 65 years, while 2021 surveys show all ages 15 and older. The 2021 survey sample excludes Kerala, which had to be excluded due to the COVID pandemic.

Source: AfterAccess and LIRNEasia nationally representative surveys, 2017-2021.

Although the improvements in access are necessary, access alone is only the first step. Having access to a device and an internet connection (even high quality) are not by themselves sufficient to meaningfully transform the lives of women and girls. There is a clear need to ensure that women — across all segments and intersections — are equipped with knowledge, skills, and agency to be able to use internet access to advance their economic and social empowerment. The second research question that this paper addresses, then, is: what is the relationship between gender and individual digital skills capabilities?

Through a series of statistical models, the paper unpacks these two research questions, looking at the role gender plays after controlling for other factors such as differences in education levels and employment status. Section 2 reviews some of the literature on digital gender gaps and digital skills. Section 3 presents the data and the statistical methods underlying the analysis. Section 4 presents the findings, and Section 5 concludes.

LITERATURE REVIEW

In an era marked by rapid technological advancements, the interconnectedness of the digital landscape has transformed the way we interact, learn, and work. Digital technologies have become integral to daily life, impacting diverse aspects of society, from communication and education to business and governance (Fitzgerald, Kruschwitz, Bonnet & Welch, 2013, October 7; Hargittai, 2005; Yoo, 2010).

GENDER AND INTERNET ACCESS

The empirical evidence indicates major differences between men and women in the volume, frequency, and quality of ICT access, particularly in developing countries. For instance, ITU data showed that in 2019, globally, 57 percent of women were online compared to 62 percent of men. However, for least developed countries, ITU estimates that just 19 percent of women were online in 2019 compared to 86 percent in developed countries (ITU, 2022). Other available gender-disaggregated data on access and usage indicates similar disparities between men's and women's digital access (e.g., A4AI, 2016; GSMA, 2015, 2021; Scott et al., 2017 World Bank, 2016; World Wide Web Foundation, 2020, among others).

The GSMA's 2020 global gender gap study indicates that women in low- and middle-income countries were 15 percent less likely to use mobile internet than men in 2020 (GSMA, 2021). Note that in many Global South countries, almost all internet use is through mobile devices. Outside of the Middle East region, South Asia has seen some of the widest gender gaps in mobile adoption during the 2000s (notably, however, data presented by Zainudeen et al. (2010) show Sri Lanka more similar to Southeast Asian countries in terms of gender gap). The GSMA's estimate of the gender gap in South Asia was 36 percent in 2020 (GSMA, 2021). As internet access has spread throughout the region, similar patterns have emerged, with gender gaps in internet access as high as 62 percent in Bangladesh and 57 percent in India by 2019 (15-65 age group). In the same 23-country Global South study, Sri Lanka and Nepal showed smaller gender gaps in internet access, at 34 percent and 33 percent, respectively (LIRNEasia, 2019). Further disaggregation of the data shows that the gaps also vary across other dimensions, such as location and socioeconomic group. Women who belong to other marginalized groups (e.g., rural and lower socioeconomic segments) are even less connected, and therefore likely to be further disadvantaged than women on average.

The importance of the underlying social norms within the South Asian region becomes apparent when considering the GNI per capita of the 23 countries versus their levels of connectivity and gender gaps. South Asia appears to be an outlier, with gender gaps at similar levels as poorer African countries, if not greater.

Globally, gender gaps in mobile adoption have decreased in recent years. Past research on the role of gender in mobile adoption can nevertheless have relevance for studying the role of gender in determining internet access. Studies of either mobile adoption or internet/data service use suggest that gender disparities in education and income levels can explain a considerable part of the gender disparity in digital access in developing countries, especially in Asia. Several studies from the Global South report that gender is a statistically significant variable in predicting digital adoption (Perampalam, Zainudeen & Galpaya, 2016; Rajapakse, Zainudeen, Galpaya & Perampalam, 2016; Deen-Swarray, Gillwald & Morrell, 2012; de Silva, Ratnadiwakara & Zainudeen, 2011; Milek, Stork & Gillwald, 2011; Hilbert, 2011; Zainudeen & Ratnadiwakara, 2011). In other words, being a woman means that one is less likely to be digitally included. For instance, Perampalam, Zainudeen and Galpaya (2016) show that in Myanmar, after accounting for gender differences in education and employment status, being a woman reduced an individual's likelihood of owning a mobile by 42 percent.

Studies in developed markets in the late 1990s/ early 2000s show patterns similar to current research in Asia, regarding the adoption of mobile phones and Internet (Wasserman & Richmond-Abbott, 2005; Rice & Katz, 2003; Bimber, 2000, among others). In contrast, a Research ICT Africa 2008 study found that gender was a significant determinant of mobile adoption in only 6 of 17 countries (Gillwald, Milek & Stork, 2010).

GENDER AND DIGITAL SKILLS

In the digital age, digital skills have become crucial for personal and professional success. The Broadband Commission establishes three skill tiers: basic functional skills, generic skills for meaningful use, and higher-level skills for empowerment (Broadband Commission for Sustainable Development, 2017). Hargittai (2005, p. 372) described digital skills as a "user's ability to locate content on the web effectively and efficiently." Similarly, West, Kraut, and Ei Chew (2019) describe digital skills as consisting of: copying or moving a file or folder; using copy and paste tools to duplicate or move information within a document; sending emails with attached files; using basic arithmetic formulas in a spreadsheet; connecting and installing new devices; finding, downloading, installing and configuring software; creating electronic presentations with presentation software; and transferring files between a computer and other devices. Van Dijk and van Deursen (2010) classified digital skills in four broad categories: operational (the ability to operate hardware and software); information (the ability to search, select, and process information in a computer); strategic (the ability to use a computer and the Internet to achieve specific goals); and formal (the ability to navigate in a hypermedia context).

There are numerous techniques for gathering data on digital skills. Standardized tests and observations can give the most accurate assessment of individual skills, but these are expensive and difficult to scale up (Hargittai 2002; van Dijk & van Deursen, 2010; West et al., 2019). Most current statistics on digital skills come from self-reported questionnaires in which individuals rate their degree of expertise in a variety of digital activities, though this self-reporting method has significant problems of validity (Mccourt Larres, Ballantine & Whittington, 2003; Hakkarainen et al., 2000; and Tai, 2005). Some self-reporting digital skills studies use binary response (yes/no) questions (Hargittai, 2005), while others use a Likert Scale (Hargittai, 2005; Hargittai & Hsieh, 2012; Hargittai & Hinnant, 2008; van Laar et al., 2019). Other approaches include multiple-choice tests and assignment-based evaluations to assess digital literacy (Hargittai, 2002; Martínez-Cantos, 2017; van Dijk & van Deursen, 2010).

Digital skills are influenced by multiple determinants such as gender, age, socioeconomic status, ethnicity, geography, level of education, employment status, and training (van Laar, van Deursen, van Dijk & de Haan, 2019; Helsper & Eynon, 2010; Mossberger, Tolbert & Stansbury, 2003). Van Laar et al. (2019) and van Dijk and Hacker (2003) found a correlation between gender and digital skills. Higher digital skills are associated with higher-educated and middle-aged respondents (Martínez-Cantos, 2017). For some categories, men and women do not differ significantly in their digital access and digital skills (Hargittai, 2002; Van Deursen & Van Dijk, 2011), highlighting the intersectional nature of the disparities. For instance, some women who are self-employed or who have completed their education have digital skills equal to or better than males (van Laar et al., 2019).

A review of the literature shows that gender disparities do persist in both digital usage and digital skills, impacting various aspects of engagement, access, and utilization. According to an International Telecommunication Union (ITU) report, the gender gap in digital skills is as high as 25 percent in some Asian and Middle Eastern countries (ITU, 2017). Structural inequalities related to demography, income, education, and employment perpetuate barriers to both access and skills, which women often experience more acutely (Kuroda, Lopez, Sasaki & Settecase, 2019; van Deursen & van Dijk, 2009, 2010; West et al., 2019). Women's limited access and utilization are exacerbated by factors such as age, low education, rural residence, disabilities, and refugee status (Kuroda et al., 2019; West et al., 2019). For instance, in rural areas, women may own mobile phones but lack the skills to fully utilize them, underscoring the multifaceted nature of gender disparities in digital skills (West et al., 2019). Martínez-Cantos (2017) discerns lower levels of digital skills that reveal pronounced gender gaps in older and less educated cohorts. Gender-based digital disparity emerges among younger cohorts as well (Gui & Argentin, 2011; Hargittai, 2010; Helsper & Eynon, 2010). Meneses and Momino (2010) find that, for skills like an online search or file download, male school students with those skills outnumber female students by 49 percent and 118 percent, respectively. Thus, the gender digital skills gap interacts with and is exacerbated by concerns of age, residence, poverty, disabilities, and education (West et al., 2019).

Even after adjusting for other socioeconomic characteristics, certain gender disparities persist. Women's self-assessment of their digital know-how is usually lower than men's (Hargittai & Shafer, 2006; Helsper & Eynon, 2013; Van Deursen & Van Dijk, 2015; Whitley, 1997). Thus, women tend to undervalue their digital know-how compared to men (Helsper & Eynon, 2013). Studies by Hargittai (2002) and Van Deursen and Van Dijk (2011) highlight this disparity. Gender stereotypes as well as differentiated expectations contribute to limiting women's engagement in technology-related activities (OECD, 2018; Sáinz et al., 2016). Gender stereotypes profoundly impact girls' and boys' confidence in their digital skills (Sáinz et al., 2016). The self-efficacy gender gap widens in secondary and tertiary education, revealing that, despite promising initial performance, girls demonstrate lower levels of confidence even when they outperform boys (West et al., 2019). Hargittai and Shafer (2006) emphasize that this self-assessment dynamic can hinder women's advances in digital engagement, in information seeking (Helsper & Eynon, 2013), in content sharing (Hargittai & Walejko, 2008), and even in contributing to collaborative platforms like Wikipedia (Hargittai & Shaw, 2015).

A lack of digital skills leads to digital inequality (van Dijk 2002; Hargittai 2002). Digital skills are required for effective use; they determine the individual's benefit from using the internet (van Dijk 2002; Hargittai 2002; Zillien and Marr 2013); and digital skills have a moderator effect on digital adaptation behaviors (Yu et al. 2017). Thus, in many cases, women utilize digital skills less and profit less from them than males (Kuroda et al., 2019).

DATA AND METHOD

DATA

The data analyzed in this paper is based on surveys conducted by LIRNEasia in Sri Lanka and India between March and October 2021. The nationally representative samples for the survey consisted of 7,000 households across India, including 350 villages and wards, [1] and 2,500 households across 125 Grama Niladhari Divisions in Sri Lanka. Multi-stage stratified random sampling methods were used to ensure representation of the target group (age 15+) at a national level, with a confidence level of 95 percent. The margin of error was +/-1.7 percent for India and +/-2.8 percent for Sri Lanka. The data also allows for disaggregation by urban/rural divide, gender, and socio-economic classification at both national and sub-national levels for major states/provinces in the two countries. [2] The sample sizes are shown in Table 1.

TABLE 1. SAMPLE DETAILS

	FULL SAMPLE	INTERNET USERS
India	6,995	3,299
Sri Lanka	2,501	1,098

Source: LIRNEasia survey data (2021)

The survey included questions on demographics, socioeconomic characteristics, internet access, and digital skills, among others. This data is used in the analysis. A broad definition of internet access was used, to include uses such as Facebook, WhatsApp, email, etc.

Digital skills were measured through self-reported responses to a set of questions on whether the respondent can perform a certain task independently:

1. Can you search for information or other content on the internet/online?

1 Excluding the state of Kerala, where the survey could not be conducted at the time due to the Covid-19 pandemic.

2 Delhi, Assam, Tamil Nadu, and Maharashtra in India, and the Western Province in Sri Lanka. Detailed methodology information for the India dataset can be found here: https://lirneasia.net/2021/11/impact-of-covid-19-on-households-and-the-workforce-in-india-survey-methodology-notes/ and for the Sri Lanka dataset, here: https://lirneasia.net/2021/12/impact-of-covid-19-on-households-and-the-workforce-in-sri-lanka-survey-methodology-note/

2. Can you post any information on the Internet/online. This can include commenting on something that you see, or posting or sharing status update, photo or link.
3. Can you install an application on mobile phone?
4. Can you create log-in details (user) and a password to use a particular service or a website online. Some examples are Facebook, Viber, Instagram, Twitter, etc.
5. Can you locate and adjust settings on an application or service on mobile phone?
6. Can you make a payment or complete a transaction online or by mobile (e.g., this can include card payments using mobile phone, mobile money services such as _____[India: PayTM, PhonePay, GooglePay/Sri Lanka: EasyCash, MCash], and using payment gateway apps such as PayPal)

The questions were asked of all respondents. For the present analysis, only the responses of internet users were considered. While this set of skills is not comprehensive, it covers a basic set of skills which would be required to operate in the digital economy, as a consumer, citizen, or digital micro-entrepreneur.

The data shows that, overall, Indian internet users report higher levels of digital skills than Sri Lankan internet users. However, there is a considerable gender gap in skill level, especially in India. Among Indian internet users aged 15+, 68 percent of males compared to 59 percent of female internet users are able to create log-in details, including a password, to use an online service or app (LIRNEasia, 2021; see Table 2).

Based on the review of the existing literature, we propose two research questions:

1. How does gender contribute to gaining access to online platforms?
2. What is the relationship between gender and digital skills capabilities?

TABLE 2. DIGITAL SKILLS

TASK	INDIA			SRI LANKA		
	MEN	WOMEN	% GAP	MEN	WOMEN	% GAP
Search for information or other content	77%	67%	13%	67%	61%	9%
Post any information on the Internet/online	72%	60%	17%	66%	65%	2%
Install an application	75%	65%	13%	68%	58%	15%
Create log-in details (username and password) to use a service or website online	68%	59%	13%	59%	53%	10%
Locate and adjust settings on an application or service on mobile phone	64%	54%	16%	53%	48%	9%
Make a payment or complete a transaction online or by mobile	55%	43%	22%	22%	20%	9%

Notes: Percent of population 15 and older. Based on self-reported ratings of ability to complete the task independently.

Source: LIRNEasia survey data (2021)

Sri Lankan internet users show smaller gender gaps in digital skills, although significant numbers of both men and women are unable to set up and manage accounts for services online and engage in transactions (Table 2). For instance, 31 percent of women internet users and 28 percent of men

internet users in Sri Lanka did not know how to create log-in details and passwords for services and apps online (and many were not even aware of such tasks). Over 75 percent of internet users in Sri Lanka, whether male or female, were unable to complete payments and transactions online (LIRNEasia, 2021).

METHOD

Binary logistic modeling is used to investigate these research questions, following the approaches of previous work. Technology adoption has often been modeled as a binary outcome (Chabossou et al., 2009; Deen-Swarray et al., 2012; de Silva et al., 2011; Lokanathan, Gamage & Senenayake, 2014; Rajapakse, Zainudeen, Galpaya & Perampalam, 2016), and the possession of digital skills has also been modeled as a binary outcome (Meneses & Momino, 2010; Min, 2010; Zillien & Hargittai, 2009). [3]

Eight models were developed for each country, to investigate the research questions. Model 1 investigates the factors affecting prior use/experience of the internet. Models 2–8 investigate the factors affecting ability to fulfil the six skills described in Section 4.1. Model 2 investigates the odds of being able to perform at least one of the six skills, while Models 3–8 investigate the six skills individually, starting with simple skills such as being able to search for or post information online, to more complex ones such as being able to make payment or complete a transaction online. The outcome variables are given in Table 3.

TABLE 3. OUTCOME VARIABLES, MODELS 1-8

	OUTCOME VARIABLE	VALUES
MODEL 1	Internet use	0 = no internet use 1= internet use
MODEL 2	Ability to perform at least one of the tasks (1-6)	0 = not able to perform any task 1 = able to perform at least one task
MODEL 3	Ability to search for information or other content	0 = not able to perform task 1= able to perform taskw
MODEL 4	Ability to post any information on the Internet/online	
MODEL 5	Ability to install an application	
MODEL 6	Ability to create log-in details (user) and a password to use a particular service or a website online	
MODEL 7	Ability to locate and adjust settings on an application or service on mobile phone	
MODEL 8	Ability to make a payment or complete a transaction online or by mobile	

Source: Authors

The main explanatory variable for this paper is gender, which is coded as 1=female (Table 4). The analysis also includes the following control variables: location, age education, socioeconomic classification (SEC) group, employment status, marital status, device ownership (including type of mobile device owned), and presence of school-aged children in the household (see Table 4).

3 For a detailed discussion of the binary logistic regression methodology see de Silva et al. (2011).

TABLE 4. EXPLANATORY VARIABLE DETAILS

VARIABLE	VALUES
GENDER	0 = male 1= female
LOCATION	0 = urban 1 = rural
AGE	0 = 15-25 years 1 = 26-35 years 2 = 36-45 Years 3 = 46-55 Years 4 = 56-65 Years 5 = 66 and above
EDUCATION	0 = up to tertiary education complete 1 = only up to secondary education complete 2 = only up to primary education complete 3 = no education
SOCIOECONOMIC CLASSIFICATION	0 = SEC A 1 = SEC B 2 = SEC C 3 = SEC D 4 = SEC E
EMPLOYMENT STATUS	0 = employed 1 = unemplyed
MARITAL STATUS	0 = unmarried 1 = married
INTERACTION TERM (MARITAL STATUS & GENDER)	Marital status * gender
MOBILE DEVICE	0 = smartphone 1 = basic or feature phone 2 = no phone
DESK/LAPTOP OWNERSHIP (INDIVIDUAL)	0 = own 1= do not own
DESK/LAPTOP OWNERSHIP (HOUSEHOLD)	0 = own 1= do not own
FIXED PHONE OWNERSHIP	0 = own 1= do not own
RADIO OWNERSHIP	0 = own 1= do not own
TV OWNERSHIP	0 = own 1= do not own
SATELLITE DECODER OWNERSHIP	0 = own 1= do not own
PRESENCE OF SCHOOL-AGED CHILDREN IN THE HOUSE	0 = present 1= absent

Source: Authors

Based on this framework, the variables listed are predicted to influence the probability of the outcomes of interest in each country, for each model. For categorical explanatory variables, the reference category (where the value takes a zero) was assigned as the more "privileged" category, for easier interpretation of odds ratios (coefficients). For example, the odds ratio for the gender variable can be interpreted as the likelihood of a female, compared to a male, fulfilling the particular outcome, holding constant all other reference-category characteristics (urban, aged 15–25, tertiary educated, highest SEC group, employed, single, owns a smartphone and other devices included in the model, and without school-aged children in the household).[4] Note that the expected signs of each of these reference category coefficients would be expected to be negative, given the outcome of interest: for instance, a rural respondent would be less likely to be online than an urban respondent.

As an initial step, the correlations of the explanatory variables with the outcome variables of interest were examined through Chi-squared tests (see Appendix A, Table A9). The tests revealed statistical correlation—and thus justification (beyond theoretical) for inclusion in the models—for all the explanatory variables except (1) gender and (2) the presence of children in the household. However, those two variables were still included in the models, as potentially bearing on the research questions. Variables were also tested for multicollinearity before running the models; none of any significance was detected.

FINDINGS AND DISCUSSION

Tables 5 and 6 present the most relevant elements of the regression outputs, relating to the role of gender in predicting the outcome variable in the model.[5]

INTERNET ACCESS AND GENDER

The statistical modeling shown in this section allows us to isolate the gender effect in determining the likelihood of an individual owning a mobile device or being online. Statistically controlling for gender differences in observable characteristics (such as age, education, employment status, etc.) implies that the differences between men and women in these characteristics have all been controlled for or "evened out." Thus, the gender variable captures other differences between men and women, which are not statistically controlled for in the models. Such differences can include unobservable factors relating to social and cultural norms which become visible by comparing the magnitude of this effect across cultures and regions. Unpacking the intrinsic role of gender, and understanding what this gender "effect" means, is beyond the remit of statistical modelling, as a task that requires a context-specific understanding of the specific country or population gained through qualitative research, which is outside of the scope of this paper.

Model 1 indicates that the gender variable does not make a significant contribution to the odds of internet use in Sri Lanka [6], with a p-value greater than 0.05. [7] In India, however, gender does make a significant contribution: women in Sri Lanka with equivalent characteristics are as likely to use the internet as men, while in India, a woman with equivalent characteristics is 35 percent less likely to have ever used the internet than a man.

4 This cluster of zero-reference category variables is referred to as the "reference male."

5 Tables of descriptive statistics for the model variables, as well as the chi-squared values for variable associations can be found in Appendix A. The full binary logistic model outputs for all models can be found in Tables B1-16 in Appendix B.

6 Odds are directly related to the probability of internet use.

7 The significance values for each explanatory variable indicate whether the respective variable makes a significant contribution to the model; values equal to or below 0.05 indicate a statistically significant contribution at the 95-percent level of confidence. Regardless of significance values, the direction and magnitude can also provide some indication of the relationship, even if weak.

TABLE 5. SUMMARY OF GENDER VARIABLES FOR MODELS 1–8: SRI LANKA

			GENDER (=0 IF MALE, = 1 IF FEMALE)			NAGELKERKE R SQUARE	% OF CORRECTLY CLASSIFIED CASES
			SIGN	SIGNIFICANCE	ODDS RATIO (EXP(B))		
SRI LANKA	**(1)**	Ever used internet	(+)	0.261	1.396	0.698	86%
	(2)	Able to perform at least one skill	(+)	0.845	1.061	0.222	78%
	(3)	Search for information or other content on the Internet, online	(-)	0.886	0.964	0.254	70%
	(4)	Post any information on the Internet, online	(+)	0.737	1.086	0.216	70%
	(5)	Install an application	(-)	0.147	0.688	0.286	71%
	(6)	Create login details (user) and a password to use a particular service or a website	(-)	0.061	0.627	0.296	71%
	(7)	Locate and adjust settings on an application or service	(-)	0.286	0.778	0.275	70%
	(8)	Make a payment or complete a transaction online or by mobile	(-)	0.741	0.917	0.153	81%

TABLE 6. SUMMARY OF GENDER VARIABLES FOR MODELS 1–8: INDIA

			GENDER (=0 IF MALE, = 1 IF FEMALE)			NAGELKERKE R SQUARE	% OF CORRECTLY CLASSIFIED CASES
			SIGN	SIGNIFICANCE	ODDS RATIO (EXP(B))		
INDIA	**(1)**	Ever used internet	(-)	0.003	0.649	0.663	85%
	(2)	Able to perform at least one skill	(-)	0.012	0.614	0.300	84%
	(3)	Search for information or other content on the Internet, online	(-)	0.012	0.651	0.259	78%
	(4)	Post any information on the Internet, online	(-)	0.001	0.594	0.268	75%
	(5)	Install an application	(-)	0.021	0.674	0.276	78%
	(6)	Create login details (user) and a password to use a particular service or a website	(-)	0.003	0.662	0.273	74%
	(7)	Locate and adjust settings on an application or service	(-)	0.015	0.690	0.282	71%
	(8)	Make a payment or complete a transaction online or by mobile	(-)	0.000	0.595	0.280	69%

As per the model outputs (shown in Tables B1–B16, in Appendix B), the key contributors to internet access in both countries are: age (with younger age groups more likely to be online); smartphone ownership; education (more educated more likely to be online); and other device ownership (computer, TV, etc.). Another contributing factor in both countries is location, with rural individuals less likely to be online than their urban counterparts. Socioeconomic classification contributes to internet access in India (with higher groups more likely to be online), while being employed in Sri Lanka contributes to being online (those not employed are less likely to be online).

Being married appears not to make a significant contribution to the likelihood of being online, in both countries; directionally, however, the coefficients indicate a (slight) negative impact of marriage on being online. An additional interaction term, combining gender and marital status variables, was included in the models to examine whether the odds of ever having used the internet are different for married women compared to unmarried women (a possible proxy for the presence of domestic responsibilities, as well as power dynamics). In both countries, that interaction term—marital status*gender—does not significantly contribute to the model, though, once again, directionally, the triple combination of gender, marital status, and marital status*gender variables suggest that being a married woman negatively contributes to the likelihood of having used the internet, compared to a single man, all else held constant.[8]

The presence of school-age children in a household was included as an explanatory variable to capture possible effects on internet access; for example, the need for children to be online for school during the pandemic period (when the data was collected) could potentially have a spill-over effect of bringing their primary caregivers (often women) online. The results indicate a small effect present in India (but not Sri Lanka): an individual from a household where there are school-aged children is less likely to be online, holding all other factors constant. However, this variable does not significantly contribute to the model.

INTERNET ACCESS AND DIGITAL SKILLS

Model 2 investigates the factors affecting the ability to fulfil at least one digital skill, from a set of six that are asked about in the survey. Models 3-8 conduct the same investigation on each of those six skills individually, starting with simple skills such as being able to search for or post information online, to more advanced skills such as being able to make payment or complete a transaction online.

Models 2–8 reveal similar effects of gender on the likelihood of having any of the digital skills in question listed in Table 2, as seen in the previous sub-section In Sri Lanka, gender does not make a significant contribution to the ability to perform any of the tasks (i.e., digital skills), while it does make a significant contribution to digital skills capabilities in India. The odds ratios indicate that, in India, a female compared to the reference male (i.e., holding all other explanatory variables constant) has between a 35 percent and 41 percent likelihood of being able to perform any of the tasks; put simply, being a woman in India leads to a considerably lower likelihood of being able to perform at least one of the tasks.

Comparing the six tasks revealed no variation according to the level of complexity of the task, as might be expected. For simple tasks, such as searching for and posting information online, the gender effect might be expected to be lower than for more complex tasks which require a higher level of skill, such as completing a payment or transaction online; however, the regression outputs indicate this is not the case (see Appendix B). The gender effects are highest for posting information online, payments/transactions, and creating login details. This could suggest apprehension or a lack of confidence to perform certain tasks or activities online from concern about potential digital harms (e.g., online harassment based on posting comments on social media, or contact information being revealed to strangers).

The model outputs (Tables B1–B16 in Appendix B) show device ownership as a key enabler of digital skills in both countries. Those owning smartphones and/or personal computers are more likely to be able to perform all the tasks. Another key predictor in both countries is age: the likelihood of being able to perform any of the tasks reduces with increasing age. For some skills, education and socioeconomic classification (SEC) group also appear to be enabling factors, especially in India: the likelihood is lower with lower levels of education and SEC. Among Sri Lankan internet users (but less in India), being employed has a positive effect on the likelihood of being able to perform the digital tasks.

Being married (for men and women overall) does not have any impact on digital skills in Sri Lanka, but it has a negative impact on the likelihood of having

8 For guidance on interpretation see: https://www.youtube.com/watch?v=LX2HBvCKjBY

the more complex skills in India (i.e., installing an application; creating login details/passwords; locating/adjusting settings; completing payments/transactions). The interaction term marital status*gender does not reveal any gender-specific patterns in any of the models.

The presence of school-age children in the household does not appear to make a significant contribution to the skills models. Directionally, however, for several of them the coefficients suggest a positive relationship, i.e., the presence of school-aged children in the household has a slight positive effect on the ability to perform the tasks in question.

CONCLUSION

This paper explored the role of gender in predicting internet access and digital skills among the population age 15+ in India and Sri Lanka. There is evidence of a gender "effect" in India in both internet access and digital skills capabilities, but not in Sri Lanka, once other gender differences (e.g., education levels) have been accounted for. A possible explanation for the observed country differences Is suggested by prior work, indicating a stronger set of gender norms in India than in Sri Lanka, such that women are less constrained in their use of technology in Sri Lanka (Zainudeen, et al., 2010).

In both countries, the key drivers of being online and possessing digital skills are device ownership, age, and education. Interventions to improve digital skills therefore should be accompanied by interventions to improve affordability of devices. Interventions should also be targeted more toward older age groups as well as less educated groups in both countries, and toward women specifically in India who lag behind. While the gaps in internet access have been narrowed considerably in recent years, and there is no apparent "gender effect" in Sri Lanka, it is notable that considerable numbers of people remain offlines, with insufficient skills to engage meaningfully online. Sri Lanka still has the challenging task of ensuring that its online population—both men and women—are equipped with the skills necessary to take advantage of digital opportunities, to better their lives.

APPENDICES

https://lirneasia.net/wp-content/uploads/2023/09/Supplementary-tables-gender-gaps-skills-Equals-Report.pdf

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FEMALE STUDENTS' EMPOWERMENT THROUGH DIGITAL LITERACY TRAINING: WHY IT IS NOT ALWAYS ABOUT CODING

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ABSTRACT

Sisters of Code, Cambodia's first female coding club, represents an innovative solution to address the digital gender divide in developing nations. Although women comprise nearly half the global workforce, they remain significantly underrepresented in STEM fields, with Cambodia showing particularly stark disparities: only 8.4 percent of female tertiary graduates major in ICT, the lowest level among ASEAN countries (World Economic Forum, 2022). Sisters of Code's program approach combines digital literacy training with confidence building and community support to overcome deeply entrenched cultural barriers. Based on an after-school informal educational program focused on visual programming, web development, online security and AI fundamentals, the program has expanded across the country via a sustainable train-the-trainer model. The initiative's success, recognized by multiple international awards, demonstrates how targeted interventions can effectively bridge the digital gender gap while inspiring a broader societal change.

KEY FINDINGS

1. Cultural barriers and gender stereotypes remain the primary obstacles to women's participation in technology in Cambodia, compounded by limited access to quality education and financial constraints.
2. All-female learning environments significantly boost confidence and engagement, with 90 percent of participants recommending the program to other girls.
3. A holistic curriculum combining digital literacy skills with creativity and problem-solving proves to be a more effective learning technique than focusing solely on coding.
4. The train-the-trainer ambassador model enables sustainable program scaling while creating local role models.
5. Early intervention and parental engagement are crucial for challenging gender stereotypes and expanding girls' perceived career possibilities.

INTRODUCTION

Although women make up nearly half of the global workforce, they remain significantly underrepresented in Science, Technology, Engineering, and Mathematics (STEM) fields. Only 33.3 percent of the world's researchers are female, according to UNESCO Institute of Statistics data for 107 countries, 2015–2018. Though this rate has increased in the past five years, there remain even larger gaps in some countries, especially the developing ones. Clearly, even in the 21st century, with digital solutions influencing all aspects of human life—from personal interactions to global business development—half of the population is largely restricted from active participation.

The overwhelming majority of digital technology creators are male. As of 2023, the percentage of female tech leaders was 14 percent, a historic high unchanged from the previous year (www.statista.com). According to Forbes, women hold just 26.7 percent of tech-related jobs globally. The digital world is primarily created by men, for men. Imagine if we had diversity in the way we design IT—what value would that bring to us and to the digital economy? Women add a unique perspective and valuable skill sets to the tech industry, such as strong communication, collaboration, problem-solving, and empathy (Ashcraft et al., 2016). The more diverse a team, the better it

is at solving problems, maintaining high levels of productivity, thinking creatively, and generating increased revenue (Diaz-Garcia et al., 2013; Ellison & Mullin, 2014; Levine et al., 2014; Phillips et al., 2009). Different perspectives drive innovation and ensure that technologies cater to the needs of a larger share of the population (McKinsey, 2018, citing Sethi et al., 2001; Egan, 2005; Woolley et al., 2010).

So, what stops women from achieving equal representation in the tech industry? Research suggests that self-doubt, systemic bias, and imposter syndrome play a significant role in deterring women from pursuing and persisting in STEM careers (Cokley et al., 2018). This disparity is often attributed to factors such as gender stereotypes, a lack of female role models, and systemic biases (Corbett & Hill, 2015). Studies indicate that women are more likely to underestimate their abilities and experience self-doubt, even when objectively performing at the same level as their male counterparts (Ewers & Wood, 2022).

The gender disparity within technology companies in Southeast Asia reflects a wider structural challenge that women face across various industries. However, the rapid expansion of the tech sector creates high demand for skilled talent. With its promising career opportunities, the tech sector is well positioned to address these inequities. The technology industry thus has the potential to serve as a catalyst for transformative change. Increasing awareness of the gender imbalance in this field underscores the necessity for collective action. Achieving meaningful progress requires coordinated efforts among multiple stakeholders to foster an inclusive and equitable environment.

Sisters of Code, a pioneering initiative in Cambodia, recognizes the importance of addressing these challenges and harnessing women's strengths through a holistic approach to digital literacy. The initiative's educational program empowers Cambodian women by providing a supportive community, fostering confidence, and equipping them with diverse skills in addition to coding, ultimately enabling them to thrive in technology sectors and contribute their valuable perspectives. The example it sets can be applied in other countries aiming to increase young women's participation in STEM.

According to the World Economic Forum, it will take 136 years to close the global gender gap unless drastic changes occur. Since the COVID-19 pandemic, progress on gender equality has in fact been reversing. Achieving economic equality will take even longer: it is now estimated that it will take 286 years to reach gender parity.

SPARKING EARLY INTEREST: OUTREACH AND EARLY INTERVENTION PROGRAMS

Research underscores the importance of early intervention in promoting digital literacy and gender equality in STEM fields (Stoet & Geary, 2018). According to the Boston Consulting Group report Boosting Women in Technology in South East Asia (2020), the first pivot point occurs when a woman decides what to study at college. Without the right educational resources—accessible to all—countries will lag in building a skilled workforce, and companies will struggle to find talent. Girls' lack of exposure to technology topics in secondary school is a challenge worldwide. For a majority of high school girls, a critical barrier to studying technology in college is a lack of familiarity with the field, suggesting that high school counseling could be effective in encouraging women to pursue technology degrees. The perceived difficulty and narrowness of tech studies are also highlighted as critical deterrents for women, who often choose another educational path.

The most significant proven approach is creating programs that expose school-aged girls to technology subjects and career opportunities. For example, the Ministry of Education (MOE) and Infocomm Media Development Authority, a statutory board under the Ministry of Digital Development and Information (IMDA) in Singapore jointly launched a program called Code for Fun that introduces all students in upper primary school to computational thinking through coding. This program helps participants develop an appreciation of core computational thinking and coding concepts, using simple visual programming-based lessons developed by MOE and IMDA. It also exposes them to emerging technologies such as artificial intelligence.

According to the Boston Consulting Group study, Southeast Asia Women in ICT, conducted in July 2020, a number of initiatives can deliver significant impact on female students' engagement in tech. Those proven to be most efficient are: programs for high school students that expose female students to tech subjects and career opportunities; career counseling linking students' interests to tech subjects; and participation of women students in events that promote higher education opportunities in tech. The study also identified some highly effective opportunities that are less available: networking and supportive women's peer groups in tech; public commitment to women's participation in the tech industry; and setting up and sharing company diversity goals, as well as measuring the progress.

FIGURE 1:

Proven Measures and Hidden Gems that can influence women to study technology

BCG Southeast Asia Women in ICT Study, July 2020

INITIATIVE	AVAILABILITY RANKING	EFFECTIVENESS (WEIGHTED %)*
Programs exposing high school students to tech subjects and career opportunities.	**1**	**7.0**
Highschool career counselling linking students' interests to tech subjects	**2**	**6.7**
Participation of women students in events promoting higher education in tech	**3**	**7.3**
Scholarship or financial incentives	4	7.4
Educational institution marketing materials aimed at women candidates	5	6.9
Female role models who represent diversity in teaching faculty within tech	6	7.1
Flexibility programs (such as part-time courses)	7	6.5
Outreach to female talent pools (such as women's high schools and colleges)	8	7.1
Bias-free day-to-day experiences (such as orientation, workshops, and events)	9	7.2
Networking and supportive women's peer groups in tech	**10**	**7.4**
Formal or informal mentoring for female tech students	11	7.2
Removal of bias from course evaluations (e.g., by creating diverse decision panels)	12	7.0
Antidiscrimination policies	13	6.9
Bridging programs from high school to higher education in tech	14	6.9
Public commitment to women's participation in tech institutions	**15**	**7.8**
Setting and publicly sharing company diversity goals and measuring progress against KPI's	**16**	**7.3**

Proven measures: baseline programs that should be in place at all organizations
Hidden gems: programs that are less widely available but perceived as highly effective

Source: BCG Southeast Asia Women in ICT study, July 2020 (n=1,645).
* Weighted average of scores for "average" and above (7-10).

These insights are reflected in Sisters of Code activities, including creating supportive women-only peer groups, career counseling linking students' interests in tech subjects, and exposing high school students to tech subjects and career opportunities.

THE DIGITAL GENDER DIVIDE IN CAMBODIA: BARRIERS AND CONSEQUENCES

As Cambodia races to keep pace with rapid technological changes sweeping the globe, a deep gender divide dominates the digital landscape. Staggering disparities exist between Cambodian men and women in access to online resources and in representation in technology sectors.

Official government data shows the scale of the digital gender gap. According to the Cambodian Ministry of Posts and Telecommunications' 2020 report, only 26 percent of Cambodian women have access to the Internet, compared to 39 percent of men. This 13 percentage point divide means that millions of women are shut out from the educational, economic, and social opportunities of the online world.

The gap extends far beyond connectivity issues. Men vastly outnumber women in employment across vital technology fields like computer programming, network management, cybersecurity, and more. The UNESCO Institute of Statistics (2018) provides the following distribution of female tertiary graduates by major field of study in Cambodia.

- Health and Welfare – 56.2 percent
- Business, Administration, and Law – 49.4 percent
- Arts and Humanities – 43.5 percent
- Natural Sciences – 34.1 percent
- Agriculture – 31.3 percent
- Social Sciences and Journalism – 23 percent
- Engineering – 15.1 percent
- Information and Communication Technologies (ICT) – 8.4 percent

The percentage of female students in Cambodia selecting ICT as their major is the lowest among the 110 countries analyzed.

Because women in Cambodia bear most of the responsibility for taking care of family members, even educated women may drop out of work to focus on family responsibilities. According to "ASEAN Gender Outlook 2024 by UN Women," women and girls in Cambodia spend three hours a day on average on unpaid domestic and care work, while men spend only 18 minutes on average for the same chores. The consequences of this situation are far reaching. Lack of digital skills, literacy, and access, burden of domestic work put Cambodian women at a severe disadvantage in the modern job market, as technology permeates every industry. The gender divide perpetuates existing income inequality, while denying women a voice and active participation in the digital economy.

From a national perspective, Cambodia cannot afford to neglect the talents of half its population. As global demand for technology workers outstrips supply, the nation is disadvantaged by its failure to cultivate and retain its full potential workforce. The digital gender gap acts weighs down the country's technological development and economic competitiveness.

Although improving infrastructure, education, and training opportunities can help narrow the divide, the roots of the problem are systemic. Deeply entrenched cultural norms and patriarchal traditions are barriers blocking Cambodian women's entry into technology. A 2020 report by Transparency International identified six major cultural roadblocks hindering women's leadership and participation across Cambodian society.

1. Patriarchal societal expectations reinforce discriminatory beliefs that leadership roles should be occupied by men.
2. The "double burden" of household responsibilities like childcare, in addition to employment, falls disproportionately on women.
3. Lack of access to quality education, especially higher education, shuts doors to career advancement.
4. Financial and political barriers impede women's ability to seek leadership positions or work in certain fields.
5. Male-dominated institutional decision-making processes have long excluded women's voices and participation.
6. Lack of encouragement, support, and positive role models discourage girls from pursuing leadership roles from an early age.

These deeply rooted cultural forces actively dissuade and shut out women from paths leading to technology careers, stifling their representation at all levels of Cambodia's digital workforce and economy.

Bridging the divide will require more than just

building computer labs and providing skills training. Eliminating the digital gender gap will necessitate a seismic cultural shift in attitudes and biases regarding women's roles, capabilities, and rights across Cambodian society. Until the systemic barriers are dismantled, the nation's technological and economic potential will remain stunted by discrimination.

THE SISTERS OF CODE APPROACH

The initiative, founded in 2019 by IT Academy STEP Cambodia Institute, is a pioneering initiative in Cambodia that aims to empower young girls through coding education. As the country's first female coding club, Sisters of Code addresses the gender gap in the technology field by providing free, inclusive, and supportive coding training programs for girls aged 10 to 20. The organization recognizes the transformative power of supportive communities and collaborative learning environments in fostering women's empowerment and long-term success in STEM fields.

PROGRAM OVERVIEW

The Sisters of Code program consists of an 18-week coding training program divided into four modules:

1. Module 1: Introduction and Code.org. Covers online security basics, visual programming, and algorithmic thinking.
2. Module 2: Scratch.com. Game development, variables, and project development concepts.
3. Module 3: HTML/CSS & WIX Website. Website building and text-based coding principles.
4. Module 4: Generative AI fundamentals and introduction to Machine Learning. Added since 2024, to keep pace with current technological advances.

The program's curriculum goes beyond coding fundamentals, fostering a holistic suite of competencies. Students develop project management abilities, teamwork, leadership, problem-solving, and communication skills, honed through collaborative, self-directed assignments as well as public presentations at the end of each term.

CREATING A RIPPLE EFFECT

Faced with a growing demand that outpaced its initial capacity, Sisters of Code innovated a sustainable scaling solution: a train-the-trainer model. Outstanding program graduates aged 18 and above are invited to become Sisters of Code "ambassadors" and to undergo advanced leadership development and project management training. These ambassadors are then equipped to launch and facilitate Sisters of Code clubs in their hometowns and communities, fostering a self-sustaining model for grassroots expansion.

One ambassador shared, "It is my honor to be a Sisters of Code Ambassador. I love this role because I want to contribute what I have learned from the Sisters of Code course to my community. Especially I want to help the other girls in the technology sector." Another ambassador adds: "I want to demonstrate that women's abilities to study technology are the same as men's."

Through this force-multiplier effect, Sisters of Code has expanded its footprint to 16 provinces across Cambodia, offering both in-person and online lessons to ensure access to high-quality coding education regardless of geographic location. The program's collaborative structure reinforces this supportive atmosphere, with small class sizes capped at 15 students, personalized attention, and progress tracking. Sisters of Code Ambassadors create both in-person clubs and online clubs to accommodate students from different provinces and allowing students to connect and attend lessons from their homes.

Lessons are led by program graduates serving as ambassadors and mentors, creating a seamless continuum of empowerment. Ambassadors also create special online groups for their students using Telegram, the most popular online communication platform in Cambodia. Students can exchange questions and receive feedback from their peers any time, so that communication and learning are not limited to two hours of training on the weekend.

CONTRIBUTING TO SUSTAINABLE DEVELOPMENT GOALS

Sisters of Code initiative's efforts directly contribute to the United Nations' Sustainable Development Goals, particularly:

- Goal 4: Quality Education
- Goal 5: Gender Equality
- Goal 8: Decent Work and Economic Growth

By fostering a robust network of empowered programmers ready to uplift those around them, Sisters of Code is impacting a cultural transformation – a future where STEM fields are unlocked through the power of community support, collaborative learning, and an unwavering belief in oneself. The organization's holistic approach to coding education equips Cambodian girls with technical skills. It empowers them to find their voice, believe in their talents, and discover new educational and career pathways for others to follow.

Sisters of Code's unique training program provides complimentary access to extracurricular quality education for girls, which has never existed in Cambodia before. At zero costs for the students, they can improve their digital skills, following 21st-century pedagogical standards.

By creating girls-only clubs, Sisters of Code contributes to the Gender Equality goals, specifically in the male-dominated field of tech. Sisters of Code graduates have already demonstrated the efficiency of the approach in ensuring decent work and economic growth. Some alumni have received international scholarships, launched successful careers in tech, and secured better employment and higher salaries.

SISTERS OF CODE STUDENT FEEDBACK

Sisters of Code pays attention to collecting data and feedback from program participants to identify possible points for improvement and to understand changes in the perception of barriers and opportunities. This can help improve program delivery and design. Every year, the program collects students' feedback and suggestions, including the following responses.

"It is the best program for all girls to know. As we know, not all girls are allowed to study technology. So, it is the best opportunity for them. The Sister of Code program will help you see what coding looks like and how to create a website. I recommend all young women to have chances to learn about coding."

As an after-school, information educational program for girls, Sisters of Code's educational approach allows more flexibility, attention to students' engagement, and acknowledgment of their feedback, which serves as important insight for further program development and improvement.

"I love learning with Sisters of Code because the learning process is relaxed. It is about teamwork, growing together, and helping each other and not a competition."

BEYOND CODING: A HOLISTIC APPROACH TO DIGITAL LITERACY

Alongside the core objectives of digital literacy and fundamental coding proficiency, the Sisters of Code initiative recognizes that true digital literacy in the 21st century requires nurturing both technical and soft skills. The program's holistic curriculum encompasses not just programming but also digital literacy fundamentals, problem-solving methodologies, collaboration and teamwork training, effective communication strategies, and exercises to spark creativity and critical thinking.

Regular surveys among the Sisters of Code initiative participants revealed that interest in digital technologies (48 percent) and the need for programming skills to further studies (39 percent) were the primary motivators for joining. This intrinsic interest is a valuable foundation, but engaging girls long-term requires tapping into their innate creativity and desire for self-expression.

The study, "Programmed Out: The Gender Gap in Technology in Scandinavia. What are Successful ways to get more girls in tech in Scandinavia?" (2018) recognizes that "Many girls see themselves as creative and crafty. Developing a message around the artistic potential of computing and providing opportunities for girls to explore relevant passion projects resonates deeply." When students can build animations, games, and websites exploring topics they care about, their enthusiasm and dedication soar far beyond checking boxes. The same study argues that creativity is pivotal to problem-solving itself: "Creating digital technologies is an inherently creative process." Lack of creative learning experiences, both in and out of the classroom, is a key barrier holding girls back from realizing their full potential with computing studies.

Thus, for training girls in coding skills, providing creative projects is the key. Sisters of Code students can choose to create their own animations and games, as well as websites on the topics that matter to them. Some create online cake shops; others create websites to promote animal rescue projects in Cambodia. The results show how diverse our interests are, and that, when tapping into personal motivation, amazing results can be achieved.

The success of the Sisters of Code initiative is underlined by the fact that an overwhelming 90 percent of participants would recommend it to other girls to join. However, real obstacles to girls' tech

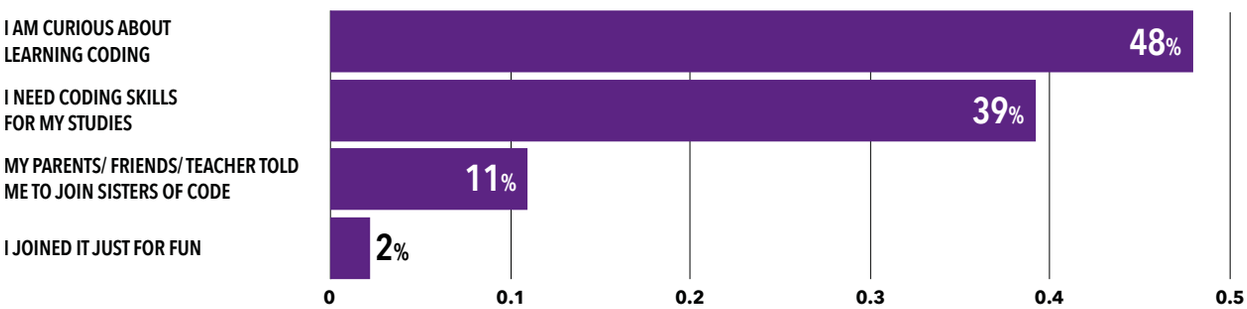
participation persist. When first surveyed in 2020, a staggering 50 percent of participants believed the myth that girls are simply not allowed to study technology. While that number dropped to 16 percent by 2024, it reflects the deep-seated cultural biases Sisters of Code is working to dismantle.

