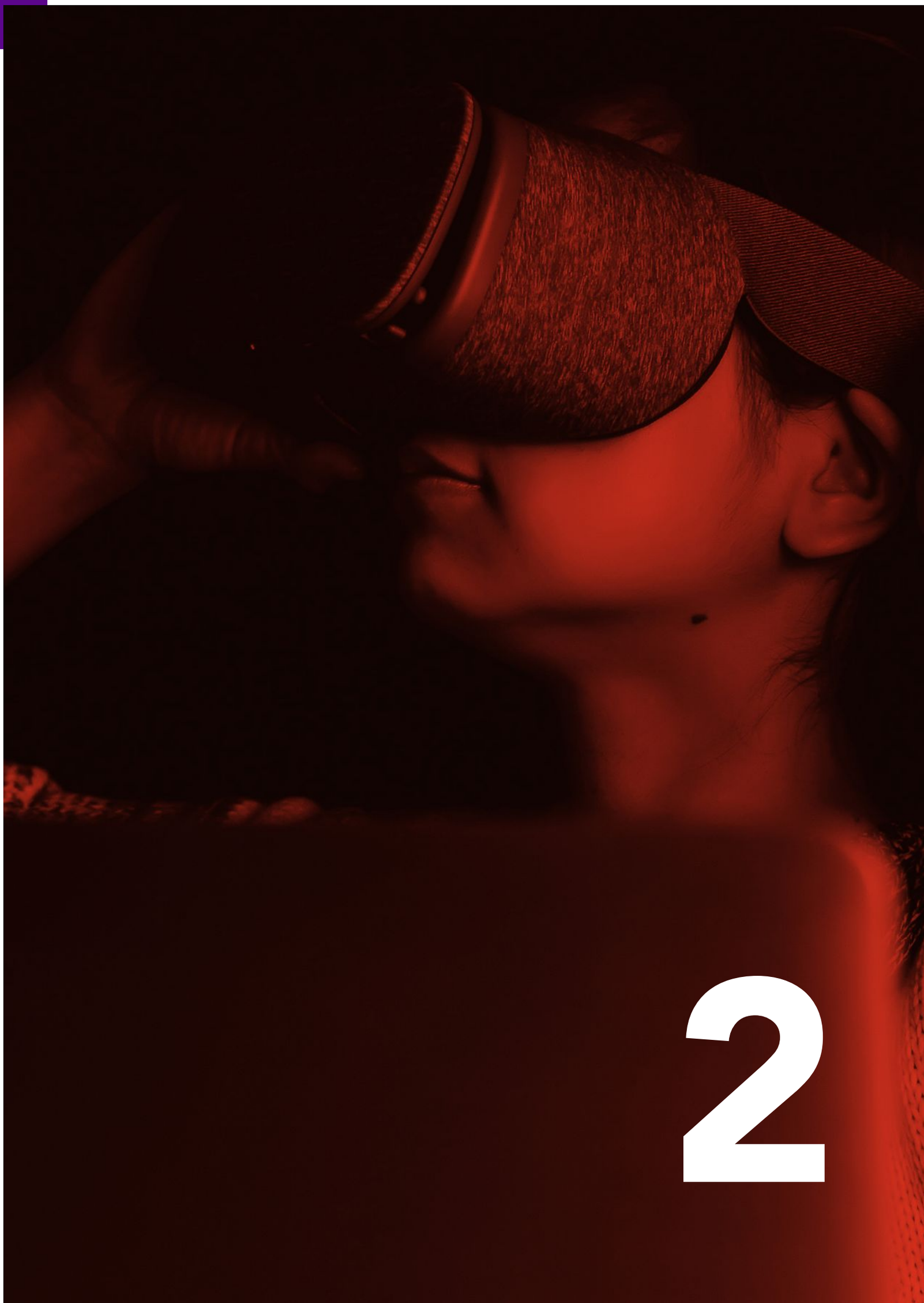

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PART TWO
CASE STUDIES

INTRODUCTION

Part Two deals thematically with three key elements in achieving goals of the EQUALS partnership: People, Skills and Pathways.

People. The emphasis on people first underlines the importance of viewing technology in its social context. Technology does not exist in a vacuum but is embedded in society: technology has social impact, and it functions in social contexts and is shaped by social factors. The People section examines how technology impacts society through inclusion or exclusion of people in various groups — on the basis of gender (in all its varieties), age, disability, and geographical location. The papers in this section cover a range of factors: gender variance in relation to technology; North vs. South differences in the gender digital gap; the participation and use of technology by female children, youth and women with disabilities; and the potential for women's empowerment in rural areas through access to ICTs.

Skills. The skills needed for full participation in technology are wide and varied. To secure privacy and security in modern society, women need at least basic digital and security skills. At a higher level, women need to be involved in designing systems and tools for privacy and security that address their situation and needs. Papers in this section focus on key questions. Are educational institutions doing the job in closing STEM education gaps? Are differential skill levels and cognitive abilities responsible for the gender wage gap in technology? And whether all jobs in the technology industry enhance technology skills and provide advancement possibilities for women, as illustrated in the case of call centre employment.

Pathways. EQUALS is dedicated to achieving global gender equality in the processes and benefits of technology, especially in information and communication technologies and STEM. What are the ways to achieve this result? What courses of action are needed? This section examines some of the paths that have been suggested towards gender equality in technology, asking whether their promises have been fulfilled and what remains to be done to achieve them. The authors examine the empowerment of women in the technology work force, the participation of women in knowledge and technology transfer, and the prognosis for gender equality in the rapidly expanding field of Artificial Intelligence.

PEOPLE

1

GENDER VARIANCE AND THE GENDER DIGITAL DIVIDE

AUTHORS:
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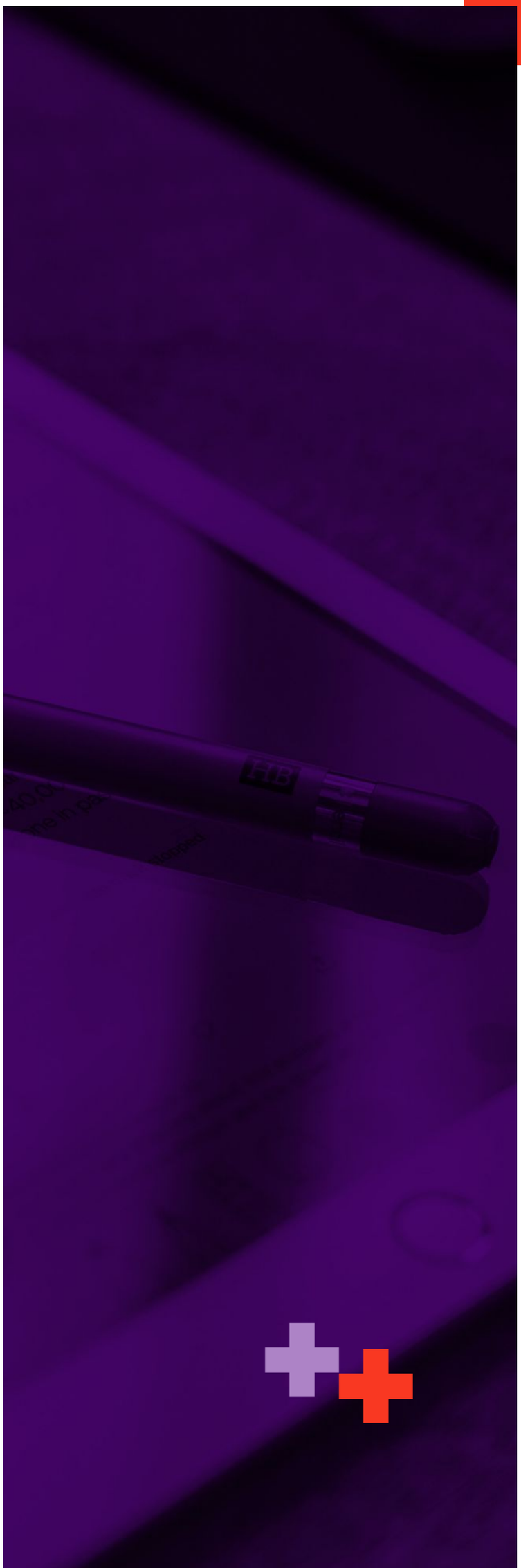

ABSTRACT

Gender is a broad and fluid social construct that is not limited to the conventional male/female dichotomy that commonly informs gender analysis in ICT. Despite two decades of lesbian, gay, bisexual, transgender, queer, and intersex (LGBTQI) scholarship that has shown how gender and sexuality are lived along a wide spectrum — with great variation across regions, age groups, times, spiritual traditions, and cultural practices — the framing of gender and ICT overwhelmingly focuses on women, understood in binary terms. Hence, data is scant on access, inclusion, and innovation of gender and sexual minorities in the ICT sector. Despite the lack of accurate data, gender and sexual minorities innovatively employ computer language coding, gaming, social media, and mobile apps as empowerment tools, using them to raise awareness about discrimination and violence and to build social and political communities. But the spread of ICTs also raises concerns of safety for gender and sexual minorities, who face harassment and violence via technology-based surveillance tactics. Because of the extreme discrimination, violence, and surveillance they face, gender and sexual minorities have a unique set of needs for ensuring their success in employment in the ICT sector, including issues of healthcare, equitable work spaces, safety, visibility, and mentorship. This chapter reviews the intersection between gender and sexual minorities and ICTs, examining the opportunities for access and use and assessing the pitfalls involved. It ends with suggestions for further research and programming to promote gender and sexual equality in ICT.

KEY FINDINGS

- Policy and research on gender and ICT generally focus on women understood as a binary category: male/female, excluding consideration of transgender people, gender identity, and sexual preference. Consequently, most approaches to women and ICT do not capture the relationship of gender and sexual minorities to ICTs.
- The spread of internet access and social media permit gender and sexual minorities authentically to express their gender within their communities, without the stress of medically and/or socially transitioning or pressures of "coming out". Smart phones and mobile apps facilitate fast, affordable, and culturally relevant dissemination of crucial services such as eHealth interventions to gender and sexual minorities.
- Recent moves by the largest social media platforms allowing users to customise their gender have made social media more accessible to gender and sexual minorities. However, social media platforms still sell to advertisers user information that is coded along binary gender categories.
- Technology-driven surveillance and cyberbullying of gender and sexual minorities is increasing. These tactics are now common occurrences worldwide, leading to workplace discrimination, physical attacks, blackmail, arrest, detention, torture, sexual assault, and murder of gender and sexual minorities.

INTRODUCTION

Scholars of gender and technology have extensively examined the gender digital divide, highlighting the marginalisation of women and girls in the tech field and the potential of ICTs to empower them (Buskens & Webb, 2014; Hafkin & Huyer, 2006; Lopes & Bailur, 2018; Sørensen, Faulkner, & Room, 2011; Treinen & Van der Elstraeten, 2018). Overwhelmingly, these studies of the gender digital divide conceptualise gender as binary system of biological "male" and "female" sexes and further assume a division between masculinity and femininity that neatly aligns with maleness and femaleness (Landström, 2007). However, over the last two decades, lesbian, gay, bisexual, transgender, queer, and intersex (LGBTQI)[24] scholars and activists have demonstrated the flaws of gender binarism, showing that gender and sex themselves are social constructs (Butler, 2011; Carrera, DePalma, & Lameiras, 2012; Currah & Spade, 2007; Halberstam, 1998; Rubin, 2011). They have also shown that, far from a coherent identity category, gender is complex confluence of an individual's self-perception of their gender, the perception of their gender by others, their own expression and presentation of their gender, and the designation of gender at birth by the medical establishment (Fausto-Sterling, 2000; Halberstam, 1998; Stryker, 2008)[25]. Moreover, both gender and sexuality also intersect with other identity categories, such as race and class, and they vary across spiritual traditions, cultural practices, and historical periods (Anzaldúa, 2012; Connell, 2014; Driskill, Chris, Brian, & Scott, 2011; Najmabadi, 2005; Snorton, 2017; Vanita

24 *Several terms — lesbian, gay, bisexual, transgender, Queer, Intersex (LGBTQI); lesbian, gay, bisexual, transgender (LGBT); lesbian, gay, bisexual, transgender, queer (LGBTQ); genderqueer; queer; and gender and sexual minorities — are often used interchangeably, although there are complex histories and theories behind each of these designations. For a full discussion of these political histories see Stryker (2008 and 2017) and Halberstam (2018).*

25 *For instance, for cisgender individuals, gender self-perception aligns with the gender assigned at birth, whereas for transgender individuals, gender self-perception may not align with the gender identity imposed at birth. Similarly, intersex individuals may be born exhibiting both male and female or atypical biological traits, but they are often coerced — by doctors, parents, and social expectations — to live as either male or female. Gender non-conforming people and those questioning their gender are similarly often forced to adopt a gender identity that does not reflect their understanding of themselves as gendered/non-gendered beings (Fausto-Sterling, 2000; Halberstam, 1998, 2018; Stryker, 2008).*

& Kidwai, 2001). Clearly, the characterisation of the gender digital divide along binary frameworks of male/female neglects the complex ways that gender and ICTs intersect.

ICTs are a double-edged sword for gender and sexual minorities. On the one hand, ICTs can empower LGBTQI populations by enabling them "to collectivise and organise to counter stigma, discrimination and violence" (UNDP, 2016). Carmen Stitt further notes the power of computer games that feature gender-fluid characters: they can "more than allow the avatar to transform the flesh" by permitting "people to escape the restriction of the bodies", even if such an escape is much harder in "real life" (Stitt, 2012). But the dominance of a gender-binary discourse in gender and technology studies can also lead to what Catharina Landström calls "technological determinism" (Landström, 2007), i.e., the presumption that the gendered subject is the "determining factor in the gender/technology relationship" (Landström, 2007). Rather than examining how gender and technology are co-constituted, technological determinism naturalises both gender binarism and "heteronormativity" — the view that "institutionalised heterosexuality constitutes the standard for legitimate and expected social and sexual relations" (Landström, 2007, p. 11). Indeed, common assumptions that technology is the domain of masculinity and men, and that "women relate to technology in a way that reflects heteronormative femininity," reinforce heteronormativity as a conceptual framework (Landström, 2007, p. 12).

Drawing on the cited works, this chapter examines gender and sexual minorities as a missing dimension of the gender digital divide. Unfortunately, the binary nature of most gender and ICT data makes this examination exploratory: there is an urgent need for data collection to enable further research on this topic. The paper begins with an overview of emerging legal frameworks for the protection of gender and sexual rights, including recent policies in the United Nations, and it reviews the ongoing discrimination against sexual and gender minorities despite increased public visibility of LGBTQI issues. The paper spotlights discrimination that hampers access to ICTs, including workplace and education discrimination and technology-driven harassment. It also discusses the potential of ICTs (such as gaming and virtual reality, social media, and mobile technologies) to advance the rights of LGBTQI people. It ends with a discussion of the need for reliable data covering a broader gender spectrum and presents research and policy recommendations for the promotion of gender and sexual equality in ICT.

EMERGING LEGAL FRAMEWORKS FOR GENDER AND SEXUAL RIGHTS

Recent activism by gender and sexual minorities has led to important changes in the public policy realm, including at the United Nations, where some of its agencies have initiated positive actions on behalf of gender and sexual minorities. The most important initiative was the 2016 resolution by the Office of the United Nations High Commissioner for Human Rights (OHCHR) denouncing "violence and discrimination based on sexual orientation, and gender identity" and appointing an independent expert on discrimination and violence against sexual and gender minorities (United Nations General Assembly[26], 2016). The OHCHR's online Free and Equal Campaign, raising awareness about human rights violations affecting the LGBTI community, has to-date generated 2.3 billion social media feeds[27]. Many United Nations agencies have also called for an end to requiring transgender people to undergo surgery and sterilisation against their will (National Center for Transgender Equality, 2014). UN Women, along with OutRight International, has similarly advocated for the inclusion of LGBTQI voices at all levels of programmatic intervention to end gender-based violence (Mlambo-Ngcuka, 2017). Regional organisations in Africa, the Americas and Europe — including the African Commission on Human and Peoples' Rights, the Organization of American States, the Inter-American Commission on Human Rights, the European Union, the European Parliament, and the European Court of Human Rights — have also passed measures affirming the rights of gender and sexual minorities (Office of the United Nations High Commissioner for Human Rights, 2015, p. 4).

Despite the growing visibility of LGBTQI issues and the emergence of legal protections, discrimination and violence against LGBTQI is rampant around the world (Carroll & Ramón, 2017). While the 2016 United Nations resolution is the most comprehensive United Nations stance on the human rights of gender and sexual minorities, it still faced objection from eighteen countries[28]. Seventy-two countries currently criminalise same-sex relationships. The movement to secure acknowledgement and enforcement of the human rights of gender and sexual minorities is, therefore, a prerequisite for their access of and full participation in ICTs. There have been some efforts on this topic

26 *United Nations General Assembly. Resolution adopted by the Human Rights Council on 30 June 2016. Human Rights Council Thirty-second Session Agenda item 3.*
http://www.un.org/en/ga/search/view_doc.asp?symbol=A/HRC/RES/32/2

27 *Free and Equal Campaign. www.unfe.org.*

28 *Free and Equal Campaign can be viewed at www.unfe.org.*

among the major United Nations organisations dealing with ICT. For instance, in 2015, the International Labor Organization (ILO) released a study of workplace protection for gender and sexual minorities in Brazil (ILO, 2015). In 2016, the International Telecommunication Union (ITU) together with UN Women established EQUALS: The Global Partnership for Gender Equality in the Digital Age, a global network of corporate leaders, governments, non-profit organisations, communities and individuals committed to ending the gender digital divide. (This report is a result of that partnership.) While these are promising trends, there is more work to be done by agencies such as the ILO, ITU, and the United Nations Conference on Trade and Development (UNCTAD), to begin or to expand their analysis of the gender spectrum in ICT.

GENDER AND SEXUAL DISCRIMINATION: THE LEAKY EDUCATION–WORKPLACE PIPELINE

While data is scarce on workplace discrimination against gender and sexual minorities in ICTs, general patterns of extensive workplace discrimination can reasonably be expected to hold in the ICT sector as well. For instance, the United States Commission on Civil Rights found that "discrimination against LGBT employees affects all occupations" (United States Commission on Civil Rights, November 2017). A seven-country study on wage discrimination against sexual minorities found that gay men earn 11% less than their heterosexual counterparts (Klawitter, 2015). A 2013 Europe Union survey found one in five LGBTQ individuals reporting discrimination, as did one in three transgender individuals (European Union Agency for Fundamental Rights, 2013). Similar trends are observed in the U.S. (James et al., 2016) and Brazil (International Labor Organization, 2015). In 2017, the U.S. retracted protection from workplace discrimination that had been afforded to transgender people under the Civil Rights Act (Horwitz & Hsu, 2017).

These patterns of workplace discrimination have been documented on the ground as well. The NYC Technology Salon hosted a workshop in 2015 on discrimination against gender and sexual minorities in the field of Information and Communication Technology for Development (ICT4D), bringing together employees in the ICT4D field from around the world. Participants reported frequent discrimination including cyberbullying, workplace hostility, and harassment by colleagues, including monitoring their personal social media accounts, spreading rumors and creating a hostile work and living environment (Raftree, 2015). Such vigilantism prevents LGBTQI workers from safely building communities against threats of physical violence and aggressive policing. Violations were especially intense in parts of the world with rampant legal and cultural discrimination against LGBT people and where hostile governments control the internet.

Employment discrimination is closely related to education discrimination. In many regions of the world, transgender students are pushed out of school by harassment and discriminatory dress codes (UNDP et al., 2016). For instance, the 2015 U.S. Transgender Survey found that 77% of surveyed individuals who were out or perceived as transgender in their school-age years had left a school as a result of abuse, including verbal harassment, restriction on dressing according to their gender identity, harsher discipline and physical/sexual assault (James et al., 2016). In college or vocational school, 24% of people who were out or perceived as transgender also reported verbal, physical, or sexual harassment (James et al., 2016). Nor do advanced degrees guarantee fair treatment: in South Africa, transgender women with advanced degrees reported working in positions far below their qualifications, due to workplace discrimination on the basis of gender identity (UNDP et al., 2016). A United Nations Educational, Scientific and Cultural Organization (UNESCO) survey of students in Thailand found that more than half of LGBTQI respondents had been bullied in the previous month, and more than 30% had experienced physical abuse; similar statistics are reported in other countries (Office of the United Nations High Commissioner for Human Rights, 2015). The implication for the ICT sector is clear. There is a "leaky pipeline" for gender and sexual minorities who are forced to drop out of school, limiting their access to work in this and other professional fields. In short, "legal gender recognition [is] a precursor to gainful employment" (Office of the United Nations High Commissioner for Human Rights, 2015, p. 42). It is imperative for states, ICT sector policy makers, employers and educators to prioritise the rights of gender and sexual minorities to fair and equal education and employment.

THE RISE OF CYBER THREATS AGAINST GENDER AND SEXUAL MINORITIES

With the rise of the internet, smart phones, and social media, technology-enhanced threats against LGBTQI people have become commonplace (Clunaigh, 2013). Anti-LGBTQI groups, individuals, and states use technology-based surveillance tactics to identify people online in order to prosecute them, harm them offline, and exclude them from political and social life. Common tactics include doxing, phishing (via software such as Trojan spyware and Fin Spy software), metadata mining, and requesting users' personal profile information from host sites or internet services (Clunaigh, 2013). Social media platforms such as

Facebook, Twitter and Skype have been transformed into tools for exposing the identities, networks, and location of non-conforming individuals to enable physical attacks, blackmail, arrest, torture, and sexual assault (Clunaigh, 2013, p. 125). Individual harassers — as well as repressive governments — also deploy these platforms as "honeypots," the illicit practice of luring gender and sexual minorities for a supposed liaison and then exposing, extorting, and attacking them (Clunaigh, 2013). Most infamously, in the early 2000s, the Egyptian government cracked down on LGBTQI communities by luring them on dating sites (Clunaigh, 2013, p. 127).

While hostile parties use technology-enabled violations against sexual and gender minorities, LGBTQI activists deploy ICTs to combat cyber threats. Activist groups such as Tactical Technology Collective (Tactical Tech) and FrontLine Defenders have responded to the growing cybersecurity threats to LGBTQI communities by providing training to human rights workers on digital safety[29]. They teach strategies such as removing work-related collaborations from social media sites and deleting metadata from files (especially photographs, which can include GPS location information). These groups also provide popular security training manuals in various languages.

ICTs are also used by human rights activists to document the range and extent of non-digital human rights violations around the world. Between 2008 and 2014, the Transgender Europe and the Trans Murder Monitoring Project recorded 1612 murders of gender-variant/transgender people in 62 countries (Transgender Europe, n.d.). Transgender people also face much higher rates of intimate partner violence than other groups (UNDP et al., 2016). Open-source software programmes such as Martus and OpenEvsys allow LGBTQI groups to securely record and report violations in real time. Martus has been used in Uganda to document 78 cases of human-rights violations against transgender people; it has also helped individuals who face risk of computer confiscation by police[30]. OpenEvsys has been useful for the Transgender Europe project's efforts to track transphobia[31]. Another possible ICT tool recommended by UNDP for adoption by gender and sexual minorities is Ushahidi, an open-source programme compatible with smart phone that is used by women's rights activists to generate Crowdmap, a digital map that allows users to record and share threats and attacks in real time[32]. As UNDP notes, programmes like Martus and OpenEvsys do not require sophisticated technical know-how, making them ideal tools for community organisations (UNDP et al., 2016).

29 *See the website for Frontline Defenders at https://www.frontlinedefenders.org/en/programme/digital-protection.*

30 *Martus can be accessed at martus.org.*

31 *Transgender Europe. tgeu.org/wp-content/uploads/2013/11/Monitoring_ Transphobic_Incidents_final.pdf; www.huridocs.org/openevsys/*

32 *More on ushahidi can be found at www.ushahidi.com*

SEARCH ENGINE ALGORITHMS AND ARTIFICIAL INTELLIGENCE (AI): NEW FRONTIERS OF DISCRIMINATION?

In Algorithms of Oppression, Safiya Umoja Noble analyses the relationship between search engine algorithms, artificial intelligence and the proliferation of sexism and racism on the internet. Noble conducts extensive analysis of the racialised and sexualised algorithms that search engines use; she notes that "on the internet and in our everyday uses of technology, discrimination is also embedded in computer code, and increasingly, in artificial intelligence technologies that we are reliant on, by choice or not" (UNDP et al., 2016, p. 1). Her analysis of Google's search engine results reveals an array of sexist and racist images of people of color, which "reflects a corporate logic of either willful neglect or a profit imperative that makes money from racism and sexism" (UNDP et al., 2016, p. 5).

Although Noble's work does not directly address gender and sexual minorities, it raises important questions about how gender and sexual minorities can be victims of the poorly understood intersection of digital algorithms and big data. As noted earlier, gender and sexual minorities face widespread technology-driven discrimination and violence (Raftree, 2015). And, as discussed in the next section, there is growing evidence that even when social media platforms allow user customisation of gender, they may violate users' preferences by selling user data to marketers that impose gender-binary categories (Bivens & Haimson, 2016).

ICTS AS EMPOWERMENT TOOLS FOR GENDER AND SEXUAL MINORITIES

MOBILE TECHNOLOGIES

Mobile technologies, while they can be used to exploit and harass women, are also noted for their potential for empowering women (Women's World Wide Web, n.d.). However, most of the literature and data on mobile devices overlooks the broader gender spectrum. Nonetheless, there are indications that mobile technologies allow gender and sexual minorities to create some relatively safe spaces, to advocate for rights and to receive important health information and services. The LGBT Technology Institute in New York City provides free cell phones and cell phone plans to homeless youth (Williams, 2016). A study in Los Angeles finds that, in addition to

connecting youth with case managers and/or social workers, these devices serve as a "relatively cheap resource which can enable youth to pursue higher level resources, such as housing and employment" (Rice, Lee, & Taitt, 2011). Homelessness is especially high among transgender youth, affecting 30% of respondents in the 2015 U.S. Transgender Survey; efforts to expand access of mobile devices for gender and sexual minorities can be life-changing or even life-saving.

Mobile technologies are also useful in the health care industry, helping facilitate fast, widespread, affordable and culturally relevant dissemination of eHealth interventions (Fleming, Hill, & Burns, 2017). For instance, cell phone apps such as TODAY! have been used by mental health workers to aid gender and sexual minorities manage depression and anxiety, by putting them in quick contact with counselors and mentors (Fleming et al., 2017). Mobile phone apps have been useful for HIV/AIDs care provision to the LGBTQI populations, a population especially vulnerable to HIV/AIDS infection (Baral et al., 2013). Some health care providers in Indonesia have adopted iMonitor+, a UNAIDS-supported mobile phone app that allows any community to find HIV care and services, report HIV medication stockouts and report incidents of health care discrimination. They report receiving real-time alerts via this app faster than with other tools used in the past[33]. Mobile health apps have also been used in outreach efforts to men who have sex with other men (MSM) about HIV/AIDS information and care (Macapagal, Coventry, Puckett, Phillips, & Mustanski, 2016), and they have been effective in reaching MSM who are members of other minority groups and who are often neglected in HIV/AIDS care provision (Mitchell et al., 2017).

While e-health interventions are promising, as UNDP points out, health information on the web for gender minorities remains scarce, and (when available) is mostly in English (UNDP et al., 2016). Moreover, in many parts of the world, low literacy presents a barrier for gender minorities' use of ICTs for health services and information (UNDP et al., 2016), reflecting the far-reaching impact of gender/sexual discrimination in education and highlighting the need for a multi-pronged anti-discrimination strategy.

COMPUTER GAMES AND VIRTUAL REALITY

The internet in particular has emerged as a "preliminary, complementary, and/or alternative" site of gender transition, community development, and empowerment of these marginalised populations (Marciano, 2014). The world of internet games and virtual reality (VR) have been especially instrumental for gender non-conforming individuals (including transgender, gender non-binary, and questioning), allowing them to express different gender identities without pressure to transition medically and/or socially (Costello, 2014). In the 1990s, role-playing games (RPGs) provided new spaces for gender non-conforming people to experiment with and authentically represent their gender expression (Costello, 2014; Cross, 2012; Griffiths, Arcelus, & Bouman, 2016; Turkle, 1997). Text-based applications particularly enable anonymity and neutrality, by eliminating vocal pitch, appearance, and other indicators of users' genders (Turkle, 1997). These include multi-user dungeons/domains (MUDs), a multiplayer real-time virtual world that integrates role-playing games, interactive fiction, online chat and so on; and Internet Relay Chats (IRCs), a chatting system that uses rules and conventions and client/server software. Graphics-based RPGs also allow more tangible trans and non-binary expression, especially for individuals who may not be able to physically transition or who are reluctant to transition out of fear of harassment, discrimination, and/or violence (Turkle, 1997). Popular games such as Second Life or Sim World offer millions of players the option to choose a gender avatar that differs from their assigned and/or lived gender and to explore new embodiments. It is important to note that many virtual worlds still construct gender as binary, limiting users' choices to "male" and "female" avatars. However, as scholar and gamer Katherine Angel Cross notes, RPGs such as World of Warcraft allow for "creative resistance" and self-transformation within a framework that was never intended by the game developers to accommodate such modes of expression (Cross, 2012). Indeed, after developers introduced gender-neutral pronouns in computer programming codes to avoid sexist language, LGBQI users quickly adopted the alternative pronoun sets of IRCs and MUDs and popularised them across servers (Danet, 1998).

SOCIAL MEDIA

Recent moves by the largest social media platforms to expand their gender marker options have opened up unprecedented opportunity for gender minorities. Facebook, Google+ and Pinterest now allow users to customise their gender or choose from a wide range of gender identifications. Facebook's user registration interface now has over 50 gender identification options. Twitter and LinkedIn do not mandate new users to supply information about their gender, and many other platforms now also give users control over their preferred pronouns. These design decisions increase access and inclusion for non-binary users, and they may also be instrumental in expanding general awareness of the broader gender spectrum, potentially beyond the digital world and into the physical.

While social media companies' foray into a wider gender spectrum opens new prospects for self-determination of gender and sexual minorities, these companies also perpetuate gender binaries by selling gender data — and doing so in ill-considered

33 *To learn more, see live.imonitorplus.org.*

ways. Social media platforms that have broadened gender concepts in certain platforms (such as the public-facing profile pages and news feeds) are shown to revert to a binary system in other spaces, such as advertiser sign-up pages, without users' awareness (Bivens & Haimson, 2016). Hence, the millions of users who joined social media platforms before gender customisation options were available still inhabit the original gender-binary categories, because marketers frequently tailor advertisement along gender binary lines, which may violate users' sense of themselves (Bivens & Haimson, 2016). For instance, Twitter and LinkedIn allow their advertising partners to algorithmically extract users' gender-based information (Bivens & Haimson, 2016, p. 7), while Facebook forces users to make public personal information, such as legal name, profile picture, and gender. Such requirements may make it more difficult for people to freely, creatively, and comfortably express their gender. Hence, while it is important to note the potential such social media practices hold to accelerate social and political change, it is equally important to underscore "the capacity for software to misgender users under the surface" (Bivens & Haimson, 2016, p. 5) and to safeguard against such possibilities.

THE NEED FOR DATA ON ICT AND GENDER AND SEXUAL MINORITIES

Gathering data about gender and sexual minorities matters because good data demonstrates the existence of gender and sexual minorities, which many repressive governments and cultural groups deny (Williams Institute, 2014); helps destigmatise gender and sexual minorities; documents their experiences and characteristics; and informs policy and programmes (Brown, Herman, & Park, 2017). UNDP points out that data also helps attract donors to support LGBTQI rights and needs, such as HIV/AIDs-related care (UNDP et al., 2016). Various models for gathering culturally relevant data on gender and sexual minorities are beginning to emerge. While there are ethical issues involved in these data gathering efforts, these models could serve as a template for the ICT sector, which lacks actionable data.

The two-step approach is the most recommended available tool for assessing gender identity. This approach asks respondents about both their assigned sex at birth and their self-perceived gender identity at the time of the survey. The single-step approach only records transgender/cisgender status and does not record assigned sex at birth or current gender identity (UNDP et al., 2016). Some government survey tools disaggregate a range of related data: self-identification (i.e., how someone identifies their sexual orientation); sexual behaviour; sexual attraction (the gender of individuals to whom one feels attracted); gender assignment at birth; gender identity at the time of data collection; and preferred pronoun choice. A number of countries have begun disaggregating gender identity data, including Nepal, whose census data questionnaire includes three gender categories: male, female, and third gender (UNDP & the Williams Institute, 2014). Germany, Bangladesh, Pakistan, and India also recognise third gender in official documents, such as census, passports, and birth certificates (Statistics New Zealand, 2014). The Australian Bureau of Statistics (ABS) and New Zealand's government are also developing gender identity data collection standards that improve accessibility, interpretability, and comparability of data (Statistics New Zealand, 2014). In the U.S., numerous federal surveys now gather sex and gender-inclusive data (GenIUSS Group, 2014).