Sisters of Code surveys show that girls are curious about technology and would like to try learning coding skills, and a growing number of students reporting that coding skills are essential for their studies. These findings manifest a growing recognition of the educational and career opportunities in technology among female students.

TABLE 1

Sisters of Code Opinion survey: reasons for joining Sisters of Code educational program

WHY DID YOU JOIN SISTERS OF CODE?



Source: Sisters of Code students survey 2024.

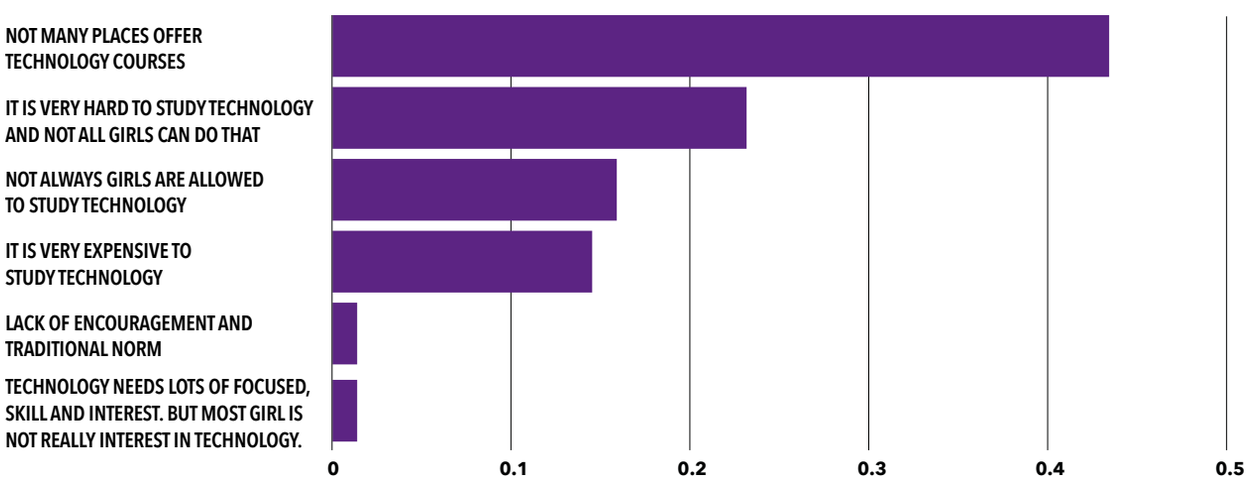
n = 46 participants

Based on Sisters of Code research with students in 2024, other perceived obstacles include lack of available courses (43 percent), the innate difficulty of the subject matter (23 percent), and financial constraints (30 percent). Interestingly, the percentage of those who find technology too demanding has fallen from 35 percent in 2020 to 23 percent in 2024, perhaps indicating the program's success in boosting self-confidence.

TABLE 2

Sisters of Code Opinion survey: the barriers female students face when studying technology

WHAT IN YOUR OPINION ARE THE MAIN CHALLENGES FOR GIRLS TO STUDY TECHNOLOGY?



Source: Sisters of Code students survey 2024.

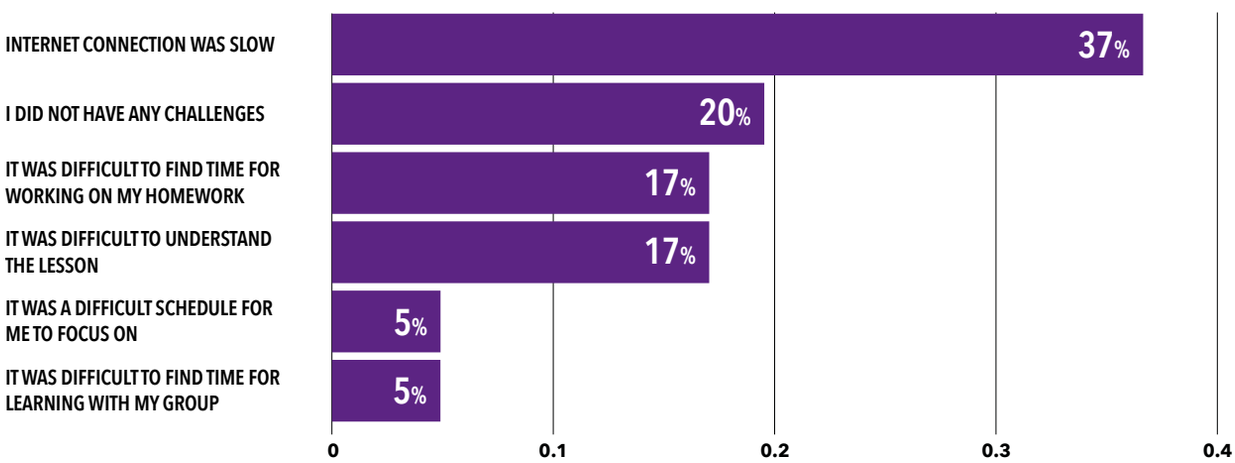
n = 69 participants

Lack of reliable internet access emerges as the primary barrier for students wanting to join the Sisters of Code's online clubs. In the digital age, the rural-urban divide is just as significant as the gender gap for ensuring equitable access to STEM education opportunities nationwide, given that 75 percent of the country's population is rural.

TABLE 3

Sisters of Code Opinion survey: challenges when studying online

WHAT WAS YOUR BIGGEST CHALLENGE WHEN LEARNING ONLINE?



Source: Sisters of Code students survey 2024.

n = 41 participants

The impressive results of the Sisters of Code initiative are rooted in its holistic approach, understanding that coding is just one facet of developing well-rounded digital citizens prepared to thrive in the modern workforce. The program catalyzes mindset shifts by creating supportive, same-gender environments that interweave technical skills with creativity, practical projects of personal interest, critical thinking, collaboration, and confidence-building. One participant summarized: "Sisters of Code showed me that with the right training, tools, and supportive network, any girl can learn digital skills; even though it seems hard, we can achieve great results."

Alongside providing coding instruction, Sisters of Code is laying the groundwork for a generational transformation—a future where a celebration of diversity that drives innovation will replace cultural stigmas. This holistic digital literacy curriculum positions Cambodia's young women to become not just coders but creative problem-solvers and tech leaders, reimagining how digital progress can support human progress. The results are already remarkable—some Sisters of Code alumni have received scholarships to study IT in Singapore, Korea, Japan, the UK, and the US. All of them confirm that participation in the Sisters of Code program boosted their confidence and inspired them to strive for more.

CHALLENGING BIASES AND STEREOTYPES: CREATING AN INCLUSIVE ENVIRONMENT

From a very young age, children internalize deeply ingrained gender stereotypes about what careers and fields of study are deemed "appropriate" for boys versus girls. By the time they complete elementary school, many kids have already developed a clear sense that STEM (science, technology, engineering, and math) is a "masculine" domain unwelcoming to female participation.

Numerous studies across countries and cultures have exposed how these biases take hold early. When asked to draw a scientist or mathematician, young girls as well as boys overwhelmingly depict men (often in lab coats). Worryingly, depictions of female scientists become even rarer as children age, indicating these stereotypes calcify over time rather than

dissipate. Research consistently shows that even from a young age, girls report lower self-efficacy and confidence in their technical abilities compared to boys, despite lacking any prior experience differential.

In Cambodia, centuries-old patriarchal traditions further cement rigid gender roles, confining women to caregiving and domestic responsibilities. A woman's purpose is still largely defined by her ability to take care of children and elderly relatives and provide support for her husband. These entrenched societal expectations severely limit young girls' perceived choices and agency in charting their own paths, especially for pursuing male-dominated fields like technology.

Because quality education often requires families to invest additional resources, most Cambodian families prioritize investing limited resources into their sons' education over their daughters', based on the assumption that girls will eventually marry and leave their birth families. In rural areas and less urbanized communities, these attitudes are particularly pervasive. Taking into account that 76 percent of the Cambodian population is rural (Asian Development Bank, Key Indicators Database 2023), there are few chances for young women to break the cost barrier. For most of them, the only chance is scholarship or non-profit programs that can offer free lessons.

This cultural duality - tradition vs. modernity - leaves many Cambodian girls torn. They feel the pull of obedience to parents' expectations, even as economic forces open up new opportunities in fields like IT that their mothers' generation never dreamed of. Interestingly, Sisters of Code has found that exposure to older brothers studying or working in technology has helped spark many participants' interests in the field even when they may have lacked female role models.

By fostering an inclusive community, Sisters of Code gives the next generation reassurance to defy societal stereotypes about their limitations. Sisters of Code has cultivated an inclusive, empowering environment where girls can find community, confidence, and a sense of belonging in technology. With two hours of free lessons on the weekend, the program helps participants overcome self-doubt, systemic bias, and imposter syndrome that is so prevalent among women in STEM, as well as giving educational opportunities for girls from a less privileged background.

The all-girls program is especially appreciated by the students. They share that they feel more confident, less under pressure, or less judged by their peers. "Sisters of Code showed me that I belong in tech, and my interest in technology matters," one student shared. Many remarked that having an all-female classroom setting was transformative, allowing them to problem-solve collaboratively without fear of judgment in a way that mixed-gender environments often discouraged.

Sisters of Code initiative also intentionally engages parents, inviting them to graduation ceremonies where girls proudly present their coding projects. Seeing their daughters' mastery of complex technological concepts firsthand has been eye-opening for many parents, accustomed to dismissing such skills as masculine pursuits. Sometimes, with tears of pride, they gain a new appreciation for their children's vast potential when provided equal opportunities.

As one of the parents shared: "I did not know that my daughter has these talents and can do better than me with technology. I believe that having this opportunity with Sisters of Code opens up new perspectives for my daughter's education in the future."

Confronting deeply rooted cultural biases is an immense challenge. However, initiatives like Sisters of Code are taking crucial first steps. By creating safe spaces for girls to explore their technical passions free from gender constraints, they are not just developing crucial STEM skills; they are catalyzing a broader mindset shift about the immense value of inclusion and diverse perspectives in driving innovation.

As more Cambodian families witness the empowerment and economic mobility these programs unlock for their daughters, societal attitudes will continue evolving. With each young woman who confidently breaks academic and professional barriers, old biases erode further while inspiring future generations to shatter glass ceilings of their own.

The road ahead remains long, but Sisters of Code is leading the way in Cambodia toward a future where gender stereotypes are conquered by competence, determination, and the universal human truth that potential has no gender.

BEYOND CAMBODIA: SCALING AND REPLICATING THE MODEL

The initiative's success indicates the potential for scaling and replicating the model in other contexts and regions, keeping in mind that adapting the approach to address local cultural and socioeconomic factors is crucial for its effectiveness. Based on the program's five-year experience in Cambodia, several considerations can be shared to scale and replicate the model in other countries.

RECOMMENDATIONS FOR ENGAGING MORE FEMALE STUDENTS IN DIGITAL SKILLS

1. Increase access and availability of technology courses tailored for girls, addressing the perceived lack of opportunities.
2. Develop engaging and interactive curricula that cater to different learning styles and that maintain interest, addressing the perceived difficulty.
3. Expand training programs with new courses in popular areas of interest, such as website development, graphic design, mobile app development, and game development.
4. Foster a supportive community through initiatives like the Sisters of Code Ambassadors program, enabling students to become advocates and leaders.
5. Collaborate with schools, organizations, and industry partners to promote the importance of digital skills and showcase diverse career opportunities in technology.
6. Free training programs are essential, addressing the financial barriers to making digital skill education more accessible.

CONCLUSION

Sisters of Code's holistic approach to digital literacy empowers Cambodian women by providing a supportive community, fostering confidence, and equipping them with diverse skills beyond coding. By challenging biases, celebrating diversity, and nurturing women's unique perspectives and strengths, Sisters of Code equips participants to thrive in technology sectors and contribute their valuable skill sets. The transformative power of the initiative's model underscores the need for stakeholders to prioritize initiatives that empower women and bridge the digital gender divide. As one participant eloquently stated, "Sisters of Code taught me that my voice matters and that I have the power to shape the tech industry." Through holistic digital literacy education and supportive communities, women can overcome barriers and become agents of change, driving innovation and progress in the tech sector.

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CASE STUDY 1.4

CODING CHANGE: A CASE STUDY OF WOMEN AND MINORITIES IN TECH

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KEY FINDINGS

- Adaptation of the selection process to cater to the organization's priority groups: {reprograma} significantly changed its selection process to be more inclusive, especially for trans and *travesti* women, by waiving the high school diploma requirement and allowing audio presentations as an alternative to video. This strategic approach led to richer participant diversity, combined with a comprehensive evaluation through interactive workshops introducing women to programming and evaluating their collaborative problem-solving capabilities.
- Comprehensive support system: {reprograma}'s addition of an educational advisor with a psychology background has been instrumental in the bootcamps' support system, ensuring that a more significant percentage of students successfully finish the program and advancing their professional readiness. The curriculum's agile, cycle-based structure—complemented by soft skills, career planning, and speed hiring events—bridges the gap between education and employment in the tech industry.
- Tracking educational and employment outcomes: Over the years, {reprograma} implemented 41 bootcamps with an 84.4 percent completion rate, resulting in 1,264 graduates. Six months after completing the bootcamps, 69.8 percent of alumnae were employed (up from 42.7 percent before the bootcamps), with 59.9 percent in the tech market; 74.6 percent continued their education, showcasing the program's success in fostering career growth. To track its impact, {reprograma} conducts four surveys with its alumnae at key milestones: one month, three months, six months, and one year after graduation. To encourage high participation, {reprograma} stresses the importance of these surveys throughout the bootcamp and may offer incentives such as event access or coupons.
- Diversity in staff and students: The organization's commitment to diversity is evident in its staff composition—56.5 percent are Black, 8.7 percent are trans/*travesti*, 50 percent are alumnae, and 17.4 percent are mothers—as well as in the student's profile, with 69.63 percent being Black, 9.59 percent trans/*travesti*, and 30 percent coming from the North and Northeast of Brazil. Building rapport with students is easier when the staff reflects the students' diversity, fostering a sense of connection to the initiative. Importantly, seeing successful women leaders who are program alumnae motivates students to pursue their education and build their own careers.

CONTEXT

The tech sector, one of the fastest growing in the world, is brimming with opportunities and attractive wages. In Brazil, in 2022 alone, 73,000 jobs were generated in the ICT area, and the average wage for this sector was 2.8 times higher than the national average (Brazilian Association of Information Technology and Communication Technology Companies [Brasscom], 2023). This growth presents a promising future. However, such opportunities are less available to women. Although they represent 51 percent of the Brazilian population, they account for only 39 percent of the ICT national workforce. This lack of representation is also reflected in the low percentage of women in ICT undergraduate courses, which has dropped from 17.5 percent to 15 percent in the last ten years (The Brazilian Institute of Geography and Statistics [IBGE], 2024).

The sector's data collection efforts do not adequately represent trans and *travesti* women, resulting in a significant gap in the available information for this group. Furthermore, aligned with the findings of Beyene and Frost (2019) and Wyers (2022), the diversity reports from Brasscom (2022) treat gender within a binary framework and lack data on trans and *travesti* women. However, if we investigate the access to education by trans and *travestis* in general, 72 percent did not finish high school, and only 0.02 percent enrolled in higher education in Brazil (Benevides, 2022). A possible approach to recruiting qualified and diverse professionals that can also be gender-sensitive is creating programming bootcamps in a "Ready-to-work" model (Aramburu et al., 2021). An example is {reprograma}, a feminist NGO whose mission is to

reduce the gender and race gap in the Brazilian tech industry by providing free online coding bootcamps to women.

BEGINNINGS: THE FUTURE IS FEMALE CODERS

{reprograma} was founded in 2016 by Mariel Reyes Milk along with Carla de Bona and Fernanda Faria. In one of her many interviews since then, Milk made a candid statement about her motivation. "They say the future is being written in lines of code, I do not want to live in a world where 50 percent of the population is not part of the equation in creating solutions for the world" (Loftus, 2018). Striving to upend this scenario, the trio created free coding bootcamps for vulnerable women, focusing on Black, trans and *travesti* women in São Paulo, Brazil.

To get the pilot project off the ground, they launched a crowdfunding campaign to cover the costs of the first four six-week bootcamps. With the help of volunteers, they tested how to reach potential students, and—although employability was not yet their primary focus—they also tested what was the best teaching methodology for the most sought-after skills demanded by the market, among other aspects ({reprograma}, 2021a). JavaScript was the selected programming language, as a widely used and demanded language in the tech sector. It was favored for other reasons as well: it is user-friendly, quick to set up, runs smoothly on less powerful computers, and has a low learning curve. It enables students to engage in practical projects early in their training, preparing them to become full-stack developers without needing to learn additional languages. Last but not least, with the expansion of its alumnae group, the initiative has its own burgeoning network of professional experts in JavaScript ({reprograma}, 2021a).

For the next three years, the program developed continuous iterations after each bootcamp with empirical learning as a guiding principle. (1) They perfected the in-person "front-end" model bootcamp (focused on the user-facing side of a website). (2) They started testing their "back-end" bootcamp model (focused on the server side of a website). (3) They developed a six-week online front-end pilot program. The nonprofit also began integrating soft skills teaching, capacity-building content, and speed hiring events for recent graduates. At the end of 2020, {reprograma} secured funding from the IDB Lab, the innovation lab of the Inter-American Development Bank, as well as five leading tech companies. This support and endorsement enabled the organization to reach a new scale, consolidate its online model, and build an online hiring platform. With the *Todas em Tech* project, {reprograma} began to reach women nationally, especially those in the country's North and Northeast regions. This project also allowed {reprograma} to strengthen one of its core values and differentials: diversity.

SCALING UP

In its *Todas em Tech* program, {reprograma} implemented concrete strategies to attract more Black, trans, and *travesti* women. The organization hired a community manager and partnered with programming communities, influencers, and LGBTQIAP+ communities to attract a more diverse pool of candidates (Almeida, 2021). It also significantly changed its selection process as well as online format to better cater to this public. The selection workshops served to introduce a broader group of women to programming, to assess their problem-solving skills, and to enable interaction with peers and instructors in a hands-on challenge. The program also revised its admission criteria regarding trans and *travesti* women. They waived the high school diploma requirement for this group, and, to accommodate candidates who may be dealing with gender dysphoria, the initiative allowed the submission of an audio presentation as an alternative to a video, protecting the candidate's self-image ({reprograma}, 2021b). Another key aspect was to include the *travesti* category along with the trans category in all its communication material, since they have different historical identities. *Travesti* is a South American identity, a racialized category frequently linked with other intersections such as class and labor, while 'trans' has historical ties to the medical field and more of a Global North perspective. By incorporating *travesti* in its communication strategy, {reprograma} attracted more individuals from this group to its bootcamps since they felt seen and represented in the organization. (For a detailed historical and cultural account of the term *travesti* in Brazil, see Brume Dezembro Iazetti (2023)).

Adapting the online format of the bootcamp, the educational team structured the curriculum into weekly cycles of lectures, hands-on tasks, and feedback, reflecting the agile development approach prevalent in the tech industry. This cycle-based learning previews the iterative workflow that students will encounter in their professional lives ({reprograma}, 2021a).

Additionally, the team added an educational advisor with a background in psychology who began holding weekly group and individual sessions, to address socio-emotional themes and to foster soft skills. The educational advisor's insights became a valuable source for assessing the effectiveness of the bootcamps as well as for promptly identifying individual difficulties in continuing the bootcamp and for developing customized plans to support them.

All these changes were shown effective when *Todas em Tech* was concluded. During the two years of the project, {reprograma} trained 354 women, with an impressive 81.8 percent retention rate. More than 70.91 percent of the students self-identified as Black and 11.29 percent as trans/*travesti.* At the end of 2021, {reprograma} was the only organization in Brazil to be selected for the Google.org Impact Challenge for Women and Girls. With this support, the nonprofit continued to broaden its operational reach within Brazil and diversified its bootcamp offerings. It also launched *EducaTech*, which trains alumnae and other women in the IT sector to instruct other women more effectively.

IMPACT

For the last three years, {reprograma} has expanded its core team from six to 23 employees, employing an ad hoc teaching team of up to 50 people. Looking to "walk the talk," {reprograma} exhibits diversity in its staff: 56.5 percent are Black, 8.7 percent are trans/*travestis*, 50 percent are alumnae, and 17.4 percent are mothers. Mirroring the diversity of its students in its staff has been key to creating rapport with students. They feel connected to the initiative, and when they see women who were once students much like themselves in leadership positions, they feel motivated to continue studying and to forge their own professional path.

From 2016 to 2023, the initiative executed 41 bootcamps, with an 84.4 percent completion rate, resulting in 1.264 graduates. Six months after the bootcamp, 69.8 percent of its alumnae were employed in various fields (compared to 42.7 percent before enrolling in the program), including 59.9 percent employed in the IT market. Fully 74.6 percent continued to study. This impact is measured over time through four surveys sent to each alumna, one month, three months, six months, and one year after graduation. Throughout the bootcamp, {reprograma} emphasizes to students the importance of answering these surveys and sometimes offers incentives, such as participating in events or receiving coupons. The program has received over 20,000 applications, and over 3,500 candidates have participated in the one-day selection workshops. Regarding the overall student profile (based on self-declaration), 69.63 percent are Black, 1.48 percent are Asian, 0.49 percent are Indigenous, 9.59 percent are trans/*travesti*, 17.2 percent are mothers, and 30 percent come from the North and Northeast part of Brazil.

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DIGITAL INCLUSION AND EDUCATION

UNTANGLING THE PROMISE AND CHALLENGE OF INCLUSIVE DIGITAL ACCESS AND EDUCATION

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Notwithstanding the notable strides being made, not only in access to digital technologies but also in science and engineering education and career pathways for both women and men, certain gender gaps remain intractable. Targets set by global bodies are unlikely to be achieved by 2030, as intended (Sachs et al., 2024) — including the gender-related targets of the Sustainable Development Goals. It is urgent therefore to support efforts to advance digital inclusion that are based on evidence, ensuring appropriate program design, effective targeting, and informed experimentation while remaining sensitive to the ever-evolving technological landscape.

Yet significant gaps remain in our understanding of what digital inclusion means in practice and how to develop initiatives with impact pathways that can stand the test of time. As a result, many of the projects designed to tackle gender digital gaps lack strong conceptual and practical grounding. The chapters in this section of the report contribute evidence to fill these knowledge gaps while drawing attention to the ongoing challenges of realizing the full potential of digital technologies for all.

The first chapter highlights the "digital possibilities" as well as the challenges of leveraging digital technologies inclusively. The authors elaborate on meaningful connectivity as an evolving concept. They point out that closing gender divides and ensuring that all users benefit from digital technologies will require policymakers to shift their focus from merely providing infrastructure to providing meaningful connectivity and inclusive services. They provide several examples of promising policy and program initiatives in Africa, Asia, and South America.

The second chapter homes in on gender divides in the use of government services. Using an intersectional lens, the authors show that demographic characteristics such as social class and race correlate with differences in the use of various online public services, not only as between women and men, but also within female and male populations. The insights derived from this type of analysis underscore the importance of disaggregated data for getting accurate measures of digital inclusion.

The final chapter is a case study of "Elas nas Exatas," a program in Brazil that sought to foster female high school students' interest in the science and technology professions. It reflects on the fate of the various projects supported by the program, the challenges of project sustainability, and the success factors that enabled certain projects to survive.

Without disaggregated statistical data and contextualized qualitative data, the true nature of digital inclusion and access to science education cannot be known. While shedding light on persistent challenges that contribute to digital injustices, these chapters also provide insights on what it might take to generate positive and sustainable human development outcomes. This invariably requires attending to matters beyond the infrastructural and technical components. These contributions point the way to evidence-based action by spotlighting the types of data that need to be collected, and by identifying the types of socio-technical systems that are more conducive to equitable digital inclusion and education outcomes. Policymakers should support the generation of data, case studies, and other forms of evidence to support decision-making, planning, and resource allocation for digital inclusion policy and program initiatives.

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2.1 TOWARD SHAPING POLICIES ON WOMEN'S DIGITAL INCLUSION AND EQUITY: CONTEXTUALIZATION BEYOND BASIC ACCESS AND SKILLS

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ABSTRACT

This chapter explores the multifaceted dimensions of women's digital inclusion in global majority countries,[1] emphasizing the need for policies that extend beyond access and digital skills to address broader socio cultural and economic contexts. Drawing on data from the Global Digital Inclusion Partnership's Connected Resilience (GDIP 2024a) research across Africa and Asia, the chapter combines qualitative and quantitative analyses to illuminate the barriers and opportunities shaping women's digital participation.

Socio cultural norms, including gender roles, household responsibilities, and time allocation to unpaid care work, significantly influence women's ability to meaningfully engage with digital platforms and services. The chapter underscores how these factors impact meaningful connectivity, with implications for women's livelihoods, access to information, education, economic participation, and online safety.

Through ethnographic case studies from India, Nigeria, and El Salvador, the analysis reveals the intersectional realities of women's lived experiences and highlights the complexities of digital exclusion. The chapter advocates for an approach to digital inclusion that prioritizes social context, quality of meaningful connectivity, and digital development policies that address multifaceted gendered barriers to participation.

The chapter concludes with examples of effective policy practices across Africa, Asia and Latin America, offering policymakers actionable insights for bridging the digital gender divide. These examples emphasize the importance of targeted interventions that address not only technical barriers but also cultural, economic, and social obstacles to women's digital inclusion.

KEY FINDINGS

- ***Intersecting gendered barriers to digital inclusion.*** Women face compounded intersecting barriers – such as gendered time poverty, socio-cultural norms, financial constraints, and geographical isolation – that restrict meaningful access to and participation in digital spaces. Ethnographic examples from India, Nigeria, and El Salvador underscore how women in diverse contexts experience these barriers across urban, rural, and remote settings, emphasizing the need for context-specific interventions.
- ***Financial and infrastructural constraints.*** Access to affordable digital devices, data plans, and connectivity infrastructure remains a major challenge to women's meaningful connectivity, especially in rural and economically disadvantaged areas.
- ***Online safety and cultural norms.*** Fear of online harassment, unsolicited messages, and social stigma discourages women from fully participating online. Cultural norms often dictate women's visibility online, restricting their participation in digital education, entrepreneurship and professional networks.
- ***Resilience and innovation.*** Despite systemic challenges, women exhibit resilience and innovative approaches to access digital resources, often relying on extended networks, shared devices or intermittent connectivity. Peer-to-peer learning

1 "Global majority" refers to the regions often identified as the global south, the developing world, or the group of low- and middle-income countries.

and community support networks emerged as critical enablers of digital inclusion.

- *Demonstration of good practices.* This chapter provides actionable insights for policymakers working to close the digital gender gap. The case studies and recommendations emphasize the need for context-sensitive, multi-faceted policy interventions to address the deep-rooted gender digital divide and ensure equitable participation for all women.

INTRODUCTION: GENDER AND UNIVERSAL MEANINGFUL CONNECTIVITY, AN EVOLVING CONCEPT

The internet serves as a gateway to accessing information and public and private services for participating in the digital economy and navigating social life. But a significant digital divide persists, particularly affecting women—especially women with low literacy levels or low incomes, as well as rural dwellers and women with disabilities. Gender inequality in internet access and use is persistent across regions, with women facing stark barriers such as affordability, digital literacy, and social norms that limit their online participation (GSMA, 2024). According to the International Telecommunication Union (2023), 244 million more men than women use the internet, and only 20 percent of women in low- income countries have access to the internet. Digital inclusion has evolved into a fundamental right in today's interconnected world. This requires specific interventions that go beyond provision of basic internet access towards delivering meaningful connectivity.

Policymakers are increasingly paying attention to "not only providing basic connectivity, but supporting connectivity that allows for meaningful access and usage of the internet" (GDIP, 2024a). This is critical for economic development as well as fostering inclusion, as countries transition to adopting digital public services. As outlined in Table 1, meaningful connectivity refers to the ability to access the internet daily, at 4G-like speeds or higher, through an unlimited access point such as at home, at work, or at school (GDIP, 2022).

In collaboration and with inputs from multiple stakeholders across the globe, the International Telecommunication Union (ITU) has set targets for universal and meaningful connectivity by 2030 (ITU, 2023a). The ITU defines meaningful connectivity as "a level of connectivity that allows users to have a safe, satisfying, enriching and productive online experience at an affordable cost" (ITU, 2023b). Countries can only achieve these with inclusive digital policies and solutions that integrate targeted measures and approaches that understand the connection between infrastructure and society and impact (GDIP, 2024a). Research, including GDIP's Connected Resilience study findings, underscores the persistent challenge that inadequate infrastructure still presents, particularly in rural areas (ITU, 2023a; OECD, 2023). Affordability remains a critical barrier as well, with millions still living in countries where data costs are above international definitions of affordability (ITU, 2022). Women are especially affected by lack of affordability, as they are more likely to have unpaid care responsibilities and lower incomes. The presence of a supportive social environment, both online and offline, plays a pivotal role in shaping the online experiences of women and girls.

In this chapter, we define meaningful connectivity as an evolving concept that goes beyond affordability and the technical elements of connectivity, further encompassing the presence of a supportive online and offline social environment, where education levels, digital skills, relevant local content, and respect for human rights are foundational to a digital society. As an evolving concept, meaningful connectivity is presented in this paper to explore how multifaceted factors shape women's opportunities to fully engage and benefit from online access, as a step toward closing the digital possibilities gap (Jorge and Makwakwa 2024). (See Figure 1 and Box 1.)

FIGURE 1

UNIVERSAL MEANINGFUL CONNECTIVITY, AN EVOLVING CONCEPT

Source: GDIP, 2024a.

BOX 1

MEANINGFUL CONNECTIVITY

MEANINGFUL CONNECTIVITY INCLUDES FOUR TECHNICAL COMPONENTS THAT ENSURE A RELIABLE AND SATISFYING EXPERIENCE.

1. A MINIMUM OF 4G SPEED

Internet speeds can make or break the online experience. Without fast speeds, services like video calls, telehealth and active participation in the digital economy are not feasible. A 4G mobile connection is the minimum threshold to support meaningful connectivity.

2. AN APPROPRIATE DEVICE

A smartphone provides the ability to create and consume content in ways that basic phones do not, as well as portability to access the internet from anywhere. Access to a wide range of device types is important for broader activities such as running a business using virtual platforms.

3. UNLIMITED BROADBAND CONNECTION

While some people have unlimited data plans, others experience severe data scarcity, which limits online tasks or requires the mobility to connect to public Wi-Fi. An unlimited broadband connection at home, or place of work or study is required to fully access the internet's potential.

4. DAILY USE

As our societies become more digital and the internet becomes more integrated into our daily lives, connecting occasionally is not sufficient. Daily access to the internet is the minimum required to see tangible benefits for work, education and communication.

Source: GDIP, 2024a.

As new digital technologies are rapidly introduced, facilitating an expanding digital economy and public services, the benefits of these tools remain out of reach for millions. The gap in digital inclusion underscores the urgent need to address the barriers preventing equitable access to the benefits of a connected society. This chapter delves into the intricacies of women's resilience in accessing meaningful connectivity ; it provides examples of policy pathways to bridge the gender digital divide, ensuring that the promise of connectivity extends to all members of society.

Global Digital Inclusion Partnership's (GDIP's) Connected Resilience study (2024a) highlights the particularly significant roles of education and geography in women's meaningful connectivity and access to digital possibilities. We define "digital possibilities" as the possibilities available in education, employment, and public participation based on the kind of internet access available (GDIP 2024b; Jorge and Makwakwa 2024).

In today's digital era, ensuring women's inclusion goes far beyond the provision of access to technology and the development of digital skills. Particularly in global majority countries, where the digital divide is most pronounced, fostering digital equity encompasses both the technological and the socio-cultural dimensions of inclusion. The frontier of digital inclusion policy requires gender-transformative solutions that "directly aim to transform power dynamics and structures that maintain gender inequalities" (UN Women Generation Equality 2024). These policies and practices "go beyond the 'symptoms' of gender inequality to address the norms, attitudes, behaviors and social systems that underlie them" (UN Women Generation Equality 2024).

The following section presents global data and insights from the GDIP's Connected Resilience research (2024a) across Africa and Asia to illustrate the experiences women face in digital participation across countries, through a mix of qualitative and quantitative analyses.

CONNECTED RESILIENCE: METHODOLOGY

GDIP's Connected Resilience (2024a) study explored what we might learn from the recent history of women's digital resilience throughout the pandemic, to envision the future of gender-transformative and inclusive digital development policy. The study methodology included: focus group discussions and ethnographic fieldwork in El Salvador, India, Mozambique, Nigeria, and the Philippines; a nationally representative mobile survey of over 6,000 women from Bangladesh, Cambodia, Ghana, Mozambique, South Africa, and Uganda (focused on women internet users as well as a 10 -percent quota sample per country of women who do not use the internet);[2] policy ethnography and interviews with policymakers in the digital sector from across Africa and Asia; and an updated analysis of the Cost of Exclusion model.[3]

2 Data was collected in six countries via a nationally representative mobile survey conducted in six countries: Nigeria, Uganda, Mozambique, South Africa, Bangladesh, and Cambodia. The mobile survey drew in just over 6,000 women respondents (around 1,000 women from each of the six countries). Respondents were exclusively women, including a mandated sample of 10 percent of women respondents in each country not using the internet.

3 The study follows the women-centered model to calculate the gender gap in internet access and projected economic losses (Cost of Exclusion) if the gap is not closed (GDIP, 2024a). To forecast the share of women and men that will be connected to the internet by 2027, the study used an Autoregressive Integrated Moving Average (ARIMA) method. The model estimates the share of women and men connected to the internet in low- and middle- income countries between 2000 and 2020. The model then forecasted the share of male and women internet users for every year between 2023 and 2027 and calculated the gaps. We converted the gender gaps (total woman broadband penetration) for each year into the corresponding percentage increase for the total population (women and men) in broadband penetration. In summary, the model consists of the digital gender gap data from low- and middle -income countries and the estimated economic losses in GDP if the gap is not closed.

TABLE 1. GDIP CONNECTED RESILIENCE STUDY METHODS AND COUNTRIES

METHODOLOGY	FULL SAMPLE
QUALITATIVE/ ETHNOGRAPHIC	El Salvador, India, Mozambique, Nigeria, Philippines
MOBILE SURVEY	Bangladesh, Cambodia, Ghana, Mozambique, South Africa, Uganda
POLICY ETHNOGAPHY	Global Majority Countries
COST OF EXCLUSION MODEL	32 Global Majority Countries*

* Algeria, Angola, Bangladesh, Burundi, Cambodia, Cameroon, Côte d'Ivoire, DR Congo, Egypt, El Salvador, Ghana, Guinea, Honduras, Kenya, Mongolia, Morocco, Mozambique, Myanmar, Nicaragua, Niger, Nigeria, Pakistan, the Philippines, Senegal, Sudan, Tanzania, Tunisia, Uzbekistan, Zambia, Zimbabwe, Uganda, and South Africa

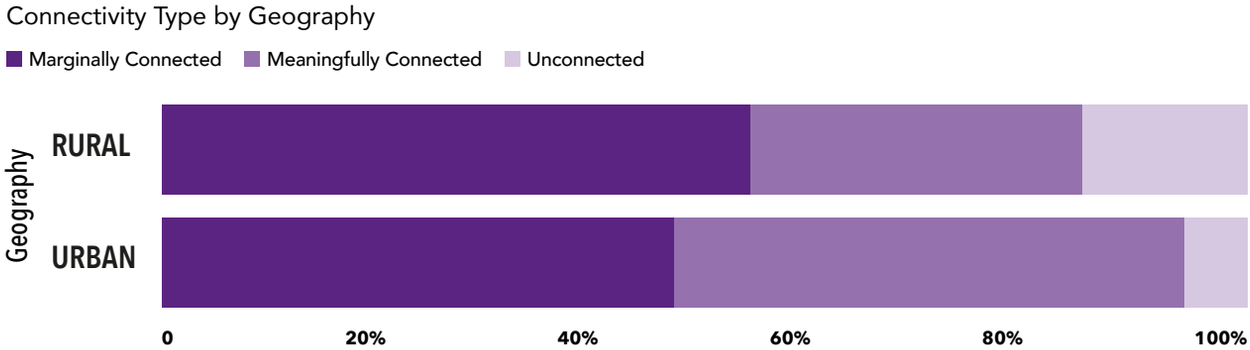
GENDERED EXPERIENCES OF MEANINGFUL CONNECTIVITY

Across the six countries surveyed, women living in rural areas were three times more likely to lack any internet access than their urban-dwelling peers; women living in cities were over 50 percent more likely to have meaningful connectivity (see Figure 2). Women with a tertiary education were nearly twice as likely to be meaningfully connected compared to their peers with less education (see Figure 3). The digital gender disparity based on education and geography further entrenches a systemic disadvantage for women's possibilities in education, employment, and public participation (GDIP 2024a). Study insights on the cost of exclusion highlight that "without substantial policy interventions to close the digital divide — countries are on track to lose over USD $500 billion in the next five years, essentially repeating economic losses" (GDIP 2024a).

While internet access during lockdowns became a lifeline for billions of people around the world, internet access is not universal nor evenly distributed. Looking at patterns between those with meaningful connectivity — defined as having daily internet use with 4G-like speeds, owning a smartphone, and an unlimited access point at home, work, or place of study — and those with only basic or no internet access , we saw key distinctions among women in our study sample based on geography and education, which impacted their experiences of the internet.

FIGURE 2

DISPARITIES IN MEANINGFUL CONNECTIVITY, BY GEOGRAPHY

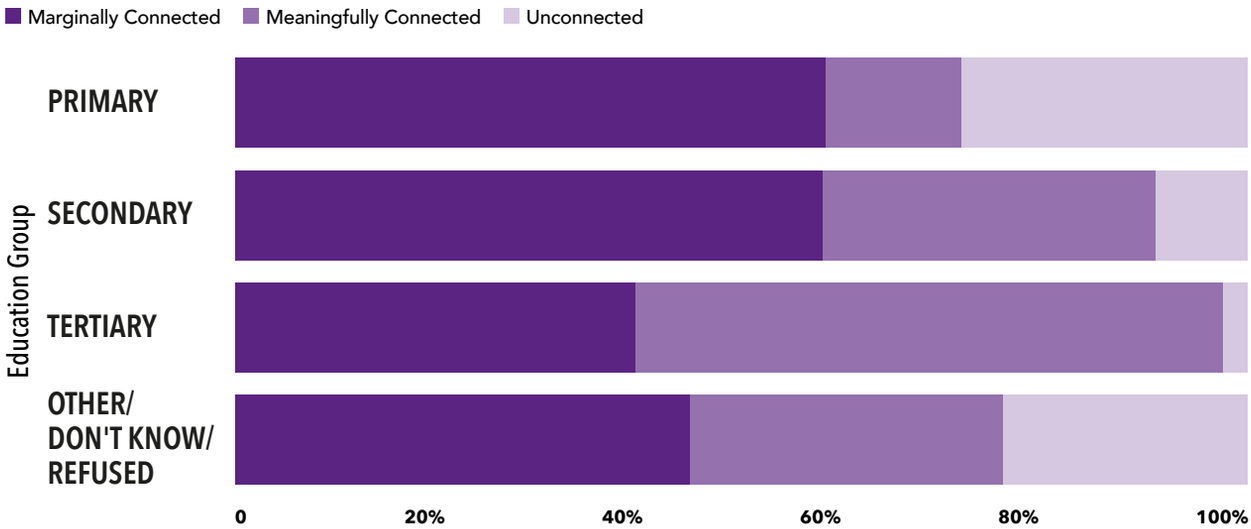


Source: GDIP 2024a.

FIGURE 3

DISPARITIES IN MEANINGFUL CONNECTIVITY, BY EDUCATION LEVEL

Connectivity Type by Education Level



Note: Survey data is based on a nationally representative sample of 6,000 women internet users across 6 countries (1,000 women per country).

Source: GDIP 2024a.

Barriers to internet access created new divides during the lockdown along the lines of gender, geography, education, and class. Women interviewed in underserved localities — such as remote villages in India and impoverished urban settlements in Nigeria — reported restricted digital access due to lack of infrastructure (such as cellular towers), high cost of devices and data services, and dependency on men in their family to use devices, as well as little or no time available for digital skills learning due to their income-generating activities and unpaid care work. The following three ethnographic case studies from India, Nigeria and El Salvador illustrate the intersecting systemic barriers to digital inclusion experienced by women.

CASE STUDY: INTERSECTING GEOGRAPHIC, INFRASTRUCTURAL AND SOCIO ECONOMIC BARRIERS TO WOMEN'S DIGITAL INCLUSION IN REMOTE INDIA [4]

This case study is based on ethnographic insights documented in the Connected Resilience study (GDIP 2024a) in remote villages in India, illustrating the complex challenges women face in achieving meaningful digital participation.

In one remote indigenous village in India, women who were interviewed reported extremely limited access to technology : women in a village population of 2,000, only 10-15 owned their own phones. (Women without personal phones reportedly use their husbands' phones and learn to use them.) In this village, women's mobility and digital access are restricted by geography, lack of infrastructure such as cellular towers or bridges, and dependence on men who control digital devices and mediate access. Women travel long distances weekly when visiting markets, where they can access intermittent mobile signals and internet connection, but they still rely on their husbands to download information. Although some women reported learning to use phones independently, systemic barriers such as poverty, early marriage, and limited education perpetuate women's digital exclusion. As a result, women from indigenous tribal villages who were interviewed reported immense challenges in participating in town halls and public events. Traveling to the nearest town to access the internet requires an arduous and costly journey by boat and bus. Attendance at community forums

4 Ethnographic data was collected by country research experts, Digital Empowerment Foundation in India.

often depends on boatmen's availability, as well as the availability of limited bus routes and of mobile signals for travel coordination. Transportation is considerably less expensive and more reliable for men, who may have motorbikes or else can hitch a ride with another man from the village. (Motorbikes are usually carried in the boat while crossing the river.) With few personal phones and limited money, women depend on their husbands who control devices as well as mobility, limiting women's access to information and public participation.

The long distances, travel time, and costs of transport required to access internet services also have greater impacts on women in terms of the disproportionate time they spend on unpaid care responsibilities (GDIP 2024a). Despite women's resilience in standing up to formidable challenges to access the internet for education, employment, entertainment, and family communication, systemic barriers around the world, such as poverty, early marriage, and education level, create thick boundaries to women's digital inclusion.

CASE STUDY: SOCIOCULTURAL NORMS AND GENDERED TIME POVERTY IMPACTING WOMEN'S AND GIRLS' DIGITAL OPPORTUNITIES IN NIGERIA [5]

This case study is based on ethnographic insights documented in the Connected Resilience study (GDIP 2024a) in impoverished urban areas of Lagos, Nigeria. It highlights the dual barriers of sociocultural expectations placed on women and the resulting time constraints that limit their participation in digital education and economic opportunities.

In Makoko, an impoverished area of Lagos, Nigeria, an initiative aimed at teaching coding to young women and girls has encountered multiple social and economic hurdles. The primary challenge is the lack of formal education among the young women, which hampers their job prospects after training. This translates into a loss of interest, as the immediate need to contribute financially through traditional roles, like selling fish at the market, takes precedence over the uncertain benefits of learning to code. Prevalent sociocultural norms in the community often undervalue education for girls and push them towards early marriages and adolescent pregnancies, perpetuating gender disparities in educational and economic opportunities.

Local boys, after their work of early morning fishing, can pursue digital activities including skills training in software like Microsoft Word and Excel, thus opening up more job opportunities. The girls, however, remain bound to time-consuming family duties in the market. This gender-specific burden limits their capacity to engage in educational or skill-enhancing activities, further widening the opportunity gap across genders. The case of Makoko reflects a broader issue of gender inequality in educational access and economic empowerment in impoverished communities (GDIP 2024a).

Sociocultural norms and household gender roles significantly influence how women in global majority countries engage with digital technologies. These norms often dictate women's economic participation and time allocation, including unpaid care work, which can severely restrict their opportunities to benefit from digital possibilities. Figure 4 shows the survey results of the sample of women who are not internet users; lack of time to use the internet was reported as a dominant barrier to internet access for those who do not currently use it. [6] On average, across the six countries surveyed, lack of time was one of the most widely reported barriers to internet access reported, after ownership of devices and high costs of data and devices.

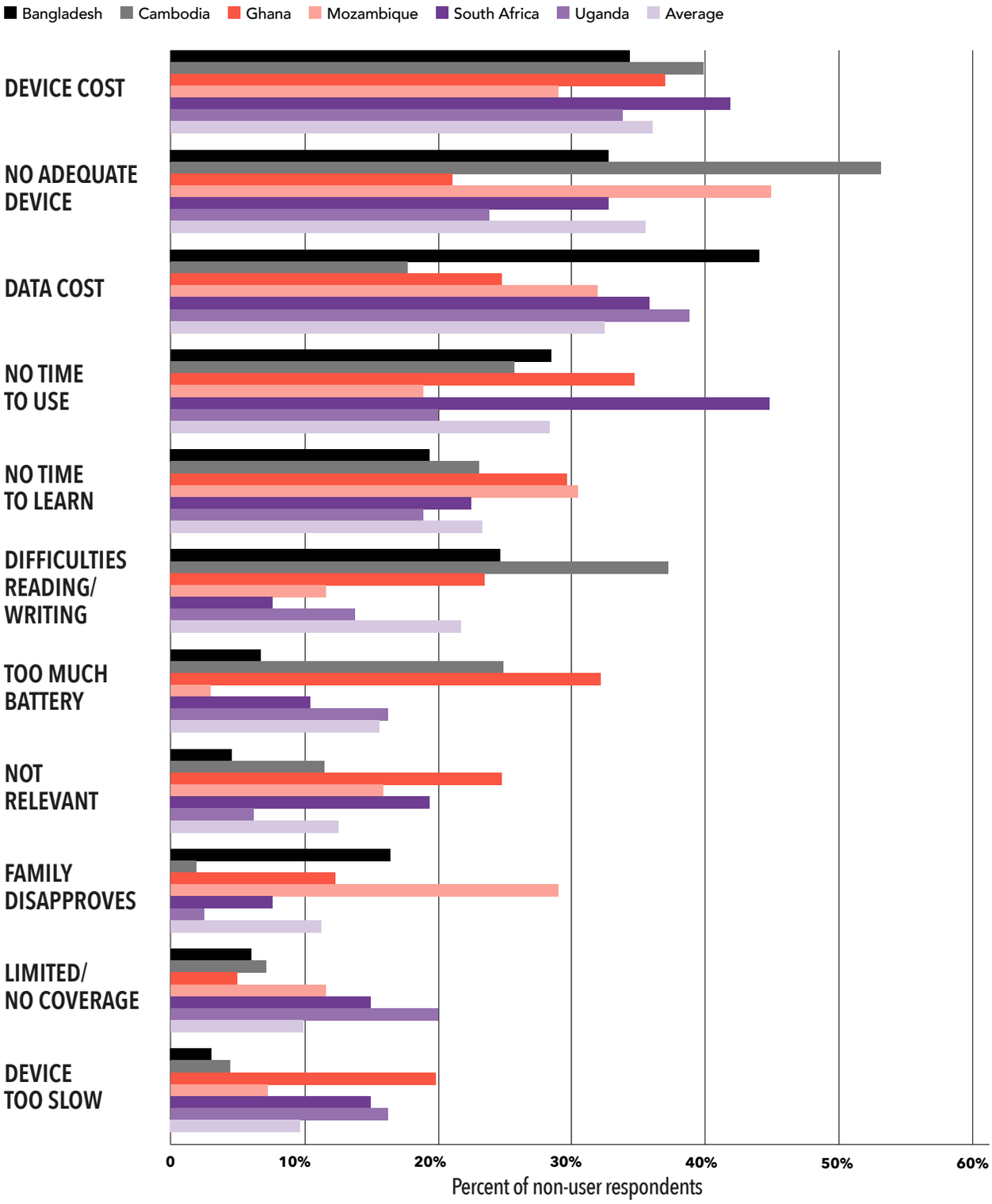
5 Ethnographic data was collected by country research experts TechSocietal in Nigeria.

6 Note that Nigeria is not included in the survey. Quantitative data is referenced here to highlight the extent to which qualitative findings are reinforced by survey results across geographies.

FIGURE 4

BARRIERS TO DIGITAL INCLUSION, AS REPORTED BY NON-USERS

Reasons to not use Internet, as % of non-user respondents



Note: Survey data is based on a nationally representative sample of 6,000 women internet users across six countries (1,000 women per country) and, a 10%-percent quota sample per country of women who do not use the internet)

Source: GDIP 2024a.

CASE STUDY: FINANCIAL AND EDUCATIONAL BARRIERS TO WOMEN'S DIGITAL INCLUSION IN EL SALVADOR [7]

This case study is based on ethnographic insights documented in the Connected Resilience study (GDIP 2024a) in El Salvador. It emphasizes the intersecting economic constraints and educational barriers to women's digital inclusion in El Salvador, underscoring the significance of systemic barriers to meaningful digital participation.

Digital inclusion for women in El Salvador intersects with broader socioeconomic disparities. One illustrative case is a woman who, despite having a computer in her home, remains disconnected from digital possibilities, citing lack of familiarity with technology and insufficient time to learn digital skills due to extensive household responsibilities. The computer, a necessary tool for her children's education and her husband's needs, is beyond her personal access in terms of usability.

Financial constraints further exacerbate the situation. The cost of digital devices is prohibitively high; a mobile phone would cost $250 — half of her monthly household income. To manage, the family adopts a strategy of purchasing devices on installment plans, which ultimately doubles their cost, making digital access even more costly in the long run. Additionally, older phones are recycled within the family, passed from one user to another as new ones are purchased.

This case is illustrative of the multifaceted constraints to digital inclusion faced by many women in El Salvador, which include financial limitations, lack of personal access to technology, and insufficient opportunities for digital literacy training. Cumulatively, these factors limit women's full participation in increasingly digital economies and societies. This scenario highlights the need for targeted interventions that address both access to technology and training in its use, ensuring that digital inclusion extends to all members of society regardless of gender, geographical location, or economic status. [8]

ADDRESSING SOCIETAL NORMS AND ONLINE HARMS

The case studies above from India, Nigeria, and El Salvador illustrate significant barriers such as financial limitations, time poverty, and restricted mobility. In addition to these barriers, this section highlights the deep-rooted societal norms, cultural perceptions, and online safety concerns that further hinder women's ability to fully participate in digital economies.

Women face critical barriers, including online safety concerns (see Figure 5) and cultural perceptions that hinder women's professional advancement in the digital economy. In India, one interview participant who has an art business online expressed recognition that posting photos and videos of herself could increase customer engagement, but she feared receiving harassment and inappropriate unsolicited messages (GDIP 2024a). Another female artisan highlighted that the reason women are apprehensive about sharing pictures online reflects religious values and family restrictions. Although some women reported that their husbands allowed online posting and participation, most women reported conforming to communal norms, prioritizing modesty over digital visibility (GDIP 2024a). Addressing cultural, gender-based fears and social taboos through education, sensitization, and training could help empower women to use social media and online platforms for income generation and collective organizing.

Societal perceptions that stereotype gender roles can also impede women's career progression in digital sectors. A woman research participant in Nigeria shared her perspective:

> *"You hardly find people in my generation that are married going to tech at a certain level because of the stress and the cultural side of it, you know. 'You have a home, what are you doing in tech?' You have other things to do, and there's no support. For you to focus on that kind of work, even for me as a co-founder, I know how it is because I'm married and I have kids."*

In general, online harms such as online harassment, privacy breaches, and lack of trust in digital platforms disproportionately affect women, often further discouraging their active participation in digital spaces (GDIP 2024a).

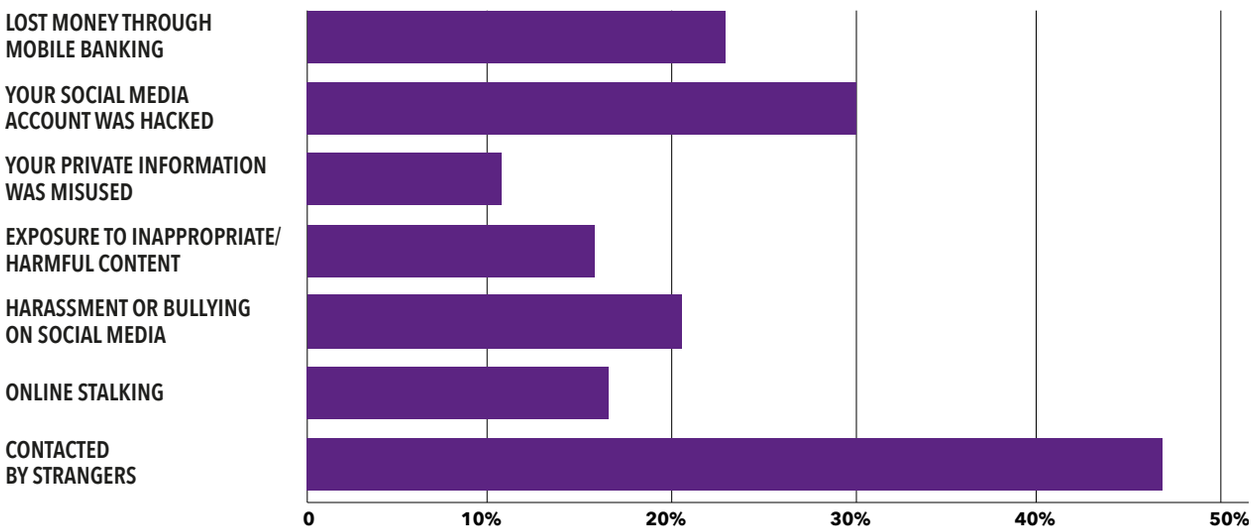
7 Ethnographic data was collected by country research experts Sulá Batsú in El Salvador.

8 While national mobile survey data from El Salvador is not included in this chapter, other quantitative data findings are aligned with the findings of this ethnographic case study.

FIGURE 5

AFTER CONNECTIVITY, ONLINE HARMS

Online harms experienced, as % of affected respondents



Note: Survey data is based on a nationally representative sample of 6,000 women internet users across six countries (1,000 women per country).

Source: GDIP 2024a.

Effective digital inclusion policies must therefore address underlying societal structures and work toward transforming gender norms. By considering factors such as time available for educational pursuits, the accessibility of economic opportunities in digital spaces, and the distribution of domestic responsibilities, policymakers can create a more level playing field where women have the capacity to utilize digital resources meaningfully.

For digital inclusion policies to be transformative, policymakers must confront these challenges head-on, promoting online environments that are not only safe but empowering for women. This comprehensive approach will be pivotal to advancing not just digital inclusion but the lived experience of digital equity for women. Policies aimed at digital equity must therefore consider not just digital connectivity, tools, and training, but also the complex socio-economic and cultural contexts that shape women's experiences in the digital landscape and use of services (GDIP 2024a).

The next section profiles public policies and initiatives to promote women's digital inclusion from across Africa, Asia, and Latin America. These policies are not only inclusive in design and implementation, but also recognize and aim to address the unique challenges women face within and across countries and regions.

DEMONSTRATION OF GOOD PRACTICE

Policies and targeted investments in meaningful connectivity will open new possibilities for societies and women in the digital economy. At GDIP, we propose four tiers of achievable solutions: deep investments, grand visions, easy wins, and scalable systems. This section highlights examples of good practices from across Africa, Asia and Latin America to demonstrate to policymakers, investors, and the ICT sector at large real possibilities and solutions available to fast-track meaningful connectivity and inclusive digital development for all (GDIP 2024a).

DEEP INVESTMENTS

Deep investments are interventions that use substantial resourcing to make profound changes in a specific policy area or for a specific community. Universal Service and Access Funds (USAFs) represent a key mechanism across the majority world for deep investment strategies. When well executed, they provide clear interventions with measurable changes in the lives of affected communities (GDIP 2024a:40).

Dominican Republic. The national ICT regulator, INDOTEL, identified that the majority of

the country's impoverished households are women-headed households. This data informed the solution to subsidize women's digital inclusion. INDOTEL designed a pilot plan called Social Digital Basket as part of the Biannual Plan 2021– 2022 Connect the Unconnected to provide a package including a partial subsidy of internet service and a smartphone, for low-income and women heads of households. The initiative has supported over 4,000 women heads of household to sustain and grow their businesses (GDIP 2024a: 41).

Ghana. Financial services provider Opportunity International Savings and Loans Limited (OISL) offers savings and loan products to hundreds of thousands of low-income clients, including women farmers. Beginning in 2021, OISL provided free smartphones to women and trained women and their spouses in both digital financial literacy and gender awareness, to boost their productivity and income. As a best practice, OISL also trained selected women in the community (including mobile agents) as trainers to ensure ongoing support for smartphone users (GDIP 2024a: 41).

Uganda . Solar-powered tablet devices, pre-loaded with data, were provided to thousands of low-income households across villages over three phases, as part of a Uganda Communications Universal Services and Access Fund (UCUSAF) initiative. The program was designed to demonstrate the importance of access and use of ICTs in eradicating household poverty. The Rural Household Devices Project aims to bridge the digital divide by addressing affordability barriers — for both device ownership and access to data — to promote the use of ICTs in selected villages and households and thus influence adoption into the wider community. Women benefited from this initiative because the tablets were intended for household use and were required to remain in the home, where women often spend more time, thus allowing them greater access to expand their livelihood activities and to maintain vital social connections with family and friends. The project provided digital literacy training and increased access to information, to drive economic opportunities as well as health, education, and lifestyle changes (GDIP 2024c).

India. The government has initiated several programs to provide subsidized devices and training to women in rural and low-income areas. The Digital India program includes a component, Pradhan Mantri Gramin Digital Saksharta Abhiyan, which provides digital literacy training at rural community centers, aiming to reach 40 percent of rural households and one member from every eligible household, including women. Over 52.4 million people have been trained. The State Government of Rajasthan launched the Bhamashah Yojana to provide free mobile phones to women living under the poverty line to help citizens access government services digitally. The state of Chhattisgarh has built cell phone towers in rural areas and distributed free-of-cost Reliance Jio and Micromax smartphones, with the goal of having "a smartphone for one woman in every household." The government's endorsement of mobile phones through the program has also contributed to the greater acceptability of young women using mobile phones (GDIP 2024a: 42).

GRAND VISIONS

More ambitious policies combine years of effort with substantial funding resources, to revolutionize the status quo. National broadband plans and other key strategy documents — when appropriately supported and resourced through implementation stages — represent a core example of grand visions within this space (GDIP 2024a: 40).

African Union (AU). The mutually reinforcing policies of the Digital Transformation Strategy and the AU Strategy for Gender Equality and Women's Empowerment illustrate how digital goals can be embedded in gender policy, and, conversely, how gender can be included within digital policy. These two policy frameworks help guide the African region's development over the next decade, guiding policymakers to collaborate for lasting, sustainable development (GDIP 2024a: 43).

Benin. The National Gender Promotion Policy (PNPG) is part of the government commitment to gender equality, aligning with international conventions including the Sustainable Development Goals. This policy mandates that all ministries incorporate gender considerations into their policies, and gender units have been established across ministries. Since 2016, aiming to transform Benin into West Africa's digital hub, the government has initiated major reforms to enhance digital service access and create jobs. In 2022, recognizing the need for greater inclusivity, the Ministry of Digital and Digitalization introduced a specific gender policy and action plan aiming to close the gender digital divide and promote digital inclusion in Benin.

Philippines. The government's Department of Information and Communications Technology (DICT) implements programs and policies that promote digital inclusion, such as the Free Wi-Fi for All Program, Tech4ED Project, and the Digital Jobs

PH Program. DICT launched the Digital Innovation for Women Advancement (DIWA) program in 2022 to promote gender inclusion in the ICT field and to increase women's participation. The department partnered with private companies and non-governmental organizations to aid in the implementation of advocacy and initiatives that educate and empower women (GDIP 2024a: 44).

Costa Rica. The national broadband plan includes women's access as a core component, setting specific targets for women's digital skills. For example, the plan commits to ICT training for 6,000 people over the age of 40 (including at least 50 percent women) by 2027; a specific government entity is assigned to achieve the goal within a definite timeframe and dedicated budget. The plan goals include, "100 percent of elderly care centres will have a connected 'smart' centre by 2021." In addition, resources from the national Universal Service Fund are allocated to internet connectivity in schools. Part of Costa Rica's success is due to the use of time-bound indicators, specific targets, and a biannual evaluation process.

EASY WINS

Relatively modest and specific changes can still create tangible value. Gender data — collecting, creating, analyzing, and using it — is a critical component to several easy wins that have been implemented in recent years. Policymakers can start with implementing research and measurement to make clear steps in the right direction (GDIP 2024a: 40).

Ghana. Gender-aware digital inclusion has been promoted through the Ghana Investment Fund for Electronic Communications (GIFEC) Rural Telephony and Digital Inclusion Project. GIFEC facilitates the achievement of universal access in underserved communities by delivering connectivity, establishing community ICT centers, and providing digital literacy and skills training. Training includes basic skills as well as education on the use of ICT for entrepreneurship and marketing, mobile money, and coding clubs. Gender quotas ensure that the programs reach women, and gender-specific outreach and community sensitization programs contribut e to successful impact (GDIP 2024a: 45).

Rwanda. The government launched the Digital Ambassador Program, which aims to promote digital literacy and skills development among women and girls . The program includes training in basic computer skills, online safety, and entrepreneurship, and it aims to increase women's participation in the technology sector. Half of the positions within the Digital Ambassadors program are reserved for women, to enable them to be advocates within their own communities and networks to encourage other women and girls.

The role of community. Other examples of digital skills training and peer-to-peer empowerment training for women have focused on the adoption of digital devices and services, such as mobile money and digital payments, vocational training, and personal development training and coaching . Peer-to-peer approaches can make upskilling and media literacy interventions scale faster and achieve greater impact, particularly among communities that are underrepresented in formal education (GDIP 2024a: 45; UNICEF 2023). As reported in GDIP's Connected Resilience study (2024a), research participants in various countries talked about learning new skills from family members and neighbors — an approach that is particularly critical for women and girls who lack access to formal education or training. A research participant in Mozambique reported,

> *It was my aunt who taught me how to enter WhatsApp, M-Pesa, e-Mola, but now I know. I already know how to transfer money. I already know how to withdraw money. (GDIP 2024a.)*

A research participant in Nigeria shared,

> *The information I get online when I implement it in my business, I then pass the new information to my customers about the new things I am doing, when they come, they also see that there is improvement in the business that I'm doing. Also, I send them messages on their WhatsApp, some I send messages sometimes through Telegram. While those who are not on the Internet, I send them text messages. Or sometimes I can give them a call telling them that I am doing new things they can come around to check. That's the way I do it. (GDIP 2024a.)*

SCALABLE SYSTEMS

Multi-stakeholder approaches and gender targets can provide the foundation for long-term, ongoing processes that scale progress towards closing the gender digital divide. By using policy and regulation tools to create mechanisms and procedures promoting digital inclusion, policymakers can build habits and routines that gradually and consistently shape the course of history (GDIP 2024a: 40).

Community networks. Organizations such as Zenzeleni in Mankosi, South Africa, and Gram Marg in India significantly benefit local communities by fostering sustainability through local ownership and

direct partnerships. Both programs have successfully enhanced human capabilities and improved livelihoods (Gwaka et al. 2022); both work to enhance connectivity by collaborating with public and private sector actors alongside village councils (1 World Connected 2020). These efforts have notably empowered women in rural areas, providing access to telemedicine, educational materials, e-government services, and economic opportunities. Policymakers need to facilitate the growth of such networks by supporting relevant regulations and exploring innovative solutions, such as using available television "white space" and optimizing spectrum allocation for rural community networks (GDIP 2024a: 47).

Bangladesh. The government set gender targets in Bangladesh National Broadband Policy 2023. With measurable targets in this key document, policymakers are encouraged to consistently consider gender within other ICT projects and developments and to create a mechanism to regularly review progress towards digital gender equality (GDIP 2024a: 48).

South Africa. The Independent Communications Authority of South Africa (ICASA) —the regulator of the South African communications, broadcasting, and postal services sectors —hosts an active Consumer Advisory Panel (ICASA 2023), with updated regulations in 2022 and 2023. This panel is composed of members nominated through a public process, including representatives of persons with disabilities, women, youth, senior citizens, and people living in ICT under-served areas. The ICASA Consumer Advisory Panel conducts stakeholder engagement and advocacy programs throughout South Africa to identify critical consumer concerns and to promote consumer interests throughout the country (GDIP 2024a: 48).

As millions more begin to use the internet, urgent concerns for policymakers will include responding to new online harms with data protection, online safety, and consumer protection laws and standards.

CONCLUSION

The new frontier of gender - transformative digital policies requires conscious efforts to give local communities and women's leadership a central role in the decision-making process. Current practices often privilege replicable and scalable measures that may not be well suited to the local context, including the norms, attitudes, behaviors, and social systems that underpin the barriers that women face in their lived realities. Insights gleaned from large-scale, impactful measures, documenting what has worked in specific contexts, should be complemented with local knowledge and an assessment of the local context to inform implementation. Reaching women with digital connectivity, tools, information, and services requires understanding the prevailing power dynamics that may affect their access to resources, autonomy, and choice. For example, restrictive social norms that limit women's digital inclusion may be upheld by authority figures in their communities, institutions, and households. Any intervention that overlooks such factors runs the risk of enhancing or replicating such power dynamics in societies and communities.

Examples of promising gender-transformative initiatives from Africa, Asia, and Latin America offer guidance to policymakers and digital development practitioners on taking the first steps toward effective policy action to close the gender digital divide. Moving beyond basic infrastructure, the advancement of meaningful connectivity and fully inclusive digital public services will require not only infrastructure and technological development but also a more supportive social environment and more affordable devices, data, and basic services. There are a range of strategies that policymakers can adopt to implement gender-transformative policies that promote women's digital inclusion and equity. Policymakers should engage directly with stakeholders and communities, including local women leaders, to design and implement the appropriate strategy for each context, to ensure that digitization and digital governance serve all in society.

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2.2 ANALYZING THE USE OF ELECTRONIC GOVERNMENT SERVICES THROUGH INTERSECTIONAL LENS

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ABSTRACT

Electronic government services, like other services available online, are among the benefits resulting from the use of digital technologies in the information society. However, studies have shown how the use of such services differs between women and men. This chapter discusses the gender digital divide related to the use of online public services, highlighting the relevance of data production. Based on the analysis of data from Brazil, the study presents socioeconomic and socio-demographic variables (such as gender, race, and socioeconomic class) using an intersectional perspective. This approach sheds light on: (1) mainstreaming disaggregated data; (2) measuring gender digital inequality in the Global South; and (3) monitoring policy interventions on gender digital inclusion.

KEY FINDINGS

- ICT-disaggregated data must consider context-relevant socioeconomic, socio-demographic, and geographic variables.
- Monitoring ICT-disaggregated data is essential to guarantee that new forms of digital exclusion are not created.
- Intersectional approaches provide a more complete picture of digital inclusion and exclusion.
- Access to and use of electronic government services are shaped by stereotypes, roles, and existing inequalities considering context-relevant socioeconomic and socio-demographic characteristics.

INTRODUCTION

The widespread adoption of technologies by society has been associated with a series of changes in how people communicate and interact with other individuals and organizations. Among other transformations, digital government or electronic government (e-Gov) increases people's access to public services and information. Nevertheless, progress in digital inclusion is uneven both between countries and between different groups within society. In particular, the most vulnerable are hindered in their access to services and public policies through digital means (Brazilian Internet Steering Committee [CGI.br], 2022).

One of these inequalities is related to gender differences in the adoption and use of technologies. According to the International Telecommunication Union (ITU), despite the diminishing gap in Internet access between men and women over the years, the gender digital divide persists, especially in lower-middle-income and low-income countries (ITU, 2023). Thus, gender has been recognized as a relevant determinant of the digital divide (Mariscal et al., 2019), going far beyond access to technologies such as the Internet.

In this context, a perspective that has gained prominence for analyzing digital inclusion is the concept of meaningful connectivity, which seeks a holistic understanding of the population's connectivity status. A study on the subject (NIC.br, 2024) showed that although the proportion of female Internet users in Brazil (86 percent) is higher than that of males (83 percent), the proportion of men with better connectivity conditions is higher than for women (Castello, 2024). Among the conditions measured by Castello

(2024) were indicators related to access to different devices (such as computers and mobile phones), frequency and location of Internet use, and online activities performed by Internet users. According to the study, more precarious conditions of connectivity among women "exacerbate the pre-existing barriers to their productive inclusion, equalization of income, public incidence, and participation in the social, political, and economic life of the country" (Castello, 2024, p. 109).

These disparities are not restricted solely to Internet access but can also appear in online activities, affecting access to the benefits and opportunities offered by the digital environment (Scheerder et al., 2017; van Deursen & Helsper, 2015). This includes gender inequalities in accessing digital government services (Macaya et al., 2021). A meaningful connectivity lens sheds light on usage differences even among women and men with similar levels of Internet access characteristics (Macaya, 2024).

An important approach to addressing the multiple inequalities is intersectionality, aimed at "uncovering and understanding the experiences and challenges faced by individuals who occupy multiple and intersecting group identities" (Badiee & Buvinic, 2024, p. 2). Thus, intersectionality is an approach that considers the combination and interaction between various forms of inequality that shape women's experiences of vulnerability and discrimination (United Nations Entity for Gender Equality and the Empowerment of Women [UN Women], 2018). In a context of inequalities, it is necessary to consider "the intersection of a number of simultaneous oppressions including (but not limited to) race, class, caste, gender, ethnicity, sexuality, disability, nationality, immigration status, geographical location, and/or religion" (UN Women, 2020, p. 1), as well as structural forms of inequality, such as legal barriers, gender identity, language, refugee status, low income, and age (UN Women, 2018; Wajcman et al., 2020; UN Women, 2020; UN Women, 2019). Treating all people "equally" can mean reproducing and exacerbating existing inequalities (United Nations Human Settlements Programme [UN-Habitat], 2018). Therefore, it is relevant to understand that women's experiences are not universal, being shaped by the intersection of characteristics that portray a diverse population (Wajcman et al., 2020; UN-Habitat, 2018).

Thus, given the importance of implementing an inclusive digital government in which no one is left behind (United Nations Department of Economic and Social Affairs [UN DESA], 2022), this article aims to discuss the gender digital divide related to the use of online public services, highlighting the relevance of data production to shed light on the remaining digital divides (Ribeiro et al., 2024). To this end, the study seeks to identify gender differences in the use of public services among Internet users by analyzing the results from the Survey on the use of information and communication technologies (ICT) in Brazilian households: the ICT Households survey, with data collected in 2023 in Brazil (NIC.br, 2023). The survey revealed a gender divide in the use of e-Gov services, which may indicate barriers to accessing public services and information. This includes social policies in critical areas such as health, education, and social assistance, which are especially relevant for vulnerable populations. This analysis can only be performed by countries that collect disaggregated Internet-related data (Ribeiro et al., 2024), enabling them to identify and address these inequalities. This underlines the relevance of disaggregated data production for policies aiming to reduce digital inequalities.

DIGITAL GOVERNMENT AND DIGITAL DIVIDE

The term "digital divide" encompasses several definitions, but it usually implies social and political inequalities related to the interactions between individuals, technology, and society (Helbig et al., 2009). Thus, while access to ICT is a prerequisite for citizens to access online public services and information, research increasingly also considers social and environmental factors when defining the various dimensions that affect the use of digital government (Helbig et al., 2009).

Beyond perspectives solely based on Internet access to measure digital inclusion, recent approaches have incorporated other dimensions, such as digital skills, usage patterns, and the tangible results perceived by connected individuals (Scheerder et al., 2017; van Deursen & Helsper, 2015). Research acknowledges that individuals have different experiences, outcomes, and benefits related to ICT, including access to public services (Macaya et al., 2021). These inequalities can significantly impact possible improvements in the social and economic conditions of the population (Helbig et al., 2009; van Deursen & Helsper, 2015). In this sense, the digital divide is not just a hindrance to the use of digital government, but it can also establish new forms of exclusion (Bélanger & Carter, 2009).

The pursuit of gender equality in access to ICT, especially the Internet, is one of the pillars of the sustainable development agenda and of national and

international commitments supported by various countries and international organizations, including the Sustainable Development Goals (SDG) (UN DESA, 2022). In this context, one of the gaps identified in the literature and in the debate on inclusive digital government, committed to leave no one behind, concerns the disparities in Internet access and usage between women and men.

Existing disparities between women and men in digital access are perpetuated, creating challenges for governments in implementing digital services and information. This situation hinders vulnerable groups, including women, from fully accessing services and information through digital means. According to the E-Government Development Index (EGDI), measured by the United Nations (UN), few Member-countries offer electronic services specifically targeted toward women (UN DESA, 2022). In addition, gender roles in society reinforce the different expectations around the activities and responsibilities attributed to women and men, reflected in the public services used (Lobato & Silva, 2024).

Factors such as gender, age, race, and income, among others, lead to systematic exclusions that limit the effectiveness of digital government policies for all people (UN DESA, 2022). Research on the adoption of e-Gov in specific countries, such as India, Jordan, Pakistan, South Korea, and Turkey, has also revealed that men use these services more than women (Macaya et al., 2021). Analyzing data from Brazil prior to the COVID-19 pandemic, Macaya et al. (2021) identified greater use of online public services among men, highlighting differences in the types of services and examining why women do not use these digital services. However, despite the importance of gender disaggregation, women are still underrepresented in the data collected: few countries measure and make available indicators disaggregated by sex (UN DESA, 2022).

An exception to this data scarcity is the measurement of ICT use in the Brazilian population conducted by Cetic.br|NIC.br, which has been measuring Internet usage among households and individuals in Brazil since 2005 (NIC.br, n.d.). In addition to developing data disaggregated by various socioeconomic and socio-demographic variables (such as sex, income, race or color, and level of education), this survey collects data to measure the demand side of digital government in the country.

METHODOLOGY

This paper draws on secondary quantitative data from the ICT Households 2023 survey to examine the digital gender gap in the use of e-Gov services. The survey, conducted via face-to-face interviews, aims to measure ICT use among the residents of Brazilian households (CGI.br, 2024).

The survey provides a representative data of the Brazilian population aged 10 and older. It can be described as a stratified sampling of clusters in multiple stages. This method was chosen to ensure a representative sample of the diverse Brazilian population, considering factors such as geographical location and socioeconomic status. The 2023 survey sampled 23,975 households from 619 Brazilian municipalities. In total, 21,271 interviews were conducted with individuals, representing some 180 million Brazilians (CGI.br, 2024).

The survey questionnaire consists of different modules. This paper analyzes indicators from module G – "Electronic government," which is exceptionally collected only among Internet users aged 16 or older (CGI.br, 2024). To provide an overview of e-Gov use in the Brazilian population, we present indicators on Internet users and use of e-government based on three socio-demographic variables: sex, color/race, and social class. Although the data's margin of error does not allow analyzing three or more variables together, the results serve as a proxy indicating the findings that can emerge when ICT-disaggregated data is available.

USE OF ELECTRONIC GOVERNMENT

DISAGGREGATED DATA ON ELECTRONIC GOVERNMENT IN LATIN-AMERICA

The scenario of gender-disaggregated data production has received attention from international organizations (Sey et al., 2019). Nevertheless, there is still a lack of data. According to Sey et al. (2019), worldwide, 90 countries shared sex-disaggregated data on use of the Internet, 78 on use of a computer, 40 on owning a mobile phone, and 34 on using a mobile phone. As is widely acknowledged, "without data, there is no visibility. Without visibility, there is not priority." (Hafkin, 2003, p. 1).

Specifically regarding sex-disaggregated data on electronic government, 98 countries reported data on "getting information from general government organizations" and 81 countries reported data on "interacting with general government organizations" (ITU, n.d.). For the Latin-American and Caribbean context, data from the ITU DataHub show a scenario of (1) lack of data, since many countries do not collect

or report these data to ITU; and (2) outdated data, as the last data collected or reported to ITU is not recent in several countries (see Table 1). Data production in a timely and frequent manner is relevant for assessing and monitoring progress and assessing remaining divides (Equals Global Partnership, 2022).

TABLE 1. FEMALE AND MALE INTERNET USERS ACCESSING GENERAL GOVERNMENT ORGANIZATIONS

(Latin-America and Caribbean, by country, year, and gender)

	INTERNET USERS			GETTING INFORMATION FROM GENERAL GOVERNMENT ORGANIZATIONS			INTERACTING WITH GENERAL GOVERNMENT ORGANIZATIONS		
COUNTRY	YEAR	FEMALE	MALE	YEAR	FEMALE	MALE	YEAR	FEMALE	MALE
ANTIGUA AND BARBUDA	-	-	-	-	-	-	-	-	-
ARGENTINA	2022	88%	89%	-	-	-	-	-	-
BAHAMAS	2010	67%	62%	-	-	-	-	-	-
BARBADOS	-	-	-	-	-	-	-	-	-
BELIZE	2010	28%	28%	-	-	-	-	-	-
BOLIVIA	2021	64%	68%	-	-	-	2018	11%	13%
BRAZIL	2022	81%	80%	2022	32%	36%	2022	29%	39%
CHILE	2017	81%	84%	-	-	-	2009	13%	15%
COLOMBIA	2022	74%	72%	2022	52%	52%	2022	10%	10%
COSTA RICA	2022	83%	82%	2012	29%	29%	-	-	-
CUBA	2019	75%	61%	2019	1%	1%	2019	1%	1%
DOMINICA	-	-	-	-	-	-	-	-	-
DOMINICAN REP.	2021	86%	85%	-	-	-	-	-	-
ECUADOR	2023	73%	72%	2023	3%	3%	2012	0%	0%
EL SALVADOR	2020	52%	57%	2020	0%	0%	2008	0%	1%
GRENADA	-	-	-	-	-	-	-	-	-
GUATEMALA	2021	49%	53%	-	-	-	-	-	-
GUYANA	-	-	-	-	-	-	-	-	-
HAITI	-	-	-	-	-	-	-	-	-
HONDURAS	2019	41%	38%	-	-	-	-	-	-
JAMAICA	2021	85%	80%	-	-	-	-	-	-
MEXICO	2022	78%	79%	2022	21%	24%	2022	6%	8%
NICARAGUA	2006	10%	10%	2006	11%	13%	-	-	-
PANAMA	2019	64%	63%	2012	0%	0%	2012	8%	8%
PARAGUAY	2022	78%	75%	2022	24%	22%	-	-	-
PERU	2022	73%	77%	2008	5%	6%	2022	11%	13%
SAINT KITTS AND NEVIS	-	-	-	-	-	-	-	-	-
SAINT LUCIA	-	-	-	-	-	-	-	-	-
SAINT VINCENT AND THE GRENADINES	-	-	-	-	-	-	-	-	-
SURINAME	-	-	-	-	-	-	-	-	-
TRINIDAD AND TOBAGO	2011	46%	74%	-	-	-	-	-	-
URUGUAY	2022	91%	89%	2022	31%	39%	-	-	-
VENEZUELA	2012	51%	48%	-	-	-	2012	6%	5%

Source: ITU (n.d.).

The ITU data reveals a generally equal profile for men and women, and in some cases a higher presence for men in the indicator "Getting information from general government organizations." For the countries with data available (11 out of 33), online interaction with government organizations was more frequently reported by men than women (Table 1)—one of the e-government advantages. While the indicators do not indicate reasons for not accessing online public services, they reveal differences between males and females regarding more sophisticated online activities such as digital interaction with government organizations.

Furthermore, the region also lacks national ICT policies addressing women and/or gender issues (which does not mean that ICT policies are not gendered). In 2016, the Economic Commission for Latin America and the Caribbean (UN ECLAC) reported that one out of 14 selected countries included "Women and ICT" as a theme in the digital agenda, and 11 addressed "Electronic government" as a topic (Patiño et al., 2018). Following similar criteria, recent studies show improvements: seven out of 18 countries included the "Promotion of gender equality" in their digital agendas, and 14 included "online services" related to electronic government. Nevertheless, the scenario presented in Table 1 sheds light on the gaps that must be bridged, and particularly the need for disaggregated data by gender.

Brazil is an exception in this context, providing information about many topics related to Internet use by sex and other variables. The following section presents a brief analysis of data from Brazil, which is analyzed by gender, race or color, and social class. This analysis indicates the gender gaps, particularly in the adoption of e-Gov, and it reinforces the relevance of producing and making available disaggregated data.

DISAGGREGATED DATA ON ELECTRONIC GOVERNMENT IN BRAZIL

According to data from the ICT Households 2023 survey, 84 percent of Brazil's population are Internet users. Although the overall results show a small difference between women and men (at 86 percent and 83 percent, respectively), the picture of the digital gender gap takes on additional nuance when analyzed through the lens of meaningful connectivity (Castello, 2024). These disparities are evidenced in the analysis of disaggregated data on electronic government in Brazil.

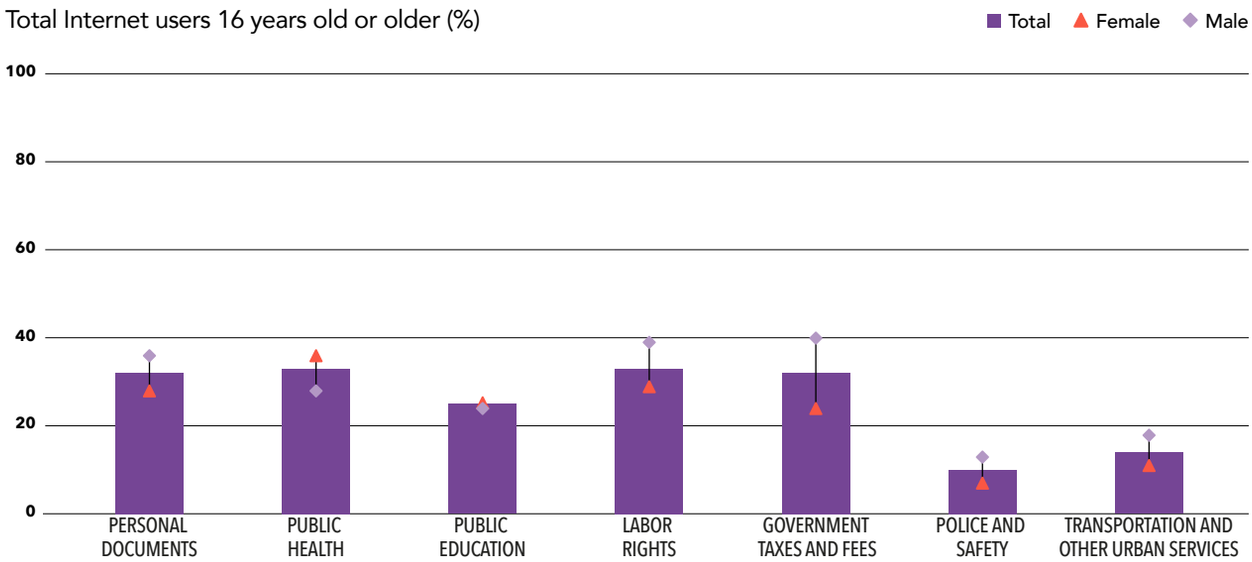
The proportion of Internet users 16 years old or older who have used e-government services rose from 65 percent in 2012 (NIC.br, 2013) to 73 percent in 2023 (NIC.br, 2023). The same data show a difference between males (at 64 percent) and females (58 percent), showing more men accessing digital government than women in general.

To identify e-Gov users, the ICT Households survey analyzes public services where Internet users sought information entirely online. Among the seven types of services surveyed, the most cited were those related to public health (scheduling appointments, requesting medications, or other public health system services) at 33 percent and services related to labor rights or social welfare benefits, also 33 percent, followed by personal documents (32 percent) and government taxes and fees (32 percent). Still, these services were mentioned only by approximately one-third of Internet users (see Figure 1). The most accessed services also showed the most significant disparity between women and men: government taxes and fees, at 24 percent and 40 percent, respectively; labor rights at 29 percent and 39 percent; personal documents at 28 percent and 36 percent, and public health at 36 percent and 28 percent (NIC.br, 2023).

FIGURE 1

INTERNET USERS, BY TYPE OF PUBLIC SERVICE INFORMATION SOUGHT OR USED IN THE LAST 12 MONTHS (TOTAL AND BY SEX, 2023)

Total Internet users 16 years old or older (%)



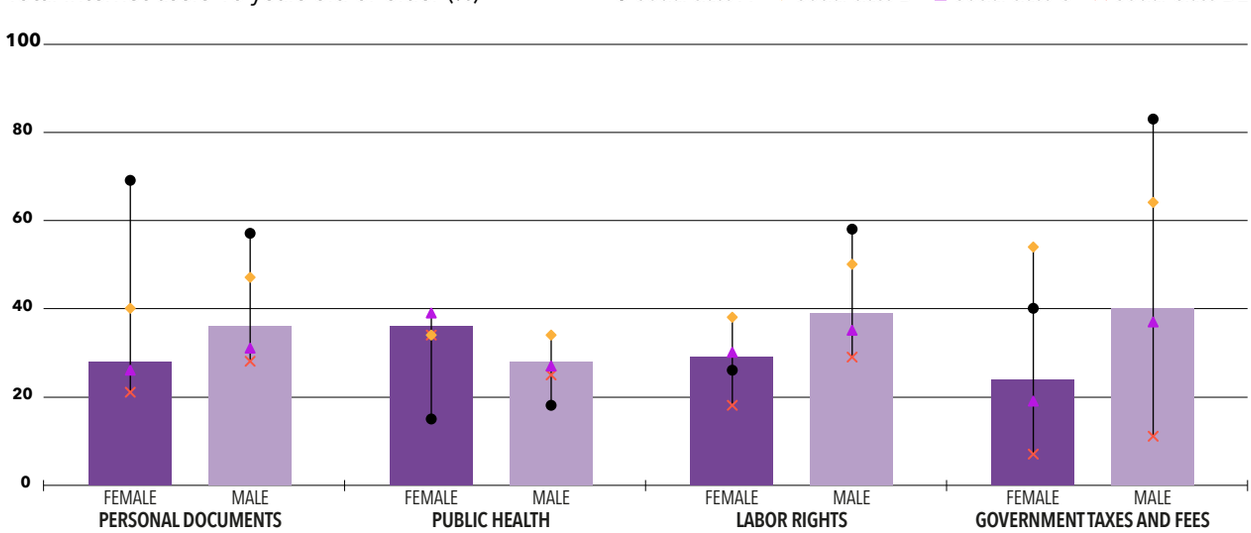
Source: NIC.br (2023).

Unlike services related to public health, services related to taxes and government fees, as well as labor rights or social welfare benefits, are predominantly sought by men. This gender disparity is also evident in the various socio-demographic breakdowns published in the ICT Households survey. For example, for seeking and using services and information related to government taxes and fees, there is a significant difference (43 percentage points) between women (at 40 percent) and men (83 percent) from social class A (see Figure 2).

FIGURE 2

INTERNET USERS BY TYPE OF INFORMATION REGARDING PUBLIC SERVICES SOUGHT OR USED IN THE LAST 12 MONTHS (BY SEX AND SOCIAL CLASS, 2023)

Total Internet users 16 years old or older (%)



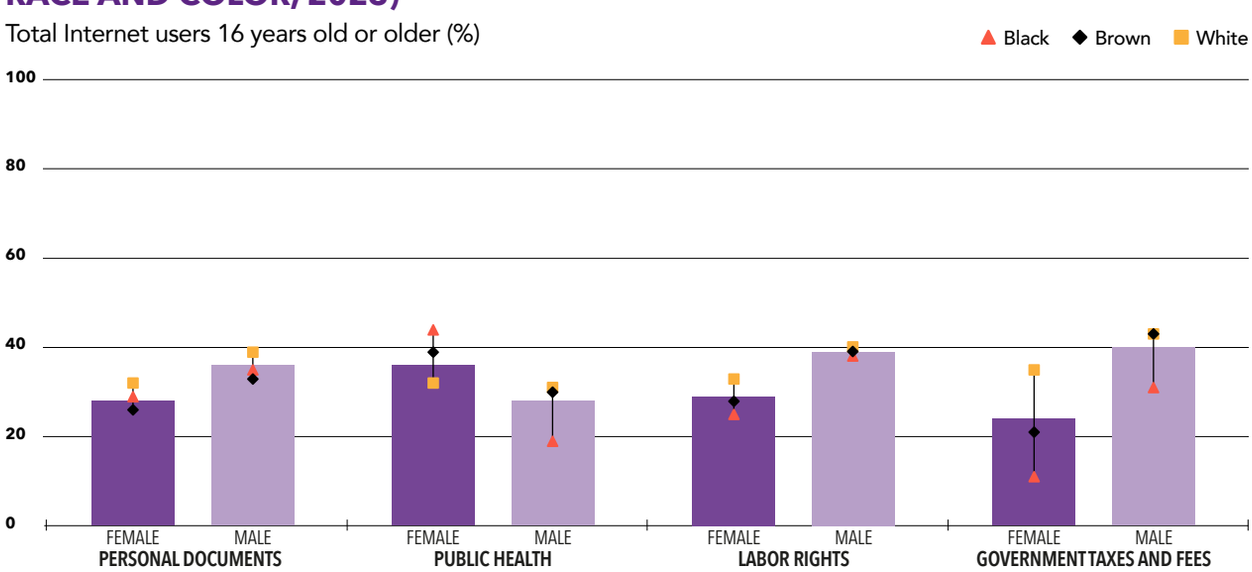
Source: NIC.br (2023).

A difference of about 20 percentage points is also noted between Brown women and men (21 percent and 43 percent, respectively) and between Black women and men (11 percent and 31 percent) (see Figure 3). There are also significant discrepancies among women by race, color, or social class; for instance, the proportion of White women who reported using any service related to government taxes and fees was 35 percent, compared to 11 percent for Black women. Differences by social class are notable only among men, however: there is a 72-percentage-point difference between men in social class A (83 percent) and those in social classes D and E (11 percent) in seeking information or using these types of services (NIC.br, 2023).

This research has also identified significant gender and racial disparities in public health service access. For instance, more women than men accessed public services related to public health, in almost all investigated categories. Black women (44 percent) and Brown women (39 percent) reported seeking information or using public health services in higher proportions than White women (32 percent). Similarly, 15 percent of women in social class A reported seeking or using any public service in this area, compared to 39 percent and 34 percent of women in social classes C and DE, respectively. These differences may stem in part from the latter's greater reliance on health services provided by the Brazilian Unified Health System (Sistema Único de Saúde [SUS]). But there also seems to be an intersecting gender role effect: except in social class A, more women than men report seeking information about or using public health services. This difference reaches 25 percentage points between Black women (44 percent) and Black men (19 percent).

FIGURE 3

INTERNET USERS BY TYPE OF INFORMATION REGARDING PUBLIC SERVICES SOUGHT OR USED IN THE LAST 12 MONTHS (BY SEX AND RACE AND COLOR, 2023)



Source: NIC.br (2023).

FINAL REMARKS

The Brazilian data from the ICT Households survey are important for better characterizing the complex landscape of digital divides, particularly between men and women and even among women in different socioeconomic contexts. It illuminates not only gender inequalities in the use of e-government, but also inequalities rooted in socio-demographic characteristics such as race or color and social class. The findings underscore various dimensions of exclusion that affect digital divides and digital government (Helbig et al., 2009), transcending the simple dichotomy of Internet access/no access as a benchmark of access to online services.

While men and women in Brazil access the Internet in equal proportions, there are gender

differences in accessing digital public services, as well as differences based on race or color and social class. These differences are shown in the types of e-Gov information and/or services sought by Internet users. These gaps can indicate lost opportunities for digital government impact.

The finding of disparities among women based on race, color, and social class has implications for the development of digital government in the country. Governments and public managers must take into account disaggregated data when providing digital services, particularly those aimed at serving the most vulnerable populations. The failure to understand the social and economic characteristics of the target population for public policies, especially beneficiaries and users of social policies, can inadvertently transform digital government services into a new source of exclusion. Understanding these disparities in access to public services via the Internet is crucial for defining actions and strategies aimed at reducing these inequalities and ensuring access for those who need it. For future studies, it is important to delve deeper into the barriers that women face in accessing e-government services. This will enable the implementation of truly inclusive digital information and services, leaving no one behind.

These analyses and reflections are made possible by the availability of timely ICT-disaggregated data. The disaggregation must consider context-relevant socioeconomic, socio-demographic, and geographic variables, to give visibility into the remaining digital divides and to prioritize public policies addressing them. Finally, it is imperative to monitor the data to guarantee that new forms of digital exclusion are not created.

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CASE STUDY 2.3

SHE IN STEM: EXPERIENCES OF BRAZILIAN STUDENTS IN STEAMS

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KEY FINDINGS

1. *Long-term impact of ELAS nas Exatas.* Launched in 2015, Elas nas Exatas continues to influence students and project coordinators. Some initiatives remain active despite changes in specific activities, demonstrating the lasting impact of the program.
2. *Challenges in project sustainability.* While some initiatives have thrived, many projects selected in 2015 were discontinued, reflecting broader challenges in Brazil's educational policies. The lack of infrastructure in schools is a key barrier to sustaining long-term engagement in STEM initiatives.
3. *University partnerships as a sustainability factor.* Initiatives that established connections with universities had greater sustainability. Universities play a crucial role in fostering dialogue among stakeholders in academic education, research, and community outreach, enhancing project continuity and impact.
4. *Empowerment and awareness among STEM students.* Participation in ELAS nas Exatas projects helped undergraduate students, particularly in engineering, reflect on gender equity in STEM. It strengthened their sense of community and professional identity while increasing their persistence and engagement in their studies.
5. *Expansion of funding and need for strategic investments.* ELAS nas Exatas inspired new funding opportunities, such as the 'Garotas STEM' and 'Programa Ciência na Escola' initiatives. However, strategic investments including monitoring and evaluation mechanisms are necessary to ensure the long-term sustainability and scalability of such projects, fostering broader educational policy advancements in Brazil.