The rise of data gathering on gender identity and sexual orientation does raise conceptual and safety issues. The counting, classifying, and surveillance of gender and sexual minorities can be a double-edged sword; traditionally, data generated on this community by observers not connected to LGBTQI movements and communities has led to "results that undermine claims for transgender rights" (Currah & Spade, 2007, p. 2). Data collection tools also need to reflect accurately local and regional gender and sexuality terminology. For instance, in parts of the Middle East, transgenderism is more widely understood than homosexuality, while in parts of Africa, Latin America, North America and Europe, homosexuality — even if outlawed or ostracised — is a term in wider circulation than transgenderism (Currah & Spade, 2007). As UNDP notes, "programmes run by trans people are often more successful in reaching trans communities and meeting their needs" (Currah & Spade, 2007, p. 6). Furthermore, good data depends on the safety of informants, and gender and sexual minorities living under duress may hesitate to partake in a data collection process (UNDP et al., 2016, p. 53). Hence, useful data and protected human rights are contingent on one another.

RECOMMENDATIONS FOR PRACTITIONERS AND POLICY MAKERS

It is imperative that states, ICT sector policy makers, employers, and educators give high priority to the protection of the rights of gender and sexual minorities and their full participation in this sector. To this effect, UN Women, EQUALS, and their partners should consider the following recommendations.

- To end violence and discrimination based on sexual orientation and gender identity, integrate

gender and sexual minorities in the framing of the global gender digital divide, and promote the resulting framework via high-profile campaigns tailored for the ICT sector.

- To ensure that the gender concepts in ICT do not mischaracterise people's self-understanding of their gender or reinforce discrimination, encourage ICT-related institutions and agencies to include gender and sexual minorities in the shaping of gender equality frameworks at all levels.
- To end technology-driven security threats, raise awareness of the threats experienced by gender and sexual minorities communities throughout the ICT sector — with employers, healthcare providers, educational institutions, and human rights activists, among others. This effort could include: integrating digital security practices into the ICT environment of specific communities at risk; supporting capacity building of groups combating cyber threats in LGBTQI communities; providing cyber safety training manuals in various languages and geared toward technology users with varying literacy levels; and encouraging social media providers to adopt cybersecurity measures to prevent their technologies being used to perpetrate crimes.
- To decrease workplace discrimination, train key ICT sector employers about the complexity of gender concepts. Encourage them to implement preferred gender pronoun use in the workplace, provide adequate health care (including gender-affirming surgery and mental health care), ensure the availability of non-discriminatory facilities, and adopt cybersecurity measures that protect the rights of LGBTQI workers.
- To expand the wellbeing of gender and sexual minorities via mobile technologies, mobile phone operators (and their associations, such as GSMA) should reach out to serve the LGBTQI community and protect their privacy.

RECOMMENDATIONS FOR RESEARCHERS

- To undertake research that provides insight into the complex interrelationship of gender and ICT, encourage the collection of disaggregated gender data by ICT-related agencies and by national and international statistical offices.
- To minimise harmful data collection and interpretation, as well as to develop culturally accurate data, include members of gender and sexual minority communities at all levels of data collection; consult best practices guidelines on data collection developed by LGBTQI groups.
- To expand under-served gender and sexual minorities' access and use of ICTs, such as internet and mobile apps, address the unique needs of those individuals who are also members of other under-represented groups.
- To protect gender and sexual minorities as ICT users, undertake an assessment of the dangers posed by ICTs at the state, private sector and community levels and propose measures to tackle the challenges.

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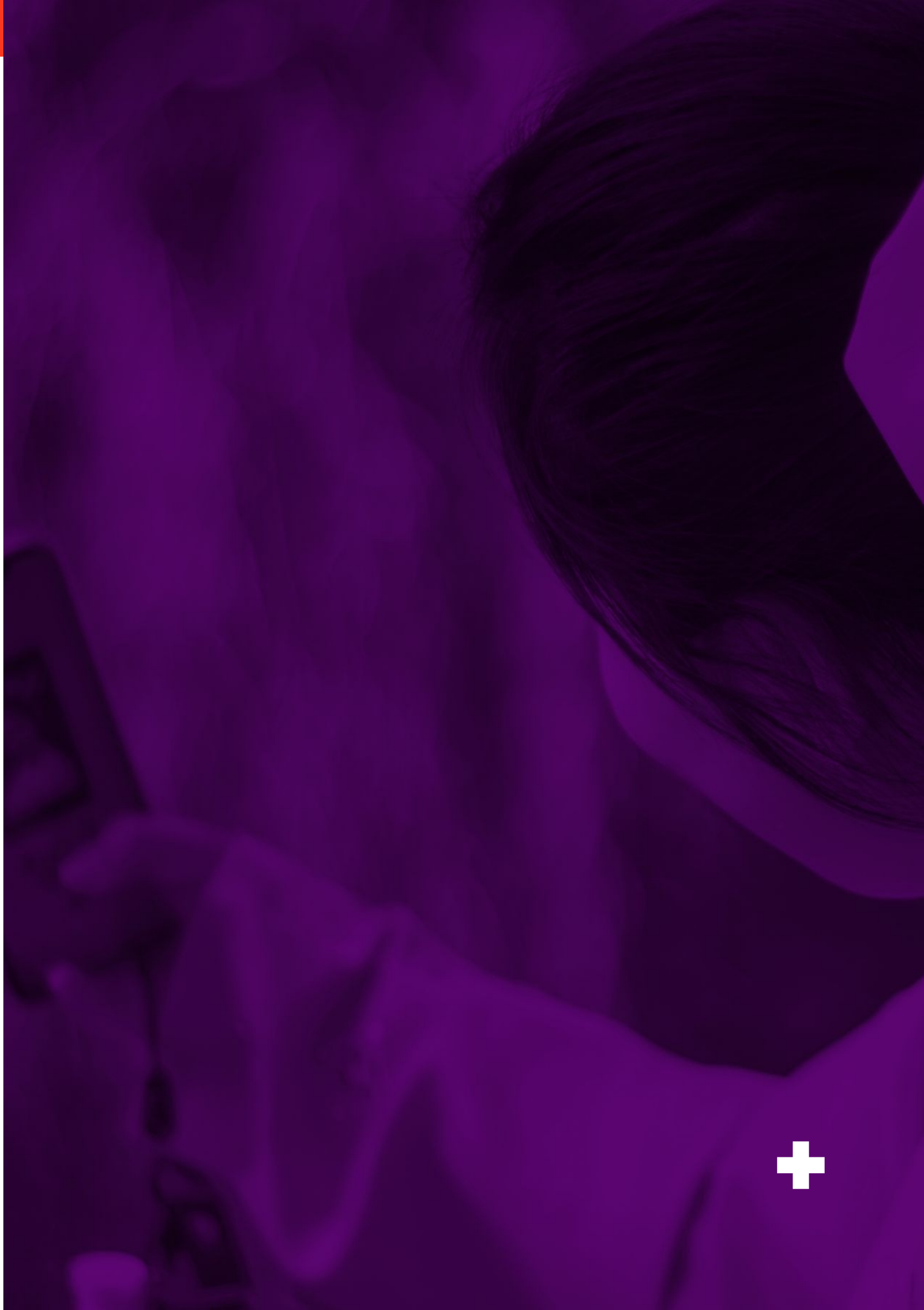

2

TOWARDS UNDERSTANDING THE DIGITAL GENDER GAP IN THE GLOBAL SOUTH[34]

AUTHORS:
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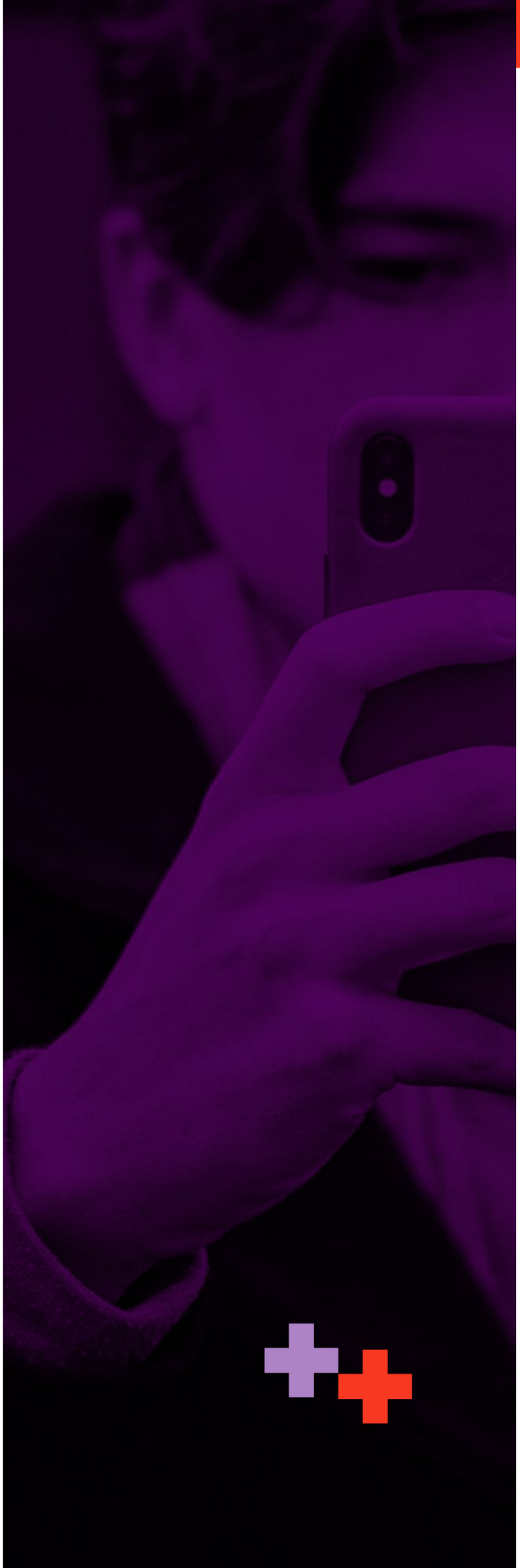


34 *The paper is a result of nationally representative ICT access and surveys carried out in 17 countries across the Global South, which identify the levels and type of digital connectivity, as well as barriers faced by persons 15 years or older. The survey was made possible by the support of the Canadian International Development Research Centre (IDRC). For more details and data, see the After Access website, at www.afteraccess.net.*

35 *Numerous people have contributed to gathering the data and preparing this chapter, including, Tharaka Amarashinge, Mariama Deen Swarray, Paulo Matos, Onkokame Mothobi, and Ayesha Zainudeen. Thanks to Chenai Chair and Anri van der Spuy for editorial assistance.*

ABSTRACT

Central to the call for digital equality are claims that the internet has the potential to be a driver of accelerated progress towards the achievement of the Sustainable Development Goals (SDGs) contained in the UN's 2030 Agenda for Sustainable Development. It is important to understand how these benefits are distributed between men and women, and why there appears to be significant unevenness in their adoption at a global and national level. Yet our ability to assess where we stand currently in relation to access and use of the internet, and to measure progress toward achieving SDG targets related to information and communication technologies (ICTs), is constrained by the dearth of reliable data. Data collection is particularly problematic in pre-paid mobile markets: supplier data does not capture the number of unique subscribers, nor does it show users' demographic characteristics. This research aims to address these data challenges through quantitative and qualitative analysis of ICT access and use across the Global South, and by examining the barriers to online access and the limitations on optimal use. Findings are derived from the After Access 2017 household and individual survey, a nationally representative survey of ICT access and use undertaken by DIRSI, LIRNEasia and RIA, across 17 countries in the Global South[36]. Households were selected from the national sampling frame using simple random sampling. First, the head of the household was interviewed to obtain household indicators. Next, an individual (15 years or older) was randomly selected from each household to be interviewed about their mobile access and usage. The findings highlight the significant demand-side challenges to achieving SDG ICT goals, including cost of devices and services, low education and associated income levels, digital literacy gaps, and limited availability of local and relevant content. Modelling the data further identifies the factors behind digital inequality that may be masked by aggregated descriptive indicators, and suggests areas of policy intervention to address gender inequality.

KEY FINDINGS

The extent of mobile phone ownership and the gender gap aligns broadly — though not perfectly — with GNI per capita. The richest of the surveyed countries show the lowest gender gap. India, Pakistan and Bangladesh show the largest gender gap in mobile phone ownership and among the largest in internet use.

There are notable exceptions to this pattern. Colombia, with lower overall mobile penetration, has gender parity in mobile ownership; and in South Africa, with high income disparity, more women than men own mobile phones.

In Africa, education and income are the main determinants of access to the internet. Women are generally less educated, less employed and have lower incomes than men.

In Asia, disaggregating women by income or wealth illustrates the importance of understanding they are not a homogenous group (just as men are not). In Latin America, the main factors affecting the gender gap include both observable characteristics (age, occupation and household characteristics) and non-observable factors that should be taken into account, in country-specific policy interventions.

INTRODUCTION

Central to the call for digital equality are claims that the Internet has the potential to be a driver of accelerated progress towards the achievement of the Sustainable Development Goals (SDGs) and the UN's 2030 Agenda for Sustainable Development (UNGA, 2015). Goal 5b specifically identifies the enhanced "use of enabling technology, in particular ICTs, to promote the empowerment of women"; SDG 9C is concerned with promoting universal ICT access, and SDG 17.6 with promoting global collaboration on and access to science, technology and innovation (UNGA, 2015).

However, for many of these goals we lack global data needed to establish baselines and to assess progress towards targets. A critical lack is the disaggregated data essential to assess the unevenness of internet access and use, particularly for the Global South, where inequality is greatest.

The limited empirical evidence available at the global level indicates major differences between men and women in the volume, frequency, and quality of ICT access. These digital equality gaps are greatest in the Global South. For example, the latest figures from the United Nations agency tasked with ICT issues, the International Telecommunication Union (ITU), indicate that internet penetration rates are 12% lower for women globally (an increase of one percentage point from 2013, when that rate was 11% lower) (ITU, 2017). While the gender gap[37] has narrowed in most regions since 2013, it has widened in Africa, where 25% fewer women than men use the internet. In least developed countries, only one out of seven women use the internet, compared with one out of five men. The only region where a higher percentage of women use the Internet is the Americas (ITU, 2017).

36 *Mozambique, Nigeria, Kenya, Ghana, Rwanda, South Africa, Tanzania, Bangledesh, Cambodia, India, Pakistan, Argentina, Paraguay, Colombia, Guatemala, and Peru. Further surveys are underway in Uganda, Senegal, Sri Lanka, Nepal, and Ecuador.*

37 *The term "gender" is used in this paper in the conventionally restricted context of a binary male/female distinction. This usage reflects the limitations of the available data, rather than a theoretical perspective.*

Critically, this research fails to assess the intersectional nature of marginalisation. The descriptive indicators used to measure the gap at the national level mask inequalities within and across groups of men and women. As the research summarised below shows, there is considerable disparity in access to the internet among women, within and across countries. Whether living in rural areas or city slums, women located at the intersection of other factors of exclusion, such as class and race (associated with marginalisation in education and employment), will experience even greater digital inequality than women overall.

Before dealing with the challenges of trying to measure digital inequality at the global level, including the "gender digital divide", it is important to consider the relevance of equality in access and use of the internet to social and economic inclusion in the contemporary world. Claims regarding the potential benefits that ICTs offer women are not yet widely supported by evidence, and it remains important to understand why these benefits are not evenly distributed between men and women. It is equally important to understand the negative implications of ICTs for women — including, for instance, the impact of surveillance or online abuse on women's rights (e.g., Cummings & O'Neil, 2015, p. 22; Garcia & Manikan, 2014; Buskens & Webb, 2009).

A more holistic understanding is also key to better comprehending the indirect effects of improved internet access on women's wider communities, including impacts on those who remain unconnected. Empirical evidence supports the notion that social and welfare investments in women have positive multiplier effects on the wellbeing of their family members, broader communities, and society at large (Todaro, 2003, cited in Gillwald, 2009). Ending discrimination against women and girls is, therefore, not only a human rights issue but is also central to harnessing all available human resources for sustainable economic growth and development.

RESEARCH CHALLENGES

The limited research available, especially in the Global South, on the access disparities between men and women has contradictory implications. Some qualitative studies support stereotypes that women are more averse to technology than men, while others show that women embrace digital communication under certain circumstances (Cummings & O'Neil, 2015, p. 9) and others that men and women of similar educations and income adopt and use mobile phones similarly (Gillwald, Milek & Stork, 2011). Little quantitative data delves beyond the descriptive statistics to isolate the factors of inequality and the scale of it, especially with regard to use of Internet. However, quantitative research often raises more questions than it answers. The qualitative research on the subject, which has such an important role to play in answering gender questions that quantitative research methods cannot, often fails to move beyond anecdotal accounts, and often raises more questions than it answers. To develop a comprehensive evidence base for policy formulation, both qualitative and quantitative methods are required.