THE "ELAS NAS EXATAS" CALL FOR PROPOSALS

In 2015 the initiative "Elas nas Exatas" Call for Proposals was created — School Management for Equity, designed to engage female secondary school students in Brazilian public schools in the technological and exact sciences through the promotion of gender equity. The call for proposals offered to provide technical and financial support to initiatives presented by groups, organizations, and associations, in partnership with or representing public high schools.

The "Elas nas Exatas" Call is considered an innovation in the field of Brazilian private social investment (Pineda, 2023) due to its execution through a tripartite partnership involving a feminist rights fund (ELAS+), a corporate philanthropy institution (the Unibanco Institute), and an education institution focused on evaluation and research (the Carlos Chagas Foundation). In the field of education, this represented a new approach to addressing gender issues in schools, since it required collaboration between the initiative coordinators and the partner schools. The participating feminist organizations had to develop strategies to adapt to the school context, treating the school as a partner in carrying out their work with students. Within schools, too, this process was innovative in requiring the schools to participate in the entire process, from development to execution and evaluation.

ABOUT ELAS NAS EXATAS PROJECTS

The program supported a variety of initiatives designed to stimulate girls' interest in the natural and exact sciences while at the same time fostering awareness of gender inequalities in educational settings.

The FCC conducted an evaluation of the first ten initiatives selected by the Call in 2015 (Unbehaum, Gava, 2017). The following five parameters were established as minimum requirements for developing gender equity projects in schools that could serve to stimulate and expand girls' interest in the fields of natural and exact sciences and to raise awareness within the school community about gender inequalities and discrimination.

1. Involvement of the school unit in all stages of the project. Ideally, linking the initiative to the school's dynamics and lesson planning while involving the science teachers.

2. The need for technical and theoretical support in gender and school management for equity for projects that generally
3. Strategies for the school community to appropriate the theme, including: sharing technologies and knowledge with teachers to support a pedagogical practice that promotes gender equity; developing actions with the initial grades of high school.
4. Actions that contribute to girls' learning in natural and exact sciences as a means of empowerment.
5. Encouraging the development of additional partnerships and support from local groups, as a strategy to increase the reach and sustainability of the initiatives.

Most of the ten projects selected for this edition of ELAS nas Exatas were discontinued. The exceptions were projects linked to universities, especially extension projects, such as the four projects outlined below.

- *Engenheiras da Borborema* (Borborema engineers), which motivates women to enter engineering and technology courses through a lecture series on women in engineering as well as workshops on electronics, computers, and new teaching methods in mathematics and physics for female public high school students.
- The *"Meninas na Ciência"* (Girls in Science) program aims to attract girls to science and technology (S&T) careers and to encourage women who have already chosen these careers to become active in the scientific and technological development of Brazil. The program trains undergraduate college students to teach science and technology in public schools, using astronomy, physics, and robotics. The project also aims to raise awareness within the academic community and in underserved communities about the role of women in society, contributing to the elimination of gender stereotypes.
- *"Meninas nas Exatas"* (Girls in the Exact [Sciences]) is an initiative aimed at encouraging high school girls to choose science-related careers and at demystifying physics. Its project, "Tem Menina no Circuito" (There's a Girl on the Circuit), was created in 2014 by three professors from the Institute of Physics at the Federal University of Rio de Janeiro (UFRJ) and has been operating since then in two schools in Rio de Janeiro, with practical activities involving electrical circuits that promote interaction and stimulate the creativity of students.
- The *OGUNTEC* project is an initiative by the Steve Biko NGO located in Bahia in the northeastern region, to promote science, technology, and innovation to reach young black students. The program incorporates scientific and technological knowledge into the students' cultural environment, preparing them to meet the new challenges of the "technological society" and help them overcome the racial and gender inequalities present in hiring and income distribution.

Successful projects emphasized the involvement of the entire school community, including both teachers and administrators, to create an institutional culture that actively confronts gender, racial, ethnic, and sexual diversity inequalities. They also provided essential technical and theoretical support in school management for equity, a crucial element for addressing gender issues within schools and ensuring the sustainability of the projects.

Despite the success of some initiatives, many projects initially funded by "Elas nas Exatas" were discontinued over time. This reflects the broader challenges within Brazil's educational system, where the lack of sustained public policies and continuous funding has hindered the long-term impact of gender equity initiatives. Projects like "Tem Menina no Circuito" and OGUNTEC show that local, community-driven efforts, particularly those targeting underserved populations, are crucial in combating gender stereotypes and racial inequalities in the STEM fields. These initiatives help bridge the gap between gender and science, while empowering young women from diverse backgrounds to persist and thrive in science and technology careers.

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DIGITAL ECONOMY

BUILDING AN INCLUSIVE DIGITAL ECONOMY FOR WOMEN

LOLY GAITAN (ITU)

As the digital economy reshapes industries and labor markets worldwide, it holds great promise for advancing gender equality. This section of the report explores how digital transformation intersects with gender, highlighting persistent barriers while identifying practical pathways for women's economic empowerment. It calls for coordinated action to ensure that women are not left behind in this evolving landscape.

Access to digital tools and platforms is essential—but it is only the starting point. Structural barriers persist: unequal access to financing, exclusion from innovation ecosystems, constraining gender norms, and women's underrepresentation in leadership. All continue to restrict women's full participation in the digital economy.

The first chapter highlights gender disparities in the use of digital technologies among microenterprises in seven Sub-Saharan African countries. Mobile phones are widely used; however, women entrepreneurs are significantly less likely than men to own smartphones—a key tool for accessing digital markets and services. Cost, limited digital skills, and lower financial inclusion contribute to the smartphone gap. For women-led businesses to thrive, interventions must address smartphone affordability and accessibility, while also expanding digital literacy and removing systemic barriers to economic participation.

The second chapter turns to innovation and intellectual property (IP), an area where women remain significantly underrepresented globally. Barriers such as limited access to STEM education, lack of funding for women-led enterprises, and weak professional networks prevent women from fully participating in innovation ecosystems. Without targeted interventions, gender gaps in patenting and IP creation may persist for decades. Closing these gaps is not just about fairness—it is essential to unlocking new ideas and driving inclusive growth.

The third chapter examines flexible, digitally enabled work in Sri Lanka. While digital platforms have created new job opportunities and have enhanced women's resources and agency, they also risk reinforcing existing inequities. Many women turn to flexible work out of necessity rather than choice, due to broader structural constraints. Policies such as affordable childcare, safe transportation, legal protections, and upskilling are needed to ensure that digital work becomes a pathway to empowerment.

Finally, the case study of the EQUALS Her Digital Skills e-Mentoring Program shows the value of combining technical skills with soft skills such as communication, leadership, and confidence-building. This holistic approach helps young women apply their knowledge in the workplace, pursue leadership roles, and envision broader career possibilities. Programs like these are essential for building a more inclusive digital workforce.

Across all contributions found in this section, one message stands out: real change requires intentional, coordinated action. Empowering women in the digital economy demands integrated strategies, including investments in access, education, finance, mentorship, and policy reform.

We call on policymakers, industry leaders, educators, and development actors to move from ambition to action. Now is the time to dismantle barriers, amplify women's voices, and build a digital economy where opportunity, innovation, and leadership are accessible to all.

3.1

UNDERSTANDING THE GENDER INEQUALITIES IN THE ADOPTION OF DIGITAL TECHNOLOGY AMONG MICROENTERPRISES IN SEVEN SUB-SAHARAN AFRICAN COUNTRIES[1]

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ABSTRACT

Microenterprises in Africa have become a source of livelihood for many, and a source of income generation especially for women. Microenterprises face challenges in accessing products, services, and markets, challenges which are often worse for female-owned businesses. The use of digital technologies can help microenterprises to tap into new markets and transact digitally.

This research aims to identify gender inequalities in the adoption of digital technologies, and to gauge to what extent these inequalities can be explained by underlying factors. It explores where intersectionality exists and how the drivers of digitalisation tend to differ for male-owned and female-owned microenterprises.

The study uses microenterprise data from the 2022 After Access ICT surveys, conducted by Research ICT Africa across seven countries in sub-Saharan Africa that employed both descriptive and econometric analysis.

KEY FINDINGS

- Mobile phone ownership among female-owned microenterprises is mainly limited to basic phones, as only 32 percent own smartphones; there is a smartphone gender gap of 29 percent.
- Use of the internet for business purposes remains low in general, at 17 percent; internet use by male-owned businesses is 24 percent, compared to just 14 percent for female-owned businesses.
- Only 43 percent of female-owned microenterprises that have smartphones use the internet, compared to 56 percent of male-owned microenterprises with smartphones.
- The cost of smartphones was a major barrier for female-owned microenterprises preventing them from using the internet. For those already using the internet, the lack of digital skills was a significant additional limitation.
- Financial inclusion and the use of financial services was higher for male-owned microenterprises than female-owned microenterprises.

INTRODUCTION AND BACKGROUND

African economies continue to be plagued with high unemployment rates amid a growing population. The working age population is expected to grow rapidly, especially in Africa (Bhorat and Oosthuizen, 2020), and this will exacerbate existing unemployment. Citizens are faced with unequal access to income-generating opportunities, causing many to resort to informal economic activities, including most microenterprises in Africa. The informal sector has been described by the IMF as a safety net for the poor, despite the sector's low incomes, low levels of productivity, and limited access to government benefits.[2] In Africa, 89.7 percent of employed women are in informal employment, compared with 82.7

1 The seven sub-Saharan African Countries discussed in this paper are Ethiopia, Ghana, Kenya, Nigeria, South Africa, Tanzania, and Uganda.

2 Video remarks by Kristalina Georgieva, Managing Director, IMF. https://www.imf.org/en/News/Seminars/ Conferences/2019/03/25/7th-statistical-forum.

percent of men, and women are more often employed in the most vulnerable situations.

Digital technologies have the potential to change the way the informal sector works, though they present both opportunities and challenges for microbusinesses. With digital technologies, microenterprises may be able to tap into new markets, marketing goods and services through online platforms and apps while making and receiving payments digitally, expanding their businesses.

This research aims to understand to what extent microenterprises adopt digital technology and to identify the factors that limit or hinder adoption, from a gender perspective. The study uses econometric models to investigate potential gender inequalities and possible underlying factors, to understand where intersectionality exists.[3] The study makes use of microenterprise data from the 2022 *After Access* ICT surveys[4] conducted by Research ICT Africa, across seven countries in sub-Saharan Africa. Building on the limited evidence-based research on microenterprises in Africa, this study hopes to add to existing literature and to articulate areas for future research.

MICROENTERPRISES IN AFRICA AND SUSTAINABLE DEVELOPMENT

The microenterprise sector in Africa has grown over the years, and it is believed to have played a major role in economic development and in absorbing the unemployed. Microenterprises in developing economies are seen as the main source of livelihood for many, contributing toward the implementation of the 2030 Agenda for Sustainable Development and toward achieving the Sustainable Development Goals (United Nations, 2015). The micro and small enterprise (MSME) sector employs the majority of the labour force in Africa and is referred to as 'the missing link' for inclusive growth (International Trade Centre, 2018). According to the World Economic Forum, women have a higher likelihood of experiencing unemployment than men. There are fewer women participating in the labour market, and among that cohort very few are considered to be employed (World Economic Forum, 2023). Microenterprises operating in the informal economy have therefore become a source of income generation for women who are often excluded from the formal economy.

Microenterprises found in developing nations are mostly 'necessity' or 'survivalist' enterprises that require little capital investment, minimal or no skills training, and low levels of technological input. Such businesses are intended to make money for daily needs and therefore pursue business diversification rather than specialization. It has been noted that such businesses are often owned and/or run by women.

Microenterprises face challenges including low productivity, lack of finance, and poor access and use of digital technologies. This is even more so for female-owned businesses, which face inequalities in access to products, services, and markets, resulting in inequalities in performance. These microenterprises mainly rely on the owner's personal savings, as they seldom have access to loans from banks due to strict requirements. A study by the International Finance Corporation on South Africa found that 79 percent of informal businesses have never borrowed money, and of those that have, only 21 percent made use of a bank loan (Botha and Maylie, 2020). Lack of access to electricity and the constant power outages have also been a barrier to productivity for micro businesses (Ishengoma, 2018; Abdisa, 2018; Carlsson et al., 2020).

DIGITALIZATION AND DIGITAL INEQUALITY

There is growing evidence in the private sector that digitalization and digital business solutions increase productivity, capital, and revenue of enterprises (World Bank, 2020). Disse and Summer (2020) showed that digitalization transforms industries, value chains, and economic segments, including in the MSME sector. Central to the call for digital equality between women and men are claims that the Internet has the potential to be a driver of accelerated progress towards the achievement of the Sustainable Development Goals (SDGs) as well as the UN's 2030 Agenda for Sustainable Development (United Nations General Assembly, 2015).

It is believed that digital technologies provide an avenue for microenterprises to improve

3 Intersectionality is a term which has gained popularity in social sciences since the writings of Kimberlé Crenshaw in the late 1980's and early 1990's (Crenshaw, 1991). It is a critical theoretical framework which explores the interlinkages between power dynamics in society and how this results in systems of marginalistion which intersect and mutually reinforce each other (De Silva, 2020; Guan, et. Al, 2021).

4 The After Access survey was undertaken between 2022 and 2023 by Research ICT Africa. The nationally representative household and individual survey undertaken in each country, was complemented by a microenterprise survey which contains questions on the ways in which microenterprises use ICTs within their businesses. These surveys are conducted every three years, subject to funding.

performance, giving them a platform to tap into local and global markets and thus reduce transaction costs while offering easy access to information, improved productivity, and a smooth transition to formalization (Bhattacharya, 2019). According to the IFC, 25 percent of MSMEs in Africa scaled up their use of digital tools during the COVID-19 pandemic, with no difference found between women-owned and men-owned businesses (International Finance Corporation, 2020).

For those who face challenges in penetrating the more formal labour market, a digital economy can provide income-generating opportunities (Ahmed et al., 2021). There continue to exist inequalities in the formal labour market, especially for women. While digitalization is envisaged to narrow these inequalities, women continue to engage in small micro-businesses in the informal economy (Rogan and Alfers, 2019). However, for microenterprises to tap into the potential benefits of digitalization, they will need more than connectivity, device ownership, and internet access. The ability, skills, and know-how to use digital technologies is vital.

Research shows that although the gender ICT access gap appears to be decreasing, this is belied by the observed use patterns of digital tools. In order to be empowered through technology, women need to be able to use digital tools in ways that will benefit their business and day-to-day activities. The gender gap in digital skills, as well as other non-digital inequalities, puts women at a disadvantage. A recent study assessing the gender gap in basic, intermediate, and advanced digital skills found that, in most of the countries assessed, women are not only less likely than men to have advanced digital skills, but they also lag behind in basic digital skills (Kang and Junio, 2019).

MICROENTERPRISES AND DIGITALIZATION IN SUB-SAHARAN AFRICA

Digitalisation has become widespread in Africa, as a focus of governments trying to build a digital economy: the increased availability and affordability of mobile phones, including smartphones, is matched by the increasing number of mobile subscribers. Despite this advance, research shows that significant inequalities continue to exist both between countries and across population segments within African countries (Gillwald and Partridge, 2022). Research further shows that income and education—the factors that drive digitalization—are also the factors that drive economic access (Aguilar et. Al., 2020; Chair et. Al., 2016).

While evidence points to an increase in adoption of digital technologies among microenterprises in Africa, progress seems to be slow compared to other parts of the world. It has been acknowledged that an intervention is needed if African microenterprises are to participate fully in the digitalisation process and avoid further marginalization in the global economy (United Nations Economic Commission for Africa, 2023).

The access and use of the internet remains very low in Africa, especially in its use for business purposes by microenterprises. In the countries surveyed, the use of the Internet for business purposes stood at 17 percent on average: 24 percent for male-owned business and just 14 percent for female-owned businesses (Research ICT Africa Survey, 2022). Studies have shown that microenterprise use of ICTs is hindered by low levels of internet access, the lack of access devices, and inadequate infrastructural development, including electricity, in the countries surveyed. The nature of the digital divide in the informal economy shows women at a more disadvantaged position.

DATA, METHODOLOGY AND ANALYTICAL FRAMEWORK

DATA AND METHODOLOGY

The latest round of the After Access surveys conducted by Research ICT Africa took place between May 2022 and September 2023. This survey covers seven countries: South Africa, Nigeria, Uganda, Ethiopia, Kenya, Tanzania, and Ghana. This nationally representative household and individual survey was accompanied by a microenterprise survey that asked about the use of ICT within their businesses and the barriers to its use. A microenterprise was defined as a business with ten or fewer employees that is not part of a franchise.

A total of 3,904 interviews were completed. For 37 enterprises, the gender of the owners was not available, and they were excluded from the sample for this study on the gendered aspects of microenterprises digitalisation, leaving a relevant sample of 3,867 microenterprises. As the sampled microenterprises were not obtained from business listings, the results should be considered as indicative rather than representative of all microenterprises in the surveyed countries. As such, although weights are estimated, for the purpose of this analysis unweighted data is used.

ANALYTICAL FRAMEWORK

The first step for a business adopting digital technologies is access, defined to include: (1) the availability of digital technologies; (2) the availability of appropriate equipment; (3) the regularity and intensity of use; (4) the skills and knowledge required; and (5) the appropriateness of language and user interfaces (United Nations, 2021). The factors enabling use are essentially the same as for access, but they impact use differently than access.

The quantitative analysis has two objectives. First, identify gender inequalities in the adoption of digital technologies for African microenterprises in the context of the analytical framework. Second, assess how the drivers of digitalisation differ for male-owned and female-owned microenterprises, to identify potential points for interventions that might reduce the inequalities.

ECONOMETRIC ANALYSIS FRAMEWORK

An econometric model was developed to assess the core drivers of digital technology and how they differ based on gender ownership. Two separate regressions were run to assess the drivers of the two key channels of digital access listed in Table 1.

TABLE 1. EXPLANATION OF MODELLED DEPENDENT VARIABLES

r	y^r	DESCRIPTION
1	**INTERNET**	Dummy indicator variable that is given a value of 1 if the microenterprise uses the internet for business activities.
2	**FINANCIAL INCLUSION**	Dummy indicator variable that is given a value of 1 if there is a financial transaction or store of value (bank or mobile money) used by the microenterprise.

The explanatory variables for the regression are factors believed to have the potential to influence the adoption of digital technologies, based on literature review and the descriptive analysis conducted in this study.

As both independent variables are binary, it was necessary to employ a discrete choice model. It was decided not to use a linear probability model, as the marginal effects are not bound between 0 and 1 and therefore it can result in outputs that cannot be interpreted probabilistically. The study therefore estimated both a probit and logit model, both of which rely on a latent utility model though they differ in their assumptions regarding the distribution of the error term.

A Hosmer-Lemeshow test indicated that the probit model, where the errors are assumed to be normally distributed, was a better fit for the specified model than the logit model, where a logistic distribution of the errors is assumed.

To test for multicollinearity among the explanatory variables, Ordinary Least Squares Regressions were run, excluding interaction terms, and Variance Inflation Factors (VIFs) were calculated. The results show VIFs ranging from 1.08 to 1.73, indicating that multicollinearity is not an issue in the model.

The full model description, including the list of explanatory variables and the goodness-of-fit and multicollinearity test results, are provided in the Appendix.

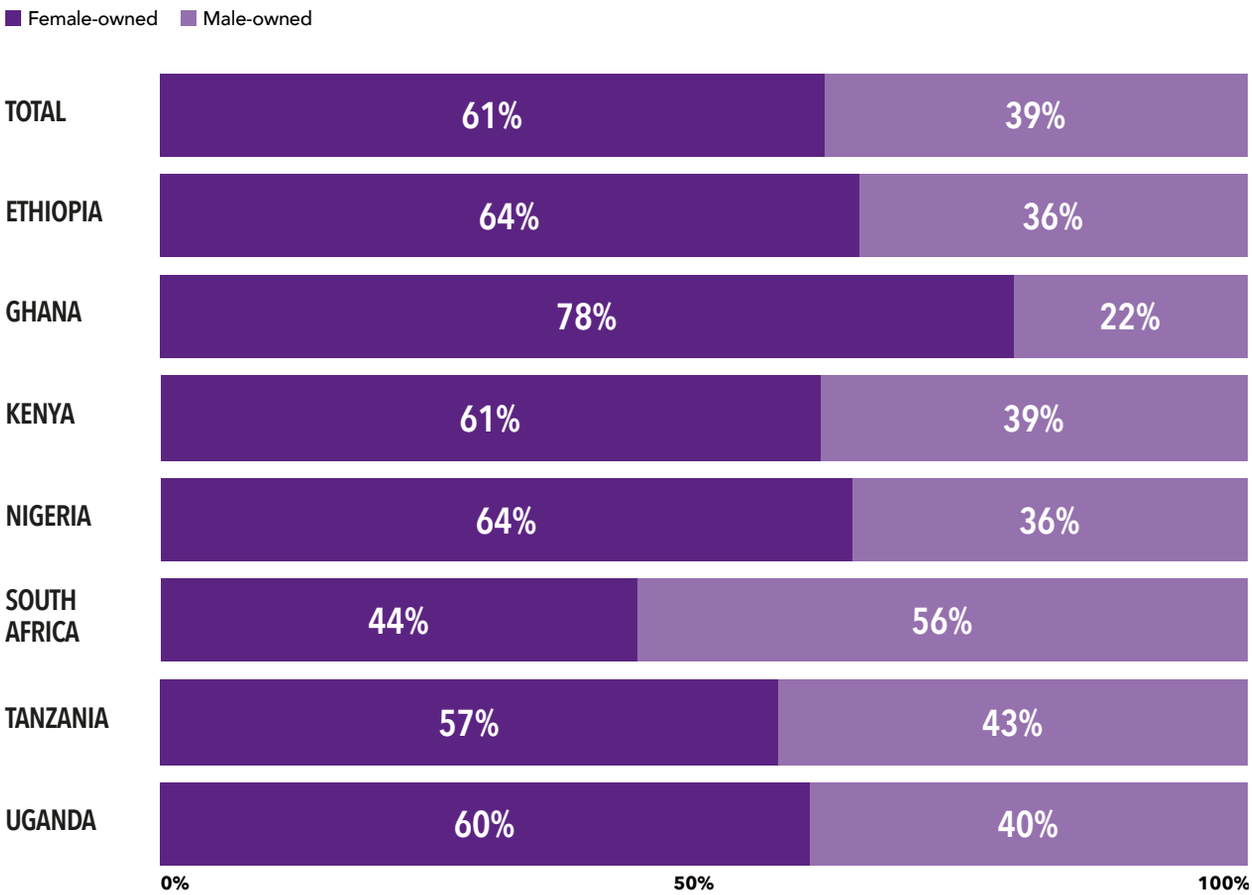
DESCRIPTIVE FINDINGS

PROFILE OF INFORMAL BUSINESSES

The country breakdown shows that the minimum sample size at the country level was 483 (Ethiopia) and the maximum was 704 (Nigeria). Microenterprises were observed to have a high level of female representation, with 61 percent of businesses female-owned. While the extent of female ownership differed across countries, only in South Africa was male ownership higher, as seen in Figure 1.

FIGURE 1

GENDER SPLIT OF OWNERSHIP OF MICROENTERPRISES IN EACH COUNTRY



Source: Research ICT Africa (2022)

Most microenterprises surveyed were either service providers or traders. Female-owned microenterprises had a higher propensity to be traders than male-owned microenterprises, which had a higher propensity to be service providers.

Female-owned microenterprises are slightly less likely to be formalized than those owned by males. Conversely, 76 percent of female-owned microenterprises were observed to be informal, compared to 67 percent of microenterprises owned by males. The level of informality, and the magnitude of the difference by gender, varies across countries. However, for all countries there were higher levels of informality for female-owned enterprises.

Male microenterprise owners had notably higher levels of education than female owners. There were higher shares of male-owned microenterprises than female-owned microenterprises at all education levels from completion of secondary school and above, but higher shares for female-owned microenterprises at education levels below secondary school completion.

It is clear that microenterprises are important for female empowerment, as the majority of microenterprises in the study were run by females. This is particularly the case when considering that informal businesses and businesses owned by individuals with low levels of education disproportionately make up female-owned microenterprises.

ICT ACCESS

MOBILE PHONES

Across all the countries surveyed, digital device access is predominantly driven by mobile phones.

Mobile phone ownership ranged from 65 percent (Tanzania) to 90 percent (Kenya). Mobile phone ownership among female-owned microenterprises was relatively high at 78 percent, though lower than that of male-owned microenterprises at 85 percent. The high rates of mobile phone ownership highlight the importance of mobile cellular technology in driving digital access in Africa.

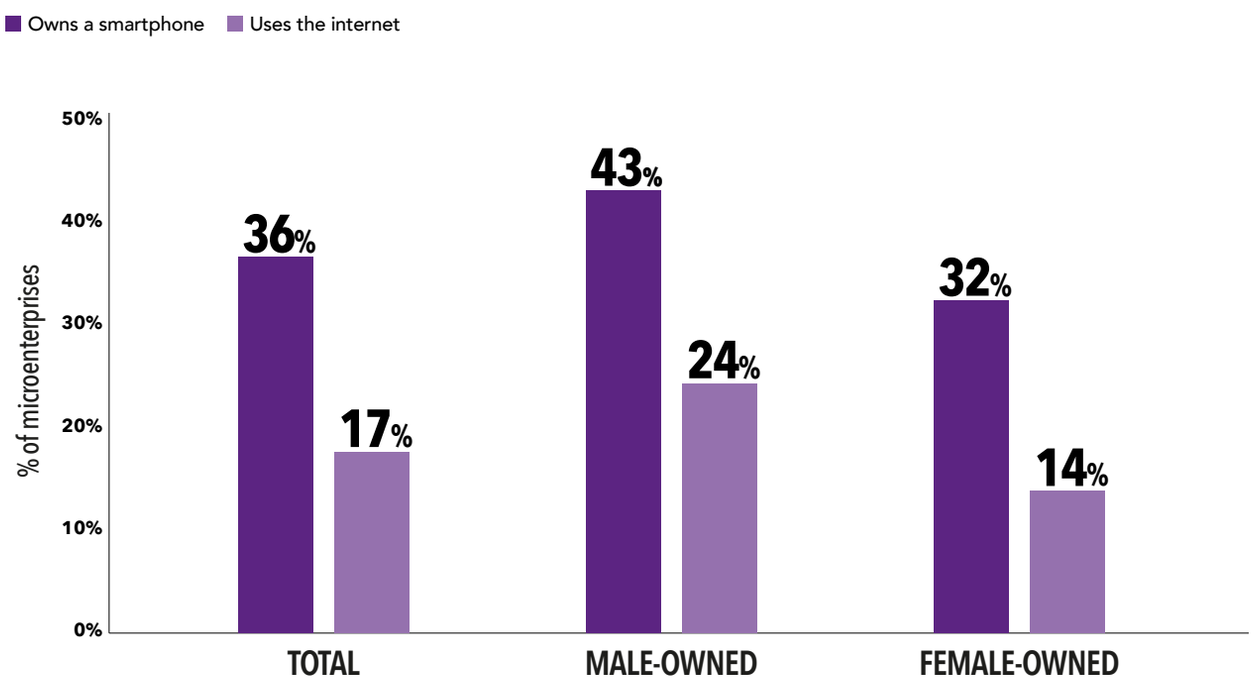
Mobile phones encompass smartphones, which allow access to apps and the internet to provide full exposure to digital opportunities. However, it also includes feature phones and basic mobile phones with limited digital functionality. Basic mobile phone ownership was higher for female-owned microenterprises, indicating a particularly large gender gap in smartphone ownership. This is reflected in the finding that the mobile phone gender gap in the sample was just 9 percent, compared to the smartphone gender gap at 29 percent.[5]

INTERNET

In total, only 17 percent of microenterprises surveyed claimed to use the internet for their business. As illustrated in Figure 2, this is notably lower than the level of smartphone ownership (36 percent). This means that more than half of businesses owning a smartphone—the foundational means of getting online—do not use the internet for their business at all. If all enterprises with smartphones were aware of the benefits of digitalisation, and were able to make use of it, this would presumably greatly increase the use of the internet by African microenterprises. This is particularly the case for female-owned microenterprises, where only 43 percent of microenterprises with a smartphone use the internet, compared with 56 percent of male-owned microenterprises.

FIGURE 2

SMARTPHONE OWNERSHIP AND INTERNET USE



Source: Research ICT Africa (2022)

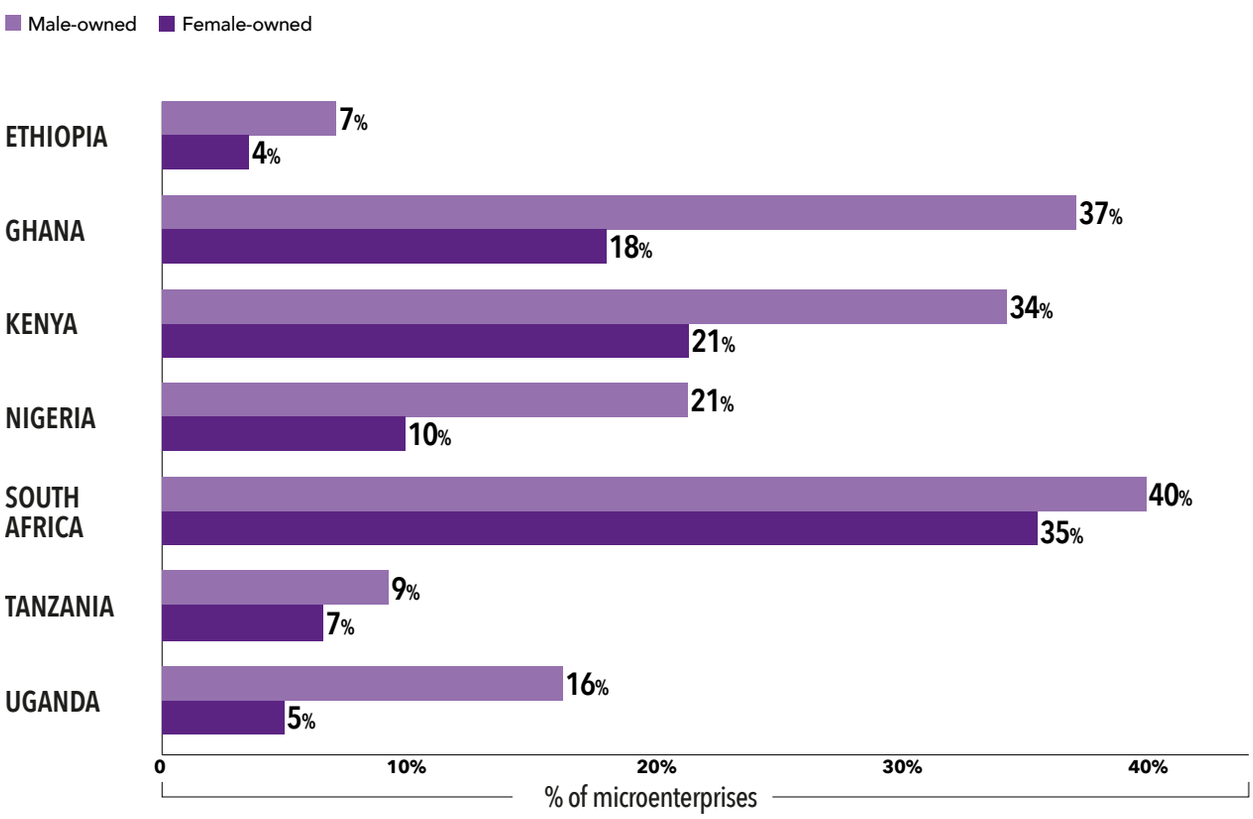
5 The gender gap for a particular variable x is equal to the difference between male and female values divided by the total for the population: $gap_x^{gender} = \frac{x^{male} - x^{female}}{x^{total}}$

The gender gap for internet access was substantially higher than for device ownership, calculated at 59 percent across the sample. The level of access and the magnitude of the gender gap differed across sectors, but the gap consistently advantaged male-owned microenterprises. Of particular concern is the finding that traders had the highest gender gap, at 96 percent, as the activity most concentrated with female-owned microenterprises. Only 8 percent of the female-owned microenterprises that identify as traders—accounting for almost half (47 percent) of female-owned microenterprises—use the internet in their business.

The gender gap in internet access across countries consistently favoured male-owned enterprises. In four of the seven countries surveyed (Ethiopia, Ghana, Nigeria, and Uganda) the gap is greater than 70 percent, and in Uganda it is as high as 119 percent.[6]

FIGURE 3

MICROENTERPRISES USING THE INTERNET, BY COUNTRY



Source: Research ICT Africa (2022)

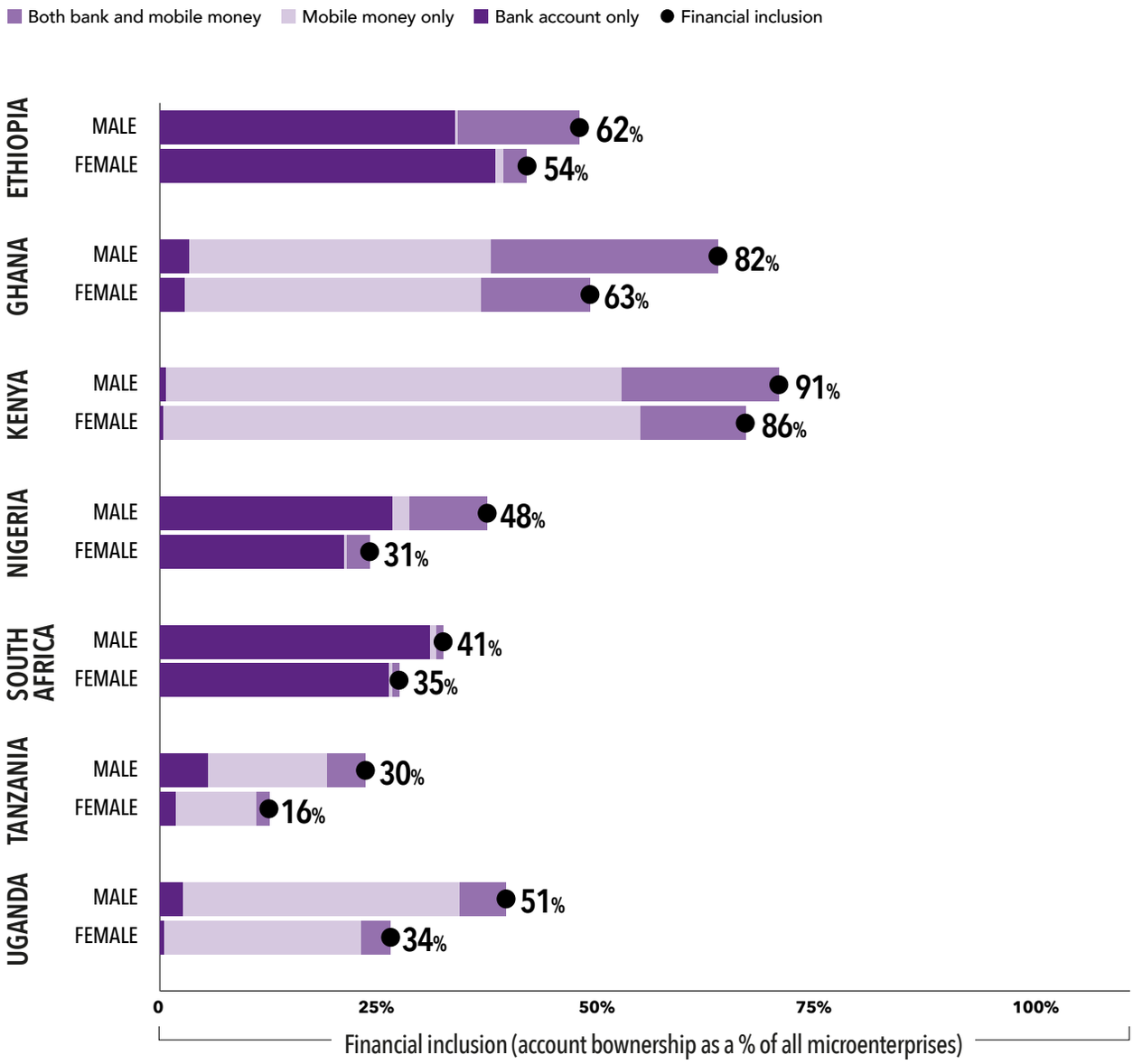
FINANCIAL INCLUSION

As Figure 4 shows, across all countries financial inclusion was higher for male-owned microenterprises than for those owned by females. In Ghana, Kenya, Tanzania, and Uganda, financial inclusion is driven mainly through mobile money; in Ethiopia, Nigeria, and South Africa, financial inclusion is driven primarily through the banking sector, with mobile financial services offered directly by banks or by fintech companies accessed through banking institutions. The level of financial inclusion is greater for the countries focused on mobile money.

6 The gender gap for a particular variable x is equal to the difference between male and female values divided by the total for the population: $gap_x^{gender} = \frac{x^{male} - x^{female}}{x^{total}}$

FIGURE 4

FINANCIAL INCLUSION AMONG MICROENTERPRISES, BY TYPE OF ACCOUNT



Source: Research ICT Africa (2022)

Access is a critical first step in being able to benefit from digitalisation, but access alone does not guarantee the realization of benefits. The following section assesses how digital technologies are used by microenterprises that have achieved access.

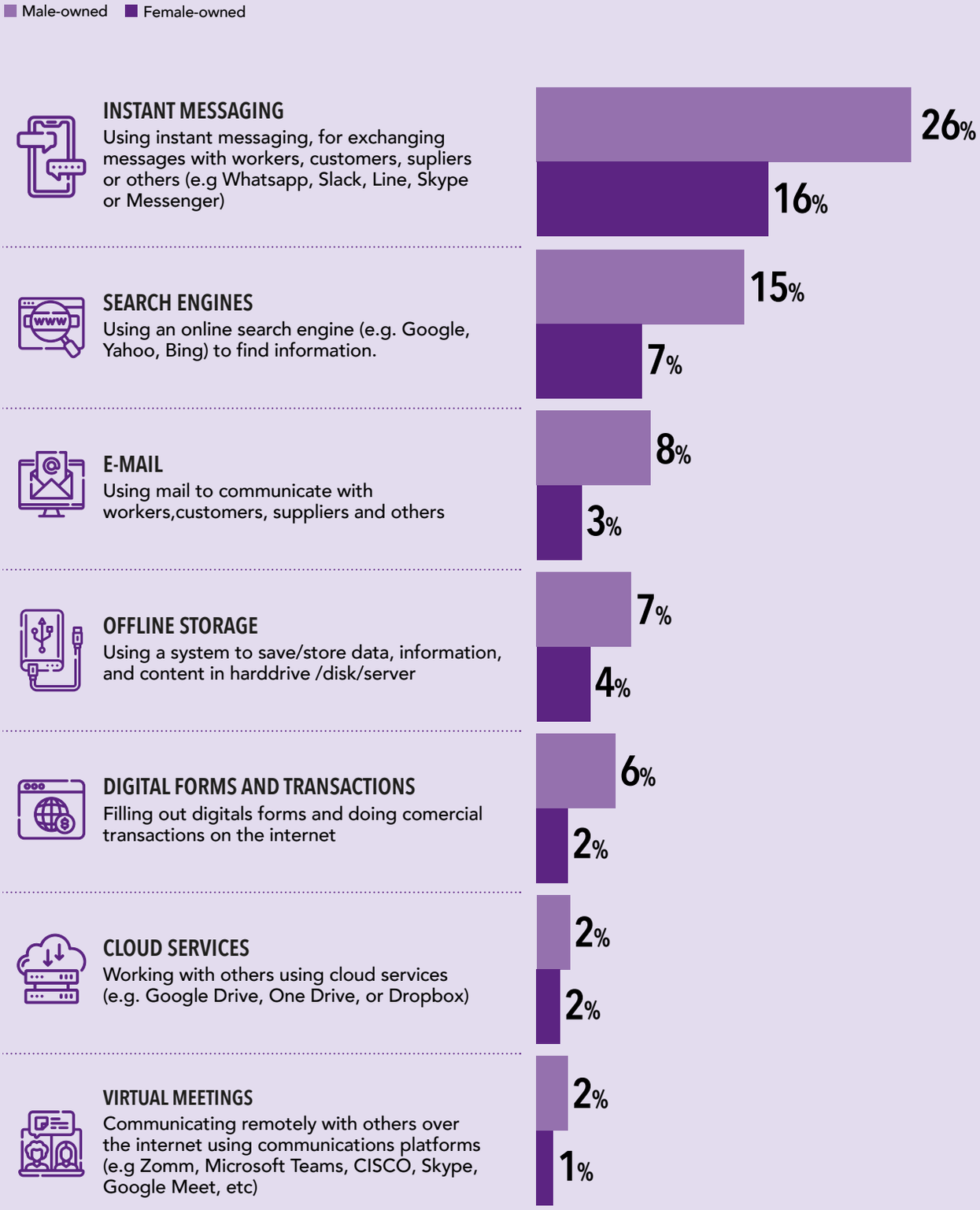
ICT USE

Gender inequalities are also reflected in the use of specific digital technologies: use by male-owned microenterprises exceeds that of female-owned microenterprises for all technologies surveyed (Figure 5). The largest gaps pertained to use of digital forms and offline storage (both approximately 97 percent), while the smallest gap pertained to cloud services (35 percent). Even the use of instant messaging and search engines show gender gaps of 50 percent and 70 percent respectively. However, the use of all the technologies is very low overall: even instant messaging is used by less than 50 percent of male- and female-owned microenterprises combined.

FIGURE 5

USE OF DIGITAL TECHNOLOGIES BY MICROENTERPRISES

Technology use (% of all microenterprises)



Source: Research ICT Africa (2022)

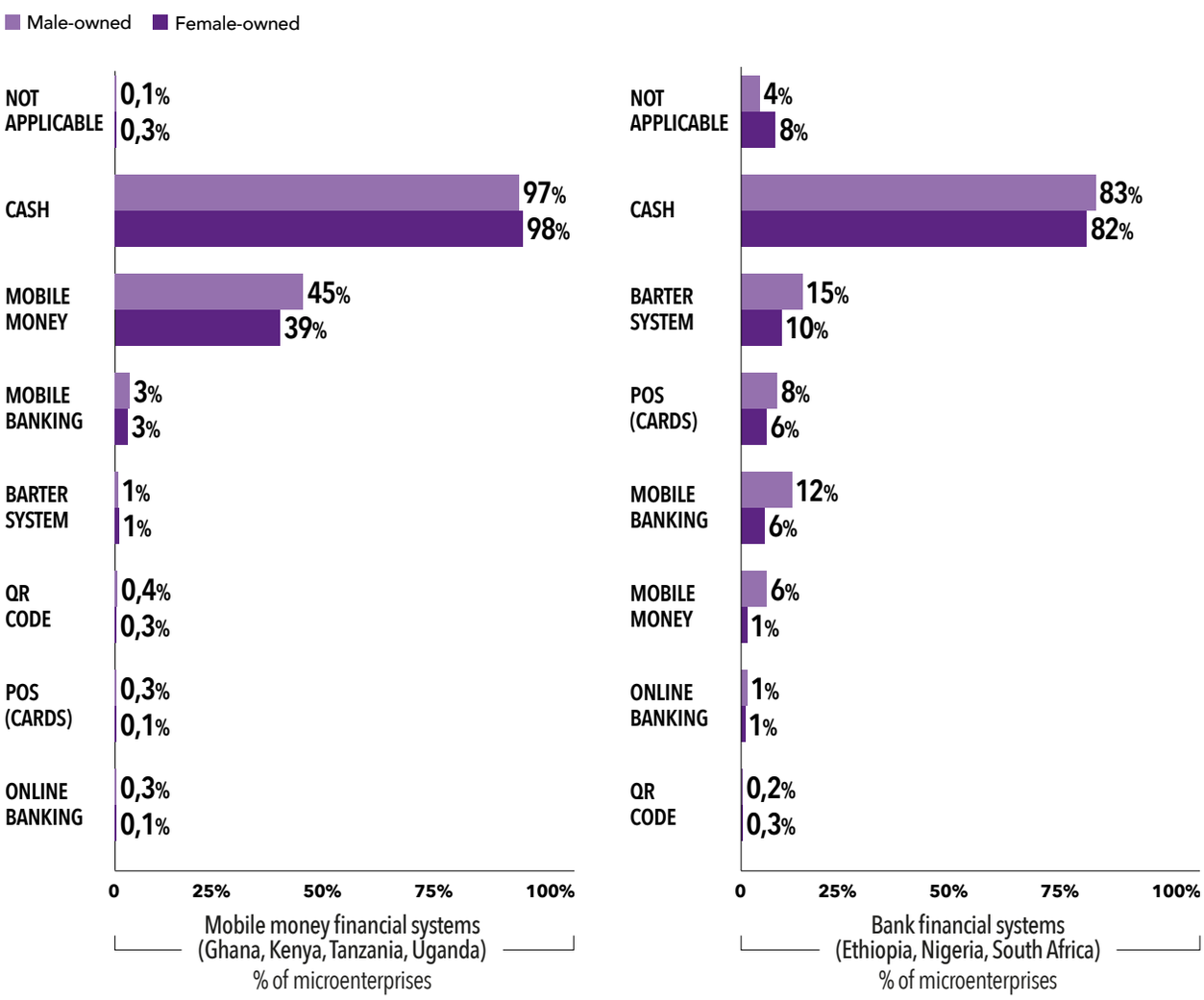
Regardless of gender of ownership, the application of digital tools to core business activities is very low. Most businesses perform these activities solely through offline tools and processes; they use digital technologies only for making phone calls and sending SMS, with negligible use of mobile applications and platforms and even less use of computer software.

Despite the high levels of financial inclusion in some of the countries, the use of financial services remains low. For all services relating to access to credit, financial management, and risk management, use was higher among male-owned microenterprises than female-owned microenterprises. Although countries where the financial system is focused on mobile money showed higher levels of financial inclusion overall, microenterprise access to financial services is generally higher in countries where the system is bank-focused. The only exception is for bank loans, hinting at the fact that banks in countries where the financial system is bank-focused may implement more stringent credit checks and compliance requirements, disadvantaging microenterprises. In all of these services, female-owned microenterprises lag behind their male counterparts.

Microenterprises generally transact business through multiple payment channels. The majority of microenterprises transact with cash at least some of the time. A significant share of microenterprises in mobile money focused countries use mobile money for making or receiving payments. Use of all digital payments is lower for female-owned microenterprises than those owned by males.

FIGURE 6

WAYS MICROENTERPRISES MAKE AND RECEIVE PAYMENTS



Source: Research ICT Africa (2022)

There are clear gender inequalities in the use of digital technologies by microenterprises. However, even if these inequalities were resolved, overall levels of access and use remain notably low in most cases. Greater efforts are therefore needed to improve the capacity for microenterprises to access and use digital technologies.

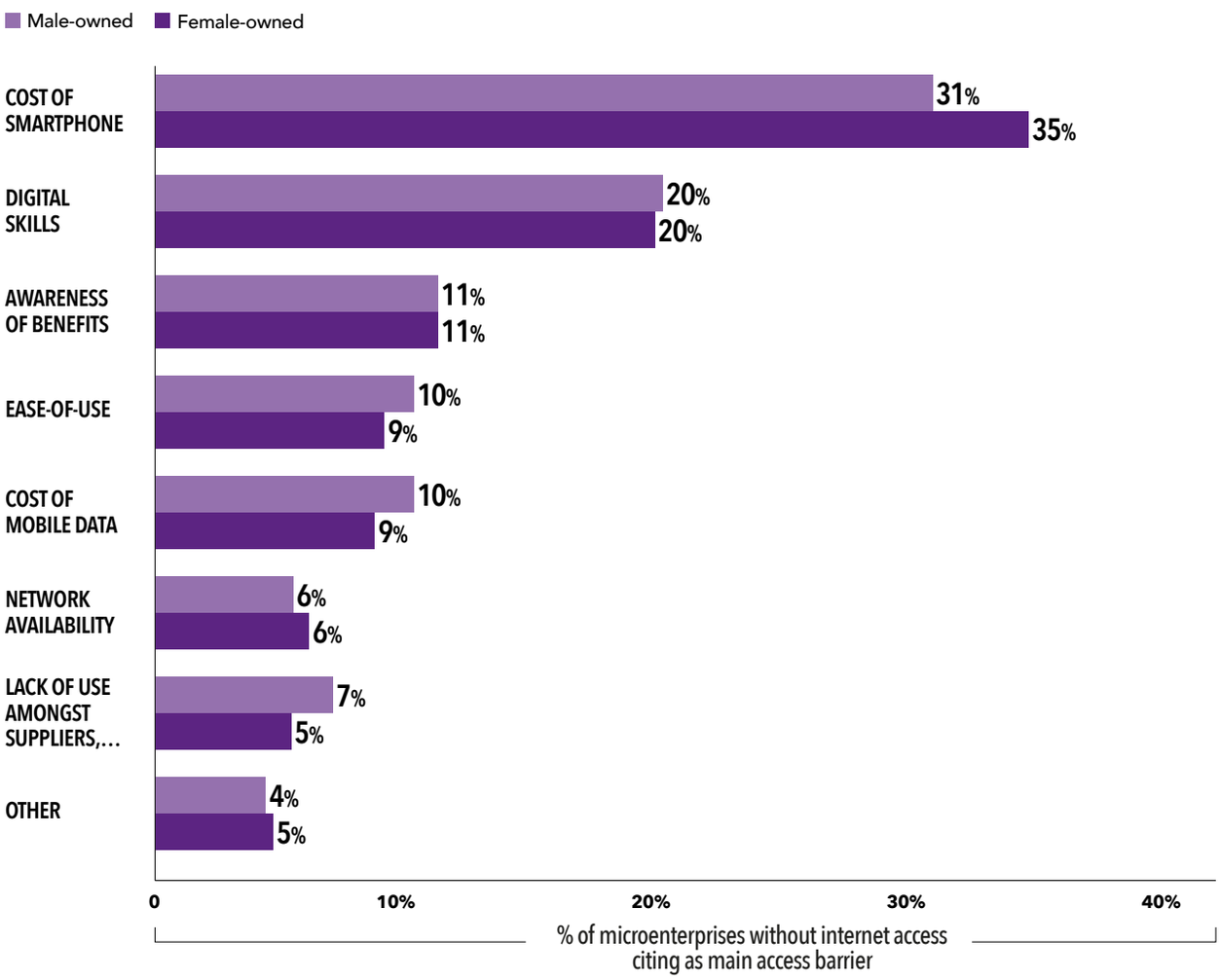
LIMITATIONS AND BARRIERS TO ACCESS AND USE

The main barriers and limitations to the adoption of digital technologies by microenterprises were assessed by asking what it would take for a business to either start using a particular technology or to use it more.

The main barrier to internet access for all microenterprises was the cost of smartphones, an issue of affordability that affected female-owned more than male-owned microenterprises (Figure 7). The lack of digital skills was a significant barrier that affected female- and male-owned microenterprises similarly.

FIGURE 7

MAIN INTERNET ACCESS BARRIER

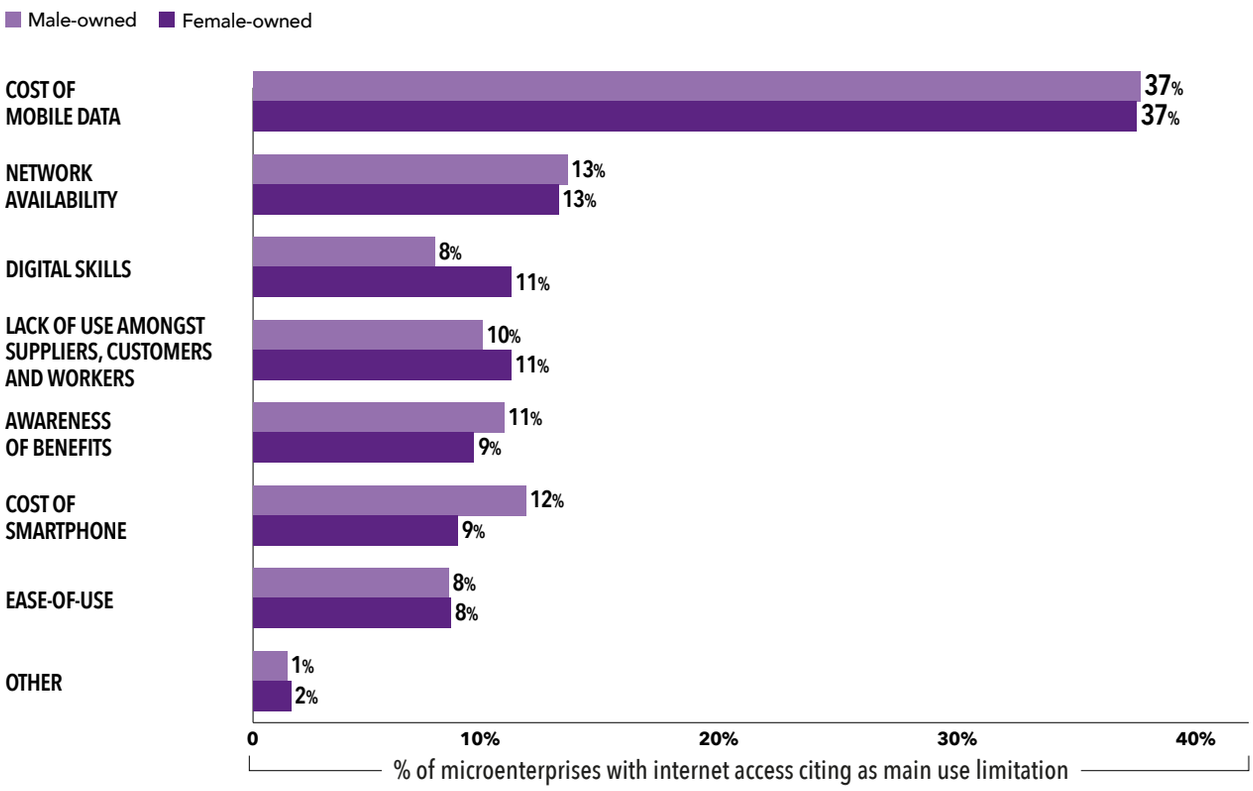


Source: Research ICT Africa (2022)

Among microenterprises already using the internet, the main limitation affecting its use for the business was the cost of data for both male- and female-owned microenterprises (Figure 8). Limited digital skills presented a significantly greater limitation for female-owned microenterprises (already using the internet) than those owned by males.

FIGURE 8

MAIN INTERNET USE LIMITATION



Source: Research ICT Africa (2022)

The main barrier to using apps and software for core business activities [7] was the lack of awareness of the potential benefit, a slightly greater factor for male-owned microenterprises (28%) than for female-owned microenterprises (27%). For female-owned microenterprises, the cost of smartphones emerged as a particularly significant barrier. Lack of digital skills was similarly a more pressing barrier for female-owned microenterprises than for those owned by males.

When microbusiness owners were asked what hinders the use of digital financial services, the awareness of benefits was the most reported barrier, followed by the cost of smartphones. For females, the cost of mobile data was almost as significant. As with the other types of technologies assessed, the cost of smartphones was a more pressing barrier for females compared to males.

Overall, the greatest barriers to getting online and using the internet are the cost of smartphones and cost of mobile data. For specific uses, the lack of awareness about the benefits emerges as the most constraining barrier, highlighting the need to demonstrate the potential benefits for microenterprises of using digital technologies for business functions. The cost of smartphone devices emerged as a more constraining factor for female-owned microenterprises than for male-owned, suggesting that the provision of more affordable smartphones could help to address some of the gender digital inequalities observed in the microenterprise sample.

7 Accounting, planning, supply-chain, sales, marketing, and payments.

ECONOMETRIC RESULTS AND ANALYSIS

Table 2 provides the outcome of a Hosmer-Lemeshow test using a group size of 10. For both regressions, the null hypothesis can be rejected to assume a satisfactory level of goodness-of-fit (greater than 10 percent). A sensitivity analysis was run with smaller and larger group sizes, and both models retained a satisfactory goodness-of-fit.

TABLE 2. HOSMER-LEMESHOW GOODNESS-OF-FIT TEST RESULTS (GROUPS = 10)

	OBSERVATIONS	CHI² STATISTIC	P-VALUE
INTERNET	3 650	5,55	0,70
FINANCIAL INCLUSION	3 659	11,17	0,19

Source: Author's own calculations using Research ICT Africa Survey Data (2022)

Table 3 highlights the significant coefficients from the probit regression across the different explanatory variables. The indicator columns provide the significance and direction of the relationship of the coefficients for each of the characteristic variables; the interaction columns show the significance and direction of the relationship of the coefficients on the interaction terms for each characteristic with the female indicator.

TABLE 3.SUMMARY OF PROBIT REGRESSION OUTPUTS ON THE MICROENTERPRISE CHARACTERISTICS DRIVING DIGITAL ACCESS

	INTERNET				FINANCIAL INCLUSION			
	INDICATOR		INTERACTION		WINDICATOR		INTERACTION	
VARIABLE	Significance	+/-	Significance	+/-	Significance	+/-	Significance	+/-
FEMALE	**	-			***	-		
FORMALITY					***	+		
BUSINESS PREMISES	***	+	***	-			*	+
ELECTRICITY			***	+			***	+
RURAL	***	-						
TRAINING	***	+			***	+		
ADVICE							**	-
FINANCIAL RECORDS	***	+			***	+	*	-
EDUCATION	***	+			***	+		
EMPLOYEES					**	+	**	+
BUSINESS AGE					***	+		

*Significance: * p<0.1 (weak significance); ** p<0.5 (moderate significance); *** p<0.01 (high significance)

Direction of the relationship of the coefficients
- positive relationship
- negative relationship

Source: Authors' calculations using Research ICT Africa (2022)

Even after controlling for all of the specified independent variables, female ownership had a negative effect on the probability of digital access. The calculated marginal effects show that female-owned microenterprises were six percentage points less likely to use the internet for their businesses and seven percentage points less likely to be financially included, holding all else constant. This means that even controlling for intersectional inequalities in relation to the specified variables, female-owned microenterprises were less likely to have digital access.

The importance of skills development is evident from the high significance of the positive relationship between both measures of digital access and both business training and the education of owners. Each additional "rung" on the owner education categories improved the probability of the business using the internet by four percentage points and improved the probability of being financially included by five percentage points. Employees receiving training improved the probability of the business using the internet by ten percentage points and the probability of being financially included by eight percentage points.

Keeping financial records was the other factor that was highly significant for both areas of digital access, increasing the probability of the business using the internet by four percentage points and increasing the probability of financial inclusion by 12 percentage points.

Having designated business premises was not a significant determinant for financial inclusion but was significant for internet use. Microenterprises operating out of a designated business space, whether rented or owned, were three percentage points more likely to use the internet than those operating from their homes, as street vendors, or in shared spaces. Similarly, rural location was significant only as a determinant of internet access: rural microenterprises were five percentage points less likely to use the internet than those in urban areas.

Formality was not deemed a significant determinant of internet use but was significant in determining financial access. Formal microenterprises were 11 percentage points more likely to be financially included than those operating informally. Similarly, the number of employees and the age of the business were significant only in determining financial inclusion. Each additional employee was associated with a four percentage point increase in the likelihood of being financially included, and each additional year since the business was established was associated with a 0.4 percentage point increase.

Only a few of the interaction terms emerged as significant in the model, indicating that most of the relationships between the microenterprise characteristics and digital access were not significantly different for male- and female-owned microenterprises.

The impact of having a designated business space was significantly lower for female-owned microenterprises. The calculation of the margins shows that while having a designated business space increased the probability of male-owned microenterprises using the internet by seven percentage points, it decreased the likelihood for female-owned microenterprises, albeit by a negligible amount (less than one percentage point).

The impact of the size of the business (measured as number of employees) on financial inclusion was significantly stronger for female-owned microenterprises. The margins show that while each additional employee increased the probability of financial inclusion by two percentage points for male-owned microenterprises, it increased probability by five percentage points for female-owned microenterprises.

In contrast, the relationship with keeping financial records was stronger for male-owned microenterprises than for those owned by females, increasing the probability of financial inclusion by 15 percentage points for male-owned microenterprises but by only 9 percentage points for female-owned microenterprises.

Overall, electricity access had an insignificant impact on both internet use and financial inclusion. Electricity access was associated with an eight-point increase in the probability of internet access for female-owned microenterprises but only a two-point increase for male-owned microenterprises. Electricity access was associated with a four-point increase in financial inclusion for female-owned microenterprises and a four-point decrease for male-owned microenterprises.

Similarly, there was an insignificant relationship overall between receiving advice through official channels and financial inclusion, though with significant differences between male- and female-owned microenterprises. Receiving advice through official channels—business centres, business incubators, community centres, government programmes, local non-governmental or non-profit organizations, and private consultants—was associated with a seven-point increase in the probability of financial inclusion for male-owned microenterprises but a six-point decrease for female-owned microenterprises.

The relationship between digital access and business type shows national differences not explained by other factors in the model. Financial inclusion showed no significant differences between types of businesses. However, compared to traders, service providers were six percentage points more likely to use the internet, and manufacturing enterprises 12 percentage points more likely.

CONCLUSIONS AND POLICY RECOMMENDATIONS

The analysis highlights the core characteristics determining adoption of digital technology by African microenterprises as well as the extent of digital inequalities that are only partially associated with microenterprise characteristics. It also highlights areas where policy interventions can be targeted to have the greatest impact on digital inequalities, as well as areas of intervention which could unintentionally widen them. The complexities of these relationships highlight the need for carefully planned interventions as well as the need for demand-side microenterprise data that is disaggregated for gender and other key characteristics, to inform evidence-based policymaking and achieve positive net outcomes.

CONCLUSIONS

The study shows that access alone is not sufficient to reap the benefits of digitalisation for microenterprises.

As most microenterprises are run by females, they are clearly important for female empowerment—particularly informal businesses and those owned by individuals with low levels of education, that tend to be female-owned.

Despite the high rate of mobile phone ownership among female-owned microenterprises, at 78 percent, this mainly relates to basic phones. The mobile phone gender gap is just 9 percent, compared to the much wider smartphone gender gap of 29 percent.

Despite smartphone ownership at 36 percent, only 17 percent of microenterprises surveyed indicated that they use the internet for business purposes. More than half of microenterprises with the means to get online do not do so for their business. For female-owned microenterprises, only 43 percent of those with a smartphone use the internet.

The highest internet gender gap was recorded among those in trade, at 96 percent. Trade is also the sector in which most female-owned microenterprises are found, and it accounts for almost half (47 percent) of female-owned microenterprises. Only 8 percent of female-owned microenterprises that identified as traders use the internet in their business. The econometric analysis showed that service providers and manufacturing enterprises were more likely to use the internet than traders.

The analysis on use highlights important challenges for policymakers. While the use of digital technologies included in this study is generally very low, there are gender inequalities, showing that use among female-owned microenterprises are comparatively lower.

Overall, the cost of smartphones and mobile data present the greatest barriers to getting businesses online and using the internet. For female-owned microenterprises the cost of smartphones was most significant, while data cost was a much bigger barrier for male-owned enterprises.

Lack of awareness about the benefits of using technologies for business purposes also emerged as a constraining factor, for both male- and female-owned businesses.

The lack of digital skills was also found to be a significant barrier for all microenterprises, and significantly more pressing for those female-owned microenterprises already using the internet. This is reflected in the significant positive relationship between receiving training and information on the use of the internet and being financially included. Similarly, the level of education of the business owner increased both the probability of the business using the internet and the probability of being financially included. Similarly, employees who received training improved the probability of the business using the internet and being financially included.

Financial inclusion was higher for male-owned microenterprises than for those owned by females. Despite the low use of financial services by microenterprises, the study found that use was generally higher for male-owned than female-owned microenterprises. The lower levels of access to bank loans across both genders depict the possible existence of stringent requirements by banks that may not be favorable to microenterprises.

The study found that being female-owned had a negative effect on the probability of digital access by microenterprises. The calculated marginal effects showed that female-owned microenterprises were less likely to use the internet for their businesses and less likely to be financially included. This shows that, even controlling for intersectional inequalities in relation to the specified variables, female-owned

microenterprises were less likely to have digital access compared to male-owned microenterprises.

Businesses that keep financial records and have a designated business space were more likely to access and use digital tools and services; this relationship was stronger for male-owned than female-owned microenterprises. Location of the business also affected internet use, with rural microenterprises less likely to use the internet than those in urban areas.

Access to electricity had a stronger positive relationship for female-owned microenterprises accessing the internet, while receiving advice through official channels had a negative effect on female-owned microenterprises.

POLICY RECOMMENDATIONS

Policies should focus not only on access. Once access has been achieved, microenterprises need to be able to use digital technologies in ways which are appropriate and optimal.

With almost half of female-owned microenterprises engaged in trade, this is an area that can be leveraged to bring more women online, by introducing them to ways to conduct trading activities using the internet.

Greater efforts are needed to improve the capacity for microenterprises overall to access and use digital technologies. However, policy-makers need to be aware of the underlying gender inequalities to avoid exacerbating them through increased digitalisation.

The cost of devices seem to pose the greatest barrier to internet use for female-owned microenterprises, suggesting that the provision of more affordable smartphones is necessary to address some of the gender digital inequalities observed in the microenterprise sample.

The cost of data should also be considered to facilitate internet use. However, without addressing the affordability issue of smartphones, reducing data costs may end up widening gender inequality.

This highlights the need to target initiatives to demonstrate the potential benefits of using digital technologies for business purposes and transactions.

Initiatives and programmes that provide specific training, including digital education, need to be developed to increase digital literacy among microenterprise owners.

Policy makers should engage the banking sector to develop more favorable conditions for microenterprises to be able to access and make use of financial services.

The study found that female ownership had a negative effect on the probability of digital access by microenterprises. The calculated marginal effects showed that female-owned microenterprises were both less likely to use the internet for their businesses and less likely to be financially included. This shows that even controlling for intersectional inequalities in relation to the specified variables, female-owned microenterprises were less likely to have digital access compared to male-owned microenterprises.

Availability of electricity increased the probability of accessing the internet for female-owned microenterprise, so ensuring better and more reliable electricity supply could be an intervention to address the gender inequalities.

Advisory channels may need to be tailored to better serve female-owned microenterprises, as they do not seem to benefit from receiving advice through these official channels.

To inform evidence-based policymaking to achieve positive outcomes in ensuring digital inclusion, there is a need for demand-side data.

Government and development agencies need to invest in regular surveys, to have data for longitudinal analysis.

There is a need for digital indicators in the GDC and G20, which also require longitudinal demand-side data collection.

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3.2 EMPOWERING WOMEN IN INNOVATION AND INTELLECTUAL PROPERTY: A CALL FOR ACTION

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ABSTRACT

This paper addresses the existing systemic gender disparities in the field of innovation. It underscores the underrepresentation of women in fields related to technology transfer and intellectual property (IP), due to a gender gap that not only limits individual opportunities in science and creativity but also hampers broader economic and social development to which females can effectively contribute.

Through extensive analysis, the paper identifies the entrenched biases and practical challenges women face within the technology creation and IP processes, including significant disadvantages: lack of support to females in science, technology, engineering and mathematics (STEM) education; lack of access to funding for female-led SMEs; and lack of professional network-spaces where women can nurture leadership skills. Drawing on case studies and recent statistics, the paper provides a comprehensive overview of the current situation and offers a strategic plan to empower women, aiming to achieve gender equality in the scientific and creative innovation processes often enriched by the smart use of IP.

The paper offers recommendations to tackle these issues, such as enhancing support and opportunities to influence female-sensitive policies in science and creativity and emphasizing the need for a systemic shift in how gender equality is pursued to boost scientific innovation and IP generation (i.e., creation, registration, and protection of IP rights such as copyrights, utility models, patents, trademarks, and designs by females).

KEY FINDINGS

Analyzing the challenges and disparities faced by women in the fields of innovation and IP yields three important conclusions.

- Underrepresentation of women in technology transfer and IP-intensive fields is a global issue.
- There are broad systemic issues that hinder women's full participation, such as limited female-sensitive policies in STEM education, limited access to finance for women-led small and medium enterprises (SMEs), and limited training for leadership within the technology transfer process.
- Key statistics reveal stark gender gaps in patenting and design registrations, with a projection that gender balance in patenting may not be achieved until 2070.

INTRODUCTION

This report presents an overview of the current state of gender inequality both in the innovation cycle and in the limited use of intellectual property (IP) by female scientists, innovators, creators, and entrepreneurs. Drawing on available disaggregated data, it highlights the key challenges faced by women in the knowledge-based economy (KBE). It also provides recommendations for policy change including tailored interventions to promote gender equality and enhance women's participation in the innovation cycle, with special focus on technology transfer (TT) and smart use of IP.

Understanding the systemic gender disparities within innovation and IP processes—evidenced by the underrepresentation of women in technology transfer and IP-intensive roles—highlights a gender gap that not only restricts opportunities for women in science and creativity but also hinders broader economic and social development. This underscores the need for dedicated policies.

Understanding the current state of gender, innovation, and entrepreneurship policies is crucial for identifying the optimal policy mix to address gender inequality. Section One explores how innovation processes in these areas—STEM research (in Science, Technology, Engineering and Maths), technology transfer, and IP protection—often lack gender analysis and may embed unintended biases. Section Two presents data illustrating the challenges women face in innovation and entrepreneurship, assessing whether current policies still reflect a male-dominated knowledge-based industry or whether science-based policies are incorporating gender equality as a structural feature. Section Three outlines tailored approaches and lessons learnt from Europe to inform decision-makers with clear recommendations to support policy changes to foster inclusive innovation—whether gender-oriented, gender-neutral, or addressing indirect gender discrimination.

WOMEN'S PARTICIPATION IN THE INNOVATION CYCLE

For authors such as Rastogi & Gupta (2023), gender equality in technology transfer is crucial for fostering inclusive economic growth and social progress, especially when intellectual property rights (IPRs) promote innovation, creativity, and economic progress, boosting women's socioeconomic status. Similarly, Utz & Dahlman (2007) argue that IPRs can enable inclusive technology transfer, by providing female scientists and entrepreneurs a secure environment for collaboration and investment that ensures fair competition, restricts unauthorized use of creative works, and rewards innovators financially. Making smart use of IPRs will allow females to protect their inventions, trademarks, copyrights, and patents, fostering more inclusive innovation and the creation of new technology, products, and services, while also giving these individuals exclusive rights and increasing their chances of success with a more safeguarded position when competing in the KBE market.

Despite efforts to advance SDG 5, which aims to achieve gender equality and empower all women and girls as a foundation for a peaceful, prosperous, and sustainable world, a recent study by Khan (2023) reveals that, despite some global progress on Gender Equality and Women's Empowerment (GEWE), progress towards SDG 5 remains too slow in both developed and developing countries.

In Europe, for example, despite substantial advancements achieved in the last decades, women remain marginalized in both the knowledge-based economy and IP-intensive jobs, leading to a loss of economic opportunities (Parra-Meroño, De-Juan-Vigaray & Volcan, 2020). To redress this trend, the authors recommend more female-sensitive policies in STEM education along with empowering women to make smart use of IP. Such strategies can play a vital role in driving women's contribution to economic growth, assisting Europe in the competition to develop breakthrough, impactful and scalable products and services.

The commercialization of IP-protected innovation can substantially improve the quality of life of female scientists, creators, and innovators (Polkowska, 2013). This is one of the most important challenges that emerging European innovation ecosystems must tackle, in the effort to transform scientific knowledge and technological achievements into commercial successes.

Transforming technology transfer from science into business can become the bedrock for building a strong KBE, while helping to overcome the entrenched biases in technology transfer processes that disadvantage women. Moreover, Ezell (2023) shows that without IP protection, revenues of breakthrough startups decline, and entrepreneurs accordingly reduce their investment in innovation.

Empowering women to increase their participation in the innovation cycle and to make smart use of IP is an essential part of shaping future pathways for prosperity, which however requires political will

and advocacy to overcome systemic issues (as detailed in the next section). Maluwa-Banda (2004) suggests that this process can only be driven by dedicated gender- and diversity-sensitive policies in education, along with more access to finance to enable women's technological ideas to be nurtured—along with related business and leadership opportunities—in the high value-added side of the economy. Other scholars (Davis, 2002; Liberda & Zajkowska, 2017) envision an entrepreneurial culture that encourages and supports people, particularly young women and men, by creating decent work and by changing how we see work and people's relationship to it throughout their life cycle. This new architecture of work, these authors highlight, has profound implications for social and economic policy with the removal of barriers that block or discourage people's entrepreneurship, that make it difficult for startups to ensure access to credit without collateral, and that prevent innovations that might unleash the potential of all people to innovate, create, catalyze, be resourceful, solve problems and take advantage of opportunities while being ethical.

Gender inequality hinders economic growth by shrinking the pool of potential talent for production, often due to unequal access to education, employment, entrepreneurship, and innovation. As such, it must be recognised as a significant challenge. This calls for stronger support and opportunities to influence female-sensitive policies in science and creativity and highlights the need for a systemic shift in the pursuit of gender equality.

GENDER GAP IN STEM

The term "technology transfer" (TT) encompasses a range of activities that facilitate the movement of knowledge, expertise, and inventions from the research and development stage into practical applications in the market. Performance is often measured with indicators such as the number of start-ups, IP rights, or licensing deals. What is often missing is a performance analysis showing where the participation of women in these processes can help improve and enrich the development and application of new technologies with a wider lens on diversity needs, not only benefitting the women entrepreneurs and innovators but also contributing to the potential scaling up of new solutions in global markets.

According to Rothwell (2013), there are two STEM economies. First is the professional STEM, in which graduates in science, technology engineering and maths maintain close links with research universities while working mainly in the corporate sector. The second STEM economy draws from high schools, workshops, vocational schools, and community education; while less directly involved in inventions, they are crucial to the implementation of new ideas, advising researchers on feasibility of design options, costs estimates, and other practical aspects of technological development.

Global research indicates that the gender gap in technology transfer (TT) shows two main unexpected trends. First, women having STEM degrees are only slightly more likely to patent an innovation than those without, indicating that the so-called 'pipeline problem' plays only a secondary role in the gender gap in TT—despite conventional views that the pipeline problem (or 'leaking pipeline,' as defined by Polkowska (2013), directly relates the shortage of women in IP to the shortage of women in STEM degrees and fields. This suggests that the underlying reason for low female participation in IP is more complex. Second, the scarcity of detailed gender-disaggregated data for technology transfer, including for protecting and licensing of patents, designs, and copyrights, hinders institutional ability to track trends in gender imbalance in technology transfer.

Although some prominent universities have developed initiatives to attract women and reward institutions working to increase women's involvement, most universities in both developed and developing countries still lack a well-thought-out support program. Notably, integrating women into senior academic positions, especially in the STEM fields, must be an essential aspect of promoting women's advancement and also has significant implications for female entrepreneurial and innovative potential.

Jackson (2013) argues that TT support systems allow young female students the opportunity to engage in discussion and activities with individuals with whom they feel comfortable, including family, faculty, staff, and administrators. When female students were asked to discuss their support systems and the impact of these support systems on their decision to pursue a STEM discipline, they affirmed that the support system (family, faculty, and advisors) was vital to their success, but they did not report a preference regarding whether that support consisted of males or females, challenging the assumption that mentors must be of the same gender as the mentee to be effective. Other findings show that family, faculty, and advisors all play an essential role in women's persistence and retention in pursuing degrees in male-dominated areas of study (Creamer & Laughlin, 2005), highlighting the positive impact of support for females in STEM.

In the effort to understand what is the situation in leading KBE states such as Israel, Bar-Ziv, Fischman-Afori & Marcowitz-Bitton (2021) conducted a study to assess the gender gap in the Israeli academy by examining the nature and extent of women's participation in transferring knowledge from the academy to the industry based on registration of patents by these academic institutes. Results indicate that although the gender gap in Israeli's academia has long been the focus of public discourse regarding the role of academic institutes in promoting social values, female academic patenting has received little attention thus far.

INTELLECTUAL PROPERTY OWNERSHIP DISPARITIES

Registering and protecting scientific ideas as IP is an essential step toward marketing an invention, but it is only the beginning of the process. Despite their potential, many scientific ideas—up to 95 percent in the U.S. and the EU—never progress beyond the IP protection or patenting stage (Dreyfuss, 2020).

The gender disparity in IP ownership, starting with patent registrations, is a pressing issue. According to the World Intellectual Property Organization (WIPO), in 2021 women accounted for only 16.2 percent of all inventors listed in Patent Cooperation Treaty (PCT) applications, up only one percentage point from 2020, even though the share of women inventors has grown in every geographical region over the past 10 years. The same study notes that about 96 percent of all PCT applications listed at least one man as inventor, whereas only one-third listed at least one woman as inventor.

EQUALS (2020) similarly indicates that, although in recent decades the world patent system shows some progress toward gender parity, at current rates gender balance in patenting would not be achieved until 2070 (EQUALS, 2020). Rosser (2009) notes that this situation also hurts scientific innovation, technology, and competitiveness overall. The European Patent Office (EPO) reported that in 2019, only 12.6 percent of patent applications had at least one woman inventor. Portugal had the highest proportion of women inventors in patent applications, at 20.9 percent, followed by Spain at 18.8 percent. The EUIPO Observatory's 2023 Study on Women in Design found that in 2021 only 24 percent of designers were women, and only 26 percent of designs registered at the EUIPO by EU-based companies had at least one woman designer. It concluded that at the current pace of growth, it would take 51 years to achieve parity in Community Design registrations.

CHALLENGES IN WOMEN'S PARTICIPATION IN THE INNOVATION CYCLE

Experts agree that the gender disparities in innovation and technology are not just a matter of numbers; they also reflect broader systemic issues that hinder women's participation. Factors such as limited support and mentorship for women inventors as well as challenges in accessing funding and resources contribute to the lower rates of patent registrations by women. Sanders and Ashcraft (2019) suggest that the absence of women in innovation and technology is because they are often ignored, not recognized, or not given credit for their ideas. They conclude that this is especially troubling given the ample evidence of the benefits diversity—of ideas, perspectives, voices—can bring to innovation, problem-solving, and creativity. Others (Fox, Johnson & Rosser, 2024) consider that numerous social and cultural influences are increasingly impeding women's contributions to technical creation in today's tech workforce. They present three main strategies for improving the situation: technical design teams need to employ democratic principles and techniques for making sure ideas are heard and discussed; managers and supervisors (both men and women) need to perform as champions for their female technologists; and they need to be informed and equipped to do so effectively, with a clear understanding of both the values and unique challenges to gender inclusion embedded in our current systems and operations.

Why Does Addressing Women's Absence Matter?

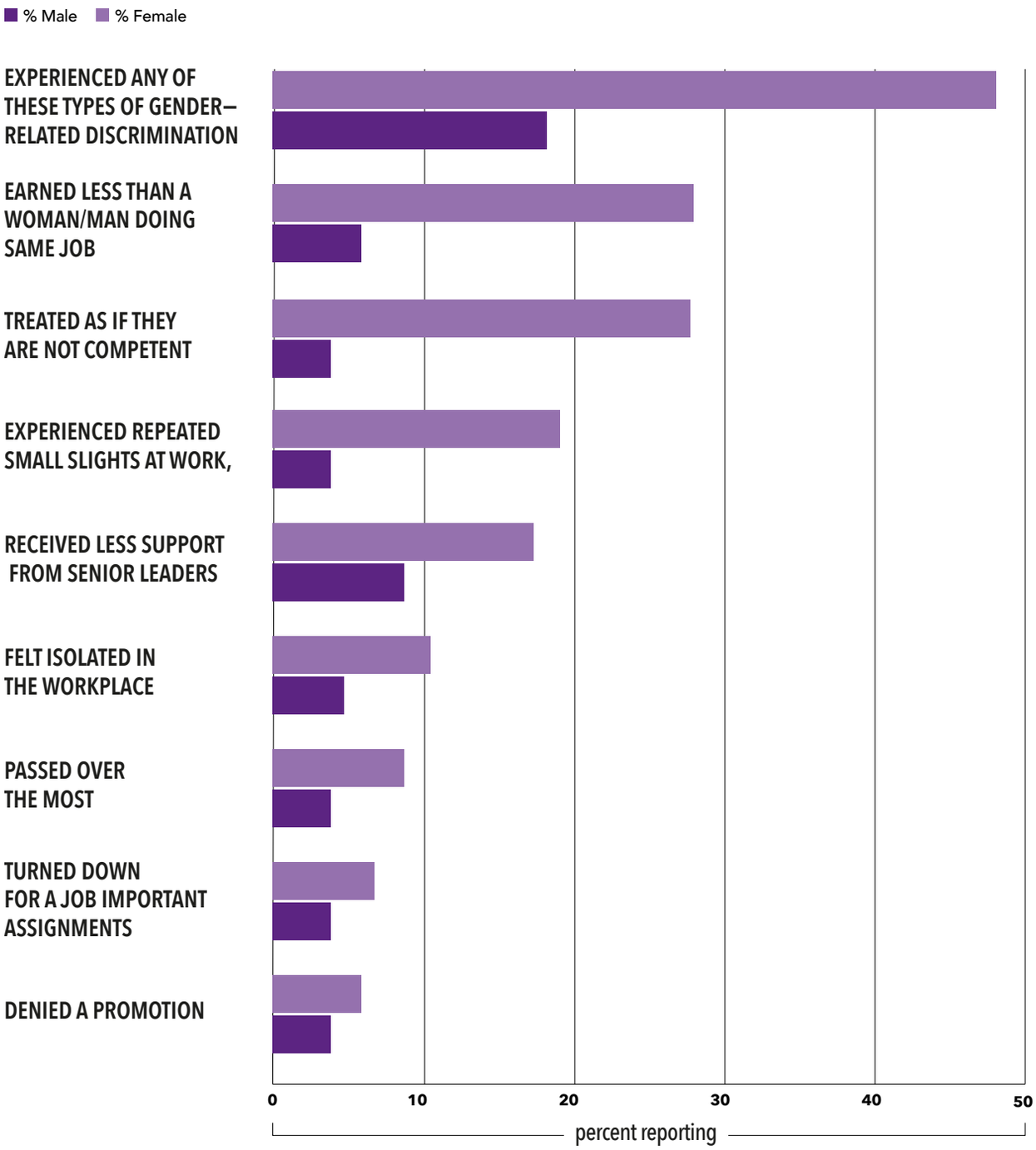
Women's current underrepresentation spells trouble for the tech industry and for the future of technical innovation, especially in light of an increasing body of research documenting the significant benefits that diversity brings to innovation. Some of these key benefits are summarized below. For instance, a 2007 study by the London Business School of one hundred teams at 21 different companies found that work teams with equal numbers of women and men were more innovative and more productive than teams of any other composition. They attributed this finding to the fact that members on these teams were less likely to feel like "tokens" and better able to meaningfully contribute their ideas and efforts.

GENDER DISCRIMINATION IN INNOVATION

According to the World Bank (2020), women in STEM jobs are likely to report workplace discrimination by gender much more than men (see Figure 1).

FIGURE 1

STEM JOBS ARE ASSOCIATED WITH MORE DISCRIMINATION TO THE DISADVANTAGE OF WOMEN

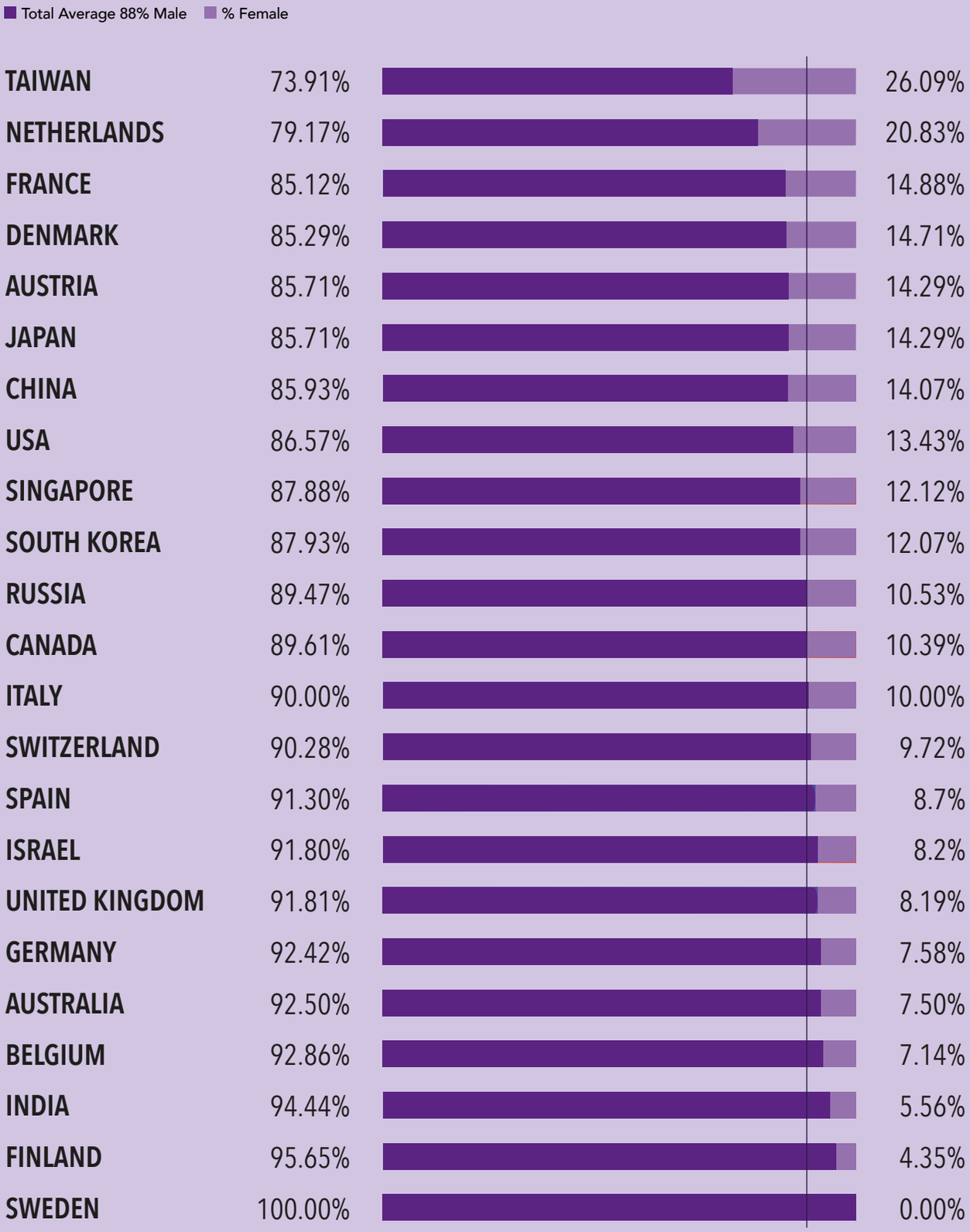


Source: Funk and Parker 2018, as depicted in the Equality Equation, World Bank 2020

In the AI sector, WIRED (2018) conducted research to estimate the diversity of leading machine-learning researchers in 23 high-income countries and found that, on average, only 12 percent were women (see Figure 2). This indicates that untapped female resources should be channelled in all possible ways between science and business to reach optimum social benefit from applied ICT.

FIGURE 2

THE GENDER IMBALANCE IN AI RESEARCH ACROSS 23 COUNTRIES



Source: Element AI (Mantha and Hudson, 2018)

The issue is also widespread in specific technological areas in Europe. Available statistics show that the proportion of women obtaining patents is less than the already small proportion of women engaged in STEM fields (Bar-Ziv, Fischman-Afori & Marcowitz-Bitton, 2021), highlighting the need to address gender equity in technology transfer. They report that women and girls are 25 percent less likely than men to know how to leverage digital technology for basic purposes, four times less likely to know how to program computers, and 13 times less likely to file for a technology patent. At a moment when every sector is becoming a technology sector, these gaps should alert policymakers, educators, and citizens to action.

FINANCIAL CONSTRAINTS FOR WOMEN INNOVATORS WANTING TO ENTER THE ENTREPRENEURSHIP SPHERE

Women innovators face considerable barriers in accessing funding and investment for innovation and IP development, limiting their ability to bring their ideas to market. Dedicated government policies are needed to encourage unbiased financing schemes to incubate female-driven technologies to the point that venture capital firms and other investors might become interested.

Providing impact finance to support ideas presented in scientific papers or early IP filings can facilitate women's engagement in the technology transfer (TT) process. Universities and other innovation agencies could provide impact acceleration funds to support prototype development by women inventors.

Additionally, research on the constraints that disproportionately affect women in attracting private sector funding for the proof of concept (POC) process is essential. POC serves as a bridge between the development of a new technology and its market viability. It represents a critical juncture where inventors and potential investors can assess the commercial potential of an innovation in a tangible and practical manner. By funding POC initiatives, inventors gain the resources needed to prototype their ideas, showcasing a real-world version of their product or service to potential clients and investors prior to full-scale commercialization (Alunni, 2020).

Despite its crucial role, securing funding for POC projects can be challenging. Investors tend to be cautious about investing in prototyping ventures, a hesitation that extends to projects led by female inventors. This reluctance may stem from various factors including perceived risk, uncertainties about market demand, or a lack of familiarity with the technology or its potential market.

Moreover, while POC projects typically require smaller funding amounts compared to later stages of development, they are often seen as less attractive to private finance. This disparity can be attributed to the perceived higher risk associated with early-stage projects as well as the potential for longer timelines before returns are realized.

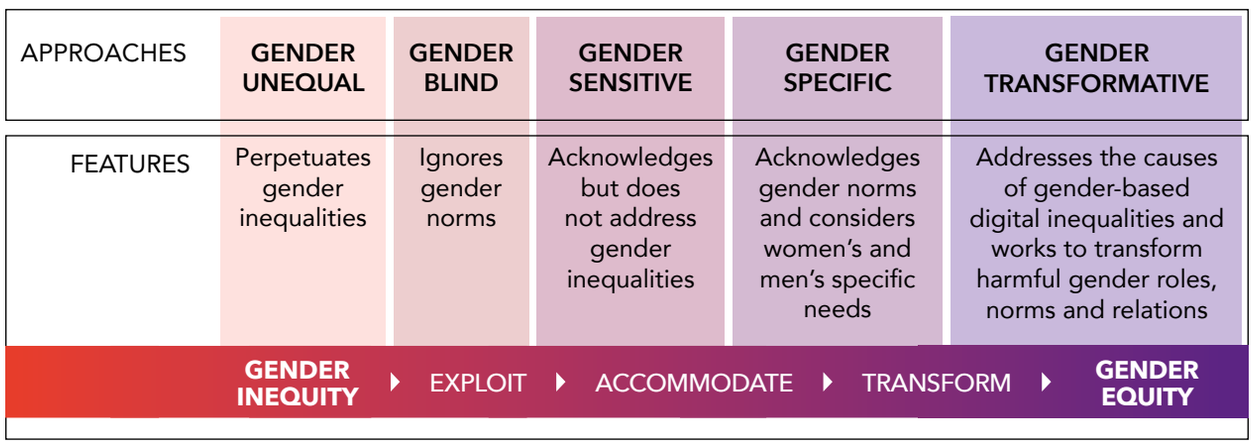
For technology transfer offices (TTOs), facilitating POC projects presents additional challenges, especially for female inventors. These offices play a crucial role in supporting inventors through the tech transfer process, providing resources, guidance, and connections to potential investors. However, limited resources and funding constraints can make it difficult for TTOs to fully support POC initiatives, particularly those led by female inventors who may already face barriers to accessing funding and support. While POC is a critical phase in the technology transfer process, its funding and support remain challenging, especially for female inventors. Addressing these challenges requires a concerted effort from stakeholders across the innovation ecosystem to provide adequate resources, support, and investment opportunities for POC projects led by all inventors, regardless of gender.

NEWNESS OF THE GENDER TRANSFORMATIVE CONCEPT IN THE WEALTH CREATION PROCESS

Gender transformation is a relative concept that describes a shift in gender roles and relations closer to gender equity in a given context. Since gender equity is still far from being fully realized, gender transformation can be considered a nascent process (see Figure 3).

FIGURE 3

A CONTINUUM OF APPROACHES: FROM GENDER UNEQUAL TO GENDER TRANSFORMATIVE



Source: Adapted from "A Continuum Of Approaches to Action on Gender and Healthy" (CEWH, n.d)

Without specific gender analysis, decision-makers lack a clear representation of the opportunity TT represents for women in entrepreneurial ecosystems. They lack needed information for choosing best approaches to promote female engagement in TT and gender-inclusive co-creation, while establishing a bridge between innovation and growth.

TAILORED APPROACHES AND LESSONS LEARNT

European attempts to assist female innovators, promoting inclusive growth by increasing women's access to necessary resources, include an array of interventions where tailored approaches have been adopted. Lessons learnt stress the importance of implementing targeted mentorship programs, gender-sensitive policies, and increased funding opportunities for women-led innovation projects to foster more inclusive innovation processes and ecosystems.

Policies aimed at providing equal opportunities in accessing resources, training, and support help to create an enabling environment that allows women to actively participate in and benefit from innovation processes. Ensuring equal access to resources and support systems enables women to fully contribute their innovative ideas and talents, leading to more inclusive and diverse innovation ecosystems. Authors in this field highlight that this approach benefits not only women but also society, as it leads to the development of more impactful and sustainable solutions to complex challenges.