Since gender is constructed differently across time and regional location, and because it is impossible to distinguish clearly gender effects from race, class, culture and religion, gender specialists have argued that it cannot be understood as a discrete, quantifiable indicator or even as a separate area of social science. But, as Tepe-Belfrage and Steans point out, "in order to speak to policy makers and to inform and influence discussion and decision-making it is often necessary to produce rigorous gender differentiated data which will elucidate myriad gender inequalities" (Steans & Tepe-Belfrage, 2016, p. 2).

While acknowledging the dangers of treating a binary construction such as male /female as a "coherent and stable category of analysis", the goal of research-to-policy influence requires us to find sufficiently reflective approaches that do not rely on the crude forms of gender essentialism, often evident in policy and practice, that treat women's and men's attributes as universally feminine or masculine (Steans & Tepe-Belfrage, 2016, p. 2).

Besides these methodological and analytical challenges related to defining gender indicators, other issues hamper efforts to better understand and address digital inequalities. These include: the relevance of standard ICT indicators in predominantly prepaid mobile markets in the Global South, used to assess gender inequality; the relevance of existing targets to address gender access discrepancies, in the absence of baseline data; the practical challenges of rigorous and timely data collection; and challenges associated with global comparability.

The survey results described below contribute to filling some of these information gaps in the Global South. They build on previous studies that have attempted to grapple with the challenge of accurate data collection, including gender-disaggregated data, for the purpose of informing policy interventions in developing and emerging economies.

In Asia and the Pacific, LIRNEasia has surveyed access and ownership among lower income populations in several countries, tracking changes over time. The gaps are especially large in South Asian countries compared to the Southeast Asian countries studied. Significant reliance on shared phones was observed among women in South Asia, reflecting the gap in ownership. By 2011, the little internet use observed in South Asian countries was predominantly that of men (LIRNEasia, 2011; Zainudeen et al., 2010).

Similar national surveys conducted by Research ICT Africa across 17 African countries, in 2008 and again in 2012, indicated that in 11 of the countries

women generally had less access to ICTs than men (Deen-Swarray et al., 2016; Gillwald et al., 2010). While disparities between men and women in mobile phone ownership flatten out as more people come online, the authors show that gender differences then increase as the technologies and services become more sophisticated and expensive, requiring greater levels of income and education to access and operate them. This is because women are concentrated in the lower income and education levels. The data from the surveys below build on these studies and provide some insights into the diversity between and within regions in the Global South.

The findings of an ICT access and use survey undertaken by DIRSI, LIRNEasia and RIA across 17 countries in the Global South during 2017 (with the exception of Myanmar, which was undertaken during 2016) goes some way to addressing some of the problems identified above. As the survey is nationally representative, the data can be disaggregated based on sex to provide an accurate picture of gender differences in access and — importantly — in use, in prepaid mobile environments. The questionnaire has several questions that track some of the core indicators that have been collected in surveys in Africa, Asia and Latin America for over a decade. It also includes questions on income, education and expenditure that allow for data modelling to identify the real factors contributing to gender inequality, in a way that descriptive statistics cannot.

METHODOLOGY

The After Access[38] Survey (2017) of household and individual ICT access and use was conducted using enumeration areas (EAs) of national census sample frames as primary sampling units. The sampling was performed in four steps for households and in five steps for individuals. The national census sampling frames were split into urban and rural EAs, and EAs were sampled for each stratum using probability proportional to size. Two listings were compiled for each EA, serving as sample frames for the simple random selections. Households were then sampled using simple random sampling. An individual 15 years or older (which could be a visitor staying for the night) was then randomly selected and interviewed from each household.

The desired level of accuracy for the survey was set to a confidence level of 95% and an absolute precision (relative margin of error) of 5%. The population proportion P was set conservatively to 0.5, which yields the largest sample size (Lwanga & Lemeshow, 1991).
Two weights were constructed for households and individuals, based on the inverse selection probabilities and allowing the extrapolation of the data to national level when applied.[39]

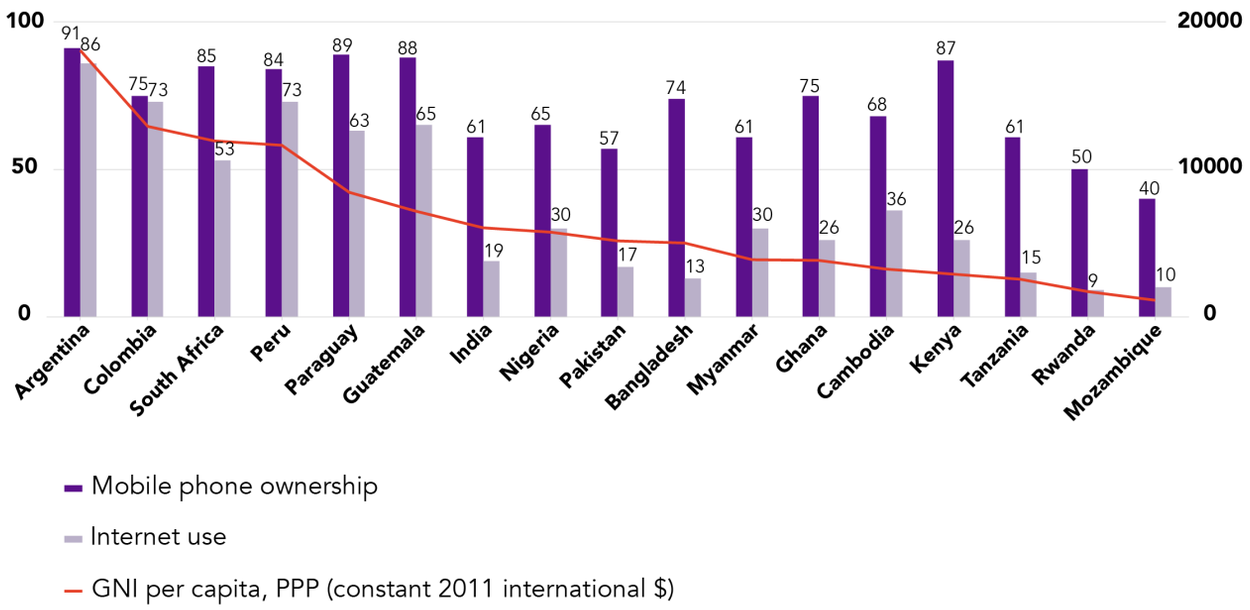
COMPARATIVE ASSESSMENT ACROSS SELECTION OF COUNTRIES IN THE GLOBAL SOUTH

As Figure 2.1 shows, mobile phone penetration is broadly aligned with GNI (Gross National Income) per capita, though with some strong outliers in each region. Argentina not only has the highest GNI per capita, but its population is almost entirely urbanised and as a result has the highest mobile and internet penetration, confirming this general pattern). Colombia has the second highest GNI per capita as well as internet penetration (along with Peru). South Africa is the only African country in same bracket as Latin American countries in terms of GNI per capita; it has much higher mobile phone penetration than Colombia (similar to Peru), but 20 percentage points lower internet penetration. The African countries have higher mobile phone penetration generally than the Asian countries surveyed. Kenya and Ghana show much higher mobile phone penetration than other African countries (except South Africa); internet penetration, however, stands at only 26% — much lower than for Cambodia, with a similar GNI per capita, at 36%. Nigeria has significantly more internet access than the populous Asian countries with similar GNI per capita — India, Pakistan, and Bangladesh — which have internet coverage similar to that of the lowest income African countries surveyed.

38 *Visit ww.afteraccess.net for more reports and data.*

39 *For a fuller account of methodology see https://researchictafrica.net/2017/08/04/beyond-access-surveys-questionnaires-methodology-and-timeframe/*

Figure 2.1
Mobile phone ownership, internet use, and GNI per capita

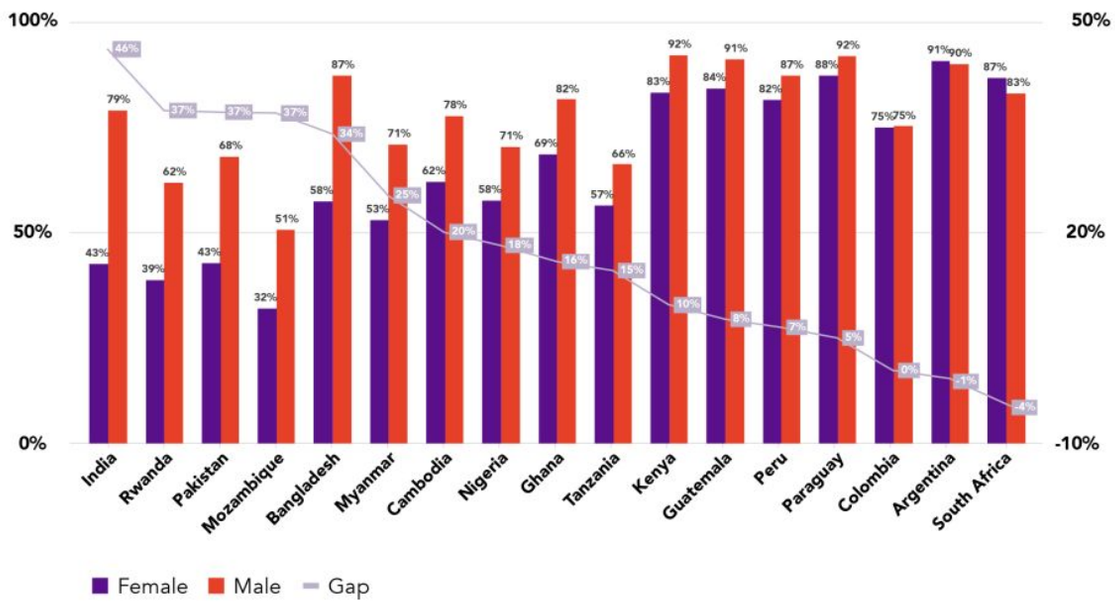


Source: After Access Survey, 2017; World Bank, 2017

Overall, the five Latin American countries surveyed, together with South Africa, are the richest among the countries surveyed and they show the lowest gender gap (Figure 2.2). In contrast, the poorer African countries show high gender disparity in mobile and particularly internet use. However, these disparities are lower than in some higher income Asian countries, where we see some of the greatest disparities in income. The GNI per capita in India and Bangladesh is more in line with that of Ghana and Kenya, but both countries, together with Tanzania, which is also among the poorest countries surveyed, have much lower gender disparities than the Asian countries surveyed.

Figure 2.2 shows an overall negative correlation between the level of mobile phone penetration and the gender gap in mobile ownership, with some exceptions. Although Colombia has lower mobile than other Latin American countries, it has gender parity in mobile ownership. South Africa, with GNI similar to the Latin American countries — despite having one of the highest income disparities in the world — has more women than men who own mobile phones.

Figure 2.2
Gender disparity in ownership of mobile phone



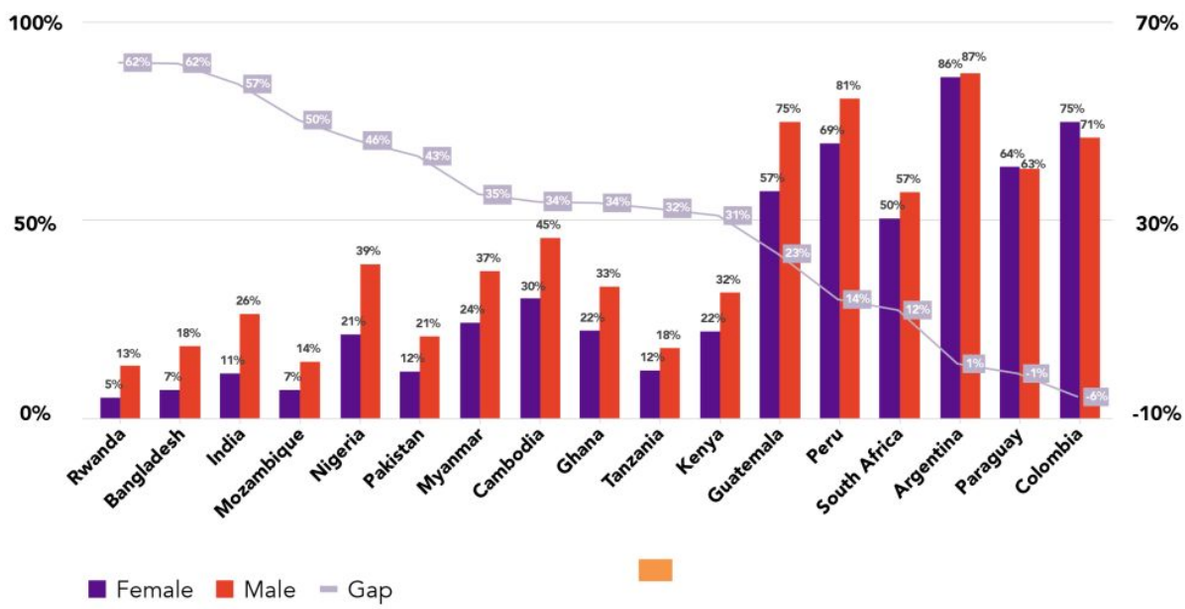
Source: After Access Survey, 2017; World Bank, 2017
Note: The gender gap is the gap between male and female mobile phone owners (or internet users) as percentages of the male and female population, respectively.

Of all the countries surveyed, India, Rwanda, and Pakistan show the highest gaps between men and women in mobile phone ownership (Figure 2.2). Rwanda and Bangladesh show the highest gender gap in internet use, followed by India, Mozambique, and Nigeria, which has by far the largest population in Africa (comparable to that of Bangladesh) (Figure 2.3). These populous nations thus account for a large number of unconnected women in the Global South, with gender gaps greater than in some of the least developed countries in Africa. The highest gender variance in African mobile ownership is in Rwanda and Mozambique. The internet gender gaps in Rwanda and Mozambique are double those of other developing African countries.

Besides South Africa, of the African and Asian countries surveyed, the only country within range of the Latin American countries is Kenya, with a relatively low mobile phone gender gap of 10% and mobile phone penetration in line with the lower- and middle-income countries of Latin America. Ghana — with a similar GNI per capita in 2016 to Kenya — follows, with a gender gap of 16%. Nigeria, with a GNI per capita twice that of Kenya or Ghana, has a mobile gender gap of 18% and penetration similar to Cambodia. Cambodia has the lowest GNI per capita (and penetration rate) of the countries surveyed in Asia, roughly in line with Ghana and Kenya. Nevertheless, Cambodia's gender gap for mobile phone ownership is just 20%, by far the lowest of the Asian countries surveyed — 15 percentage points below Pakistan and Bangladesh, and 25 percentage points below India. With the highest GNI per capita of nearly $2000 in 2016, India has a staggering gender gap: 46% in mobile phone ownership, and 57% in internet access[40].

40 *Unless otherwise noted, currencies are shown in USD.*

Figure 2.3
Gender gap in the use of internet



Source: After Access Survey, 2017.

The use of mobile phones for mobile money transactions is minimal or negligible in most of the countries surveyed, and the associated gender gap varies widely in those countries where mobile money is used (Figure 2.4). In Latin America, Paraguay stands out, with over half of both men and women using mobile money. Asia makes the least use of mobile money: even in Pakistan, the Asian country with highest mobile money use, only 13% of men and 12% of women use this service. Much has been written about the demonetisation of specific currency notes in India propelling the wide use of mobile money[41], but our numbers in fact show minimal use. In Africa, especially East Africa, mobile money is widely used. Kenya's now internationally renowned mobile money transfer service, M-Pesa, makes up an overwhelming majority of the mobile money market share in the country; over 70% of Kenyans use mobile money, with only a 4% gap between men and women.

The next sections of the paper examine different aspects of gender digital inequality in the three regions. The section on Africa highlights some intersectional aspects of exclusion, looking at gender in relation to rural/urban location and income, and then seeks to identify the factors contributing to digital gender inequality by modelling the data. The section on Asia highlights the problem of viewing women as a uniform group, showing that a basic disaggregation of rich vs poor illustrates the importance of intersectionality. Finally, the section on Latin America provides an analysis of the factors contributing to the gender ICT gap, integrating the different dimensions involved in ICT use.

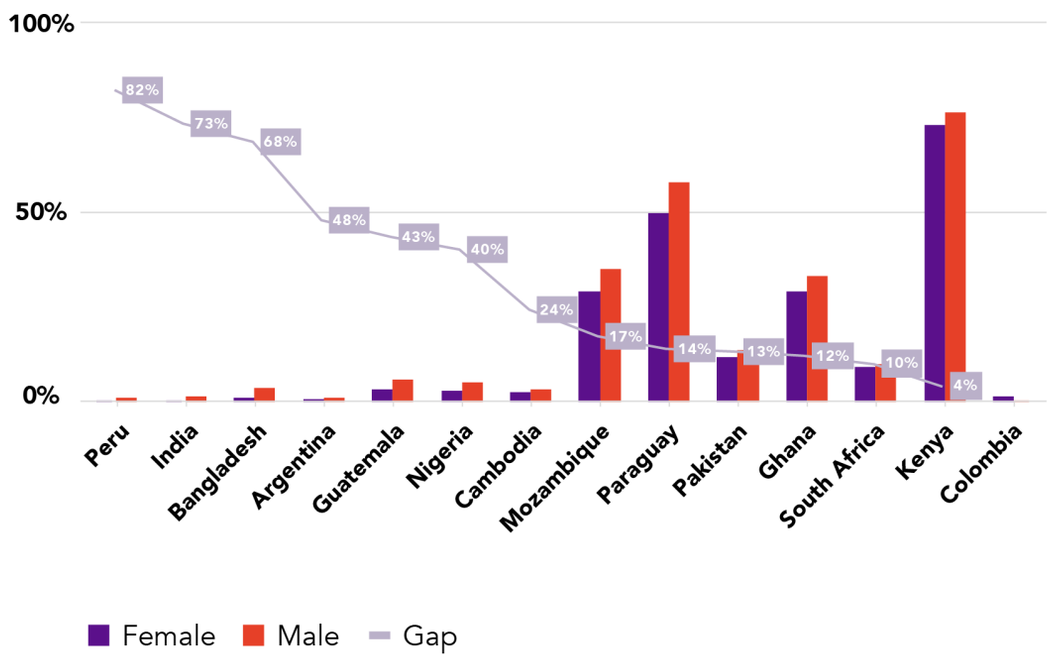
AFRICA

Data for the seven African countries surveyed shows substantial gender disparities in ICT access and use, mostly in favour of men. Modeling of the data shows that the primary determinants of mobile phone ownership and internet access are in fact education and income. Because women are disproportionately concentrated among the uneducated and unemployed, they generally have lower ownership of mobile phones, but as penetration levels increase overall the disparities between men and women reduce, with more women in South Africa owning mobile phones than men. In emergent internet markets, however, where penetration rates are low, the gap between men's and women's use of the internet is high; lower-income countries have the lowest penetration rates and the largest gender gaps. Living in urban areas is also associated with greater internet access than in rural areas (where, in some countries, women tend to be concentrated). Women living in urban areas are likely to have better access to the internet than either men or women of a similar education and income living in rural areas.

South Africa, with one of the highest GNIs in Africa, has the highest internet penetration and the lowest

41 *https://www.economist.com/comment/3318625*

Figure 2.4
Gender gap in the use of mobile money



Source: After Access Survey, 2017.

gender gap of the countries surveyed. Nigeria — now considered the largest economy in Africa, and with a population four times that of South Africa — has 25% less internet penetration than South Africa, and the internet gap between men and women is the second highest of the African countries surveyed (46%, in favour of men). Kenya has the highest mobile phone penetration (approaching 90%) and a mobile gap of only 10% between men and women. It has much lower internet penetration, however, at 25% — similar to Ghana; both countries also have notably large internet gender gaps (31% and 34%). Interestingly, the internet gender gap in Tanzania is comparable to that of Kenya and Ghana, despite their more developed and dynamic economies (from an ICT perspective) — and much lower than that of the other lower-income, lower-ICT countries, Mozambique and Rwanda, which show the highest gender gap in Africa. Despite being renowned for its prioritisation of ICT and supply-side interventions, Rwanda nevertheless has a pronounced gender gap in both mobile phone ownership and internet penetration.

In South Africa, despite a considerably higher internet penetration rate (nearly 50%), the gender gap has grown, from a minimal level in 2012 to 12% (in favour of men) in 2017. In contrast, in the nearly saturated mobile phone market, the gender gap has shifted in favour of women. In the lower income categories, however, there is not much variance between the sexes, which supports the conclusion that among the poor there are no differences between men and women in terms of affordability.

Though internet use is still relatively low in most countries, there has been an increase from 2008 to 2017. For less developed countries — Rwanda, Tanzania, and Mozambique, where internet use was less than 3% in 2008 for both sexes — internet use now ranges between about 5% and 20%. In South Africa, where internet uptake is highest for both men and women in comparison to the other countries, the use of internet among women increased at a faster pace than that of men, as lower income people, predominantly women, came online. While internet use among men in South Africa almost doubled from 2008 to 2012 and then again from 2012 to 2017, for women it more than doubled over the same periods.

BARRIERS TO INTERNET ACCESS

In Africa, the cost of devices is the primary barrier for those who are not connected, while for those who are connected the reason for low usage is the price of data services. These continue to be the biggest challenges from a policy perspective. In many countries, however, particularly in the predominantly rural populations, access to electricity is a greater challenge than access to mobile coverage.

Both men and women adopt multiple strategies to access the internet. The greater use of free public wi-fi

by women suggests greater price sensitivity. The use of free wi-fi is common in Rwanda and South Africa, which have rolled it out as part of their national access strategies. In both countries, more women than men use free public wi-fi (47.1% and 31.2% respectively).

In the African countries surveyed, men are generally more aware of the internet than women; this is consistent with the hypothesis that education is one of the major determinants of women's access to and use of the internet. In the Southern African countries (South Africa and Mozambique), lack of awareness of what the internet is or what it can be used for no longer seems to represent a significant barrier to its use. However, lack of awareness remains the biggest challenge for the West African countries surveyed (Nigeria and Ghana) and for women in Kenya. In Ghana and Nigeria, similar percentages of men and women say they do not know what the internet is, while in Kenya the number of women who indicate this as a barrier is more than double that of men.

The gender gap in access to and use of ICTs is evident in both rural and urban locations, with more men than women having access to or using a particular ICT. The gender gap for mobile phone ownership is slightly higher in urban than in rural areas. Smartphone ownership shows a wider gender difference in rural areas (at 6.5%) than in urban areas (at 4.1%).

Knowledge of the internet is lowest among women in rural areas, where less than 35% of women indicate that they know what the internet is.

Interestingly, there is also a difference in ICT access and use among women in different locations. Women in urban areas are exposed to and use ICTs more than women in rural areas. The difference is more than double across all indicators except for mobile phone ownership.

INTERSECTING FACTORS

The disparity is not always in favour of men, especially when the disaggregation is location-specific. Table 2.2, which aggregates urban and rural data across all countries surveyed, shows that women in urban areas access and use ICTs more than men in rural areas. This indicates that the gender gap is affected by other factors such as location. Where women are at the intersection of multiple factors of inequality, they are the most disadvantaged: rural women are worse off than either urban women or rural men.

Table 2.1
Main reasons cited for not using the internet

Country/ gender		Do not know what the internet is	No device (computer/ smartphone)	No interest/ not useful	Do not know how to use it	Not available in my area (no mobile coverage)	Too expensive
Rwanda	M	11.5	34.7	7	1.3	0	34.4
	F	6.1	51.7	0.5	4.1	0	31.4
Tanzania	M	1.3	62.8	16.5	12.2	0.6	3.4
	F	0.3	64.4	13.9	12.9	0	1.2
Kenya	M	15.9	24.7	29.4	13.6	2.8	4.6
	F	35.3	18.9	23.5	10.2	1.9	3.4
South Africa	M	0	38	15.1	11.7	2.4	11.1
	F	0	34.9	16.1	7.1	3	17.8
Mozambique	M	0	74.4	2.9	14.8	0.6	0.1
	F	0	77.4	3	13.4	0	1.2
Ghana	M	44.1	19.2	8	12.7	4.2	2.9
	F	42.9	23.8	10.2	15	0.8	1.6
Nigeria	M	33.3	17.4	10.2	22.2	6	3.6
	F	44.7	10.2	9.8	21.8	2.8	4.4

Source: After Access Survey, 2017.

Guided by the descriptive statistics discussed above, the study further analyses the data using binary regression techniques. The logistic regression models developed allow us to investigate the factors affecting ICT access and use and to establish the direction of inequalities. The study models the probability of ICT access and use by plotting the binary variables, mobile phone ownership and internet use, against selected demographic and socioeconomic variables.

For six of the countries studied, the sex of respondents shows a significant and negative correlation with mobile phone ownership. In South Africa, however, the relationship is significant and positive, indicating that women there are more likely to own a mobile phone than men, unlike in the other countries surveyed. The significance of the relationship (in either direction) implies that the sex of the person influences the probability of an individual owning a mobile phone.

As in the 2008 and 2012 studies, this study shows that higher levels of income and education are correlated with ownership of a mobile phone. Education in particular maintains a positive and significant correlation throughout. Location and age are also significant influencers of mobile phone ownership: those living in rural areas are less likely to own a mobile phone than those in urban areas, and in most countries younger people are more likely to own a mobile phone.

The analysis shows that in rural South Africa, higher income does not necessarily translate into increased mobile phone ownership, indicating the strong influence of other factors such as urban or rural location, and (related) proximity to infrastructure[42]. A female individual is more likely than a male to own a mobile phone, supporting the initial descriptive findings. In Kenya, however, while a woman is generally less likely than a man to own a mobile phone, in urban areas women are more likely to own a mobile phone than men.

The regression analysis shows that sex, income, education, and location are all significant determinants of whether people use the internet. Women show lower use of the internet, which supports the descriptive findings that women show lower internet use in all seven countries surveyed. People with higher levels of income and education are more likely to be online than those with lower income and education levels. Also, those in rural areas are less likely to be connected. These may be contributing factors to the gender disparities in internet use, as women are more likely to be poorer, less educated, and rural.

Table 2.2
Urban-rural gender comparison on ICT access and use

QUESTION	RURAL			URBAN		
	All	Female	Male	All	Female	Male
Do you own a mobile phone?	58,8	64,7	53,1	79,8	84,9	75,5
Is your mobile phone a smartphone?	18,5	21,5	15	42,8	44,9	40,8
Do you know what the Internet is?	41	49,2	33,2	67,4	74,3	61,4
Have you ever used the Internet?	16,9	21,5	12,4	43,1	52,3	35,2
Do you use social media?	15,4	19,7	11,1	40,4	48,5	33,4

Source: After Access Survey, 2017.

42 *This may reflect inability to use a mobile device or lack of a good signal (in very remote areas; there is over 95% 3G coverage in South Africa).*

In summary, modelling shows that the main determinants of this digital gap between men and women are education and income. These two factors are, in turn, likely to be determined by cultural and social factors, which are more likely to be captured through qualitative research. In 2017, when Research ICT Africa ran focus groups — as a pre-test for the After Access surveys and to explore gender matters arising from the 2012 survey — some of these "softer" issues also emerged.

For instance, a woman in the village, even if she wanted to use a cyber [café], she will not do that. Imagine being in the cyber at 7 pm and you are expected to be at home cooking, taking care of cows, etc. Even if you have a child abroad and you want to communicate with them, it becomes very difficult.

— Peri-urban female internet user, Kenya (Chair, 2017, p. 34)

Though internet use is still relatively low in most countries in Africa, there has been a significant leap from 2008 to 2017. Women, however, still lag behind men in the use of the internet, and this is mainly as a result of their relatively low levels of education and income.

ASIA

The five Asian countries surveyed present a sobering picture of gender disparity. Two of them, India and Pakistan, account for the highest gender gap in mobile ownership among all countries surveyed, with Bangladesh not far behind (Figure 2.1). Given those countries' large populations, these gender gaps account for a disproportionate share of the overall Global South gender gap.

These three countries have often been considered highly "affordable" markets for mobile voice and data services for nearly a decade[43]. Yet, when income is disaggregated by gender, we see the affordability disparity. In India, for example, women on average earn one fourth as much as men, making mobile services significantly unaffordable to them, regardless of income decile.

Gaps in education both cause and exacerbate these income disparities: the mean number of years of education received by women in India is half that of men (Table 2.3). Even when the education gap is not significant (as in Bangladesh), a substantial income gap remains: men earn almost twice as much as women. Note that these income statistics are for women who have income, and labour force participation is lower among women than men. Therefore, both employed women and those not formally employed are less able to afford ICTs.

43 *These three countries were among the first in Asia to drop below $5 total cost of mobile ownership in 2009 (including monthly rental, voice, SMS, connection, and handset costs). According to the 2017 ITU regional price database (unpublished), Bangladesh is placed 3rd in cost of 1GB of data, while India and Pakistan are placed 6th and 7th. More recent benchmarks by the Alliance for Affordable Internet show that Pakistan is close to meeting its target of 2GB of data at under 1% of GNI, currently at 1.2% of GNI.*

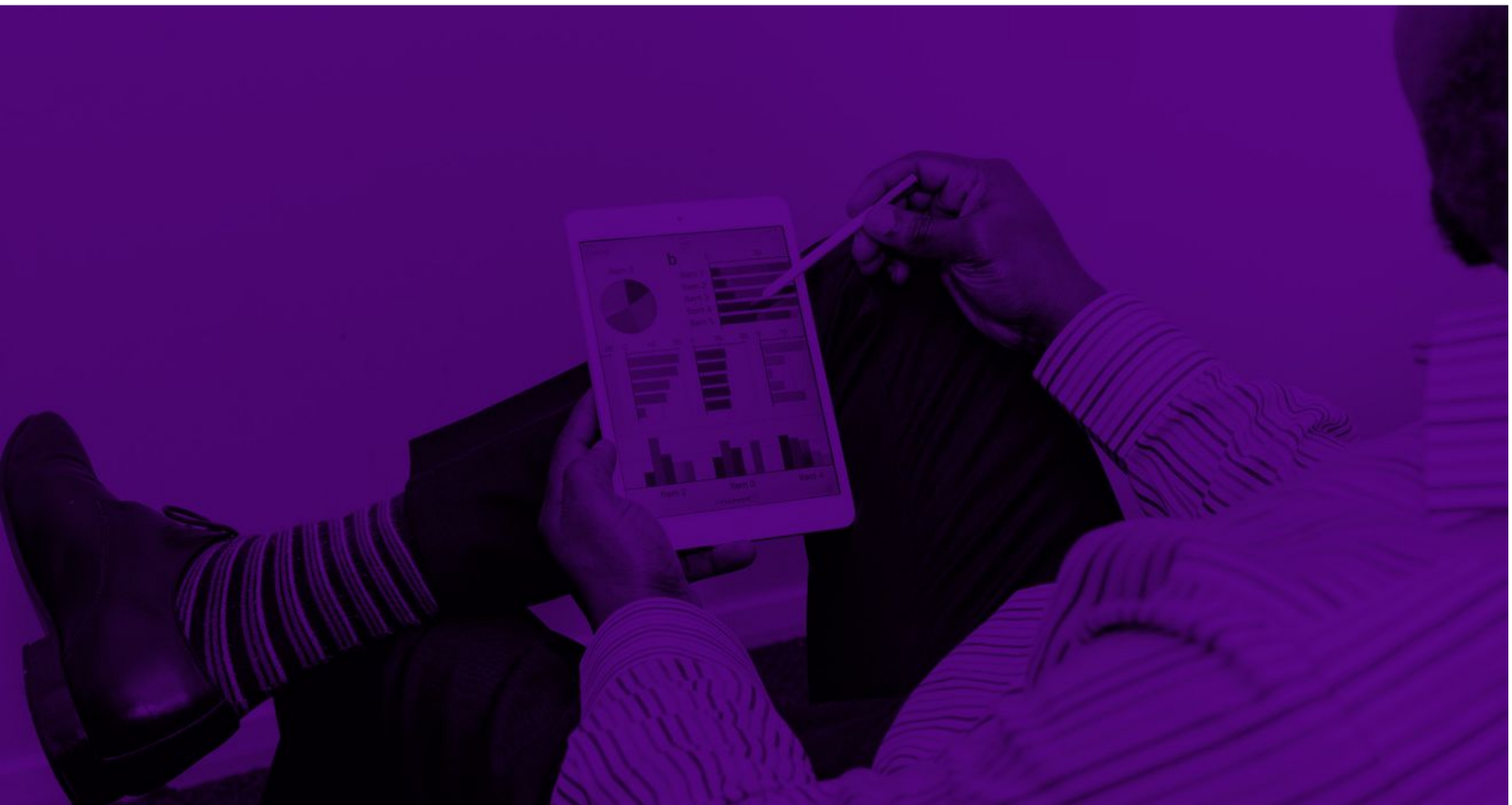


Table 2.3
Income and education statistics disaggregated by gender

COUNTRY	Mean years of schooling		Estimated GNI per capita (2015, PPP, 2011 international $)*		Labour force participation, 15 – 64 years population (2017; ILO modelled estimate)	
	Women	Men	Women	Men	Female	Male
India	64,7	8,2	2184	8897	29%	82%
Pakistan	21,5	6,5	1498	8376	26%	86%
Bangladesh	49,2	5,6	2379	4285	35%	82%
Cambodia	21,5	5,5	2650	3563	83%	90%
Myanmar	19,7	4,9	4182	5740	55%	84%

Source: http://hdr.undp.org/en/composite/GDI, https://data.worldbank.org/
Note: *Income of employed individuals.