STRATEGIES AND POLICIES IMPLEMENTED IN EUROPE

Addressing unconscious bias. Unconscious bias can directly or indirectly undermine the effectiveness of any effort to promote more inclusive environment for women. Major efforts are still needed to sensitize the innovation financial ecosystem to address gender biases, as well as to rewrite educational resources (today largely through AI) to eliminate gender bias and stereotypes, portraying women and girls as valuable participants and leaders in innovation and intellectual property.

Some authors point to positive results when research institutions have implemented policies such as flexible working hours and parental leave, to enable women to participate fully in innovation and IP development, which leads to greater workforce diversity and gender parity. Other studies have found that mentorship programs and networking opportunities designed to connect women innovators with experienced professionals, investors, and peers have led to strong partnerships and a higher rate of business success, due to more fluid communication and focused discussions with partners. A successful example in Europe is the EU-funded project Women Innovators, which aims to create a network of female innovators and entrepreneurs across Europe. The EU report "She Figures" has emerged as a useful tool that takes into account lessons learnt and highlights the importance of education in closing the gender gap in research and innovation.

Not all decision makers are well capacitated to mainstream gender or to address the underlying causes of gender inequality, although the effectiveness of collaboration in innovation depends on the capacities of the national entities addressing gender balance and women issues. Promotion of women's leadership in the technology transfer sector requires implementing a variety of policy instruments, including incentives. An interesting example is the initiative recently undertaken by international IP organisations, incentivizing women's leadership with certification schemes for industry and quality assurance seals based on reaching specific gender-inclusion indicators.

Another element of addressing unconscious bias at the institutional level in Europe is the need for corporate decision-makers to adopt measures to quantify gender inclusion, which can be done by conducting periodic lessons-learning exercises based on monitored GEWE performance, providing opportunities to share successful project experiences and to discuss challenges and opportunities to promote GEWE in innovation and IP.

TAILORED APPROACHES TO ADDRESS GENDER FINANCIAL BARRIERS

Women have increasingly participated in innovation competitions in Europe—for example, in the scaling up of the recently launched European Innovation Council (EIC) 'Women TechEU pilot' to support more deep-tech, IP-rich startups led by women. Despite efforts made in the last decades to promote gender equality in entrepreneurship, however, the reality remains discouraging.

Increasing funding for women-led startups and their innovation projects—through POC funding, grants, loans, and venture capital—has been recognized as the biggest barrier to overcome. Women face unique challenges in securing funding for their projects, which calls for a multifaceted approach.

In Europe, less than a fifth of total funding goes to teams that include women. In particular, women-led startups face an uphill battle, as the average amount raised by women-only teams is approximately four times lower than for men-only teams. Only 7 percent of funding rounds include a woman-founded startup, and such startups collectively raise a mere 2 percent of all funds raised, as highlighted by the Financial Times (Sifted).

Comprehensive approaches have been adopted to tackle the root causes of the gender gap in funding. This includes raising awareness about unconscious bias in investment decisions, providing mentorship and networking opportunities for women entrepreneurs, and implementing policies that promote gender diversity in venture capital firms and angel investor networks. Additionally, some financial institutions and government agencies have played a crucial role by offering targeted funding programs and grants specifically designed to support women-led startups; they have found that by addressing these systemic barriers, a more inclusive and equitable ecosystem can be created that empowers women to thrive in innovation and IP development.

To overcome gender disparities, findings indicate that targeted financial support and investment programs are essential. Investment programs should aim at providing women innovators and entrepreneurs with the necessary capital to develop and commercialize their ideas, as in the following examples.

Grant programs. Establishing grant programs specifically for women-led innovation projects can provide the initial funding needed to kickstart their ventures. These grants can cover research and development costs, patent and design registration fees, and other expenses associated with bringing an innovation to market.

Women-focused venture capital funds. Creating venture capital funds dedicated to investing in women-led start-ups can address the funding gap. These funds should not only provide financial support but should also offer mentorship, networking opportunities, and business development assistance to help women entrepreneurs scale their businesses.

Crowdfunding platforms. Encouraging the use of crowdfunding platforms for women-led innovation projects can democratize access to funding. These platforms can help women innovators reach a wider audience and raise capital from a diverse group of investors.

Public-private partnerships. Collaborating with private sector partners to co-finance women-led innovation projects can leverage additional resources and expertise. Public-private partnerships can also help validate the commercial potential of women's innovations, attracting further investment.

Loan guarantee schemes. Implementing loan guarantee schemes for women entrepreneurs can reduce the risk for lenders and increase access to credit. These schemes can provide a safety net for financial institutions, encouraging them to lend to women-led businesses.

SUPPORTING GENDER INCLUSION IN INNOVATION IN EUROPE

In recent decades, successful initiatives in Europe have promoted technology transfer inclusion and increased smart use of IP by women. These efforts, benefitting female scientists, innovators, creators and entrepreneurs and their models, could serve as models for future endeavours in specific fields.

EU's Horizon Europe Program. The EU's largest research and innovation program has actively promoted gender equality in research and innovation in the last decade. The program includes specific selection criteria and requirements for integrating gender considerations into research content and ensuring balanced representation of women and men in research teams and decision-making bodies.

National policies promoting women in STEM. Several European countries have implemented national policies to increase the participation of women in STEM fields. For example, Germany's "Girls' Day" initiative encourages young girls to explore careers in STEM by providing hands-on experiences in research institutions, universities, and companies. Similarly, the UK's "WISE Campaign" aims to inspire and support women and girls to pursue STEM careers, offering resources, training, and networking opportunities.

Public-private partnerships for women's entrepreneurship. Public-private partnerships have played a crucial role in supporting women entrepreneurs in innovation and IP development. For instance, the European Institute of Innovation and Technology (EIT) has partnered with private companies and academic institutions to provide funding, mentorship, and training programs specifically tailored for women innovators, helping them to commercialize their ideas and secure IP rights.

Gender equality plans in research organizations. Research organizations across Europe have adopted Gender Equality Plans (GEPs) as a strategic approach to address gender imbalances in research and innovation. GEPs include measures such as gender-sensitive recruitment policies, leadership training for women, and initiatives to improve work-life balance, all of which contribute to creating a more inclusive environment for women in innovation and IP development.

Networking and mentoring programs. Networking and mentoring programs have been instrumental in supporting women's careers in innovation and IP. For example, the European Platform of Women Scientists (EPWS) provides a forum for women scientists to connect, share experiences, and access professional development opportunities. Similarly, the "Mentoring for Research Programme" in Spain pairs early-career women researchers with experienced mentors to guide them in their professional growth and IP-related endeavours.

POLICY RECOMMENDATIONS

This study makes clear that supporting gender inclusion in technology transfer cannot be achieved solely by universities. Other stakeholders—such as champion entrepreneur alumni, industrialists, business angels, venture capitalists and other professionals—should also be engaged to identify and nurture gender inclusion in technology development.

Addressing gender disparities in innovation requires concerted efforts to create an inclusive environment that supports and encourages women's contributions to innovation. Initiatives such as targeted mentorship programs, gender-sensitive policies in research and development institutions, and increased funding opportunities for women-led innovation projects can help bridge the gender gap in IP ownership.

The following practical recommendations can be considered by practitioners and policymakers as part of their decision-making process best practices.

- Recruit more female talent by providing entrepreneurial coaching, training, internships, and managerial opportunities. This, in turn, can help create a new generation of female innovators who can contribute to making firms more productive and innovative.
- Develop inclusive cultures that support and promote women's participation in innovation and technology transfer.
- Leverage public-private partnerships to provide funding and to boost inclusiveness across sectors while encouraging the participation of female scientists and innovators in IP development.
- Support social innovation projects by encouraging start-ups and small and medium enterprises (SMEs) to have business models that promote female leadership and innovation.

In the broader picture, it is essential to involve male champions, enact gender-sensitive policies, and tackle conscious and unconscious biases that

challenge the participation of women in innovation, technology transfer, and intellectual property (IP) ownership.

Additional areas for action include the following.

- Networking opportunities for women innovators, investors, and industry leaders, promoted by dedicated platforms and events. The "Women in Tech" network, for example, offers events and forums for women in the technology sector to connect and share experiences.
- Inclusive funding mechanisms to address financial barriers by targeting women-led start-ups and innovation projects. The European Investment Bank's "SheInvest" initiative is an example of a funding mechanism aimed at increasing investment in projects that empower women and girls.
- Education and training programs that equip women with the skills and knowledge needed to succeed in the innovation ecosystem. The "Women in Digital" program by the European Commission offers training and mentorship to women looking to develop digital skills.
- Research and data collection on gender disparities in innovation, tech transfer, and IP ownership. This data can inform policy decisions and help track progress towards gender equality in the innovation ecosystem.

These temporary solutions, while addressing immediate concerns, offer only a partial remedy to the broader challenge. Comprehensive policy frameworks that effectively address gender equality in technology transfer, innovation and entrepreneurship are needed to implement more systemic approaches that address the root causes of gender inequality in innovation.

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3.3 DIGITALLY-ENABLED WORK OPPORTUNITIES AND WOMEN'S EMPOWERMENT

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ABSTRACT

The technological advancements of the recent decades, including the expansion of the gig economy, have created increasing opportunities for flexible work for both men and women across the globe. Flexible work arrangements have long been argued as an enabler of women's increased and sustained participation in the labour market and their socio-economic empowerment. Based on qualitative interviews with women in Sri Lanka, this paper explores how these opportunities are affecting women's empowerment in Sri Lanka. While the paper indeed provides evidence of positive empowerment effects on women's resources, agency, and achievements, it also provides evidence that existing gender norms and inequities faced by women in the labour market are in fact reinforced through digitally-enabled work opportunities. This paper provides recommendations toward more balanced labour outcomes for women in the digital economy.

KEY FINDINGS

- Digitally-enabled flexible work has resulted empowerment effects for women in Sri Lanka, through improved resources, achievements, and agency.
- Structural constraints limit the work choices available to women, making flexible work the most viable option, despite the accompanying challenges.
- Flexible work opportunities for women can reinforce pre-existing gender norms and inequities in the labour market.
- Policy support is needed, including safe transport, childcare, legal protections, and upskilling, to enable more balanced labour outcomes for women in the digital economy.

INTRODUCTION

Recent technological progress, combined with the growing gig economy, has created opportunities for flexible work for both men and women across the globe. These opportunities range from ridesharing to online freelance work to home-based businesses facilitated by social media and logistics platforms. This surge in digital work became even more pronounced following the Covid-19 pandemic (International Labour Organization [ILO], 2021). Flexible work arrangements—such as those offered by the gig economy—have long been seen an enabler of women's increased and sustained participation in the workforce. This is particularly pertinent for countries like Sri Lanka that have long struggled to increase female labour force participation (LFP) rates. Many have argued that these opportunities are especially advantageous for women, enabling flexibility in terms of time, location, and the conditions of work, resulting in greater LFP and wider opportunities for socioeconomic empowerment (OECD, 2018; Silim & Stirling, 2014; World Bank, 2019).

The gender implications of platform work have been little researched (Kampouri, 2022). Apart from the studies cited here, few studies have focused on female platform workers in the Global South. This study aims to provide deeper insights into Sri Lanka's situation by exploring how these opportunities are affecting women's empowerment in Sri Lanka. The

paper takes a broad approach to empowerment, based on Kabeer's framework of empowerment (discussed below). Briefly, empowerment is viewed as the process of change leading to an improved ability to make strategic life choices (Kabeer, 1999), defined as choices that affect important aspects of an individual's life, such as whether to work, where to work, whether to get married, etc. The end outcomes are mediated through 'structures of constraint' such as norms and institutions.

This paper presents evidence of empowerment in the form of improved 'achievements' facilitated by reported improvements in resources and agency, based on qualitative research conducted in 2021 among women engaged in digitally mediated earning opportunities in Sri Lanka. The women studied were participating in paid work or were running successful businesses of their own, not just in traditionally 'feminised' sectors but also in sectors where women have generally been absent, such as transportation and tech. The paper also examines changes to the 'structures of constraint.'

However, there is also evidence that existing gender inequalities and norms in the labour market can be reinforced through digitally-enabled work. This includes norms relating to women's mobility, the distribution of care work, and skills and earnings gaps. This paper provides evidence of such instances, followed by recommendations as to what might be done to ensure more balanced labour outcomes for women in the digital economy.

LITERATURE AND CONTEXT

THE SRI LANKAN LABOUR MARKET CONTEXT: INEQUALITIES AND NORMS

Although Sri Lanka demonstrates gender parity in education at the primary, secondary and tertiary level, it nevertheless lags in economic gender outcomes, ranking 115th (out of 146) on the Economic Participation and Opportunity sub-index of the World Economic Forum's Gender Gap Index (World Economic Forum, 2023). Women's labour force participation (LFP) has remained at 30–35 percent over the past two decades, compared to men's LFP at over 70 percent; the most recent estimate for women is 33 percent. Women's unemployment rate also stands higher—for instance, at 79 percent in 2021 compared to men's 3.8 percent (World Bank, 2023a). Data shows this disparity particularly affects young, educated women (Solotaroff, Joseph, Kuriakose, & Sethi, 2020). Women are more likely to be employed in lower quality, lower-paid jobs or in the informal sector, which employed nearly half (49.7 percent) of employed women in 2021 (Department of Census and Statistics, 2021).

Women's low labour market participation in Sri Lanka is due to domestic care burdens, skill gaps, and gender discrimination both inside and outside of the labour market (Domestic and Care Work Is a Feminized Sector with High Informality and Low Salaries, 2022). Insufficient workplace childcare resources further limit their involvement (UN Global Compact, n.d.).

Restrictive labour laws in Sri Lanka, such as limits on night hours and overtime work for women, along with inadequate sexual harassment legislation, also deter women's participation (Bakmiwewa, 2021). Lack of recognition for part-time and flexible work—often preferred by women seeking work-life balance—is another factor. Recent data indicates that women in Sri Lanka are twice as like to engage in part-time work as men (Advocata Institute, 2022). Those engaged in non-standard employment (including gig workers) are not covered by the legal protections afforded to those in full time employment and are thus at greater risk of exploitation (Bakmiwewa, 2021). While calls have been made to update the legal framework to enable such arrangements (Sri Lanka to change laws, 2017; Incorporate flexi-work, n.d.), to date little substantive progress is evident.

Seneviratne (2019) observes that the combination of lower fertility rates, increased tertiary education, and declining income among younger generations has driven women into employment, although social stigma and other factors weaken this effect. UN Women's research (Gunatilake & Chandrasiri, 2022) shows that labour market gender segregation focuses the demand for female labour in low-skilled jobs in both manufacturing and services, reflecting the low investment in capital and technology in these areas. In particular, although women workers are particularly sought in finance, education, health, and social services due to sector-specific needs (p. 95), gender biases and restrictive laws limit women to lower-paying, unstable jobs with poor growth potential, mainly in 'feminized' sectors like domestic and care work (Domestic and Care Work Is a Feminized Sector with High Informality and Low Salaries. | UN Women – Americas and the Caribbean, 2022).

Women face significant mobility and safety challenges in Sri Lanka. One survey found that 90

percent of female respondents had experienced sexual harassment on public transportation at least once, affecting their willingness to work due to safety concerns (UNFPA, 2018, p. 17). Women's reliance on public transport to access employment or education underlines the impact of such harassment. Hence, remote work may be seen as a more appealing option, since it can be done from the safety of the home. A recent IFC study on "Women and Ride-hailing in Sri Lanka" observed that ride-hailing had opened up increased opportunities for women's mobility. "Fifty-one percent of women riders said that they are able to work more frequently thanks to ride-hailing; 64 percent said that they can access more job opportunities or better jobs; and 88 percent said ride-hailing gives them access to new places" (IFC, 2020, p. 9). However, these benefits are not evenly distributed, and "men continue to cite these benefits at even higher rates than women" (p. 9).

The education-to-employment transition for Sri Lankan Women presents a human capital mismatch, as increased educational achievements do not lead to similar gains in skilled employment opportunities. While higher education increases female labour force participation (FLFP), it has not produced a rise in medium and high-skilled jobs for women in the face of a growing gender gap favouring men (Solotaroff, et al., 2020, p. 60).

Women's participation in the digital economy has improved in recent years, with the online gender gap reducing from 34 percent in 2019 to 7 percent in 2021 (LIRNEasia, 2019; LIRNEasia, 2021). However, the digital skills needed for a meaningful internet experience are often lacking. For instance, 42 percent of women online (compared to 32 percent of men) were unable to install an app independently or at all; 47 percent of women (and 41 percent of men) were unable to set up an account and passwords for a service online; and 80 percent of women online (and 78 percent of men), did not know how to complete a payment or transaction online (Galpaya & Zainudeen, 2022).

Quantifying the number of women workers or total workers in the platform economy is a challenging assignment (ILO, 2021). In 2020 it was estimated that 30–40 million workers engaged in platform-mediated work across the global south (Heeks et al., 2020), mainly in India, Bangladesh, and Pakistan (Online Labour Index, 2020). Accurate estimates are difficult because of the transient nature of women's participation in the digital economy as well as their participation through social media platforms, often using multiple platforms simultaneously. Nevertheless, OLI data indicates that 28 percent of the online labour supply on digital work platforms in India are women (Stephany, Kassi, Rani & Lehdonvirta, 2021). Nationally representative surveys conducted in Sri Lanka and India in 2021 found that 6 percent of women aged 15–65 in Sri Lanka, and 2 percent in India, used digital platforms for selling goods or services (LIRNEasia, 2021).[1]

While women are increasingly engaging in the digital economy, there remain clear gender differences in the extent of their participation and the sectors they participate in. Globally, women engage more often in areas such as writing and translation, while men are more present in sectors such as software and technology; a sharper divide is seen in countries like India than in (for example) the United States or Ukraine (ILO, 2021; Stephany et al., 2021).

GENDER NORMS, WORK AND THE PLATFORM ECONOMY

Feminist theory has always engaged with women's roles in work, advocating for fair wages and working conditions alongside the right to work outside the home. These demands navigated within patriarchal work structures (Rahman, Arora, & Könog, 2023). Both the first and second waves of feminism grappled with the division between public and private spheres in capitalist societies, where women's role in reproduction often confined them to home-based work or burdened them with a 'second shift' of unpaid domestic labour alongside their waged work (Ferguson, Hennessy, & Nagel, 2023). Persistent cultural norms limit FLFP, including religion and caste in South Asia (Das & Desai, 2003; Desai & Jain, 1994; Das, 2006; Göksel, 2013; Jaeger, 2010; Panda, 1999; Klasen, 2018). In Asia, women from affluent families may remain confined in traditional gender roles (Desai & Jain, 1994), while those from less privileged families may be compelled to join the labour force out of economic necessity (Eswaran, Ramaswami, & Wadhwa, 2013).

During the COVID-19 lockdowns, cultural norms in Sri Lanka apparently contributed to a rise in unpaid care work for women, although comprehensive national data is lacking (Centre for Poverty Analysis, 2020; Gunatilaka, 2013; Gunewardena 2015; Perera, 2017; Salman, 2021). Platform work has failed to remedy gender work disparities, with women still found predominantly in lower-paying jobs (Gerber,

1 Excluding the state of Kerala, which could not be surveyed at the time due to the Covid 19 pandemic.

2022). Persistent socioeconomic challenges—like poverty, which is more relevant in less developed regions—make the situation for women worse.

As observed by Beneria, Berik, and Floro (2003, p. 27), economic justice is intrinsically linked to gender justice: typically, poor women suffer most from unequal resource distribution in families and from restricted reproductive rights, while wealthier women benefit from greater political representation and opportunities. Moreover, the COVID-19 pandemic disproportionately affected working women, further burdening them with caregiving at home (Bateman & Ross, 2020). In the US, for instance, caregiving responsibilities are calculated to reduce a mother's lifetime earnings by an average of 15 percent, with an additional impact on her retirement savings (Johnson, Smith & Butrica, 2023). The impact is likely to be greater in the Global South, where larger shares of women work in informal sectors (UN Women, n.d.).

The online platform economy has been viewed as a potential means to level the 'playing field' by offering flexible and often home-based or remote income-earning opportunities to marginalized groups, including women, reducing the barriers to workforce entry (Hoang, Blank, & Quan-Haase, 2020). Such flexibility may allow women to participate in the labour force while managing their domestic and care responsibilities. The reality is more complex, however, as traditional inequalities persist online (Lutz, 2019). Gerber (2022) found that women in the US and Germany often rely on irregular employment in lower-paid platform work, despite seeking more stable alternatives. "They more often reported feeling economically dependent on crowd work, working flexible hours, and having atypical or no other employment aside from crowd work. While voicing a stronger desire for alternatives, they were also more likely to perceive crowd work as a long-term option."

While online spaces can provide new ways of working with significant earning opportunities, the promise of digital inclusion does not automatically equate to gender empowerment. Often, traditional family roles or societal stigmas around women's employment serve to constrain this empowerment. While some women find ways to navigate these barriers (for example, using social media to expand their businesses), the digital economy does not always prevail against deeply ingrained social norms around women and work (Dixit & Banday, 2022). Such norms, seen across various countries and regions, include: restrictions on women's mobility; feminised sectors within the digital economy; women's increasing representation in the informal sector; and generally lower earnings and greater precarity of women's work (Dewan & Sanyal, 2023). In the case of women platform workers in India (particularly in sectors like waste management and recycling), the institution of some level of formalization potentially offers them better social security and working conditions (Mehta, Raman and Arora, 2023). However, the gendered division of labour persists, with women typically confined to lower-skilled, less technical roles that limit their opportunities for growth. The gender gap in digital literacy and competence further compounds these issues, as women often lack the skills required for more technical or higher-paying roles. This division keeps women in traditional roles even within new platform economies, preventing them from breaking free of gendered expectations. In Thailand, women digital workers have been seen facing economic precarity, taking on several jobs to make ends meet, even while shouldering significant domestic responsibilities. This multifunctionality, while offering diverse income streams, often results in poor work-life balance, as women struggle to meet the demands of both paid work and unpaid care responsibilities (Sutassanamarlee, 2023).

Similar evidence is seen in Latin America, where the platform economy is seen as a way to improve women's workforce participation by offering flexibility and by reducing barriers to entry. However, socio-cultural norms continue to place the burden of unpaid care work squarely on women, limiting their ability to make full use of platform opportunities. Gender gaps persist in skills, resources, and time, making it difficult for women to move into higher-skilled or more lucrative fields. The platform economy, while it offers some improvement in access to work, often reinforces existing gender roles, with women still underrepresented in occupations traditionally dominated by men (Ballesty & Albrieu, 2023).

In Africa, the challenges are even more pronounced due to the digital divide. Women in many African countries face significant barriers to participating in the platform economy due to limited access to the internet, lack of mobile technology, and inadequate digital skills. In countries like Kenya, Nigeria, and South Africa, where gig work has gained popularity through platforms like Uber, Jumia, and Bolt, women are still largely relegated to gendered occupations such as domestic work or caregiving roles. Even when women acquire the necessary technology or skills, socio-cultural constraints along

with limited demand for female workers in high-skilled positions inhibit their economic advancement. The lack of data on women's participation in platform work makes it difficult to fully assess their contributions, but the evidence suggests that women remain concentrated in lower-paying, informal sectors (Wairegi, 2023). In sub-Saharan Africa, moreover, the gender gap in mobile internet access remains persistently high: women are 30 percent less likely to own smartphones than men, restricting their ability to engage in the digital economy. Even in regions where mobile ownership among women is increasing, the cost of smartphones and the lack of digital skills remain significant barriers. Women who do participate in the platform economy are often confined to specific sectors or roles due to limited access to technical education and training, further entrenching gender norms in the labour market (Wairegi, 2023).

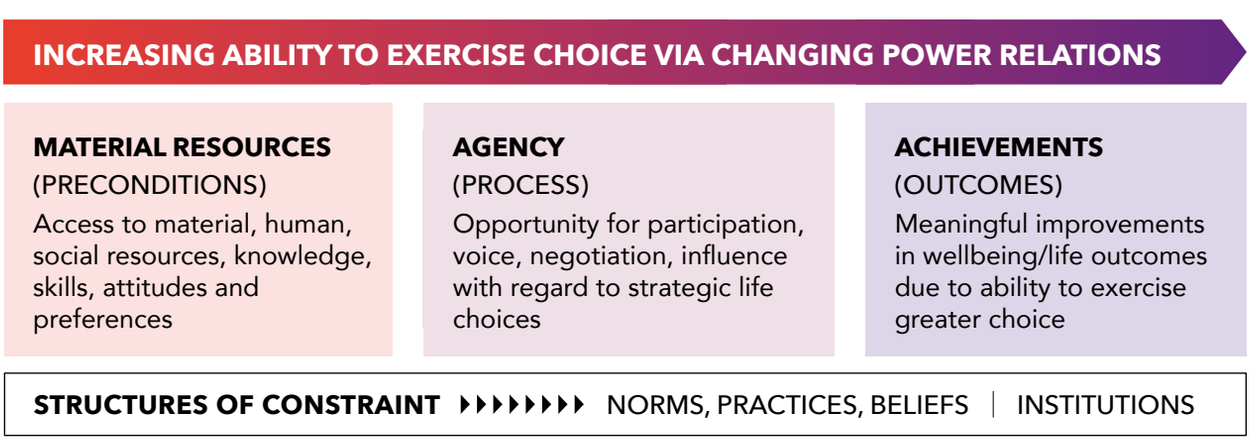
Across all these regions, platform work does not fully deliver on its promise of gender empowerment. While digital platforms offer new ways for women to earn income with some measure of flexibility, traditional gender roles and socioeconomic barriers continue to limit their economic advancement. Women often experience lower earnings, fewer opportunities for career growth, and greater stress from managing multiple roles. The impact of these constraining factors highlights the need for policy interventions, better regulatory frameworks, and broader cultural shifts to address persistent inequalities. Without such changes, the platform economy may merely replicate the same gendered challenges that exist in traditional labour markets, rather than offering an effective path to empowerment for women.

AN EMPOWERMENT FRAMEWORK

In Kabeer's model, empowerment is viewed as the process of change leading to an improved ability to make strategic life choices (Kabeer, 1999), which are defined as choices that affect important aspects of an individual's life: whether to work, where to work, whether to get married, etc. Kabeer articulates three interrelated dimensions of empowerment: (1) improved resources together with (2) improved agency lead ultimately to (3) improved achievements or outcomes (the end goal). The end outcomes are mediated through 'structures of constraint' such as norms and institutions.

FIGURE 1

FRAMEWORK FOR EMPOWERMENT



Source: Author's illustration based on Kabeer (1999).

Kabeer defines empowerment as the 'processes by which those who have been denied the ability to make choices acquire such an ability)' (1999; p. 437). Kabeer specifies some defining conditions. First, the process entails change, starting from a disempowered position. Second, the notion of choice implies the 'possibility of alternatives,' i.e., the ability to exercise meaningful choice (p. 437). Third, the choices addressed in the model are those that can shape the individual's life – strategic life choices such as whom and whether to marry, choice of livelihood, etc. Further, women's empowerment is conceived as a

change in power relations in regard to three factors: (1) women's access to material resources; (2) their agency; and (3) the achievements that are enabled by their exercise of choice (1999, Figure 1). Kabeer argues that the end outcomes are mediated by 'structures of constraint' that include norms and institutions which are often inherently gendered, impacting the process of empowerment and shaping outcomes. Kabeer highlights the need to distinguish between an individual's choices and their ability or inability to exercise choice, even in cases when the resulting outcome or achievement is the same.

DIGITALLY-ENABLED WORK OPPORTUNITIES AND EMPOWERMENT

Applying this framework, this paper addresses two questions:

- Are digitally-enabled work and earning opportunities changing women's access to material resources, agency, and achievements?
- Are digitally-enabled work and earning opportunities changing the 'structures of constraint' that affect empowerment outcomes?

For the purposes of this study, digitally-enabled work is defined as work and other income-earning opportunities that are mediated through a digital platform. Digital platforms are understood to include a broad spectrum, from general or multi-purpose platforms (such as social media, messaging platforms, and delivery and logistics platforms) to dedicated digital work platforms (such as ride-hailing platforms and online freelancing platforms). Women were seen to engage in three types of work:

- Location-based work (e.g., uber driving, beauty services), where the worker's physical presence is required at the location where the good or service is provided
- Non-location-based work (e.g., online freelancing, microwork), where the job can be performed remotely
- Digital businesses (e.g., home baking, handicraft production, etc.), where a good or service is marketed and sold via digital platforms, including social media.

METHOD

This paper presents qualitative interviews with six men and 41 Sri Lankan women engaged in diverse forms of digitally-enabled work, including ride-hailing, transcription, tutoring, and selling homemade items (baked goods, jewellery, etc.). The sample represents various ages, socioeconomic backgrounds, and ethnicities, mostly comprising micro-entrepreneurs and non-location-based service providers (Table 1). Fewer women were found engaged in location-based services, likely reflecting their limited prevalence. Apart from ride-sharing drivers, most respondents accessed clients through social media and offline networks rather than through sector-specific platforms. Six men were included to examine gendered aspects of the findings.

TABLE 1. TOTAL SAMPLE BY CATEGORY

		WOMEN	MEN
DIGITAL ENTREPRENEURS	Micro-entrepreneurs	11	1
	Creative entrepreneurs	7	
	Home chefs/food entrepreneurs	7	
NON-LOCATION-BASED SERVICE PROVIDERS	Micro-workers / online freelancers	8	2
	Online tutors	2	
LOCATION-BASED SERVICE PROVIDERS	Transport/delivery/logistic workers	4	3
	Beauty worker	2	
TOTAL SAMPLE		**41**	**6**

Source: Authors.

In addition, interviews were conducted with 11 companies covering ride-hailing, freelancing, and marketplace platforms. They shed light on women's work circumstances and their interactions with these platforms.

The research was conducted during the Covid-19 pandemic (April to July 2021), an event that expanded opportunities for many to work remotely, and also pushed many to find new ways to supplement household income. Interviews were conducted remotely–by phone call or video call—using Sinhala, Tamil, or English, depending on the respondent's preference.

Verbatim transcripts of the interviews were analyzed using the framework analysis approach. Kabeer's framework for empowerment (Figure 1) was used to develop the analysis framework. Initially, 59 codes were developed in alignment with Kabeer's empowerment framework.

FINDINGS

The research findings address two research questions, examined through an in-depth analysis of qualitative data. (1) What impact do digitally-enabled work and earning opportunities have on achievements, through improvements to material resources and agency? (2) To what extent are these digital opportunities reshaping the norms, practices, beliefs, and institutions that have traditionally constrained women's achievements, through improved material resources and agency?

MATERIAL RESOURCES

Improvements in access to material resources were seen in the form of increased incomes, better access to *market information*, and improved *skills and experience as* well as improved social networks.

Digitally-enabled work led to many instances of women's increasing incomes. Some reported being able to earn more than they could in other jobs. One taxi driving digital worker reported earning far more operating her taxi on platforms than she did in a regular job working in a canteen. An online freelancer said she was able to renovate her house with her earnings. Both cases were successful in spite of the Covid-19 pandemic. However, during the 2022 Sri Lankan economic crisis, many of these lines of work were affected due to inflation, stagnation in demand, and lack of products/raw materials.

Access to market information improved for many through access to platforms. This mainly applied to information on work opportunities – both location and non-location-based work. Various online platforms provide important access to market information for non-location-based workers, including rosters of professional providers of specific services. A digital marketer reported: "When it comes to my work, I may need voice artists, I may need to know some people of that sort. Then I go on [online platforms] and check who is there."

Some reported improving their skills and products through the increased use of social media, such as learning new mehendi (henna pattern) designs and formulas on Instagram. Others reported that their digitally-enabled work gave them essential experience as a stepping stone in their career path. An online tutor indicated that the teaching experience she gained online would help her obtain a job in the education field, e.g., as a university lecturer or in the Ministry of Education.

Improved professional-social networks can also be important, building confidence and trust while leading to new sales/earning opportunities. These include collaborations among digital entrepreneurs to boost their online social media profiles. Parties who would conventionally be seen as competitors may instead create a community of online sellers and entrepreneurs, with mutual benefit. As one woman reported,

> I have joined a few groups of women entrepreneurs, and I find it fascinating. Women in these groups tend to fall into two categories—some are highly competitive, while others foster a strong sense of community. I personally appreciate the community-driven aspect of these groups. It's inspiring to see how women, even those in the same industry, like jewelry business owners, can build friendships, collaborate, and create better opportunities together. - Micro entrepreneur, 43, female, Sri Lanka

Delivery services, too, can develop professional relationships. Some have been successful in developing customer networks, leveraging (for example) their school networks and other family members' networks. One entrepreneur who uses social media to promote her coconut husk business reported that these platforms had enabled her to expand her business and gain access to international customers.

AGENCY

Improvements in agency can come in the form of improvements in an individual's ability to affect their 'strategic life decisions' through improved

opportunities for participation, voice, negotiation, and influence. In this regard, improvements in intangible factors such as confidence and status (both within and beyond the family) can improve a woman's ability to affect those decisions.

Improved social mobility could be seen among women from lower socioeconomic groups who run their own businesses. One woman cited being invited for various community programs and conferences for small business owners, based on her experience. Another respondent related that she had seen an improvement in the social recognition of her line of business after posting videos of her work online:

> Initially we were not given recognition as people said that coconut husk business is not a respectable work, but after I started posting videos on social media I was given respect. People in my area have seen my videos and they praise me. They won't know what is happening inside the factory as they don't visit my factory, but there are outsiders who visited my factory, the school I work for requested my permission to bring students. - Micro entrepreneur, 34, female, Sri Lanka

Other respondents reported that their stature had improved in the family. A home-based baker said her family members were impressed that she was able to do things by herself after starting her business. Improvements in social status within the wider community were seen more in rural settings, while improved status within the family was more often seen in urban settings.

Agency can also be advanced through improved confidence: some respondents were able to do something new. One 21-year-old micro-trader in Jaffna had built a successful bulk clothes distribution business through social media; she reported that, whereas earlier she would require her father to accompany her out of the house, she now had the confidence to go by herself. She also had the confidence to advise young women in her distribution network on their personal issues; they now looked up to her as a kind of role model.

In other examples, some women were now, as a result of their work and their personal growth, more involved in household decision making, or were newly consulted about problems in the household. One woman stated, "[in the past] on anything I used to ask my family. But now my dad and brother always [tell] me to take the decision. They say that now I'm matured enough, hence decision making is left to me." This demonstrates that these opportunities can build both self-confidence and the confidence of others, ultimately leading to a more active role in household decision-making.

ACHIEVEMENTS

One prominent outcome reported by the workers is their new financial stability. One food producer highlighted the reliability of her income — consistently remaining above a certain threshold even during less active periods. This financial stability has provided these workers with a sense of security and confidence in meeting their basic needs. Their increased income has enabled individuals to pursue personal goals and aspirations.

A ride-hailing driver related that her platform income covered diverse financial obligations, including vehicle leasing costs, loan payments, household expenses, her child's education, and emergency savings. As the primary breadwinner for her family, her income has become indispensable in ensuring her household's financial well-being. Another respondent, engaged in data entry, directed her earnings primarily towards her child's education, emphasizing the transformative impact of digitally-enabled work opportunities in making meaningful investments in the future.

Digitally-enabled work has facilitated the diversification of income streams for workers, reducing their reliance on a single source of income. A young online freelancer, involved in multiple platforms, shared how she earned substantial income from both Upwork and online tuition work. This diversification has not only strengthened their financial security but also provided greater flexibility in managing their finances.

> I was working in a corporate job, and realistically, earning LKR 300,000 in that setting is only possible if you're a director, manager, or someone in a high-ranking position—which I wasn't. I was earning well below 50,000. Transitioning into teaching allowed me to see new opportunities and earn a substantial income that I feel comfortable with. – Online tutor, 30, female, Sri Lanka

However, it was evident that the workers' earnings vary significantly. Some workers expressed that their income was not stable, like a regular worker, but rather fluctuates based on the calendar, the nature of their work, their customer base, and external factors such as the pandemic. Some find it to be a stable and fulfilling source of income, while others face challenges in managing their finances while experiencing fluctuations in their earnings.

Digitally-enabled work and earning opportunities have fulfilled diverse achievements for the workers

through their income. One content creator has successfully established a smooth payment process for her business, ensuring financial stability. She takes pride in supporting her family at a young age through her earnings. A 25-year-old, working simultaneously as an online tutor and counsellor, found a balance by combining her teaching job with personal classes, allowing her to earn significantly more and to work toward her long-term goal of becoming a licensed therapist. By diversifying her work, she achieves financial stability and aligns her career aspirations with her earnings.

The interviews also revealed respondents' achievements in attaining goals, independence, and self-efficacy. This was commonly expressed as achieving financial independence, and not having to be a burden on others. Some were able to contribute to their own costs as well as contribute to their household and children's expenses – which they previously could not.

> I feel I have taken a weight off [my parents]. If I was doing nothing, I have to ask money from them. But now it isn't needed. I feel I've taken a weight off my mum. – 21-year-old entrepreneur, Jaffna

Other women report being able to create their own brand, seeing themselves grow, being "mentally and financially relaxed," enjoying the work that they do, and being able to use their artistic skills or express their creativity, as well as being able to travel, live healthier, and other benefits.

STRUCTURES OF CONSTRAINT

The interviews also yielded examples of digitally-enabled work and earning opportunities affecting the 'structures of constraint' that serve to limit resources, agency, and achievements — i.e., that mediate the empowerment process (Kabeer, 1999). The structures of constraint in this context can include the norms, practices and beliefs around women's participation in the labour market; they can also include institutional factors, such as how platforms are designed and operated.

PERCEPTIONS AND ATTITUDES TOWARD WOMEN'S MOBILITY

South Asian cultural norms often preference women staying at home, to attend to their domestic and care (unpaid) responsibilities and also to avoid the use of public transport (due to safety concerns) as well as possibly to avoid social stigma. Many women mentioned as a key advantage of digitally-enabled work opportunities the ability to work from home. The perception that working from home is a 'good' option for women stems from the idea that they don't have to travel outside the home; women themselves spoke about this as an advantage, and some also indicated that their families encouraged them to take up these kinds of opportunities. Most believe it is a good career choice that they can continue once they get married and have children. One respondent's parents had actively discouraged her from attending an interview for a job that would take her out of the house. The option to work from home, through digitally-enabled work opportunities, thus reinforces these mobility norms.

While platform-enabled work opportunities outside the home, such as ridesharing and delivery, might provide women with the opportunity to break such mobility norms, the evidence suggests that this doesn't happen on a large scale. The social stigma associated with to taxi driving presents a barrier to more women taking up these types of jobs, as reported by women respondents as well as by a major ride-hailing platform that was interviewed for the research.

BURDEN OF UNPAID CARE WORK

As noted in much of the literature, social norms in South Asia generally place the bulk of the burden of unpaid domestic and care work on women. Sri Lanka is no exception (Gunewardena, 2015; Gunatilaka, 2013), contributing to women's time poverty (UN Women, 2019). The interviews with women revealed that, although women were taking up more earning responsibilities through digital opportunities, they felt that they were still expected to take on the unpaid domestic and care work roles. Given the flexible nature of the digital work, there is an implicit expectation that they will adjust and fit things in to manage the 'triple burden' of unpaid domestic and care work and paid labour. The appeal of flexible work through digital platforms thus increases for those women with domestic and/or care responsibilities. In general, this trend has several important implications related to empowerment outcomes.

1. Women are increasingly engaged in informal work, often under precarious conditions — with no access to labour market protections or the entitlements associated with full-time formal employment. While digitally-enabled work and earning opportunities provide them opportunities, these

forms of work do not help women to move into stable work with better working conditions.

"It is not like a full-time job where I go and work somewhere, [where] even though I [take] a sick day I would get paid for that day. So, it is bit of a difficult – not a nice ride I would say."

"I got fever during that time and had to quarantine for 14 days… That was a challenge during that time – if I don't do anything for the 14 days, I will lose my customers."

2. Due to the triple burden that many women face, and relatively easy digital access to flexible work opportunities, some women are working below their skill level. To avail of the flexibility that allows them to balance unpaid domestic and care work with paid work, they may select low-skilled tasks. One highly qualified woman with an MBA, the mother of toddlers, engaged in translation and transcription services as a 'low cognitive demand' strategy to manage her triple burden. Women with fewer care responsibilities (often younger, unmarried women) were able to dedicate the time to advance their skill levels, keep up with digital marketing trends, and progress to higher levels of achievement. But women with more care responsibilities may stagnate and fall behind in their career progression, similar to the women in the 'offline' labour market who may have to settle for lower-skilled, lower paying work after taking a break for motherhood.

Working below their skill level — taking on smaller, less cognitively demanding, and lower paying jobs — can potentially impact women's earning capabilities, both compared to men and over their lifetime. Additionally, women often lack the time to upskill or to develop a digital marketing strategy that can boost their business, while those with fewer care responsibilities go forward, making it harder for others to compete. Evidence from the US indicates that a mother's lifetime earnings are 15 percent less on average due to care giving, not accounting for their reduced retirement income (Johnson, Smith & Butrica, 2023); it seems likely that the impact may be greater in the Global South, where larger shares of women work in informal sectors (UN Women, n.d.). Such informal work should not be discounted, in the absence of alternative earning opportunities – in particular, when faced with job losses due to the pandemic and the Sri Lankan economic crisis of 2021. However, the differential outcomes reflect the particular constraints faced by women.

TRADITIONALLY 'FEMINIZED' SECTORS

This study was not designed as fully representative of women engaged in digitally-enabled earning opportunities. However, interviews with workers and platform administrators depicted a clear gender divide in employment sectors. As in the offline labour market, women were more often found in 'feminised' sectors, such as food and catering, beauty work, and online tutoring, and were absent from sectors such as transport and logistic services.

Although digital platforms can facilitate women's participation in some traditionally male-dominated sectors such as ride-sharing and delivery, this was not seen on a large scale. A major ride-sharing platform had made considerable efforts to boost the number of women drivers, but indicated that it struggled to do so due to the social stigma about women engaging in these sectors. Women engaged in these kinds of work might do so at the displeasure of their extended family, or might have to hide their occupation from their neighbours. However, one woman interviewed indicated that once her ride-sharing income reached a certain level, her family members no longer minded that she engaged in this kind of work.

FLEXIBILITY AS AN ENABLER OR CONSTRAINT?

Many of the women interviewed indicated that flexibility was a key motivator for them to take up digitally enabled work, whether driving on ride-hailing platforms, teaching online, providing remote transcription services, or selling home-made creations through social media. Flexibility has been viewed as a way to increase and sustain labour force participation across contexts. This is because flexibility allows women to better align working hours with their care and other personal responsibilities, enabling them to (re-)enter and remain in the job market, and in theory, to achieve better work-life balance.

In the short run, there is potential for women's LFP to increase through flexible work opportunities, but it is questionable how sustainable and long-lasting this participation will be. Many respondents related that accessing a digital platform – even a social media platform – allowed them the space to monetize a skill or passion at a relatively low cost. However, many of these ventures have been short-lived, superseded by newer ventures or simply shelved due to a disruption to the household or family, such as an illness or a pregnancy. In fact, some respondents

reported that the stress of balancing flexible paid work on top of unpaid domestic work can lead them to take on too much work; this can lead to overload, physical and mental health issues, and even burnout in some cases. This is especially true for time-poor women. The lack of labour protections for these workers adds to the precarious nature of their work. There is thus a risk that many women withdraw from the labour force altogether, forgoing any potential achievements in the medium to long term.

CONCLUDING THOUGHTS

The research reveals that some women who engage in digitally-enabled work experience improved access to material resources and improved agency; these factors in turn have helped them to achieve financial stability and independence, to meet their financial responsibilities, and to improve their skills, knowledge, confidence, and even their status within their families. While digitally-enabled work opportunities have opened opportunities for these women to be empowered, structures of constraint nevertheless tend to mediate these outcomes, stemming largely from the norms and inequalities that characterise the 'offline' labour market. There is little evidence of these structures of constraint being broken, or even dented, in this context; many of these norms, such as those relating to mobility and the burden of care work, are in fact reinforced.

Importantly, women cannot be considered as one homogeneous group. Interviews with platform companies showed that they generally consider women participants on their platforms to be stay-at-home-moms. The evidence shows that women with different levels of care responsibilities and belonging to different socioeconomic groups face different sets of challenges. Companies need to take a broader view in how they perceive women workers and how they design for them. Digital platforms – designed for digital work, marketplace, or social commerce – need to proactively disaggregate the data they collect to better understand gender dynamics: which categories of women tend to earn more, take on higher value work, spend more time working, etc.

The larger question is, how can women's longer-term engagement in the labour force be supported and sustained? While flexible digital work and earning opportunities offer great potential for empowering women, as this paper has shown, these outcomes can still be considered sub-optimal given the structural constraints that work in the opposite direction. A key advantage of online opportunities, especially for women, is their remote and flexible nature; however, flexible work comes with pitfalls. As Dewan observes, "a woman's choice to work from home is not entirely free; it is a constrained choice contingent on several factors including socio-cultural considerations" (2022, p. 8). There are not sufficient work opportunities without these constraints in the 'offline' labour market for women to make real choices. The barriers to women's participation in the labour market and the associated challenges – both online and offline — need to be addressed urgently.

Availability of safe transportation is essential to removing these barriers, to enable more women to consider roles that necessitate travel or even to take on location-based gig work. Therefore, any policy agenda aimed at promoting women's economic inclusion through digital platforms or other means, should prioritize investments in safe and reliable public transportation.

Affordable childcare services would not only allow more women to engage in digitally-enabled work but would also enhance their productivity and earning potential by freeing up time otherwise spent on caregiving. Policies that support subsidized childcare or employer-supported childcare facilities can play a transformative role in enabling women's greater and more sustained engagement in the digital economy, improving women's labour force participation rates.

Current labour laws in many countries, including those of Sri Lanka,[2] do not recognize part-time or flexible work arrangements, thus excluding these workers (often women) from labour protections and benefits such as paid sick leave and maternity benefits. By extending entitlements and protections to non-standard work arrangements, governments can promote greater economic security for women in the gig and digital work economies, and thus can increase female LFP.

At the same time, efforts are needed to help women to move to higher skill, higher paying jobs in the digital labour market, through support for digital skills, financial literacy, and other necessary elements to grow and sustain their businesses. Such efforts need to be designed for different categories of

2 However, at the time of writing, the government of Sri Lanka has commenced the process to revise the existing legal framework to address this concern.

women to be effective, considering education/skill level as well as time poverty (at a minimum), taking into account their specific needs and the constraints they face.

A larger question relates to how we can shift the underlying social norms and stigmas that act as structures of constraint. These indeed present harder and larger challenges; but, as one ride-sharing interviewee suggested, when the pay-off is great enough, perhaps the constraining norms and stigmas might be overlooked.