Analysis of nationally representative survey data also show how education and income inequalities contribute to mobile phone non-ownership among women. A binary logistic regression model was used, where mobile adoption is modelled as the dependent variable, taking a value of 1 for adopters and 0 for non-adopters; the results give the change in the odds (directly related to the probability) of mobile adoption assignable to a unit increment of the independent variable. The model (detailed in Perampalam et al., 2016) showed that the completion of secondary and tertiary education is a significant predictor of mobile phone adoption.

For Myanmar, the completion of secondary education is associated with a 55% increase in the odds of mobile adoption, while the completion of tertiary education, though limited to a small percentage of the population, is associated with a 378% increase in the odds of adoption. Similarly, being employed is associated with an 84% increase in the odds of mobile phone adoption.

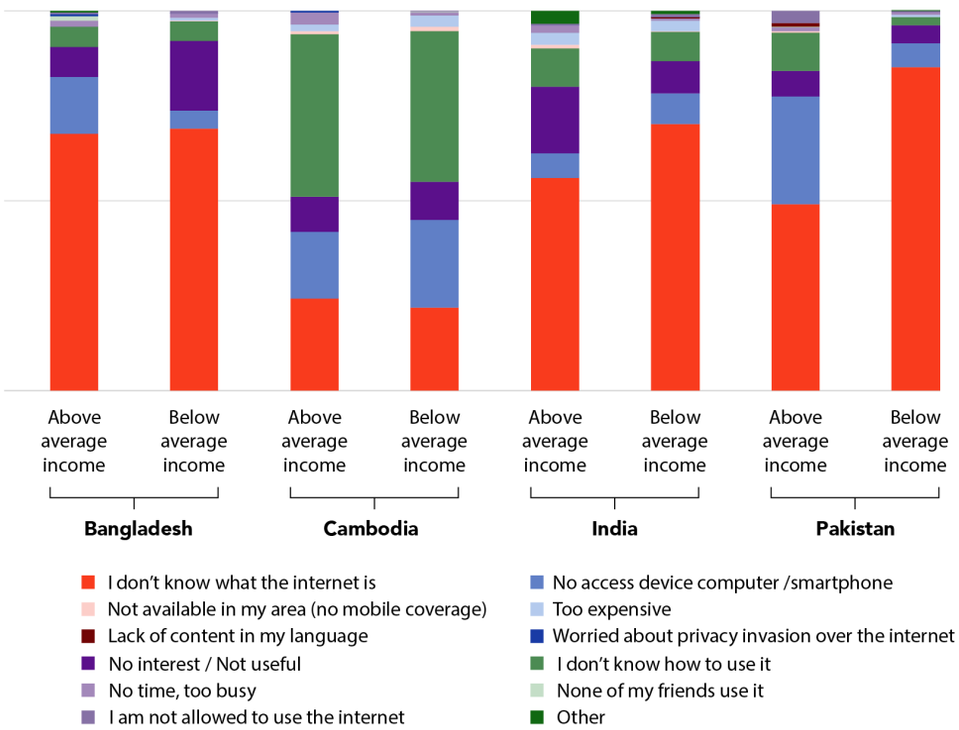
However, the same binary logistic regression model showed the complicated and intertwined nature of mobile access with gender, income, and cultural factors. The gender disparity persisted even after accounting for all the independent variables that show a statistically significant impact on mobile phone adoption (such as secondary and tertiary education, proportion of friends with mobile phones) and others that are direct or indirect indicators of wealth (such as employment status, monthly household expenditure, TV and electricity in the household, and age). After controlling for all these contributing factors, being a woman in Myanmar still reduces the chance of mobile phone ownership by fully 42%. This finding was surprising, since women hold important status in Myanmar society, in comparison to its South Asian neighbours (see, among others, Sein, 1972; Ikeya, 2005/2006; Kawanami, 2007). Ethnographic observations detailed in Zainudeen and Galpaya (2016) showed that women are the "chief financial officers" of the family, receiving money from employed family members and allocating and managing the budget. A woman decides when her family has sufficient funds to purchase a phone. Yet, because these women have little technical knowledge and few opportunities to obtain it, they are not involved in the decision of which phone to purchase. Furthermore, when the phone is purchased, it then "travels" with the person who works or studies outside the home. So, even if a woman is working from home as well as managing the family finances, she is unlikely to have access to the phone for significant hours each day.

The gender gap lies at the intersection of other forms of marginalisation: gender, income, education, urban/rural, and cultural identity. Therefore we cannot treat men and women as homogenous social groups. When our survey data is disaggregated by income, the chasms become apparent between "rich" women (those earning above the national mean income) and "poor" women (those earning below the national mean income). When non-users were asked about

the reason for not using the internet, a considerably higher percentage of poor women than rich women responded that they did not know what the internet is (Figure 2.5). Similarly, in Pakistan, nearly 30% of poor women found it challenging to afford the digital device (phone, computer), compared to only 6% of richer women (Figure 2.5).

Figure 2.5

Reasons for not using the internet among women, disaggregated by household income (% of non-internet users, among women aged 15–65 years)



Source: After Access Survey, 2017

For women accessing the internet, gender also impacts their online experience — how much time they spend online and what content they access. As a follow-up to the Myanmar survey, in 2017 we conducted semi-structured interviews with 98 men and women who had been using the internet for at least a year. Both men and women reported that their social media accounts (mainly Facebook) were regularly hacked. In fact, not everyone even knew that Facebook required a password. Many men and women had their Facebook account (username and password) created by the shop workers who sold them their phones.

While hacking was the main challenge for men, the women worried about more varied online challenges. In particular, many women worried about a stranger downloading a photo from their Facebook feed, editing ("photoshopping") it to impose a naked body or manipulating it in other ways and circulating it via social media in a manner that would draw attention or shame to them, often as a precursor to extortion. The result was that women self-censored their online behaviour by limiting or avoiding the posting of photos of themselves, or by only posting photos that they believed could not be manipulated.

It is pretty rare that a full body image pictures [is posted by me]. Maybe just my head or only the upper part of my body… I have heard that it is easier to make photoshop out of full body images.

— Female, 25 years, Yangon, Myanmar

A friend of mine likes to wear trendy revealing clothing, and her pictures are used by people with bad intentions. Through the messenger, they threaten her by using pictures of her. They said they will change it into pornographic picture. She got that a couple of times.

— Male, 28 years, Yangon, Myanmar

Many respondents, men and women, had multiple Facebook accounts in order to navigate multiple identities. Women did so by creating a separate account and listing their gender as male or adopting a male name, or by posting their husband's photo as their profile picture. Other women signalled they were "unavailable" for sexual advances and harassment (by often unknown men) by posting photos of their husband and children. Others simply avoided opening an account for themselves at all, preferring to share the account of a male relative and limit their use to simply browsing the news feed. Many felt it was easier to engage in certain public online conversations while using their "male" accounts, even when they had a female account they used to connect with friends and family. More specifically, it was "easier" to engage in sensitive conversations related to religion and politics if one was seen to be a male belonging to the main ethnic group, Bamar. For example, many Kachin women and men, whose Kachin ethnicity can be often identified with their name, had an account in a non-Kachin, Bamar name. So, in fact, Kachin women are harassed online both as women and as Kachin (minority ethnicity) — highlighting that "women" is not a single, uniform category.

From a gender perspective, there are issues to be tackled on multiple fronts in order to achieve equitable and meaningful access for all. The gaps in mobile and internet access seem to be worse in the Asian countries than in Africa and Latin America. Key challenges for women in the Asian countries relate to skills (in turn related to education) and economics. The lack of skills is a particular barrier preventing them from getting online; for those who are online, it can leave them vulnerable to privacy and safety threats. Affordability, as measured by average data prices as a percentage of per capita income, is a particular barrier for "average" women, who often earn less than men, or don't have their own incomes at all; the situation may be even more worrying if lower income deciles are analysed.

While disparities in education and income may explain a large component of the gender gap in mobile and internet access, the "pure gender effect" still plays a role in determining and conditioning women's access, as the Myanmar case demonstrates. Deeply embedded in this effect are the social and cultural norms and attitudes that are not measured in the other explanatory variables. What this means is that there are greater and deeper concerns that need to be addressed in these societies: change is needed in the attitudes and perceptions that shape the ways in which women gain access to technology and are able to make use of it.

While attitudes and perceptions are not easy to change in the short term, a good starting point may be to focus on more tractable solutions that can help women to become (and stay) affordably connected, and to provide them with the skill set to make use of the host of services and platforms offered through mobiles and the internet, in a safe and secure way — and perhaps even earning a living from these opportunities.

LATIN AMERICA

Women represent more than 50% of the total Latin American population [44]; here, as in many parts of the world, they face a set of barriers that result in unequal conditions for them relative to their male peers. Particularly in this region, women are overrepresented in lower income quintiles, informal labour sectors, and low-payment activities. According to the International Labour Organisation (ILO, 2016), the unemployment rate for women is around twice the level as for men, they receive lower wages in all occupational segments, and they face worse labour conditions.

Although there have been significant advances towards gender equality in accessing the basic levels of education, women remain underrepresented in STEM fields (science, technology, engineering, and mathematics). These differences are more pronounced at the highest levels of academic and professional hierarchies (Castillo et al., 2014; UNESCO, 2015a). Gender disadvantages are also evident in other social and cultural contexts. Women face entrenched discriminatory social norms and persistent structural barriers: early motherhood, gender-based violence, and gendered division of household labour, among others (UNESCO, 2015b).

The ICT field is not an exception. Opportunities to access and use the internet are not evenly distributed between men and women (Gray et al., 2016), and factors such as the ones mentioned above contribute to gender differences in ICT use (Robinson et al., 2015). However, the existing literature about this topic is scarce, especially for Latin America, and a comprehensive analysis becomes more challenging when attempting to include all the different dimensions of ICT use (including mobile ownership, mobile use experience, mobile apps use, e-banking and e-commerce, internet use, and type of internet use).

In this section of the paper, we analyse the factors that determine the gender gap in ICT use, integrating these different dimensions. We first describe the components of the proposed ICT index and estimate its value for each country in the After Access Latin American sample. Then we briefly describe the quantitative methodology used to identify the factors underlying the ICT gender gap and provide the most important results. We conclude the section by explaining the ICT gender differences.

44 *World Bank Indicators (2017) https://datacatalog.worldbank.org/dataset/world-development-indicators.*

THE ICT INDEX FOR FIVE LATIN AMERICAN COUNTRIES

The ICT index for the Latin American region consists of two sub-indexes and eight indicators. The first sub-index is related to mobile phone use and includes the following variables: smartphone ownership, mobile use experience, mobile application use, and mobile banking and e-commerce. The indicators in this sub-index are mainly related to the more modern uses of mobile phones; for example, it includes only smartphone ownership (excluding "basic phones" lacking internet access). It also takes into account the use of a wide variety of mobile applications (nine different types).

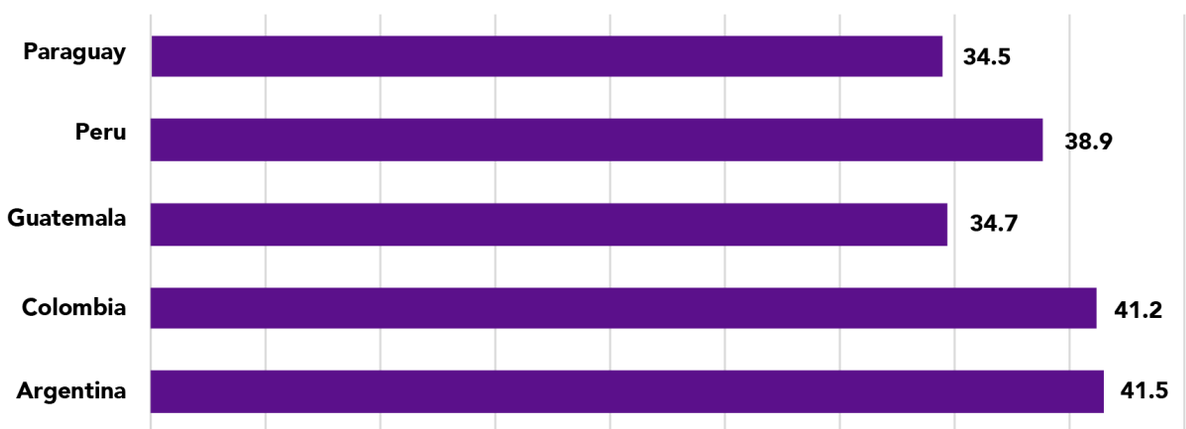
Similarly, the second sub-index includes internet use and has the following four indicators: internet use, internet use experience, internet devices, and online activities[45].

Figure 2.6 shows the average values of the ICT index for each country of the Latin American After Access survey, including values by gender; this provides an approximation on the indicators described above. In particular, Argentina and Colombia have the highest average values for the index, which means that both countries have a wider variety and higher intensity of ICT use. These countries show more advanced use in terms of mobile phones (level of ownership and number of applications used), internet, and social media. On the other hand, Paraguay and Guatemala show the lowest levels of use in the region. The overall range is quite narrow, however — between 34.7% and 41.5%.

In terms of gender differences, Peru and Guatemala exhibit the largest disadvantages for women. In both countries, women's use of mobile phones, internet, and social media is about 18% lower than their male peers, compared to Argentina, Colombia, and Paraguay which show a difference of just 5%. The main objective of this section is to identify the major factors underlying this gender inequality.[46]

Figure 2.6
The % ICT index by country and gender (average values)

Figure 2.6a
By country

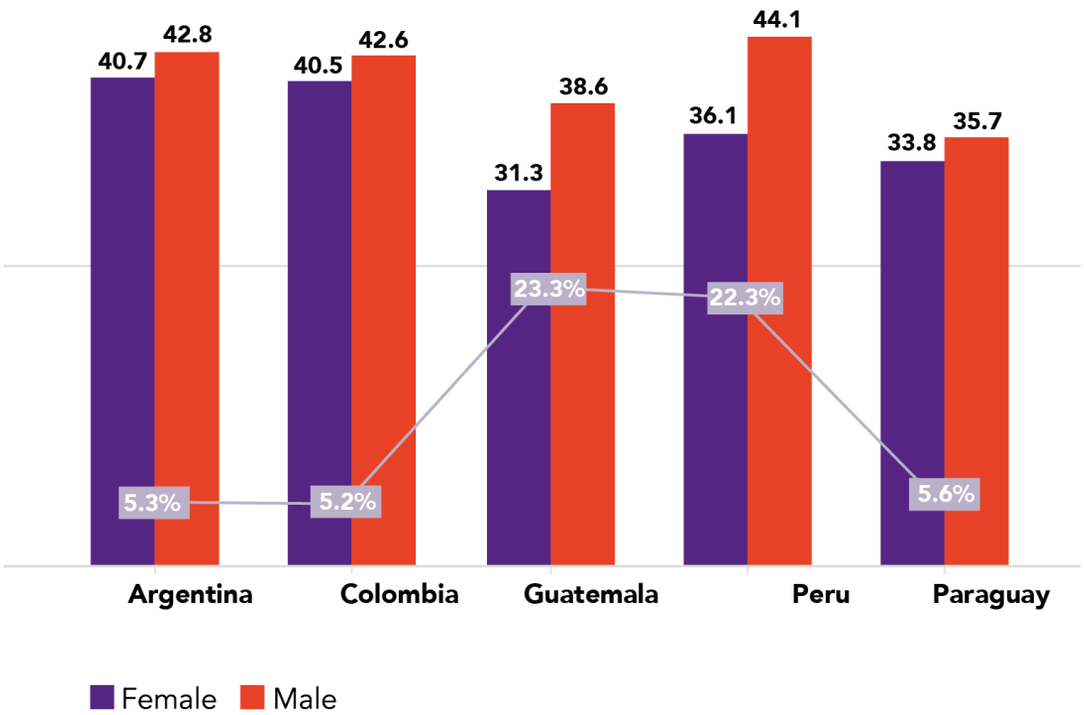


Source: Authors' elaboration based on After Access Survey, 2017.

45 *The ICT index is the simple average of the eight normalised indicators. The normalisation process is needed to make sure that all the indicators are in the same scale, and it follows this formula:* x=x-xminxmax-xmin

46 *The definition of the ICT gender gap used here is the same as proposed in the previous sections.*

Figure 2.6b
By gender



Source: Authors' elaboration based on After Access Survey, 2017.

EXPLAINING THE ICT GENDER DIFFERENCES

Adapting the methodology used by Ñopo (2008), analysing gender wage gaps in Peru, we identify the factors behind the differences between men and women in the ICT index for each of the five Latin American countries under analysis. Ñopo's methodology provides an estimation of the effect of observable characteristics (such as age, occupation, and household characteristics) and the effect that is related to non-observable factors[47]. In the same way, we suggest there are two main components of the gender gap:

1. The explained component. This is the share of the gap that is attributed to differences in observed characteristics (such as education, occupation, and household characteristics).
2. The unexplained component. This is the share of the gap that cannot be attributed to differences in observed characteristics and thus indicates the influence of other factors (such as discrimination, cultural factors, sexism, and racism).

The following observed variables are taken into account: age, education level, the presence of children and youngsters in the household, location, language, socioeconomic level, and occupation. These variables have been documented extensively in the literature as important determinants of ICT use: see, for example, Mendonça et al. (2015), Wang (2015), and Barrantes (2007). Descriptions of the indicators are presented in Table 2.4.

47 *We have simplified the explanation of the methodology for a general audience. For a more detailed explanation of the method see Ñopo (2008).*

Table 2.4
Determinants of ICT adoption

INDICATOR	DESCRIPTION
Age	It takes the value of 1 if the respondent is less than 18 years old; 2, if he/she is between 18 and 25; 3, if between 26 and 39; 4, if between 40 and 59; and 5 if he/she is more than 60 years old.
Education	It takes the value of 1 if the respondent has less than complete secondary education; 2, if he/she has complete secondary education; and 3, if he/she has higher than secondary education.
Child	It takes the value of 1 if there is an under-aged person in the house, otherwise 0.
Rural	It takes the value of 1 if the respondent lives in a rural location, otherwise 0.
Local Language	It takes the value of 1 if the respondent affirms that the language that he/she speaks in his/her house is a native language, otherwise 0.
SEC	Socioeconomic Level index in quintiles
Occupation	It takes the value of 1 if the respondents is unemployed; 2, if he/she is a student; 3, employee; 4, employer; 5, independent; 6, non-active.

Source: Authors' elaboration based on After Access Survey, 2017.

Table 2.5 shows the kind of relationship found between the ICT index and the variables described in Table 2.4. In particular, people in higher socioeconomic and education levels and those who live with children and young adults show advantages regarding mobile, internet, and social media use.

In contrast, being an older adult, speaking a local language, and living in a rural location show a negative relationship with the proposed ICT index. Regarding occupation, there are different types of relationships for each employment category, but the outstanding ones are related to "employer", showing a positive relationship, and "non-active people" showing a negative relationship[48].

These results show the strong association between the variables related to digital disadvantages (low educational levels, rural location, or ethnic issues) and those related to social disadvantages in general. As Kularski and Moller (2012) highlight, digital exclusion is caused (and reinforced) by traditional dimensions of inequality, such as socioeconomic level or race. Nevertheless, the digital divide is a complex phenomenon, and social and digital inequalities do not always move together (Bauer, 2016). An interesting example is the presence of children in the household. According to Ñopo (2010), having children could imply a significant negative effect for women in terms of wage and labour status. However, regarding technologies, younger people in the household could have an important role in the process of internet adoption by other older household members (Barrantes & Cozzubo, 2017).

On the other hand, it is important to highlight that the types of relationships shown in Table 2.5 are relevant to a better understanding of how personal and household characteristics contribute to widening or narrowing the ICT gender gap. For example, being highly educated represents an advantage in terms of the ICT index; in this sense, if women are less educated than men, education would be a factor that contributes to widening the ICT gender gap.

Figure 2.7 shows the contribution of each independent variable to the ICT gender gap. Bars with positive values indicate the percentage increase in the ICT gender gap associated with inclusion of a specific factor. For instance, gendered occupations contribute to increasing the gap by 2.5%; this means that if there were no structural differences in occupation between women and men, the gap would be 7.5% in the five Latin American countries instead of around 10% — the actual average gap (illustrated in Figure 2.6b). A negative sign means that the particular factor reduces the ICT gender gap.

As indicated in Figure 2.7, education, socioeconomic level (SEC), occupation, and the presence of children in the household are factors that contribute to widening the ICT gender gap, disfavouring women. The first three factors are well documented in the literature (Castillo et al., 2014; ILO, 2016; UNESCO, 2015). Women in the region have fewer educational opportunities, belong to lower SECs, and are

48 *The category "non-active people" refers to those who are currently not employed, not looking for work, and not studying.*

Table 2.5
Preliminary analysis
– Observed effects of independent variables

Independent Variable/ Dependent variable: The ICT index	Observed effect
SEC	+
Education	+
Age	-
Occupation: Employers (+); Non-active (-)	+/-
Local Language	-
Rural	-
Children	+

Source: Authors' analysis.
Note: Based on multiple regression analysis using the After Access Survey 2017. In all the cases there is a 99% statistical significance.

overrepresented in informal and low-profit labour segments. On the other hand, having children in the household is seen to have little overall impact on the gender gap, because its effect is not one-directional. Children may have an important positive role in increasing technology adoption and use by older household members (Barrantes & Cozzubo, 2017). However, since women are disadvantaged in terms of domestic division of labour, the presence of children in the household significantly increases the demand on women's time, allowing them less free time (Beltran & Lavado, 2014) — less time for informational development. Overall, the negative effect prevails: the presence of children in the house widens the gap by 0.4%. Finally, the ICT gender gap was reduced by age and rural location and local language[49].

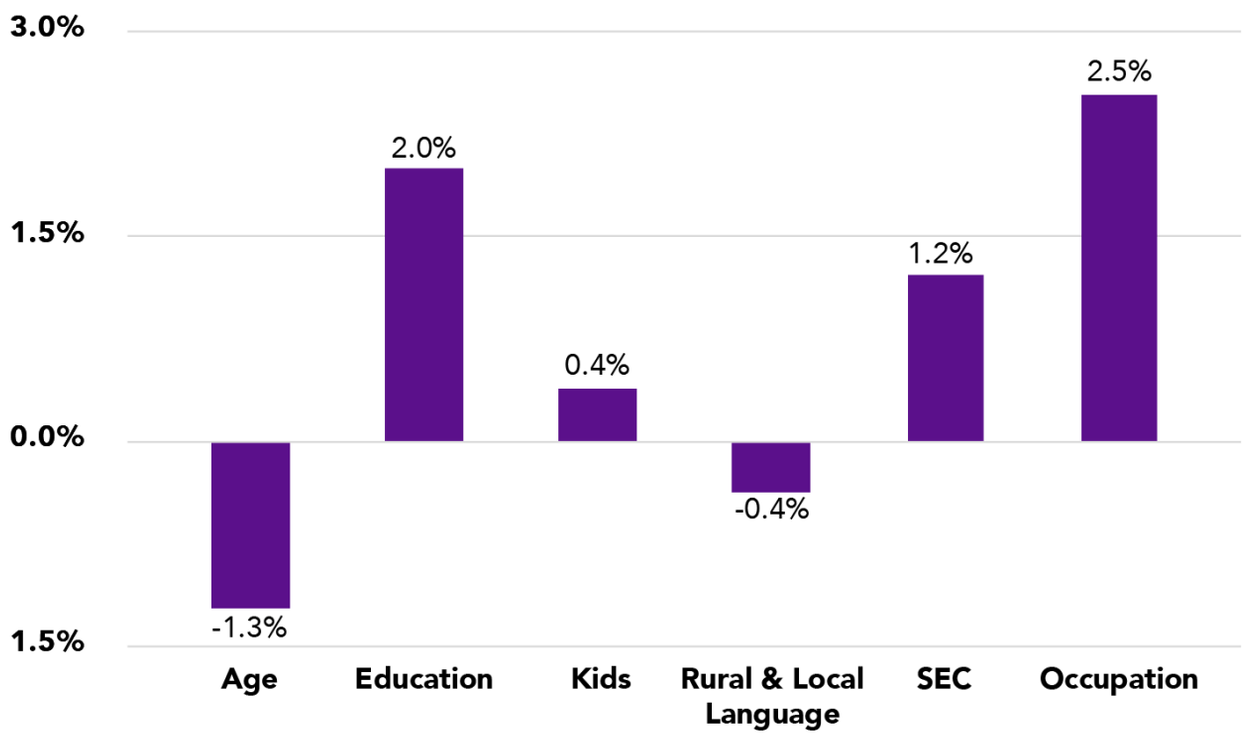
Figure 2.8 shows the part of the ICT gender gap that remains unexplained after including the analyzed factors (age, education, children, rural, language, SEC, and occupation). This unexplained component is usually described in the literature as related to factors of culture, stereotype, and sexism, among others. Interestingly, in Argentina, Colombia, and Paraguay, the ICT gender gap is explained entirely by the analyzed factors (education, SEC level, and occupation) and the unexplained component is not statistically significant. Conversely, in Guatemala and Peru, other factors such as gender stereotypes and sexism apparently have an important effect on ICT gender disadvantages, representing more than the half of the ICT gender gap.

Highlighting these factors could help policymakers design policies for reducing the ICT gender gap most effectively in each country. For example, in Argentina, Colombia, and Paraguay the focus should be on improving the educational and labour opportunities for women, while in Peru and Guatemala, addressing gender stereotypes and sexism is critical.

49 *Women who are older or who speak a native language and live in a rural location are generally at a greater disadvantage than men with these characteristics. This comes from a previous regression analysis (see Table 2.5). However, Figure 2.7 shows a decomposition analysis in which both factors negatively influence the ICT gender gap, and this is related to the distribution of the sample and the general population in these countries (CEPAL, 2005).*

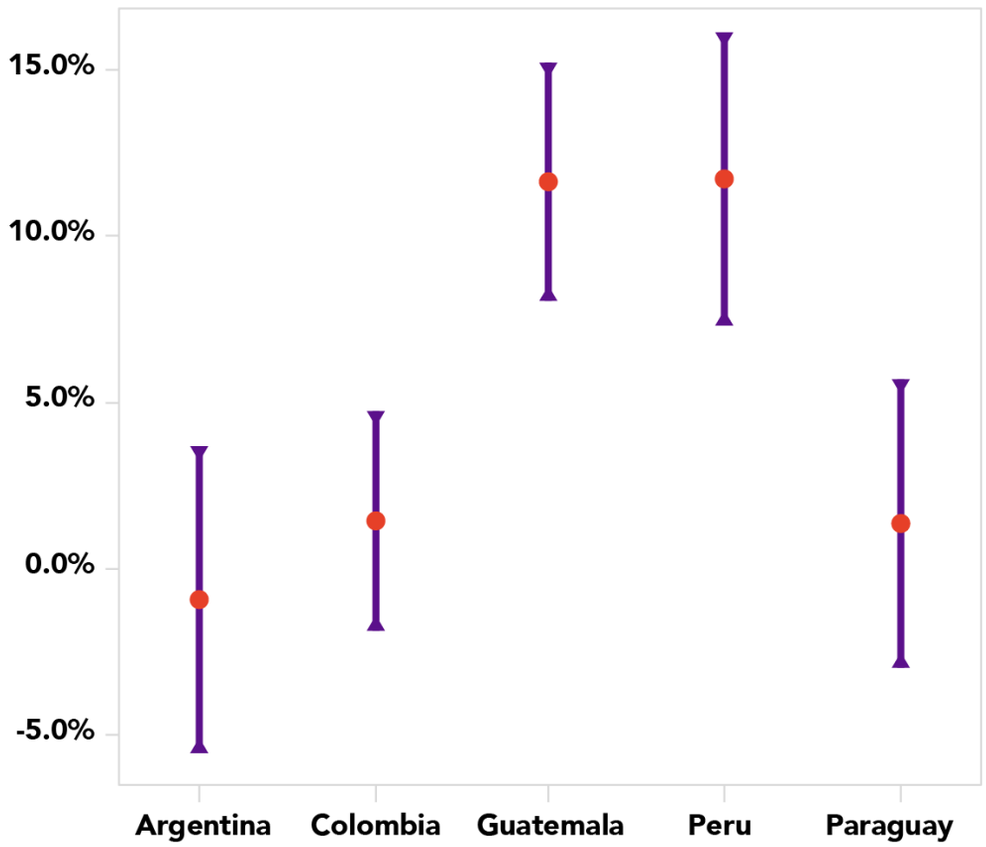
Although not as stark as this in all countries, the main results show that digital inequality will not disappear even when those currently marginalised from services — disproportionately women, in most countries surveyed — become connected. From a policy perspective, it is clear that demand-side interventions that address not only affordability but also e-literacy and education, are as critical to digital inclusion as supply-side connectivity measures. Moreover, as the Latin-American cases show, there are deeply entrenched factors such as social and cultural norms, including attitudes towards women, that need to be taken into account when analyzing women's access and use of ICT.

Figure 2.7
Independent variable contribution to the explained ICT gender gap



Source: Author's elaboration based on After Access Survey, 2017.

Figure 2.8
Confidence Intervals for the unexplained gap by countries (full set of independent variables)



Source: After Access Survey, 2017. Authors' own elaboration

CONCLUSION AND RECOMMENDATIONS

Nationally representative surveys of ICT engagement enable the disaggregation of indicators to show the disparities between men and women. In prepaid mobile markets — even with SIM card registration — this is the only way to obtain sex-disaggregated data. Supply-side data based on active SIM cards cannot identify unique subscribers or their gender; moreover, surveys show that individuals have multiple SIMS, as part of their access and affordability strategies. Similarly, descriptive indicators reported at the national level can mask digital inequalities between men and women and can fail to detect the specific factors determining the uneven take-up of ICTs, as well as inequalities that may exist among women and among men. Through a survey, sex-disaggregated data can be linked to other indicators, such as income, education, location, age — all critical for identifying points of policy intervention required to address the ICT gender gap.

In many countries, the data shows that merely by connecting those individuals currently marginalised from services — who are disproportionately women, in most countries surveyed — digital inequality will not be resolved. Demand-side interventions, that enhance not only affordability but also e-literacy and education, are as critical to digital inclusion as are supply-side connectivity improvements. Moreover, as seen in the Asian and Latin American cases, deeply entrenched factors of social and cultural norms and attitudes towards women need to be taken into account when analysing women's access to and use of ICT.

Although further investigation is needed, it appears that ICT adoption and diffusion through commercial models is associated with high education and income levels of early adopters, showing low levels of gender variance in societies and economies that do not structurally disadvantage the participation of women. As more users come online, greater gender disparities in ICT access and use may reflect gender disparities in relation to education and income (employment); but as prices of devices and services come down and poorer people (disproportionately women) come online,

markets begin to saturate and the figures for men and women tend to equalise. Initiatives to make internet use more affordable and thus lower the income barrier for men and women would reduce the gender gap in internet access.

RECOMMENDATIONS FOR PRACTITIONERS AND POLICYMAKERS

Effectively redressing digital inequality will require transforming the structural inequalities that perpetuate economic and social exclusion and that are simply mirrored — and sometimes amplified — in the digital world. As women are concentrated among the most marginalised in society, initiatives that make internet use more affordable and accessible are likely to contribute to reducing the gender gap in internet access. While affordability remains the primary barrier to digital inclusion from a policy perspective, it is clear that demand-side interventions are as critical to digital inclusion as supply-side measures. Demand-side policy initiatives will have to extend well beyond the communications sector to redress disparities between men and women's access to the internet. Since education and income are the primary determinants of gender inequality in ICT access and use, sustained intersectoral state co-ordination will be required, going beyond the telecom sector. Moving beyond consumer measures of digital equality to digital production, we can predict that inequality in education will become even more significant in perpetuating gender inequity, unless access to education and employment at all levels, in most developing countries, is transformed.