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CASE STUDY 3.4

BUILDING SOFT SKILLS FOR YOUNG WOMEN IN THE TECH SECTOR: EQUALS HER DIGITAL SKILLS E-MENTORING PROGRAM

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KEY FINDINGS

1. Building human-centric skills following technical skills training increases participants' ability to take on leadership and employment opportunities.
2. Expanding the interaction between learners and professionals improves participants' ability to see themselves in a variety of career paths.

DESCRIPTION

Building soft skills among young women is essential for bridging the gender gap in the ICT sector and ensuring their competitiveness in the job market. While technical expertise is vital, it is often soft skills—the ability to communicate effectively, lead teams, manage time, and solve problems—that distinguishes exceptional candidates and positions them for leadership roles. By fostering personal and professional growth, such initiatives help young women leverage their technical knowledge and become more attractive to employers in the rapidly evolving digital economy. This holistic approach not only enhances individual career prospects but also contributes to a more inclusive and equitable ICT workforce globally.

In 2021, the mentoring component of the *EQUALS Her Digital Skills Initiative* (HDS) was designed by co-founders ITU, GSMA, EY, and W4 as part of an integrated approach to learning digital skills. Integrating soft skills development into technical training was seen as essential to equip young women with resilience and self-advocacy to navigate professional challenges.

Mentoring and 1:1 coaching activities were designed to focus training on key skills that are immediately commercial or can lead to commercial or business use; they used micro-accreditation approaches to certify learners' accomplishments. Webinars and other knowledge-sharing opportunities are available to learners and alumni to continue to grow and develop their skills.

The co-founders believe that the combination of skills, network, resources, and capabilities across the four organizations represent significant advantages when combined to address the digital gender divide.

The HDS team recognized early on that one challenge facing young women and girls who have attended an ICT training session can be making use of the skills learned and identifying how to apply them to a professional role. In addition, they lack role models in professional fields to answer questions or demonstrate the work of a website designer, a programmer, an entrepreneur, or other role the participant may want to seek. As is often referenced: "You can't be what you can't see." Developing these human-centric skills can provide the lever that allows workshop participants to succeed in their ICT careers and next steps.

The HDS e-mentoring program addresses both challenges. It offers participants the opportunity to be matched with mentors who can answer their questions and can also share their own individual perspectives and experiences. These interactions are conducted digitally via an online platform. Monitored for quality and for the protection of the mentees, due to their age, the mentoring program is structured to focus on positive reinforcement of action, self-advocacy, and agency, while providing the opportunity to learn more about the work and life of a professional woman in technology. The mentoring program provides access to women who can discuss how technological skills and curriculum are used in their daily work, while sharing lessons learned and opportunities with the HDS participants.

Participants in HDS workshops are paired with vetted professionals from private sector companies such as EY, Verizon, and other organizational partners of HDS. Both mentees and mentors are introduced to the guidelines and objectives of the program and are given tutorials on using the platform and what types of information are appropriate to share. Mentors also participate in two to three organized meetings throughout the program to share good practices and raise concerns or questions with the program coordinators. Program coordinators provide continuity across locations and partner organizations.

Tailored to address participants' individual concerns, skills and aptitudes, the program covers the following eight topics over the course of eight weeks.

1. Introductions
2. Goals and dreams
3. Personal strengths
4. Problem solving skills
5. Time management
6. Leadership skills
7. Teamwork
8. Self-confidence

Each week, mentees reflect on their progress and prepare comments, questions, or concerns based on prompted questions and topics. The mentors then review and respond, providing actionable steps and real life scenarios that might be applicable; they continue to encourage building personal and professional strengths.

The virtual approach addresses connectivity and time zone concerns while fostering the development of written communication skills. One participant in Pakistan reflected, "I enjoyed the easy and comfortable communication with the mentor via letters. It was easy to express my views and ask questions by writing letters. I was more comfortable and expressed myself better." A mentor based in the U.S. commented: "The first time I received feedback from my mentee about how I can read between the lines of what she was sharing with me. It made me really happy and proud to make her feel heard and seen. We connected immediately and were able to relate to each other through similar past experiences and that added much value and meaning to our interactions."

Below are some examples of topics or prompts, along with written responses from mentors.

How do you build self-confidence? Mentor #1 (from South Africa): "We will never feel 100% ready and sometimes we will be afraid of the next steps. Just move forward despite your fears."

How do you handle working on a team? Mentor #2 (from UK): "Do not wait for people to recognize you to value yourself."

How do you achieve your goals? Mentor #3 (from Brazil): "Take a step each day to work towards achieving your goal. If later in your life, there is a change in priority, you can always adjust your goal accordingly."

The value gained by participants (both mentors and mentees) from these interactions is extraordinary. Mentees consistently rate the program as valuable: over 90 percent report complete satisfaction with the program, the content, and their mentors; 95 percent indicate they would be interested in participating in future Her Digital Skills e-mentoring programs. Participant responses included the following:

Mentee #1 (from Pakistan): "I feel more confident about my skills, and the program kicked the Imposter Syndrome out of my life."

Mentee #2 (from Pakistan): "I got incredible learnings on problem-solving and salary negotiation. I also discussed a part with my mentor where she shared her valuable suggestions on how I can let my voice and input be heard and let other employees know when I am not okay with certain behaviors in regard to inefficiency at work, for example."

Since 2021, over 2000 women and girls have participated in Her Digital Skills e-mentoring programs from 17 countries, including large cohorts from Afghanistan, Antigua and Barbuda, Australia, Barbados, Burundi, Germany, Guyana, Jamaica, Kenya, Lesotho, Pakistan, the Philippines, South Africa, Trinidad and Tobago, UAE, Uganda, and the United States.

TABLE 1. IMPACT DATA FROM HDS EMENTORING PROGRAMS

TOPIC OR COMPONENT OF THE EMENTORING PROGRAM	PERCENT OF RESPONSES
More than or very satisfied with their relationship and exchanges with their mentor.	**96.4%**
More than or very satisfied with how their mentor helped them fix clear goals and strategies to meet their goals	**96.4%**
Improved their knowledge, skills, and abilities regarding the topic "Setting Goals"	**92.8%**
Improved their knowledge, skills, and abilities regarding the topic "Identifying Personal Strengths"	**89.3%**
Improved their knowledge, skills, and abilities regarding the topic "Problem-Solving Skills."	**100.0%**
Improved their knowledge, skills, and abilities regarding the topic "Time Management"	**89.3%**
Improved their knowledge, skills and abilities regarding to the topic "Leadership Skills"	**96.4%**
Improved their knowledge, skills and abilities regarding to the topic "Teamwork."	**96.4%**
Improved their knowledge, skills, and abilities with regard to the topic "Developing Self-Confidence"	**96.4%**
Would like to participate in future EQUALS Her Digital Skills E-mentorship programs to develop further skills.	**100.0%**

Source: Aggregated from HDS session feedback data

The addition of the e-mentoring sessions to HDS workshops improved the satisfaction ratings from participants and increased the long-term impact of the sessions on participants' lives, as they feel better equipped to handle working on teams and in professional settings. The relationships between the mentors and mentees often continue after the program ends, providing additional professional networking opportunities for both sides. It is also cited as a key reason participants remain involved in STEM and ICT activities. This is why HDS believes it is a critical success factor for all technology-related instruction.

EQUALS Her Digital Skills (HDS) e-Mentoring program continues to provide a safe and encouraging environment focusing on developing human-centric soft skills following the completion of digital skills trainings. Through an online, monitored, and structured series of interactions, participants from HDS workshops and professionals from HDS partner organizations share experiences and learn from each other, building personal resilience and self-advocacy.

AI AND CYBERSECURITY

HARNESSING THE ROLE OF TECHNOLOGY TO PROMOTE AN EQUAL AND SAFE DIGITAL ENVIRONMENT

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In researching and producing knowledge on issues at the intersection of gender and technology, we seek to respond to their dynamic nature. On the one hand, we address the need to reduce barriers: the persistent inequalities in access and use—which still need to be remedied—and the development of skills required for using digital technologies. On the other hand, we address specific aspects raised by women's participation in the digital economy, as well as the risks that the use of technologies can create and some potential remedies. These problems are not only dynamic but also complex: existing gender inequalities are apt to be produced and reproduced in deploying new technologies, with greatly increased scope and scale of impact.

This chapter reviews the literature on the gendered dynamics of cybersecurity, adopting Sen's "capabilities" approach—an approach that, according to the authors, can inform cybersecurity risk assessment. The authors examine the importance of promoting cybersecurity capabilities for women and girls as a means to remedy the digital gender divide. A case study approach considers the victims of deepfake crimes, beginning with a scoping review focused on the characterization of the victims, their personal experiences, and gaps in the existing literature.

Additional case studies address the possibilities of resilience and potential cybersecurity measures. One study discusses how social media is being used by civil society organizations (CSOs) to promote the Women, Peace and Security (WPS) agenda. By analyzing social media posts from CSOs in Southeast Asia, the research seeks to shed light on the intersection of social media use, content creation, and gender-inclusive peacebuilding among such organizations. This case study is followed by an analysis of cybersecurity and cyber-resilience of women's civil society organizations (WCSOs), highlighting the role of human factors and gender issues in cybersecurity. The final case study presents an initiative designed to mainstream gender equality and social inclusion using Artificial Intelligence (AI) policies and initiatives in four Southeast Asia countries.

Cybersecurity plays a critical role in addressing the gender digital divide, by ensuring the safety of women and other marginalized groups as they participate in the digital world. As more aspects of life move online, including education, employment, and social interaction, it is essential to create a safe digital environment that protects users from cyber threats including harassment. Research and policies that produce effective cybersecurity measures—resulting in equal opportunities to access and benefit from digital technologies, without fear of exploitation or harm—can promote greater digital inclusion by empowering women to fully participate in the digital economy, ultimately contributing to a fairer and more inclusive society.

4.1 EXPLORING GENDER DIVIDES IN CYBERSECURITY FROM A CAPABILITIES APPROACH

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ABSTRACT

Women and girls are disproportionately negatively affected by cyber threats but are also under-represented at all levels of leadership and decision making in the field of cybersecurity. In a global context, where women and girls increasingly experience technology-facilitated gender-based violence, surveillance, and sexualised online harms, the gendered inequities in cybersecurity present a critical challenge. The gender divide in cybersecurity can be described in terms of imbalances in access, skills, and leadership, but it stems from the larger socio-technical context of women's systemic and pervasive marginalisation. This chapter undertakes a scoping review of the relevant literature, applying Sen's capabilities approach as the analytical lens for exploring and framing the gendered dynamics of cybersecurity. The capabilities approach has been used extensively to highlight normative influences that contribute to women's technological and digital capabilities, broadly speaking. Few researchers have applied the framework in cybersecurity, however; and, more importantly—due to a pervasive techno-centric focus—there is little appreciation of the complex interrelationship between cybersecurity and gender. The capabilities approach allows cybersecurity to be framed in terms of the individual, social, and environmental conversion factors that contribute to women's cybersecurity capabilities. The chapter also proposes ways that the capabilities approach can inform cybersecurity risk assessment, to promote meaningful cybersecurity capabilities for women and girls as a means of addressing the digital gender divide.

KEY FINDINGS

- Gender divides persist within the cybersecurity domain, where females are disproportionately affected by cyber threats and are underrepresented both in cybersecurity professions and at all levels of leadership and decision-making in cybersecurity.
- Cybersecurity gender divides must be understood with reference to the extensive body of knowledge in gender and security studies, critical security studies, and feminist security studies.
- The capabilities approach allows for cybersecurity gender divides and asymmetries to be framed in terms of the personal, socio-political, and environmental "unfreedoms" that hamper the capabilities of women to achieve the kinds of digital lives that they desire and value.
- The capabilities approach can be operationalized, through a capabilities-centric risk assessment process, to develop a nuanced appraisal of women's cybersecurity landscape and to formulate comprehensive countermeasures that address not only the technical challenges but also the personal, socio-political, and environmental factors.

INTRODUCTION

The digital gender divide is reflected in persistent inequalities between women and men at all levels. Fewer women than men enjoy access to and use

of digital technologies; fewer women than men participate in STEM education pipelines or transition into professional roles in the information and communication technologies (ICT) sector; and fewer women than men hold positions of leadership in policy and decision-making within the ICT industry (OECD, 2018; Sey & Hafkin, 2019). This digital gender divide—across access, skills, and leadership dimensions—has been well documented around the world, with variations reflecting contextual factors (Sey & Hafkin, 2019). Regardless of these differences, however, in many ways the digital gender divide is universal and pervasive, impacting all women around the world at varying levels.

One critical corollary of the digital gender divide is that women disproportionately experience and are more negatively affected by cyber threats or adverse incidents that take place via digital technologies. Notably, research has found that the digital world has both enabled new forms of threats against women and compounded their existing disadvantage, precarity, and vulnerability through the cyber-enabled and technology-facilitated risks they face (Strohmayer et al., 2022; Stuart, 2024). Beyond gender asymmetries in the experience of cyber threats, marginalisation is also observed across the access, skills, and leadership dimensions of the gender digital divide as specifically experienced in the cybersecurity domain. These asymmetries in cybersecurity and in the digital online world are part of the complex socio-technical assemblages of women's marginalisation in the current global environment. While extensive research has been undertaken to explore the digital gender divide broadly, the focus on gender and cybersecurity is a nascent area of research. Further, while many of the insights from previous research apply to understanding gender divides in cybersecurity, the fields of Gender and Security and Feminist Security Studies can better inform a nuanced understanding of the specific gender divides in cybersecurity.

This chapter, which is targeted at researchers, policymakers, and cybersecurity practitioners, aims to contribute to this growing area of research by explicating gendered dynamics in cybersecurity, as the basis for more gender-sensitive cybersecurity policymaking and practice. The chapter begins by exploring existing inequalities and asymmetries across the areas of "gender and security" and "gender and the digital." It then briefly introduces the capabilities approach as a normative framework for understanding the mechanisms and dynamics of gender divides in cybersecurity. As a first step, a scoping review synthesises the existing body of research and uses a capabilitarian perspective to investigate gender divides in cybersecurity. Second, the chapter presents a novel, gender-sensitive cybersecurity risk assessment approach based on the capabilities approach. The chapter concludes with a discussion of the key contributions and limitations of this approach.

GENDER AND SECURITY

Gender is intricately connected with security. However, to explicate this connection it is necessary to challenge the definition of "security" as the term is used in the context of international and national security. Feminist international relations scholars and critical security studies scholars have long questioned the state-centric framing of security as well as the construction of security narratives in terms of "the binary metaphysics of the Western culture – such as inside versus outside, us versus them, and community versus anarchy" (Tickner, 2004, p. 46). They also adopt a bottom-up, human-centric, and emancipatory definition of security as "freeing individuals and groups from the social, physical, economic, and political constraints that prevent them from carrying out what they would freely choose to do" (Tickner, 2004, p. 47).

Feminist security research has demonstrated how women's insecurity and suffering has not only been delegitimized and ignored in the name of national and international security, but has been a direct outcome, and sometimes the key factor, in the pursuit of national and international security interests (Sjoberg, 2018; Tickner, 2004). An often-quoted example is the prostitution of kijich'on women, which has been documented not only as part of life at United States military camps in South Korea, but as a well-orchestrated part of military negotiations and agreement between the two countries, in effect using "women as instruments in the promotion of two governments' bilateral security interests" (Moon, 1997). Similar exploitation of women and gender violence has been documented in US military bases across Southeast Asia as well as in conflicts in Bosnia, Yugoslavia, and Rwanda and in United Nations peacekeeping operations (Tickner, 2004; Vojdik, 2019). In these as well as more recent examples, gender violence is perpetrated as a "tactic of war" designed to undermine and humiliate the "foreign others"; in addition, documented cases of sexual assault and rape by men against fellow military officers highlight the pervasiveness of violence also against women who are part of the ingroup (Kirby, 2013; Wood & Toppelberg, 2017). These experiences highlight how notions of "security," "defender," and "threat" are socially

constructed to position powerful (typically masculine) securitising actors.

If security is understood instead in terms of individual agency over one's risk situation, then these masculinised norms and power imbalances by gender identity highlight women's precarity and insecurity. This is exemplified in the widespread experience of direct violence and physical insecurity, as one in three women around the world are estimated to have experienced (UN Women, 2024), as well as in the many less violent practices that compromise women's wellbeing, safety, and security, such as gender pay gap, unpaid care work, and pregnancy discrimination.

Recognition of the intricate relationship between gender and security, including during conflicts and wars, has been codified in the United Nations Security Council (UNSC) Resolution 1325 on Women Peace and Security (WPS) which was passed in 2000. Since then, another nine related resolutions have been adopted by the UNSC. The WPS agenda acknowledges the disproportionate and unique impacts of conflict and violence on women and girls and aims to prevent violence against women, to improve the participation of women in decision-making related to peace and security, to protect women's security and rights, and to provide access to relief and recovery support to women in need of assistance. The WPS agenda was formulated in the context of conflict and wars—and cybersecurity is not explicitly mentioned in UNSC resolutions that constitute the WPS. Nevertheless, the WPS imperatives are relevant and applicable to security in the digital world, where women continue to face forms of marginalisation that compromise their safety and security.

DIGITAL GENDER DIVIDE

Gender divides, sometimes called gender gaps, are the disparities between different genders in societies. These gaps occur in various societal settings: in education, disparities exist in enrolments across specific programs; in the labour market, gender discrimination manifests with respect to recruitment, wages, career progression, and job responsibility; at home, the gender gap affects family roles and responsibilities; and in politics, leadership roles are generally strongly gendered. These disparities and asymmetries reflect the complex intersection of factors such as social norms, beliefs, cultural worldviews, histories, economics, politics, social structures, and institutions. With global digital transformation, these disparities are manifested in the online world as digital gender divides—the biases, barriers, and constraints that prevent women and girls from adopting and fully realizing the benefits of digital technologies in their lives. The United Nations High Commissioner for Human Rights considers the digital gender divide as "both a consequence and cause of human rights violations" (OHCHR, 2017).

Globally, fewer women (60 percent) than men (70 percent) are using the Internet, there are less females in STEM education pipelines, and fewer women in positions of leadership and influence in the ICT industry (ITU, 2023; Sey & Hafkin, 2019). In general, men have more computer and internet knowledge and experience than women and tend to use these technologies more often. Further, there is evidence of widening gaps and growing inequalities in disadvantaged areas and low-income countries alongside the development of new technologies (ITU, 2023; OECD, 2018). However, the digital gender divide is not only a problem for developing nations; inequalities between genders in accessing and using ICT can also be found in developed countries. The context of a widespread, pervasive digital gender divide provides a helpful backdrop for understanding gendered issues in cybersecurity.

GENDER DIVIDES IN CYBERSECURITY

Gender divides in cybersecurity can be seen as resulting from women's marginalization in security generally in combination with the digital gender divide, both of which represent complex assemblages of women's marginalisation. The cybersecurity gender divide, like the digital gender divide, is manifested in access, skills, and leadership. Along the leadership dimension, globally the highest proportion of women in cybersecurity professions is just 26 percent, within the under-30 cohort. Women have similarly low representation in cybersecurity leadership and decision-making positions. (ISC2, 2023.)

Cybersecurity is traditionally framed in a techno-centric perspective, focusing on the protection of information, computer systems, and networks in the service of business and national security goals. Therefore, many socio-technical cyber threats (such as disinformation, scams, and online abuse) are located outside the scope of cybersecurity, addressed in a separate digital safety and eSafety agenda (Miller et al., 2021). Much as in traditional security approaches, this framing fails to recognise the security of individuals as an inherent part of national and international security. Moreover, it positions designated actors, such as information security professionals

and executives of organisations or governments, as having responsibility for mitigating cybersecurity threats. A more holistic and comprehensive approach to cybersecurity adopts a human-centric perspective, recognizing humans and their rights, as enacted in digital spaces, as the primary referent object in cybersecurity (Strohmayer et al., 2022). The human-centric approach does not diminish the importance of data, network, and systems security, but rather positions them as part of the mix of security imperatives necessary to assure human security (Stuart et al., 2024).

Further, risk assessment approaches fail to take into consideration the differing mechanisms and impacts of cybersecurity threats experienced by different individuals. For example, cybersecurity policies and procedure rarely account for the gendered dynamics around privacy, although research has found that women show more privacy concerns, as well as greater cybersecurity policy compliance, compared to men (Allen & Mack, 1990; Anwar et al., 2017; Herath & Rao, 2009; Ifinedo, 2014; Sambasivan et al., 2018).

Of course, women's cybersecurity experiences are neither homogeneous nor universal. There are intersectional dynamics associated with gender and cybersecurity: women's experiences can vary by age, race, background, and geography, which means that their experiences should be understood with contextuality in mind. Research on age cohorts shows that, while girls express a need for training and information about career opportunities in cybersecurity, early-career women are mainly concerned about being underappreciated and undervalued and mid-career women are concerned about harassment in the industry (Giboney et al., 2023). Regarding geographical differences, Ifinedo (2014) found Canadian females to be more likely to comply with organizational policies than males, whereas in Finland, Vance et al (2012) found no gender differences in employees' intention to comply with organizations' information systems security policies.

Some of the solutions proposed to mainstream gender in cybersecurity include the three-pillar framework: design, defence, and response pillars (Miller et al., 2021). The design pillar recognises that technology design is gendered, and that cybersecurity solutions "inherit the gendered omission, biases and reinforcement of gendered assumptions that are evident in technology design" (Miller et al., 2021, p. 20; Pittman, 2015). The defence pillar recognizes that masculinised notions of security and protection inform the approaches adopted to mitigate cybersecurity risks, potentially allowing certain threats to be ignored or minimised and individuals' experiences to be downplayed or disregarded. The response pillar recognises the gendered dynamics associated with incident response, including the prevalent gendered attitudes of victim-blaming.

For gender sensitivity and mainstreaming in cybersecurity, it is important to adopt analytical frameworks that centre the individual experiences of women and that examine their situations in specific contexts. The capabilities approach has this potential.

THE CAPABILITIES APPROACH

The capabilities approach is a theoretical framework articulated by Amartya Sen that has its roots in critiques of the traditional economic models used to understand poverty and inequality and to measure wellbeing and development (Comim et al., 2008; Robeyns, 2003; Sen, 1979). Sen suggested that normative appraisals of wellbeing and development should instead focus on "the real freedoms that people have for leading a valuable life, that is, on their capabilities to undertake activities … or of enjoying positive states of being" (Robeyns, 2003, p. 61). These two elements—"doing" and "being"—are defined as functionings; the total of achievable potential functionings represent an individual's capabilities. Applied to the cybersecurity domain, individual capabilities might include being safe online, having private online conversations with family, accessing a confidential document securely, and being free from discrimination and harassment (among many others). Capabilities must be achievable; the set of individual capabilities represents their freedom to lead a life that they have reason to value. This notion of "reason to value" is an important element of the capabilities approach because it emphasizes reflexivity, for individuals to scrutinise their own motivations for valuing certain life outcomes. However, it also privileges individuals' agency to uniquely define what matters for them (Robeyns, 2003).

The capabilities approach makes another key observation: individuals with similar access to certain resources may differ in their ability to convert those resources into specific functionings, that is, their personal utilisation function differs. This ability to covert resources into functionings is termed a "conversion factor," which can manifest at the personal, social, or environmental level (Sen, 1999). For example, an individual who has access to password management software but does not have the skills to use it (i.e., personal conversion factor) is unable to convert the affordances of the software (resource) into secure password management practice (functioning). A wife

who is expected to share her phone with her husband due to cultural pressures (i.e., is lacking an element of social conversion factors) is not able to use her phone (resource) to maintain privacy online (functioning) (Sambasivan et al., 2018).

In advocating for a capabilities approach to understanding gender inequality, Sen (1995) makes an observation that inequality represents an injustice that in some contexts is accepted as 'natural' or 'appropriate', with direct impacts on the wellbeing and security of women and girls. Adopting the capabilities approach elevates the importance of the freedom and capabilities of women to pursue the outcomes that they wish and that they have reason to value, which depends on resources available to them as well as their ability to convert those resources into functionings.

This chapter explores women's cybersecurity from a capabilitarian perspective in order to demonstrate the multidimensional barriers that contribute to women's insecurity in both the online and offline worlds. It also highlights the conversion factors (or their absence, known as "unfreedoms") across multiple levels that can contribute to women's cybersecurity, based on a scoping review of the literature at the intersection of gender and cybersecurity, the chapter presents a gender-sensitive cybersecurity risk assessment approach that embeds these key insights derived from the capabilities approach.

METHODOLOGY

SCOPING REVIEW

A scoping review of the literature was undertaken using elements of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews (PRISMA-ScR) to guide the methodology (Tricco et al., 2018). A scoping review is an approach to producing a research evidence synthesis that is commonly used for "reconnaissance" and to summarise research findings, identify research gaps, or make recommendations for future research (Peters et al., 2015; Pollock et al., 2023). Unlike a Systematic Literature Review (SLR) which aims to undertake a comprehensive and in-depth coverage of validated research evidence within a subject area, scoping reviews are broader in their scope and more amenable to inductive inquiries that surface new insights. A scoping review is appropriate for the inquiry in this research, as it aims to undertake a broad exploration of the research on gender and cybersecurity.

The key question addressed in the scoping review, framed through the Population, Concept, and Context (PCC) framework is: "What capabilities and conversion factors are associated with women's cybersecurity?" (See Table 1.)

TABLE 1. FORMULATION OF THE SCOPING REVIEW QUESTION

POPULATION	All women
CONCEPT	Capabilities and conversion factors (as per the Capabilities Approach)
CONTEXT	In cybersecurity (security associated with online and digital worlds)

Note: PCC framework adapted from Pollock et al. (2023).

PRISMA APPROACH

Elements of the PRISMA-ScR guidelines and checklist were adopted in this research to inform the selection of relevant literature as well as the reporting on the research undertaken. Three databases were used for the systematic search of articles: the Web of Science (WoS) by Clarivate; the Studies on Women and Gender Abstracts (SWGA) database by Francis and Taylor; and the Association for Computing Machinery (ACM) Digital Library database. The keyword searches across these databases were framed broadly around gender and cybersecurity, as detailed in Table 2. Across all the databases, the inclusion criteria comprised (English-language) peer-reviewed articles published in journals as well as conference proceedings. Articles were excluded that focused on technology artifacts or interventions in cybersecurity without consideration of the gender dynamics and issues; there was no limitation on the date of publication.

TABLE 2. SEARCH STRATEGY ACROSS DOCUMENT DATABASES

WEB OF SCIENCE (WOS, CLARIVATE)
gender OR wom$n (Title)
AND cyber*security (Topic)

STUDIES ON WOMEN AND GENDER ABSTRACTS DATABASE (SWGA, FRANCIS AND TAYLOR)
(wom?n OR gender)
AND security AND (digital OR cyber)

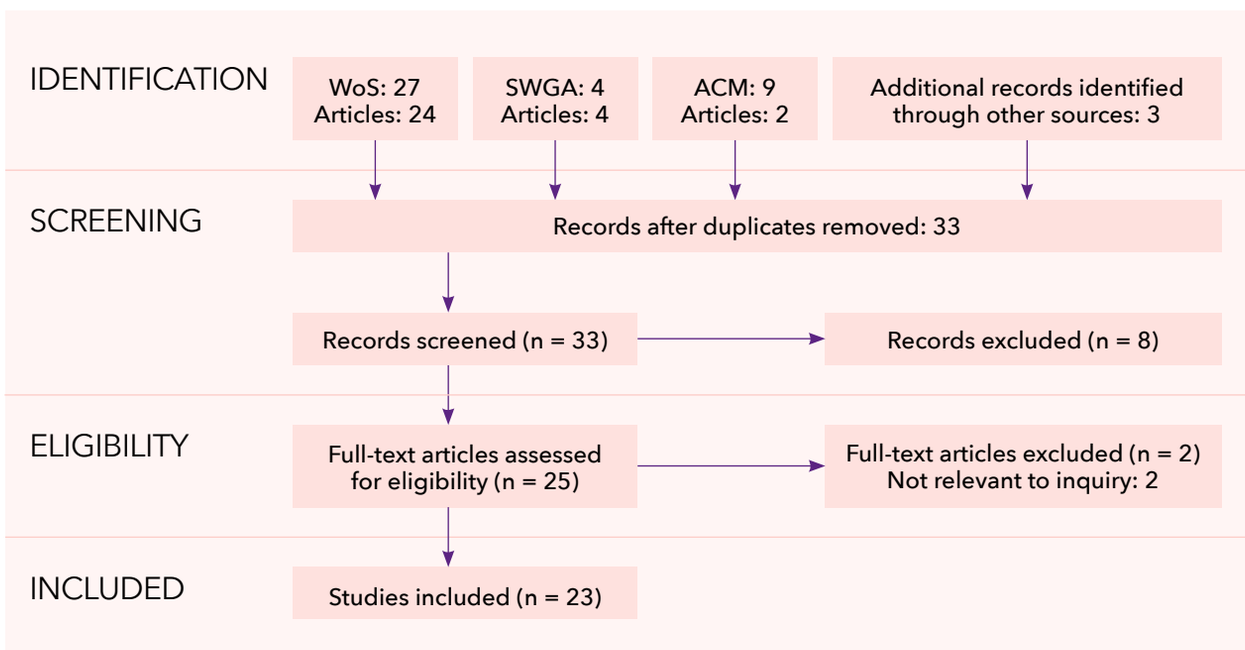
ASSOCIATION FOR COMPUTER MACHINERY DIGITAL LIBRARY (ACM)
[[Title: gender] OR [Title: wom?n]]
AND [[Abstract: cybersecurity]
OR [Abstract: "cyber security"]]

INCLUSION CRITERIA
- Peer-reviewed journal articles and conference proceedings
- Related to cybersecurity

EXCLUSION CRITERIA
- Non-English
- Articles focusing on technology artifacts and interventions in cybersecurity, without discussing gender issues

The preliminary identification of articles from the three databases resulted in 27 documents from WoS, 4 from SWGA, and 9 from the ACM. Three other articles were identified through snowballing and were included in the study (Figure 1). These articles were filtered based on the inclusion criteria (Table 2), resulting in a total of 33 documents that were subsequently screened. The screening process first reviewed the titles and abstracts, followed by eligibility evaluation to determine alignment with the inquiry. Ten articles were excluded, resulting in 23 articles for inclusion in the narrative analysis using the template analysis approach.

FIGURE 1
DOCUMENT IDENTIFICATION STRATEGY BASED ON PRISMA



TEMPLATE ANALYSIS

The 23 selected articles were imported into the NVivo software for subsequent textual analysis using a template analysis approach. Template analysis is a hybrid coding approach that starts with a deductive coding of text based on an a priori list of codes; these codes are revised and refined through inductive coding as the text is analysed (Brooks et al., 2015). For this research, the a priori codes were derived from the four key elements of interest within the capabilities approach: "Capabilities and functionings identified"; "Personal conversion factors"; "Social conversion factors"; and "Environmental conversion factors".

Within the capabilities approach, environmental conversion factors are typically associated with the physical and built environment and the impacts of those factors on individuals' ability to realise desired functionings from a set of resources. A classic example of this shows how geographic remoteness can be an environmental barrier for women to access health services at health facilities. While the physical and built environment do play a role in the cybersecurity of women, in this research the concept of environmental conversion factors has been expanded to include any contextual factors beyond the social that contribute to or hamper women's cybersecurity. This revision is inspired by ecological theories and multi-level models that understand individual's behaviours and situations as influenced by their environment and the broader context, including regulations, policies, and the global cybersecurity climate. This revision allows the research to surface a broader set of dynamics that impact women's conversion factors in cybersecurity.

GENDERED CONVERSION FACTORS AND CYBERSECURITY "UNFREEDOMS"

The focus of the scoping review was to surface conversion factors that have been documented to contribute to women's cybersecurity. Conversion factors help explain the mechanisms through which resources are transformed into desired cybersecurity capabilities; conversely, the deficiency of these conversion factors creates "unfreedoms" that hamper the realisation of cybersecurity capabilities. These factors have been clustered into personal, socio-political, and environmental factors.

PERSONAL

Within the capabilities approach, personal conversion factors are identified as those internal to individuals that they leverage to convert resources into capabilities. The full list of personal conversion factors identified from the analysis can be found in Table 3.

A key personal conversion factor that has been identified as a key predictor of cybersecurity behavioural intention is *self-efficacy*: an individual's belief in their ability to perform a specific activity or task. Self-efficacy is gendered: men are generally found to have higher self-efficacy than women (Ameen et al., 2020). It is not clear if high self-efficacy among men, beyond predicting behavioural intentions, actually translates to secure behaviours (Anwar et al., 2017; Branley-Bell et al., 2022). However, low self-efficacy in women has been found to negatively influence their choice of a career in ICT (Bagchi-Sen et al., 2010).

Another key personal conversion factor that has been documented as both gendered and important for individuals' cybersecurity is perception, specifically as it relates to susceptibility, vulnerability, severity, benefits, barriers, response cost, and risk (Ameen et al., 2020; Anwar et al., 2017; Bagchi-Sen et al., 2010). Many of the theories and frameworks for understanding the cybersecurity behaviours of individuals within organisations—for example, the Health Belief Model (HBM) and the Protection Motivation Theory

(PMT), which have been used in policy compliance studies—are grounded on personal conversion factors linked to elements of *perception* (Anwar et al., 2017). For example, the perception of severe adverse consequences of cyber-attacks to an individual's organization has been found to have a more significant effect on cybersecurity behavioural intention in women than in men (Ameen et al., 2020; Anwar et al., 2017).

In general, there are several gendered personal conversion factors that play an important role in women's cybersecurity behavioural intentions, cybersecurity practices, cybersecurity education, and cybersecurity career choice and progression.

SOCIO-POLITICAL

Socio-political conversion factors emanate from the wider society and include elements of *social norms*, *power relations*, and *societal hierarchies*. Socio-political factors play a large role in the continuing marginalisation of women in offline, online, and cybersecurity domains. Many of the socio-technical threats against women, including forms of online harassment and abuse, in fact leverage the lack of social conversion factors to hamper women's cyber capabilities.

Within the skills and leadership dimension, research has shown how social and *cultural expectations* on women—different from those on men—hamper their participation in cybersecurity workforce (Anwar et al., 2017; Giboney et al., 2023; Kshetri & Chhetri, 2022). Further, more women than men claim *institutional barriers* and *social expectations* as isolating them from ICT education and careers (Bagchi-Sen et al., 2010; Yao & Bertino, 2017). Once launched on a cybersecurity career, women have less opportunities than men to build strong mentorship relationships due to the shortage of mentors and the phenomenon of "old boy networks" (Bagchi-Sen et al., 2010). Many women who end up in cybersecurity find it difficult to conform either to gender stereotypes of what women should do, or to the stereotypes around the cybersecurity professional (Corneliussen, 2021). This is linked to the effect of perceived gender roles in different societal contexts. Other gendered socio-political conversion factors are detailed in Table 3.

ENVIRONMENTAL

While environmental conversion factors are commonly formulated as emerging from the physical or the built environment, in this research they are understood to include broader national and global contextual factors. *Regulatory and legal frameworks* play a critical role in the protection of women's safety and security, especially with regard to privacy protections and recourse against cyber threat actors. Policies, regulations, and laws provide a context that can shape women's access to cybersecurity solutions, education, and career choices (Giboney et al., 2023). Conversely, legal and regulatory factors can also hamper women's cyber capabilities, for example in countries where Women Human Rights Defenders (WHRDs) are silenced and surveilled (Kshetri & Chhetri, 2022; Stuart, 2024).

The personal, socio-political, and environmental factors identified in this research have been mapped across the three dimensions of cybersecurity "use, access, and experience", skills, and leadership (Table 3). The "use, access, and experience" dimension accounts for women's positive and negative engagements in cybersecurity—their use of and access to cybersecurity solutions, and their experience of adverse cybersecurity incidents.

TABLE 3. IDENTIFIED CONVERSION FACTORS MAPPED ACROSS THE USE AND ACCESS, SKILLS, AND LEADERSHIP DIMENSIONS

	PERSONAL CONVERSION FACTORS	SOCIO-POLITICAL CONVERSION FACTORS	ENVIRONMENTAL CONVERSION FACTORS
USE, ACCESS, AND EXPERIENCE	Self-efficacy Perceived susceptibility and vulnerability Perceived severity Perceived benefits Perceived barriers Perceived response cost Risk perception Computer skills Prior experience Level of expertise	Peer-behaviour Social roles Gender socialization Cultural values	Gender laws and policies National cultural values Regulatory and legal frameworks
SKILLS	Level of education Computer skills Information seeking skills	Gender roles Gender identity Gender stereotypes Role of parents Cultural expectations Role models and mentors	
LEADERSHIP	Educational background Personality traits Communication skills Management skills Job experience	Cultural acceptance Role models and mentors Organizational climate Institutional culture and structure Social expectations Educational opportunities Family responsibilities Family obligations Work-family conflict Gender roles "Political landmines" Gender stereotypes Cultural expectations Institutional barriers	

CAPABILITIES-CENTRIC RISK ASSESSMENT

One noted challenge of the capabilities approach, addressed in this section, is that it can be difficult to operationalize (Comim et al., 2008). Cybersecurity is primarily enacted through risk management processes, at individual, organizational, and national levels. Improved cybersecurity outcomes for women will require risk management practices that are designed for the complex dynamics of their cybersecurity landscape. The capabilities approach must be operationalized to develop a capabilities-centric risk assessment and threat modelling approach. Technically, risk assessment and threat modelling are two different processes, relating to the strategic and operational levels respectively. Risk assessment is about identifying potential adverse situations, assessing their likelihood and impact, and putting in place controls to manage the risks. Threat modelling is about identifying specific threats against an entity and putting in place countermeasures to deal with those threats. The approach presented here informs both risk assessment and threat modelling processes.

Several risk assessment and threat modelling approaches are used in cybersecurity. These include:

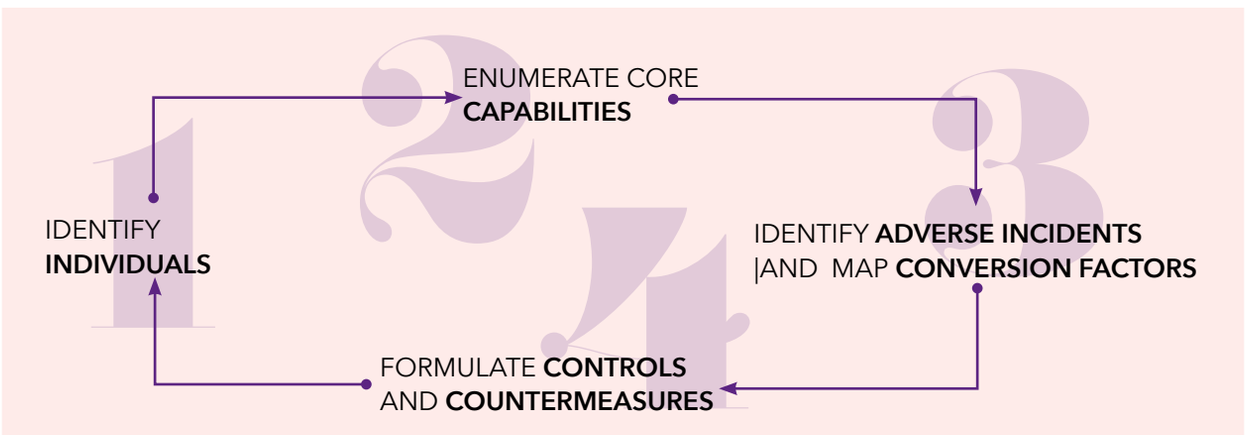
- asset-centric approaches, such as PASTA (Process for Attack Simulation and Threat Analysis), DREAD (Damage potential, Reproducibility, Exploitability, Affected users, and Discoverability) and OCTAVE (Operationally Critical Threat, Asset, and Vulnerability Evaluation)
- adversary-centric approaches, such as attack trees, intrusion kill chains, courses of action matrix, and diamond model
- threat-centric approaches, such as STRIDE (Spoofing, Tampering, Repudiation, Information disclosure, Denial of service, Elevation of privilege) and VAST (Visual, Agile and Simple Threat modelling)

All these approaches tend to be either technology- or organisation-focused. They are therefore very limited for accounting for the nuanced manifestation of cybersecurity risks against individuals in general and against women specifically.

This research proposes a capabilities-centric risk assessment (CCRA) approach comprising four high-level steps (see Figure 2):

1. Identify the individuals who are the subject of the risk assessment and threat modelling.
2. Enumerate the core cyber (security) capabilities that they desire (or "have reason to value").
3. For each cyber capability, identify potential adverse incidents (i.e., risks) that can hamper that capability; map out their interaction with different resources and conversion factors.
4. Formulate controls and countermeasures to mitigate the identified adverse incidents.

FIGURE 2
CAPABILITIES-CENTRIC CYBERSECURITY RISK ASSESSMENT AND THREAT MODELLING: KEY STEPS



Like other risk management processes, this is a continuous and iterative process that must respond to the evolving cybersecurity risk environment by re-evaluating the identified core capabilities, reassessing risks to those capabilities, and revising and reformulating new responses where necessary.

Table 4 illustrates the application of this approach to a specific case study—a project to enhance the cyber resilience and support the digital rights of Women Civil Society Organisations (WCSOs) and Women Human Rights Defenders (WHRDs) in Southeast Asia (Stuart, 2024).

TABLE 4. APPLICATION OF CAPABILITIES-CENTRIC RISK ASSESSMENT AND THREAT MODELLING

STEP	EXAMPLES FROM THE WCSO AND WHRD CASE STUDY
1. IDENTIFY INDIVIDUALS	Women Human Rights Defenders
2. ENUMERATE CORE VALUED CAPABILITIES	Safe, secure, private, and confidential (social media) communication. *"They can share whatever sentiments they have in [social media] community because it's … a private group. So it's easier for them to share whatever they want to share without, you know, any hesitations [or potential repercussions]." (Stuart, 2024, p. 22)* *"But we also use social media to communicate with WHRDs; because of the encrypted message system, we are able to communicate safely." (Stuart, 2024, p. 23)*
3. IDENTIFY ADVERSE INCIDENTS AND MAP ASSOCIATED CONVERSION FACTORS	Adverse incidents • Online harassment and abuse, phishing, spyware. *"Because they were holding an online women's empowerment conference, they experienced that someone, an unauthorized person, entered the event and shared their screen... they ended up cancelling the event on that day." (Stuart, 2024, p. 29)* *"There was a hack on my colleague's Telegram, and that's why I feel a bit insecure for myself as well because I do a lot of communication through Telegram and a lot of sensitive information is out there." (Stuart, 2024, p. 32)* Personal conversion factors • Digital self-efficacy (or lack thereof) • Risk perception • Digital (and cybersecurity) competencies Socio-political conversion factors • Misogyny and restrictive patriarchal operating contexts *"Yes, women and girls are at a greater risk because they are already more vulnerable in the first place." (Stuart, 2024, p. 34)* • Gender stereotypes *"Yes, they are more prone to get attacks because attackers think women are lacking the skills and knowledge to protect their devices." (Stuart, 2024, p. 34)* • Anti-feminist social sentiment Environmental conversion factors • Censorship of Internet content in Southeast Asia • Limited legal protections *"We talked a lot about what we can do about this kind of digital threat because in each country in Southeast Asia, there is no law to protect us from digital threats." (Stuart, 2024, p. 35)*
4. FORMULATE CONTROLS AND COUNTERMEASURES	The identified countermeasures should aim not only to prevent the immediate technical threats, but also to address the broad set of personal, socio-political, and environmental "unfreedoms" that limit WHRDs' desired capabilities.

The capabilities-centric approach, as demonstrated above, allows for risk assessment and threat modelling that focuses on the specific capabilities that individuals desire, within specific situations and contexts. It recognizes that the achievement of those capabilities is hampered by multiple factors operating at different levels, and that while techno-centric solutions (e.g., adopting more secure social media platforms) might address the specific manifestation of the cybersecurity threat, the mediating factors at the personal, socio-political, and environmental levels would remain. Table 4 therefore alludes to a more comprehensive solution that might include digital competency building, advocacy work to challenge the social norms, and strengthening the legal protections afforded to WHRDs.

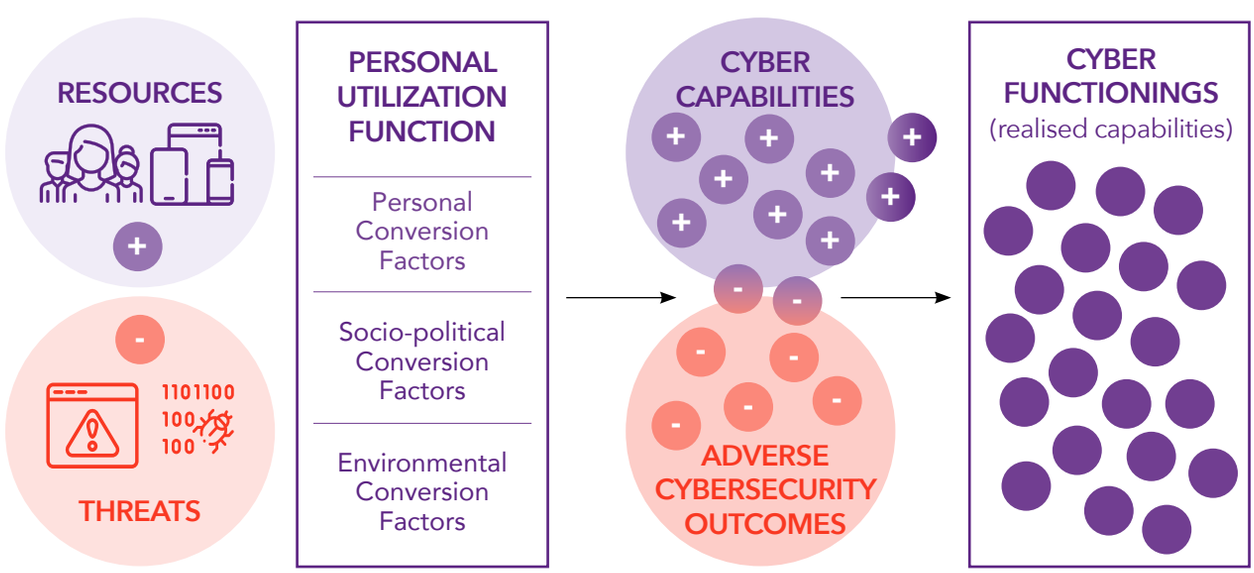
This capabilities-centric approach is meant to augment existing risk management approaches to account for broader risks that affect individuals in complex socio-technical systems. Because of the specific focus on the individual, their freedoms, and their valued outcomes in cyber space, this approach allows for a more human-centric cybersecurity risk assessment that can better account for women's security in both online and offline spaces.

DISCUSSION

At a high level, gender divides and asymmetries in cybersecurity must be understood as a product of gender disparities in security more generally—including in international security discourse—and of gender divides in both offline and online spaces. Women's security has long been sidelined in favour of security for more privileged referent objects (e.g., national security). Similarly, women's marginalization in cybersecurity reflects broader gender disparities in access (i.e., the use of and access to digital technologies), skills (i.e., information and ICT skills), and leadership (i.e., employment in ICT and related fields). Many frameworks, from gender and security, critical security, feminist security, and gender and technology studies, have been used to explicate the dynamics of these gender disparities. However, the application of these frameworks to exploring the gender disparities in cybersecurity is still a nascent area of research.

This research adopted the capabilities approach as framework for understanding gender dynamics in cybersecurity. The capabilities approach has been used extensively as a normative framework for appraisal of individuals' wellbeing and development. It has also been used extensively as an analytical framework to study gender inequalities across diverse domains. Because of the proven analytical benefit of the framework, it is adopted in this research to understanding gender dynamics in cybersecurity. The findings in this research demonstrate that, notwithstanding the techno-centric bias in cybersecurity, the capabilities approach provides a suitable framework for analysing gender asymmetries in cybersecurity and for operationalising human-centric cybersecurity.

FIGURE 3
CAPABILITARIAN FRAMING OF HUMAN-CENTRIC CYBERSECURITY



From a capabilitarian perspective, the goal is to enhance individuals' cybersecurity as well as cyber capabilities, and to enable the achievement of desired outcomes (i.e., their "beings" and "doings", also knowns as "functionings")—towards the kind of digital lives that people "have a reason to value". From this perspective, the combination of resources with specific conversion factors contributes to enhancing cyber capabilities. Similarly, adverse cyber incidents interact with individuals' personal, social, and environmental conversion factors (or lack thereof) to produce "unfreedoms" that reduce their cyber capabilities and lead to adverse cybersecurity outcomes (Figure 3).

This research has shown that the capabilities approach allows for a nuanced mapping of the impact of personal, socio-political, and environmental conversion factors on cybersecurity outcomes for women, whether on access, skills, or leadership dimensions. Further, the research shows that the capabilities approach also provides a framework for informing human-centric and gender-sensitive cybersecurity practice, as illustrated in the proposed capabilities-centric risk assessment approach as applied to the case study of improving cyber resilience for WCSOs and WHRDs.

The capabilitarian perspective, as articulated in this chapter, shows many advantages over traditional techno-centric approaches for understanding human-centric cybersecurity and for explicating cybersecurity gender divides and gender asymmetries in cybersecurity. One of the limitations of this framing, however, is that it inherits some weaknesses inherent in the capabilities approach. As a framework that centres individuals and their capabilities as the locus and unit of analysis, it has been argued that it is difficult to operationalise at the collective level, and specifically that it doesn't effectively account for the interactions between individuals and the broader structural elements within organisations or societies (Comim et al., 2008). The capabilities-centric risk assessment approach proposed in this chapter goes some way toward addressing this limitation and demonstrates how the capabilities approach can be operationalized to inform practice.

This research was not a comprehensive scoping review or a complete exploration of the conversion factors. Within the scoping review, the search strategy only searched for articles with "cyber*security" terms (Table 2), which excluded other related articles that focus on specific aspects of women's online safety and security—for example, focusing on privacy, surveillance, data breaches, or cyber bullying without referring specifically to cybersecurity. This limitation does not compromise the above findings about the suitability of the capabilities approach for understanding the cybersecurity gender divide. A more comprehensive inquiry would no doubt have surfaced additional conversion factors.

CONCLUSION

The United Nations High Commissioner for Human Rights has called the digital gender divide "both a consequence and cause of human rights violations" (OHCHR, 2017). Research shows that women's rights continue to be violated, and their safety and security compromised, in both online and offline spaces at disproportionate levels compared to men. While not explicitly articulated as an element of the WPS agenda, mainstreaming gender and addressing the asymmetries in cybersecurity are critical elements of bridging the cybersecurity gender divide while addressing the disproportionate impacts of cyber insecurity on women. This chapter makes the case that the techno-centric bias in cybersecurity hampers nuanced understanding of cybersecurity gender divides, arguing for a human-centric approach to cybersecurity. It has shown how the capabilities approach can inform the operationalisation of human-centric cybersecurity imperatives, and can inform cybersecurity practice in ways that privilege individuals' freedom to achieve the kind of digital lives they desire, unhampered by adverse cyber incidents or the related "unfreedoms".

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CASE STUDY 4.2

UNDERSTANDING CHARACTERISTICS, EXPERIENCES, AND IMPACTS ON DEEPFAKE VICTIMS THROUGH EXISTING LITERATURE: GENDER AND AGE MATTER

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KEY FINDINGS

- There is a significant gap in the deepfake literature focusing on crime victims, as compared to technical and viewer-focused studies.
- Women are disproportionately targeted by deepfake crimes—especially in deepfake pornography; younger individuals, particularly teenagers, are more likely to be victimized, with younger women facing compounded challenges.
- Deepfake victimization leads to mental distress, social harm (including stalking and reputational damage), and economic impacts including financial blackmail.
- Beyond the spread of fake videos, victims often suffer additional harms such as personal data leaks and humiliation, yet many hesitate to seek help.
- There is a critical need for systematic, institutional support for deepfake victims, rather than relying on individual or ad hoc responses.

"Deepfake" is a term combining the terms "deep learning" and "fake"; it is used to describe techniques that apply deep learning methods to replace one individual's face with someone else's, creating fake photo-realistic images and videos (Rana et al., 2022). The term emerged in 2017 within tech-savvy early adopter communities and has recently gained widespread public attention, becoming an important topic in policy discussions (Rana et al., 2022). This shift is largely due to advancements in AI technology that have made deepfake tools more accessible and easier to use (Flynn et al., 2022), leading to crimes worldwide including gender-based deepfake crimes targeting teenagers (Mackenzie & Marsh, 2024). Discussions about deepfake crime continue to focus on technical aspects, such as the detection of deepfake videos, as well as the viewers of deepfake content and misinformation. Victims, however, do not always receive the same level of attention, especially as victims may be socially vulnerable and face barriers to speak out. Understanding victims' experiences is crucial for informing effective policy.

A scoping review was conducted to investigate deepfake crime victims, focusing on their identities, the impacts they endure, their experiences, and gaps in the existing literature. The research questions examined who the victims are, what impacts they endure, what they experience, and which gaps exist in the current literature. A scoping review was chosen to identify research gaps in relevant studies. Deepfake crime victims can have varied interpretations, as recognized in the conceptual framework developed by Veerasamy & Pieterse (2022), which analyzes deepfake research through five key factors: Technical, Source/Creator, Dissemination, Victim, and Viewers. It is notable that the model analyzes victims' and viewers' experiences as separate categories. Although some research describes viewers as victims (e.g., Caramancion, 2021; Wang & Kim, 2022), the current review strictly defines the subjects of the videos as victims, with the intention of deepening the understanding of the experiences of vulnerable groups.

A literature search was conducted in January 2025 across Scopus, Web of Science, PubMed, and ProQuest, using keywords such as "deepfake," "synthetic media," and "victims." In the second round, the resulting citations were screened for meeting the inclusion criteria. In addition, a search for grey literature was conducted on Google to incorporate relevant empirical reports into the review. Because the initial search returned few results, no constraints were placed on publication date. The review only included studies written in English that focused specifically on victims, excluding those addressing viewers or the technical mechanisms of deepfakes and those examining organizations as victims, to maintain the focus on individual victims—often, from vulnerable social groups. Additionally, only empirical studies or review articles were considered, as the aim was to examine verified evidence on deepfake crime victims.

With the initial search, a total of 354 articles were identified. During screening, however, most studies

were excluded because they focused on other aspects of deepfake research, especially deepfake detection techniques rather than on the victims. After screening, 26 studies (about 7 percent of the initial set) met the inclusion criteria, highlighting the relative scarcity of research on deepfake crime victims compared to other aspects of the phenomenon. These studies were published between 2019 and 2024, indicating that scholarly interest in deepfake victims began around 2019 and has gradually increased since. The included studies were mostly reviews (n = 15, or 57.7 percent), followed by quantitative studies (n = 6, 19.2 percent); the remaining studies used qualitative or mixed methods. Through this review, we identified several perspectives on deepfake crime victims, discussed below.

CHARACTERISTICS OF VICTIMS

Gender emerged as the most frequently mentioned characteristic defining the victims, a fact that highlights the importance of the issue of gender-based deepfake crimes, particularly deepfake pornography. Women were consistently identified as the most targeted group—as not only more frequently victimized, but also as more vulnerable to the societal dangers associated with the spread of deepfake videos (Veljkovic et al., 2024). Research indicates that women are more likely to report fears of becoming targets of deepfake porn (Sippy et al., 2024). In contrast, non-pornographic deepfake videos tend to target men, often with the intent of undermining their reputations and credibility (e.g., Flynn et al., 2022; Umbach et al., 2024). These deepfakes frequently involve public figures, politicians, or business leaders, whose position makes them particularly vulnerable to reputational harm and misinformation campaigns.

Age was also a significant factor, with younger individuals, particularly teenagers, being more vulnerable to deepfake crimes (ESET, 2024; Flynn et al., 2022). This trend likely reflects both their higher levels of online activity and the greater impact such crimes can have on them. When intersecting with gender, younger women proved even more vulnerable, as their testimonies were often considered less credible (Maddocks, 2020). Other characteristics—such as disability and occupation—were noted in some studies (e.g. Flynn et al., 2022; Okolie, 2023), suggesting that individuals in reputation-dependent fields as well as other socially vulnerable groups may suffer greater harm and face more obstacles in recovering from these crimes.

EXPERIENCES OF VICTIMS

The literature revealed that deepfake crimes go beyond creating fake videos. Once deepfake content spreads online, victims often have their personal information leaked, making the crime more personal and thus more debilitating. This process not only involves making the fake videos but also actions that humiliate and exploit the victims further. Many victims are hesitant to speak out about their experiences, because they fear more abuse or because they do not trust the available support (Maddocks, 2020). However, there are cases where victims have gotten help; one victim shared her experience of receiving anonymous online support to track and remove the deepfake videos (Martin, 2022).

IMPACTS FACED BY THE VICTIMS

The most frequently reported impact was mental distress. Victims commonly described experiencing fear, anxiety, emotional distress, and a sense of powerlessness—largely due to the ever-present threat that deepfake content might reappear, given the lack of effective support (Flynn et al., 2022). Social impacts were also significant; for instance, women who become the subjects of deepfake videos may face rape threats, stalking, and unwanted sexual advances, as their images and personal details are disseminated online (Laffier & Rehman, 2023). Such social harm can disrupt the victim's everyday life, including interpersonal relationships and social standing. Economic impacts were also mentioned, particularly in cases where victims encountered financial blackmail linked to the deepfake videos (Al-kfairy et al., 2024). These broader impacts can further put victims' careers and professional reputations at risk.

CONCLUSION

Examining the victims of deepfake crimes, the review finds that women are most often targeted. Despite this vulnerability, there is limited research detailing what women experience as victims and how they respond to these incidents. This gap in knowledge may reflect several factors: underreporting; relatively few documented cases, compared to research on viewers; and the fact that victims often come from vulnerable groups—especially women

and underaged groups—who may not have proper channels to share their experiences. Few studies have addressed intersectionality, leaving unanswered questions about how factors like age, social class, and digital literacy influence both the impact of deepfake crimes and victims' access to support. In many cases, the victims are young and lack the social resources and digital literacy needed to protect themselves, in contrast to women in higher social positions who are better equipped to seek help.

Gaining a deeper understanding of the experiences of deepfake victims—especially women— can provide valuable insights into the support they truly need. Rather than relying on individual or chance-based assistance, as experienced by Martin (2022), support should be provided systematically through institutional channels to reach a broader range of victims. Effective assistance requires a consistent investment of time, resources, and technical expertise, resources that individual victims often cannot secure on their own. For example, the Advocacy Center for Online Sexual Abuse Victims in South Korea offers an image deletion service for deepfake victims (*https://d4u.stop.or.kr/delete_consulting*). Such support should be implemented in other countries and should be reinforced with policies and regulations specifically addressing deepfake victims, to ensure effective and sustainable assistance for all.

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CASE STUDY 4.3

LEVERAGE DIGITAL TECHNOLOGY FOR GENDER-INCLUSIVE PEACEBUILDING IN SOUTHEAST ASIA: A SOCIAL MEDIA ANALYSIS

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KEY FINDINGS

- Civil society organizations (CSOs) used multiple social media platforms to meet various objectives, from awareness raising to calling for participation and action. The study found that a large majority of social media posts were oriented towards increasing awareness of issues related to the Women, Peace and Security Agenda (WPS Agenda). Social media also enabled CSOs to advocate for emerging issues and to address non-traditional security threats, including discord within families, climate change and natural disasters, and women's involvement in terrorism and radicalization.
- Social media is a powerful peacebuilding tool that facilitates information dissemination, communication, advocacy, and engagement by the public and by multiple stakeholders in women's issues. Notably, CSOs creatively used texts and imagery to construct positive images of women, to amplify voices of women, and to highlight that women can play a leadership role in maintaining and promoting peace and security. CSOs also attempted to increase women's participation and stimulate behaviour change through these positive messages.
- Among a variety of themes derived from social media posts, the study found that gender-based violence remained a major threat to promoting gender-inclusive peacebuilding in Southeast Asia. CSOs were also concerned about emerging issues in the digital space, especially meaningful digital participation for women and girls, and promoted supports for online safety in advancing the WPS Agenda. Despite the rich social media content found in this study, the information was presented discontinuously across different platforms. There was little evidence of a systematic communication strategy employed in disseminating information about prevention of violence against women, girls, and marginalized groups.
- While social media serves as a tool for advancing the WPS Agenda, CSOs also raised concerns regarding the negative implications of using social media, particularly the proliferation of disinformation and its impact on gender-based violence.

INTRODUCTION

The Women, Peace and Security Agenda (WPS Agenda) underscores the need to support women's meaningful participation in the maintenance and promotion of peace and security (United Nations Security Council, 2000). The Agenda includes four core pillars, or action plans: protection of women's human rights; promotion of women's peace and security participation; support for women's roles in the prevention of conflict; and gender equality in relief and recovery (Kirby & Shepherd, 2016; True, 2020).

Since the initiation of the WPS Agenda, civil society organizations (CSOs) have played a critical role in advocating for women's rights, preventing conflict and its gendered outcomes, responding to and reducing gender-based violence, empowering women and girls in crisis and conflict recovery, and engaging women in decision making processes (Fournier-Tombs, 2024; Goldberg, 2015; True, 2020). Notably, some CSOs are advancing the WPS Agenda by harnessing digital technologies, particularly social media, to raise awareness, engage in external communications and outreach, and strengthen networked connections (Stuart, 2024).

However, social media can be a double-edged sword for CSOs, advocates, and activists who may be the target of cyber threats as a result of their work. Recent research has found that disinformation, online harassment, phishing, and trolling are commonly reported cyber threats for CSOs in Southeast Asia. Moreover, though CSOs are largely aware of these threats, they are not necessarily able to address or recover from cyberattacks (Stuart, 2024).

This research sought to explore the ways in which social media is being used by CSOs to advance the WPS Agenda in Southeast Asia. This case study aims to shed light on the intersection of social media use, content creation, and gender-inclusive peacebuilding among CSOs in Southeast Asia.

METHODOLOGY

A content analysis of official social media posts by CSOs working with or advocating for women and girls in Southeast Asia was undertaken. A list of 88 CSOs was provided by the UN Women Regional Office for Asia and the Pacific as the sampling frame. For CSOs to be included in the sample, they must have their own social media accounts and regularly post articles about women, peace, and security issues. Following this criterion, 34 CSOs were selected: 10 from Indonesia, 12 from the Philippines, 11 from Thailand, and one from Singapore. The sampling of social media posts for analysis consisted of two stages. Initially, 340 posts were collated, representing approximately 10 posts for each CSO. These posts were predominantly in English. Then, the sample was refined based on three criteria: (1) the post was relevant to the WPS Agenda; (2) the post contained at least one interaction in the form of a repost, a favorite, a comment, or view; and (3) if the post was not in English, the translation (using Google Translate) was comprehensible. The final corpus of data comprised 238 posts across social media platforms: Facebook (n=141), Instagram (n=47), X (n=40), and YouTube (n=10).

Using the MAXQDA software, the main objective of each social media post was classified and each post was assigned a code to describe the major topic of the post.

OBJECTIVES OF SOCIAL MEDIA POSTS

The results of the analysis show that CSOs used social media to meet four main objectives (see Figure 1), with the key differences among these objectives being in the content and narrative style of the post. The majority of social media posts (49 percent) aimed at increasing awareness by highlighting gender-related issues that are often overlooked, such as women's unequal access to social resources and their potential in promoting peace. This was followed by posts (27 percent) aimed at advertising CSOs' activities and events and their outcomes. Other posts (15 percent) used encouraging words, like "come and join", "need your support" to call for participation or concrete actions from relevant stakeholders and the public, through donations, consultations, and other engagements supporting women in promotion of peace and security. A smaller number of social media posts (9 percent) were aimed at sharing a wide range of knowledge about the historic development of UNSCR 1325, gender-based violence, social media risks, etc., containing rich content on various aspects of WPS agenda.

THEMES IN SOCIAL MEDIA POSTS

A variety of themes were identified within the social media posts (see Figure 2). The two themes with the largest number of posts are highlighted in this paper: women's role in peacebuilding (n=79); and prevention of gender-based violence (n=50). Other themes are notable in their content and are listed for reference in Figure 2.

WOMEN AS AGENTS IN PEACEBUILDING

The WPS Agenda affirms the important role of women in conflict prevention and resolution (Chambers et al., 2019). The case study found that 79 (33 percent) of the posts included texts and visual imagery emphasizing that women, regardless of ethnicity, religion, and socioeconomic status, are agents and not passive bystanders or victims in contexts of crisis and conflict. Despite many challenges and constraints, the women depicted and discussed in these posts were optimistic, determined, and engaged. One post profiled a smiling woman who participated in a campaign, saying, "I teach about peace and human rights, especially of women, children and indigenous people." Another showed a female domestic worker in Singapore expressing her resilience in the face of hardship: "I have worked with 10 families. Some are good, but some are the worst. I stood up for myself, faced all the challenges and did not give up." The theme of building gender-inclusive peace was discussed in other posts: "women's duty, not just politicians and world leaders"; "can broaden women's horizons and change women's personality"; and "a journey full of stories of courageous women [who] are fighting."

PREVENTION OF GENDER-BASED VIOLENCE

One of the four pillars of the WPS Agenda emphasizes the prevention of all forms of violence against women and girls in conflict and post-conflict situations (Chambers et al., 2019). In this study, prevention of gender-based violence was represented in 50 (21 percent) of the posts. This result highlights that CSOs were aware of the complexity and interrelationship of gender-based violence and peace-building and responded to this challenge in a holistic manner. One CSO had a dedicated social media campaign predicated on the aim that "a society that is well educated on gender-based violence is the foundation of a peaceful democratic nation." CSOs launched appeals through social media for legal protection for women victims and survivors of gender-based violence, particularly violence originating from economic inequality. While the posts contained rich information and resources on violence reduction, information was dispersed across platforms, possibly leading to fragmentation and limiting the audiences' comprehensive understanding of this issue and potential responses.

DISCUSSION AND CONCLUSION

The results of this analysis indicate that CSOs' use of social media aligns with many aspects of the WPS Agenda, particularly highlighting that women can act as peacebuilders, both through organizations and by using their influence in families and communities. Another concern shared by CSOs through social media is the protection of women's human rights—another core pillar of the WPS Agenda, as discussed by previous studies (Duncanson, 2019; Kirby & Shepherd, 2016; Sam Awng, 2019). The remaining themes in Figure 2 also highlight CSOs' considerations about non-traditional challenges affecting women's participation in peacebuilding, including safety in cyberspace and women's susceptibility to the rising threats of misinformation, disinformation, and harassment. CSOs also underlined the importance of fostering an inclusive digital environment and strengthening meaningful digital participation, referring to the ability to use technology in ways that bring benefits (Sey, 2021). Of note, results also find that social media enabled CSOs to advocate for emerging issues related to the WPS Agenda, including women's participation in issues of climate change and natural disasters, as well as women's involvement in terrorism and radicalization.

Despite some limitations on data accessibility due to language barriers, this study offers a starting point for discussion on leveraging digital technologies to advance the WPS Agenda. It shows that CSOs recognized, and actively utilized, social media as a communicative tool in advancing women's participation in peacebuilding in Southeast Asia by increasing awareness and supporting engagement. Social media was also employed for reducing barriers to gender equality, particularly in preventing gender-based violence, and for amplifying women's voices and leadership roles by building positive images of women and disseminating inspiring messages. It is important to note that social media also enabled CSOs to address emergent, non-traditional challenges to gender-inclusive peacebuilding. As the work of promoting the WPS Agenda extends into digital space, CSOs called for critical thinking about the adverse effects of using digital technologies. Research is recommended to further investigate the benefits and limitations for CSOs using social media to advance the WPS Agenda through different platforms, and especially to deepen the understanding of the intersection of digital technologies, gender equality, and peacebuilding among CSOs.

Building on this study, researchers could expand such studies to other ASEAN countries and other regions, as well as to the use of mobile apps and other AI-powered digital tools in the peace and security field from a gendered perspective. Future research could investigate the characteristics of CSOs and individual women—those who benefit, and those being targeted by social media. To fully unlock the potential of social media in changing mindsets and behaviors, CSOs need to employ strategic communication plans to ensure their messages are delivered efficiently to users, and to generate solutions through a systematic approach. Additionally, this analysis provides policy makers with insights into addressing barriers to gender equality and implementing the WPS Agenda through using social media and building multiple partnerships with civil society.

FIGURE 1

OBJECTIVES OF CSOS USE OF SOCIAL MEDIA FOR GENDER-INCLUSIVE PEACEBUILDING

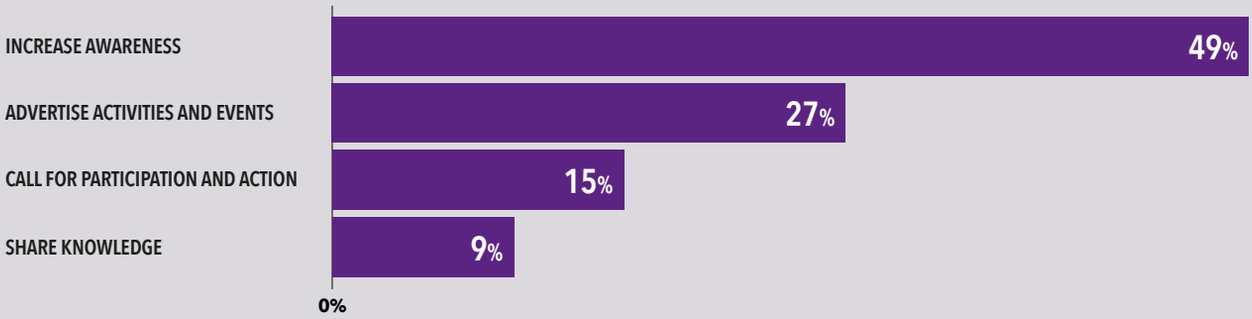
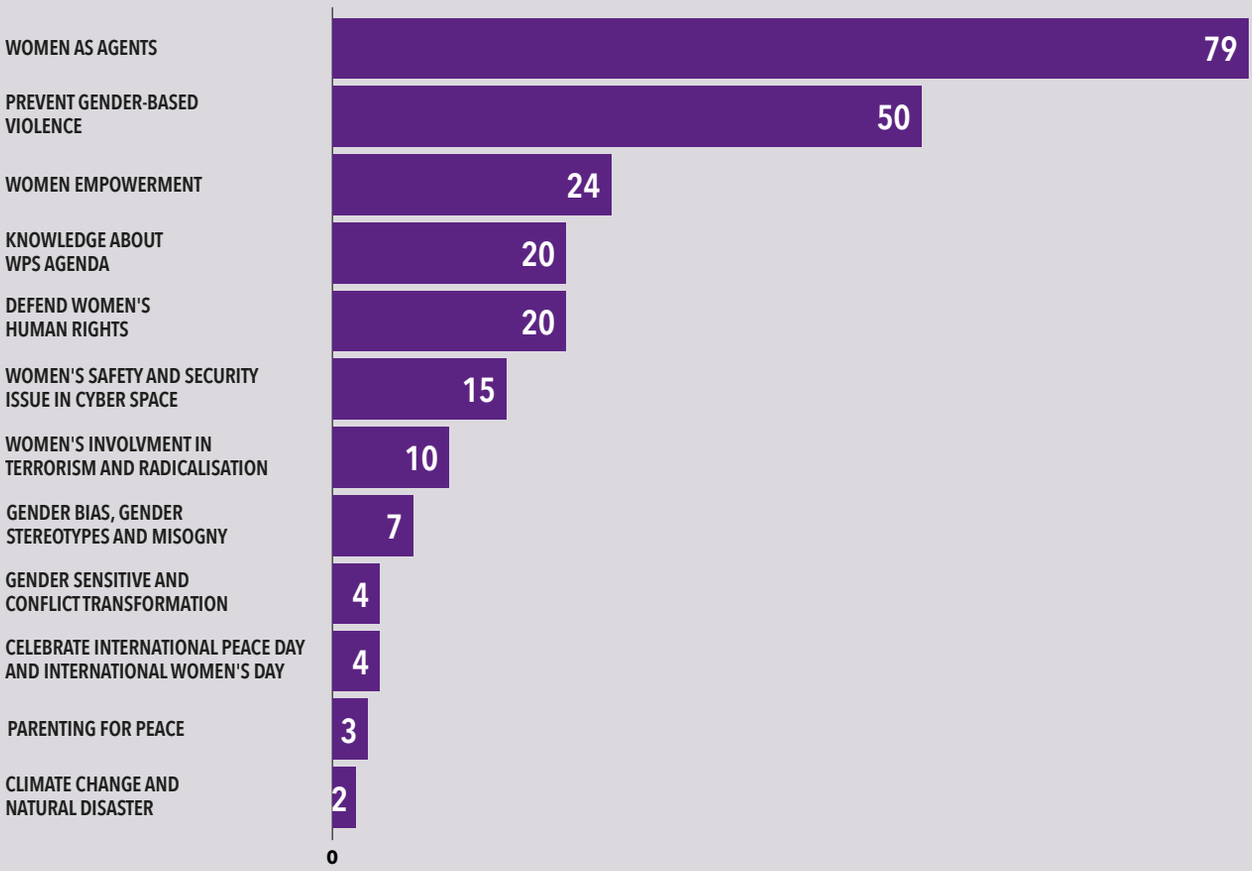


FIGURE 2

THE NUMBER OF SOCIAL MEDIA POSTS UNDER DIFFERENT THEMES



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CASE STUDY 4.4

UNDERSTANDING CYBER-RESILIENCE AMONG WOMEN CIVIL SOCIETY ORGANIZATIONS IN SOUTHEAST ASIA

JAIMEE STUART (UNITED NATIONS UNIVERSITY INSTITUTE MACAU)
MAMELLO THINYANE (UNIVERSITY OF SOUTH AUSTRALIA)

KEY FINDINGS

- Women's civil society organizations (WCSOs) rely on digital technologies to engage in service delivery, advocacy, and activism, but they also tend to experience high levels of cybersecurity risk. A gender-sensitive and human-centered approach to cybersecurity and cyber-resilience can help to address these issues.
- More than half of the participants sampled from WCSOs in Southeast Asia had relevant cyber-resilience procedures in place—including cybersecurity training programs, policies, and incident-reporting mechanisms—positively impacting their overall cyber-resilience. However, less than half of the organizations had dedicated technical support.
- Approximately half of the participants believed that their organization was well prepared to handle cyber threats, could respond effectively to cyber threats, and actively monitored organizational cybersecurity. However, fewer believed that their organization could easily recover from cyber threats.
- The research emphasizes the importance of considering human factors and gender issues in cybersecurity. A relatively large proportion of organizations lack important protective mechanisms against future threats.

INTRODUCTION

Digital technologies and interconnected cyber systems are pervasive across all areas of social and economic life, creating greater disruption and harm from cybersecurity incidents. Internationally, cyberattacks and cybercrime are increasing, alongside developments in cloud computing and Artificial Intelligence. Civil society organizations (CSOs) are at risk in this context, as many do not have basic cybersecurity policies and procedures in places due to limitations of resources and staffing that make it challenging to establish processes and meet compliance obligations (Un et al., 2021). CSOs often struggle with effective digital transformation while defending against cyber threats. Moreover, organizations and individuals who advocate for women and girls or who engage in related activism are particularly at risk, as attractive targets of threat actors due to the nature and content of their work. This research sought to understand the cybersecurity and cyber-resilience of women's civil society organizations (WCSOs) in Southeast Asia, where digital society and economy are rapidly increasing.

HUMAN-CENTRIC AND GENDER SENSITIVE CYBERSECURITY

The term "cybersecurity" broadly means a state in which information and/or computer systems and networks are free from threat, and it includes the specific practices undertaken to ensure security (Cains, 2022). Cybersecurity can include firewalls, antivirus software, software updates, data protection, access control, and incident response policies, as well as having dedicated personnel to monitor and respond to threats and providing digital skills training. The goals of cybersecurity tend to be technocentric: the prevention of adverse cyber events to ensure the confidentiality, integrity, and availability of both technical assets (infrastructure, systems, software and platforms) and information. This technocentric conceptualization in effect positions digital devices and systems as the targets of protection, underemphasizing critical human factors.

Human-centred cybersecurity, in contrast, highlights that, beyond these technical concerns, we must understand the role of psychological and behavioural factors in preventing, responding to, and exacerbating cyber risks (Zimmermann, & Renaud, 2019). Human-centred cybersecurity positions people as the subjects of protection, focusing on safe and secure digital devices as well as systems that support well-being and uphold human rights, especially among those who are vulnerable to harm or exploitation via ICTs (Comninos & Seneque, 2014; Diebert, 2018). Women and girls are a key group that can benefit

from human-centered cybersecurity, given that gender influences access to and use of digital technologies as well as the exposure to cyber risks and resultant harms.

Gender dynamics in cyberspace tend to perpetuate existing power relationships and inequalities, reinforcing or amplifying social and political structures (Brown, & Pytlak, 2020; Millar et al., 2021). For example, women and girls are disproportionately targeted online by hate speech, sexualised abuse, non-consensual distribution of images, and deepfakes (Dunn et al., 2023). Moreover, gender disparities in technology access, digital competencies, and digital self-efficacy make it harder for women to protect themselves from cyber threats (Branley-Bell et al., 2022). Actors who speak out against injustice or promote equality for women are also increasingly at risk: research shows that cyber-attacks have been systematically deployed to discredit and silence women, particularly those in public positions such as politicians, journalists, and human rights defenders (Posetti, 2021). A gender-sensitive, human-centred approach to cybersecurity is essential in recognition of the fact that humans—human rights, safety, and wellbeing—are impacted by cyber threats, and that women and girls are at particular risk in this context. Such an approach contrasts with normative "techno-centric" conceptualizations that view cybersecurity as neutral in terms of targets and that focus narrowly on adverse impacts on systems and technologies.

WCSOS AND CYBERSECURITY

WCSOs are particularly susceptible to cyber threats due to the sensitive nature of their work and the confidential information they manage, and because they may lack the resources and expertise to protect against them. In Southeast Asia (as in many other regions), WCSOs have been subjected to online harassment, threats of violence, doxxing, hate speech, and cyber-attacks (e.g., ransomware, data breaches, and malware), reducing advocates' ability to speak out on critical human rights issues (Al Hussein, 2018; UN Women, 2021). Furthermore, online surveillance has been used to monitor, silence, or intimidate civil society leaders, resulting in their self-censorship and disengagement (DigitalReach, 2023).

To address this issue, the research project on which this case study is based explored the overall cybersecurity ecosystem of WCSOs in Southeast Asia from a gender-sensitive and human-centered perspective, examining digital resources as well as cyber threats, cyber vulnerabilities, and the harms they cause (see Stuart, 2024). Here, we build on that research by examining WCSO's cyber-resilience, defined as their ability to prevent, respond to, and mitigate cyber threats (Björck et al., 2015). Examples of cyber-resilience strategies include: implementing monitoring and improvement processes and policies; developing incident response plans; resourcing technical support; and fostering cultures of cybersecurity awareness. Developing cyber-resilience means that, despite the experience of cyber incidents, these need not have long-term negative effects and may even have positive long-term effects (i.e., improving the ability to manage future events). Protective measures that are undertaken within the preparation phase, before the onset of adverse incidents, facilitate better handling of and recovery from threats. Therefore, this research focused on the preparedness of WCSOs to address cyber threats as an indicator of cyber-resilience.

METHODS

An anonymous online survey was distributed via email to participants identified through a stakeholder review of CSOs in Southeast Asia as well as snowball sampling supported by UN Women. A total of 57 participants who completed the survey were identified as currently employed in a WCSO: either the organization had a specific mandate to address issues for women or girls, or women and girls were a key client of the organization. The demographic characteristics of participants are outlined in Table 1; additional details on methodology are presented in Stuart (2024). While this case study focuses on data from WCSOs (a sub-sample), the full research analyses data from a broad range of CSOs; however, the methods of collection and instrumentation remain the same.

This case study analyses two questions contained in the survey. First, were participants aware of organizational cybersecurity procedures ("yes," "no," or "don't know"). Second, did they believe their organization: was prepared for cyber threats; actively monitored cybersecurity; was responsive; and could easily recover in the face of cyber threats (1= strongly disagree; 5 = strongly agree).

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF WCSOS

	DEMOGRAPHIC CHARACTERISTIC	FREQUENCY	PERCENTAGE
COUNTRY	CAMBODIA	16	28.1
	LAO PDR	3	5.3
	MYANMAR	8	14.0
	PHILIPPINES	18	31.6
	THAILAND	9	15.8
	VIETNAM	3	5.3
GENDER	FEMALE	32	56.1
	MALE	18	31.6
	OTHER/ NOT DISCLOSED	7	12.3
PRIMARY ACTIVITIES OF WCSO (MULTI-RESPONSE OPTION)	ADVOCACY	41	71.9
	CAPACITY BUILDING	47	82.5
	RESEARCH	25	43.9
	SERVICE DELIVERY	28	49.1
	SOCIAL ACTIVITIES	39	68.4
	OTHER	12	21.1
CAREER LEVEL	EXECUTIVE	39	68.4
	SENIOR	6	10.5
	MID-LEVEL	9	15.8
	JUNIOR	3	5.3

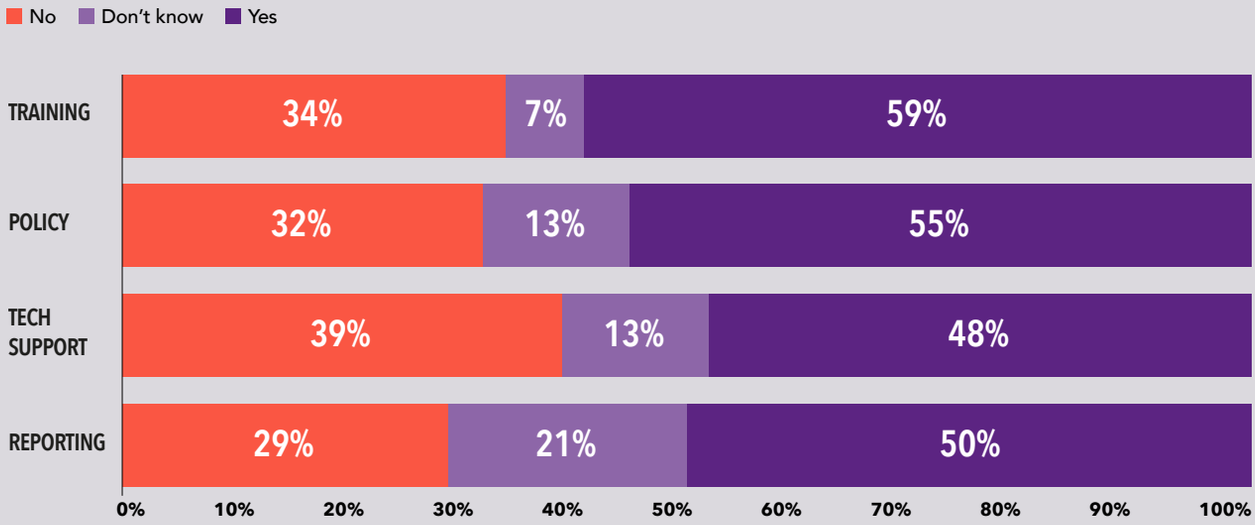
N=57

RESULTS

More than half of the participants reported having cybersecurity procedures in place in their organization, such as cybersecurity training programs, policies, and incident reporting. However, less than half had dedicated technical support (Figure 1). The majority had two or more of these procedures (57 percent). Another 16 percent reported only one, and 27 percent reported none (Figure 2).

FIGURE 1

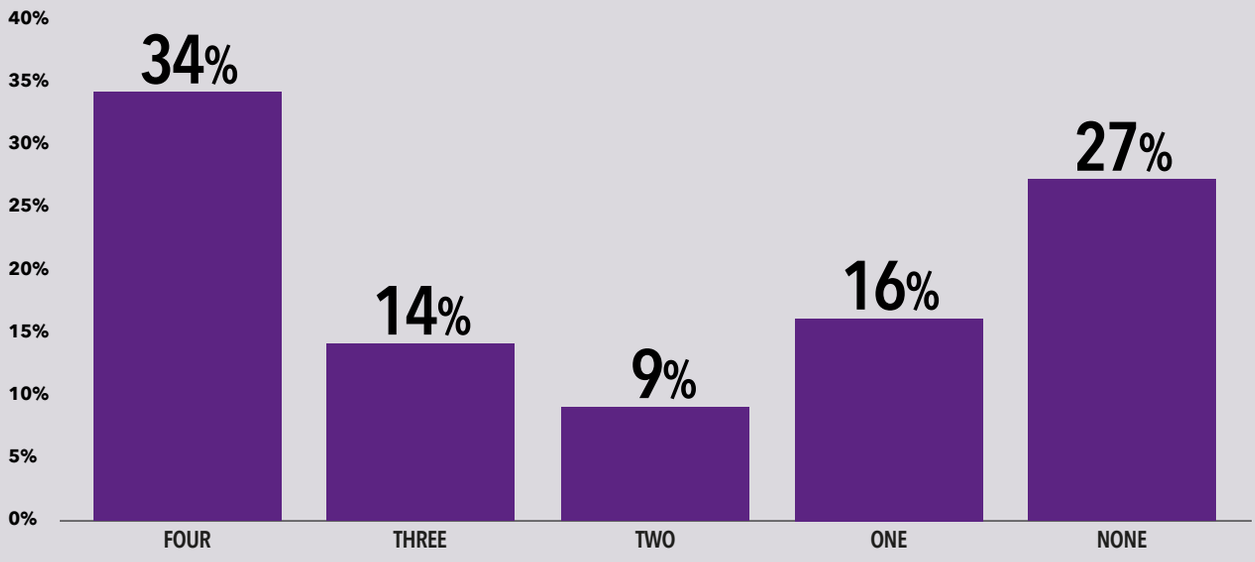
ORGANIZATIONS WITH CYBERSECURITY PROCEDURES IN PLACE



Note: Based on self-reporting by organization representatives.

FIGURE 2

NUMBER OF ORGANISATIONAL CYBERSECURITY PROCEDURES



Note: Based on self-reporting by organization representatives.

Half of participants agreed or strongly agreed that their organization was "well prepared" to meet cyber threats. Similar proportions agreed that their organization could respond immediately (52 percent) and actively monitored cybersecurity (50 percent); a smaller group (44 percent) agreed that their organization could easily recover from cyber threats (Figure 3). The average rating of cyber-resilience was computed from these four questions (M = 3.18, SD = 1.16), and the correlation between number of organizational procedures was calculated. A strong, positive correlation was identified (r= .63, p<. 01)

FIGURE 3

PERCEIVED LEVELS OF ORGANISATIONAL CYBER-RESILIENCE

Note: Based on self-reporting by organization representatives.

CONCLUSIONS AND RECOMMENDATIONS

In the context of normative cybersecurity, risk management practices tend to overlook human factors and disregard gender issues, effectively missing many opportunities for protection and empowerment. This research found that over half of the WCSOs in the sample had organizational procedures supporting cybersecurity in place. The greater the number of these mechanisms, the higher the level of cyber-resilience. Training and policies (i.e., passive protections) were more common than incident-reporting mechanisms or dedicated technical support (i.e., active protections). Notably, while each of the procedures form an important element of a resilient cyber-ecosystem, active protections are essential for meeting novel threats in a context of rapid technological advancement. It is positive that many organizations surveyed had passive protections, but over a quarter of them had none of these procedures. One-third disagreed with the statement that their organization exhibited cyber-resilience at any stage of response.

These results highlight that, while many WCSOs exhibit elements of cyber-resilience, a large proportion are at risk. These organizations critically need resources for technical support, reporting, and effective incident response processes, especially for those organizations that have few protective mechanisms in place. Cybersecurity experts maintain that organizations are only as secure as their weakest links, as these will be exploited. Hence, the general recommendation is that all WCSOs need to improve their maturity across the range of cybersecurity functions to reduce the likelihood of harms.

Recently, observers have urged organizations to intentionally apply a gender lens at each phase of the design, implementation, and utilisation of cybersecurity systems (Millar et al., 2021; Strohmayer et al., 2022). We adopted that perspective by investigating the experiences of WCSOs with a gender-sensitive human-centred approach. As suggested by Stuart et al. (2024), human-centric approaches "reorient and supplement, not supplant, technical cybersecurity efforts," by centralizing the agency and freedoms of users. Digital transformation has created a context in which technology is central to work and life—meaning that cybersecurity is everyone's responsibility. It is important to empower individuals, especially women and girls and their advocates, to take an active role in creating safe and secure digital environments.

This case study highlights the strengths, gaps, and needs for cyber-resilience among WCSOs in Southeast Asia. While the research is limited in scope, considering the small sample size, it can offer some key insights for future research and practice.

- WCSOs should be supported to implement cyber-resilience-oriented procedures and to become

empowered in proactively preparing, monitoring, responding to, and learning from cyber incidents.

- WCSOs should be supported to improve their maturity across the different cybersecurity functions, including identification, detection, prevention, recovery, and response.
- Human-centred and gender-sensitive approaches should be adopted in cybersecurity policies and practice.

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CASE STUDY 4.5

IMPROVING GENDER SENSITIVITY IN AI POLICY IN SOUTHEAST ASIA

ALEX HÖGBACK (INTERNATIONAL TELECOMMUNICATION UNION)

KEY FINDINGS

We provide four policy recommendations for countries in Southeast Asia for improving gender-sensitivity in AI policy making.

1. Establish national task forces charged with assessing the impact of AI systems — in particular, high-risk systems — on women and vulnerable groups in society.
2. Create guidelines and modules on AI and gender to be incorporated into national and regional AI frameworks.
3. Develop gender-sensitive technical standards on AI that inform all parts of the AI lifecycle.
4. Invest resources to accelerate the inclusion of women in AI development and policy making.

Artificial intelligence (AI) is permeating contemporary society, affecting people's lives in myriad ways. The benefits of AI are well documented, including increased efficiency, automated processes, improved services and products, and innovation that affect a variety of fields such as health care, education, transportation, agriculture, and public and social services. In Southeast Asia, AI is expected to add up to $1 trillion in GDP growth by 2030 (Chua & Dobberstein, 2020).[1] However, AI also carries important risks, including potentially discriminating against individuals and groups, reinforcing or exacerbating existing stereotypes and inequalities, and violating fundamental human rights like the right to privacy. Women are particularly affected. Studies have shown that AI systems — in particular, generative AI systems — can contribute to gender-based violence, can discriminate against female job seekers, can reinforce harmful gender stereotypes, and can penalize women loan applicants, among other harms (see, e.g., UNESCO, 2023, 2024).

Regulation can be an effective way to mitigate these risks. Thus, in 2021, the International Telecommunication Union (ITU) — the United Nations specialized agency for information and communication technology (ICT) — launched a project called "Enhancing the Development of Standards and Frameworks for Critical Technologies in Southeast Asia" (ITU, 2021). The aim of the project was to support the development of AI standards, policies, frameworks, and initiatives that mainstream gender equality and social inclusion in four countries – Indonesia, Malaysia, Thailand, and the Philippines – and to ensure that AI was responsibly and inclusively developed and deployed in the region. The project, which was managed by ITU's Regional Office for Asia and the Pacific, ran until the end of 2024 and was financed by the Australian Department of Foreign Affairs and Trade (DFAT).

The project was designed to build the capacity of policymakers, regulators, and other stakeholders in the project countries. A series of workshops, seminars, webinars, and other events were carried out in the four countries to build these stakeholders' understanding of AI, and specifically of the impact AI can have on women and marginalized groups in society and the need to develop socially inclusive AI policies to ensure that AI is being used in a safe and secure way and does not negatively affect women. In addition, a network of women AI policy makers was also created to link women and allies in the project countries for an exchange of ideas and experiences across borders. ITU also provided technical assistance to the project countries and worked with the United Nations Educational, Scientific, and Cultural Organization (UNESCO) to assess the project countries' readiness to implement ethical AI standards, in line with UNESCO's Recommendation on the Ethics of Artificial Intelligence (UNESCO, 2021).

As part of the project's capacity-building efforts, ITU produced, in collaboration with the United Nations University Institute in Macau, a research report titled "Gender-Sensitive AI Policy in Southeast Asia" (United Nations University Institute in Macau, 2023). The report, published in January 2023, applies a gender lens to analyse the AI policy environment in the four project countries, provides practical examples of how AI is being applied, and develops a

1 Dollar figures are USD.

number of recommendations to inform gender-sensitive AI policy making. In discussing the policy environment, the report notes that while gender is mentioned in the AI road maps and strategies in place in the four countries, it is done so only in passing and is not explored in depth as a risk factor in AI systems. Similarly, while those road maps and strategies emphasize fairness and inclusiveness, they do not specify which target groups might already be marginalized or discriminated against.

The report provides four sets of recommendations for improving gender-sensitivity in AI policy in Southeast Asia. First, it recommends the establishment of committees or task forces charged with leading gender and societal impact assessments of AI systems, to ensure that specific risks are identified in each country and mitigated. This would apply in particular to high-risk use cases of AI such as biometric identification, employment, policing, and access to essential services. Second, the report recommends the creation of gender and AI guidelines, either ensuring that gender and social inclusion are incorporated into upcoming ethical AI guidelines or developing a gender module to accompany existing AI guidelines. Third, the report proposes the development of gender-sensitive technical standards for all parts of the AI life cycle, as well as risk mitigation techniques including gender impact assessments, gender disaggregated datasets, system access analyses, and post-deployment monitoring. Fourth, the study recommends continued investments in efforts to accelerate the participation of women in various stages of AI and AI policy development.

Important progress was made in the four project countries prior to the project's conclusion in December 2024. However, much work remains in the Asia-Pacific region to ensure that women and marginalized groups in society can benefit from advances in AI technology and do not suffer from AI-enabled discrimination and harm. ITU's Regional Office for Asia and the Pacific is therefore exploring new project countries as well as potential partners for a second phase of the project, which would continue to provide support to policymakers and regulators, including capacity-building programs, to develop gender-sensitive and socially inclusive AI policies, standards, and frameworks.

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