RECOMMENDATIONS FOR RESEARCHERS

The dominant research on ICT and gender is binary in its conceptualisation, reducing gender to the distinction of women and men. It is important to find ways of developing indicators for other gender categories, as well as ways that these can be safely examined, especially where such groups and individuals are marginalised and even victimised on the grounds of their sexuality. This research priority presents a challenge that the United Nations, as a rights-based body, needs to address, with the support of research communities. Even within the narrow confines of gender as currently defined, there is still a dearth of rigorous quantitative research on digital inequality between men and women. Such research needs to delve beyond descriptive statistics to model the available data, to understand factors of exclusion and to better inform policymakers. Further, many gender research questions cannot be answered by quantitative analysis and instead require qualitative and hybrid research approaches. Deeply entrenched factors, such as social and cultural norms and practices, are best explored through qualitative research and theory. Effectively redressing digital inequality will require transforming the structural inequalities that perpetuate economic and social exclusion and that are mirrored, and sometimes amplified, in the digital world. Political economy research that examines relations of power and interests in relation to gender can provide insights into the nature of digital inequality and how it might be structurally addressed.

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3

TECHNOLOGIES AND YOUTH: KEY DIMENSIONS FOR INVESTIGATING GENDER DIFFERENCES IN INTERNET ACCESS AND USE

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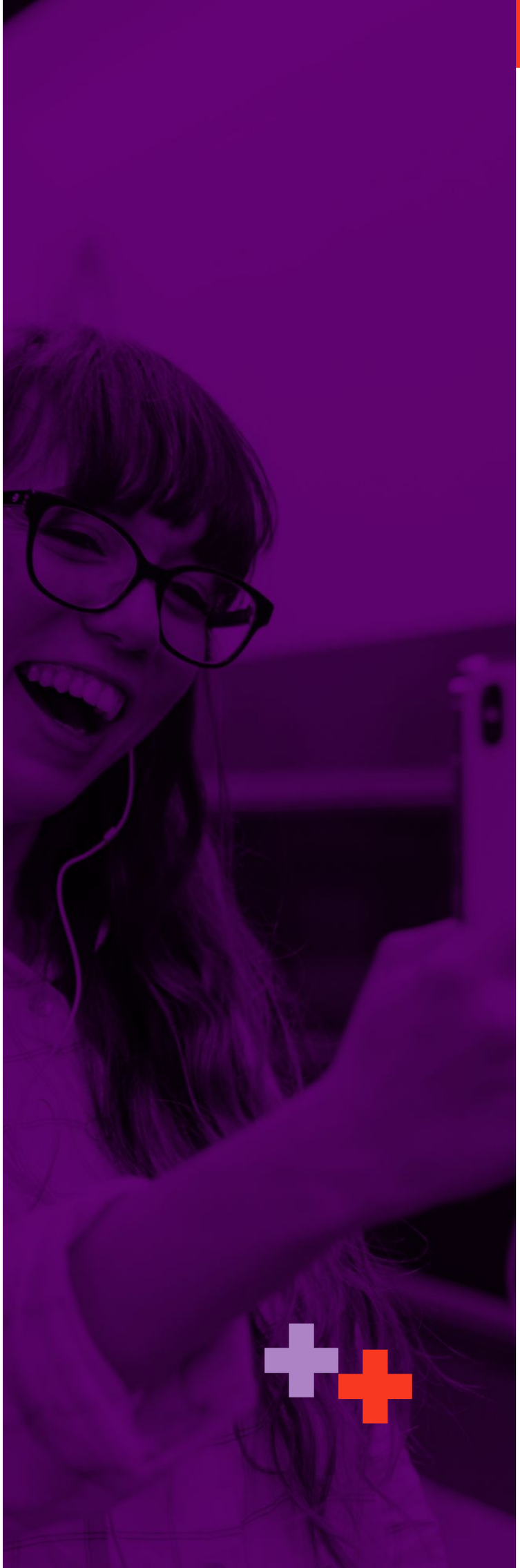

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ABSTRACT

This chapter underscores the importance of understanding the use of the internet through a gender perspective and acknowledging gender-specific discourses on the uses of information and communication technologies (ICTs), as well as their implications in terms of opportunities and risks for the young population. The growing use of digital technologies by youth highlights the importance of understanding how these transformations affect their lives. ICT use potentially provides a multitude of opportunities, for example, by supporting children's rights, including those pertaining to gender equality. However, internet use also replicates inequalities affecting young people, and it creates new inequalities which may not be adequately portrayed in quantitative research. Gender inequalities affect both the uptake of ICT-related opportunities by girls and boys and the nature and extent of their online risks. In this context, how can researchers identify the inequalities related to the access to and use of ICTs by the young population? How can we identify gender differences in terms of opportunities and risks online? This information is crucial to inform policymaking that aims at bridging the gender digital divide. The Regional Centre for Studies on the Development of the Information Society (Cetic.br), a department of the Brazilian Network Information Centre (NIC.br), developed a qualitative research framework that takes gender as a fundamental cross-cutting dimension for understanding the social implications of digital technologies in the lives of the young population. This research aims at investigating practices of access and use as well as activities of young people online which escape quantitative approaches. The qualitative study was implemented in the urban setting of São Paulo, Brazil, by Cetic.br in 2016. Focus groups were conducted with internet users aged 11–17, as well as mothers, fathers, and teachers, in order obtain insights into gender-specific issues on the use of ICTs by the young population. Additionally, in-depth interviews were conducted with young people selected according to their self-identified gender identity and or sexual orientation. This chapter presents preliminary results on the intersection of two important dimensions, online privacy and violence, examining how this population manages their information online and exploring the role of gender in this complex process.

KEY FINDINGS

- Girls and boys manage their privacy settings according to their intended audiences, and digital skills prove to be particularly relevant for this.
- Both boys and girls aged 11–17 believe that parents are more restrictive and controlling of girls' use of the internet. Many attribute this difference to gendered norms of what is appropriate or acceptable for girls. However, limited access to ICT may influence how children find and uptake opportunities.
- Girls have more concerns about their personal information online being more exposed to risky situations; they are also more likely to suffer negative consequences from this than boys.
- The non-consensual disclosure of nude photos appears to be a common practice that affects youths' lives. This practice is gender-based: girls' photos are disclosed by boys, without consent. The consequences of such actions are perceived as extremely problematic for girls, with consequences ranging from changing schools to depression and suicide attempts.
- Both girls and boys say they don't know how to proceed or to whom they would turn for help in situations of non-consensual disclosure of nude photos.

INTRODUCTION

New media have been widely embraced by young people for purposes of communication and connection to peers, as well as for self-expression online. In 2017, it was estimated that one in three adolescents under 18 were online worldwide — a fast-rising proportion of Internet users (Livingstone et al., 2016). Such rapid growth in youth's access to the Internet, further enhanced by the spread of mobile Internet devices, has led to increased attention to young people's uses of digital technologies.

In spite of advances in access to digital technologies worldwide (ITU, 2018), digital inequalities and exclusion, especially related to gender, remain of a particular concern[51]. Gender-related data on ICT are essential to map patterns in access to and use of ICT, to inform national policy and to monitor the advancement of international policy goals of equitable information and knowledge. Unfortunately, the scarcity of sex-disaggregated ICT data, especially for developing countries, may hinder the development of ICT policies that can benefit girls and women (UNCTAD, 2014). This is of particular relevance since gender can influence young people's access to and use of technology, including how they use devices, what activities and opportunities they are encouraged to pursue by means of ICT use, and the consequent benefits (and risks) they experience.
A review of recent research shows a general lack of

51 *The digital gender divides have been addressed by numerous international initiatives, including the World Summit for the Information Society (WSIS, 2003, 2005), the WSIS+10 Outcome Document (ITU, 2014), and Agenda 2030 adopted by UN member states (UN, 2015; UN Women, 2015), which focus on ICTs as strategic for improving gender equality and ensuring opportunities of learning, empowerment and participation (SDG 5 - Gender Equality).*

up-to-date and reliable data on children's gender, age, or internet use. Considerably more data is collected in the Global North (albeit unevenly distributed among and within regions), although girls aged 10–14 are understudied (Livingstone et al., 2017).

The available data nonetheless point to relevant gender gaps in ICT access and use: "in homes where digital technology is provided by parents, it is more likely that girls will be given access at an older age than their male peers, that the access which they are given will be more curtailed or surveilled, and that the idea of ICT-related careers will be more associated with boys than girls" (Livingstone et al., 2017, p. 1). More wide-ranging, systematic gathering of gender-disaggregated data is needed to investigate existing digital divides in relation to affordability, digital skills, online risks, and underlying socio-economic factors (UNCTAD, 2014). Qualitative investigations are also needed to shed light on aspects that are difficult to analyze by means of quantitative methods.

This chapter presents a qualitative research framework aimed at understanding perceptions and discourses around gender-specific uses of ICT. The framework was developed by the Regional Center for Studies on the Development of the Information Society (Cetic.br)[252], in partnership with FLACSO Argentina (the Latin American Faculty of Social Sciences). We also present preliminary findings of data collected in São Paulo, Brazil, addressing the issues of online privacy and violence.[53]

QUALITATIVE RESEARCH FRAMEWORK ON YOUTH, ICT AND GENDER: KEY DIMENSIONS

This Qualitative Research Framework aims to illustrate practices of access, use, and activities of young people online, exploring social representations, perceptions, and discourse of young people around gender-specific uses of ICT. Social representations (SRs) are collectively generated; they do not exist outside the social groups that produce them, and they have a functional role in enabling individuals to make sense of the world. The framework builds on Teun van Dijk's (2008) conceptual triangle linking "discourse – cognition – society" in the context of ideology. Specifically, the research framework addresses the following key dimensions: access, uses and opportunities; self-representation; privacy and online violence[54].

The aim is to investigate how social representations are construed, validated, or challenged in young people's discourses around use of ICT, viewed from a gender perspective. Discourses that are deeply embedded in social representations and social situations may be less prone to discursive challenges, whether from academics, government agencies, or media. This may be especially true of highly naturalised social representations, including those about children and childhood, or of hegemonic ideals about masculinity and femininity; such social representations are, accordingly, readily reproduced and resistant to change.

ACCESS, USES, AND OPPORTUNITIES

Inequalities in access to and use of ICTs still persist along socioeconomic divides. Differences in digital literacy, skills, and experience with digital technologies, and in opportunities to engage in more creative uses, mean that not all young people are able to take up opportunities equally even when these become accessible (Livingstone et al., 2017).

This dimension of the research explores several aspects of ICT access and use : the role of peers and family members, including siblings; gender-specific social representations and perceptions around access to devices and uses of the internet; gender-specific social representations around uses and activities online; and what opportunities and benefits young people feel they have, and how these connect to gender differences.

Research questions

Access. Do conditions of access to devices differ for boys and girls, and how do they differ? What do young people perceive as limiting or enabling? Do they feel supported and encouraged by family members and other adults to access devices and the internet? Do they experience restrictions and limitations, and are these related to gender? Which devices are used the most, in which locations, and do these findings differ by gender?

Uses. What activities do young people do online?

52 *The Regional Center for Studies on the Development of the Information Society (Cetic.br), a department of the Brazilian Network Information Centre (NIC.br), is responsible for the production of indicators and statistics on the availability and use of the Internet in Brazil. In 2012, Cetic.br was nominated a Category II UNESCO Center, with the mission of contributing to building inclusive knowledge and information societies in Latin America and the Portuguese-speaking countries of Africa through information and communication technologies.*

30 *The Research framework was implemented by FLACSO Argentina, and data was collected in Buenos Aires in 2016. Despite some methodological differences with the Brazilian approach (e.g., differences in criteria for sample selection), data was coded following the codebook used in Brazil, allowing for comparisons between the datasets.*

54 *The research framework and dimensions for investigation were developed by the research team at Cetic.br, drawing on literature and previous studies on the uses of ICT by the young population.*

What are their perceptions about how girls and boys use the internet? Are they either encouraged toward specific activities or limited by family members and adults, and, if so, does this differ by gender? Do they explore a wide range of activities, or are they directed towards gender-stereotypical uses?

Opportunities. Are children creating content online, and why? Why is it important for them, who do they perceive as the audience, and what are they communicating about themselves? What does this activity mean for them? Is there a connection to issues of gender, e.g., as power relations? Do they engage with online communities or group discussions, or otherwise search for new information or points of view? What opportunities do they feel they may have, or lack, through access to and use of ICT? Are any of those opportunities gender-related? Are they encouraged by family members and/or other adults to explore a wide range of opportunities, or are they directed toward gender-stereotyped benefits and results of internet use?

SELF-PRESENTATION ONLINE AND SELF-IMAGE: THE USE OF SOCIAL MEDIA TO CONSTRUCT AND PERFORM GENDER IDENTITIES

Although social media has been widely adopted by young people generally (Livingstone and Mason, 2015), girls face the challenge of having to express hyper-feminine and sexualised roles — projecting stereotypical, body-objectified self-concepts, as promoted by media and (often) internalised — while maintaining the image of "proper" feminine behaviour. Conversely, young boys are pressured into adopting hyper-masculine gender roles, exhibiting dominant and macho behaviour (Ringrose & Eriksson Barajas, 2011), and projecting images of emotionless, aggressive, and toxic masculinity (Holloway, 2015) in their expressions on social media.

Research suggests that gender-typification (i.e., showing interests, attitudes, and conduct that are stereotypically associated with own gender) also plays a role in online victimisation and cyber-bullying, with those not conforming to traditional roles being more victimised (Navarro, 2016). The way young people express gender-stereotypical traits on social media — or, conversely, choose to challenge stereotypical self-presentation — not only enhances (or reduces) digital inequalities but also relates to potential risks of online victimisation.

This dimension explores how young internet users conform to stereotypical gender norms online (for example, performing macho and "toxic" masculine roles) or challenge and exploit them (for example, performing hyper-sexualised gender roles while maintaining the appearance of "proper" behaviour) (Ringrose, 2010). Related practices include "policing" other young people, and being "policed", through social stigma (Ringrose & Barajas, 2011).

Research Questions

How do boys and girls construct and perform identities online? What do they feel is appropriate to express and present online, as feminine or masculine or other identity? What kinds of profiles do they use with their family members and friends? Are their profiles gender-stereotypical or gender non-conforming? Are their standards of physical appearance/beauty reinforcing heteronormative expectations? How do their standards of physical appearance relate to issues of race and class? Are girls and/or boys encouraged to construct and perform stereotyped online gender identities or to explore online non-conformative, alternative expressions of gender?

PERCEPTIONS OF PRIVACY ONLINE, SOCIALISATION OF PRIVACY AND PERSONAL BOUNDARIES

As social networks are increasingly used by the young, concerns about breaches of privacy and misuse of personal data emerge as a specific category of risks in the research and policy agenda. How do young people deal with privacy issues around different personal networks (e.g., peers, family, teachers); how do they use different online platforms and privacy settings for different purposes (managing what information is shared with whom online); and how do they tackle issues around trust and password-sharing? These questions are closely connected with the perspective of privacy as co-constructed by various actors in one's network (Petronio, 2002). This area, too, needs to be examined through the lens of gender: reflecting on how young girls and boys think about the meaning of privacy, both online and offline, and how they perceive gender differences, is important to understand the specific privacy issues and risks that young people face online.

This dimension explores how different socialising agents (family, school, media, peers) promote different ideas about personal boundaries and privacy and whether these messages vary according to gender. For example, are only girls specifically warned against sending nude photos, or are all children (boys and girls) being equally socialised in consent culture and the right to privacy? A related question is how these ideas and messages may be either reinforced or challenged in the content that young people choose to share of themselves online, and with whom they share it.

Research Questions

How are boys and girls socialised by various agents (family, media, school environment and groups of peers, wider community) regarding what is appropriate to share online, and with whom? How are they encouraged (or discouraged) regarding managing degrees of disclosure, setting and enforcing boundaries, and maintaining control over their privacy? (For example, are girls or boys asked to share their passwords with others in their peer group, or to share pictures on the device or on social media?) How do they manage their privacy settings and perceive online risks, and does this vary by gender?

ONLINE VIOLENCE

Young people's exposure to online risks, the types of risks they encounter, and the connection with face-to-face risks (e.g., violence) are widely discussed and debated. EU Kids Online has formulated some key observations: not all risks result in harm (Hansson, 2010); young people have various degrees of resilience; and young people who are most vulnerable, both online and offline, are most likely to be in danger of harm[55]. The risks related to online violence, such as the dissemination of nude photos without consent and sexual cyber-bullying, are marked by unequal gender dynamics, with girls usually being more affected by gendered pressures towards sexual behaviour, experiencing more negative consequences and ensuing harm. The situation is often worsened by low levels of knowledge, little support, and lack of discussion of consent, by peers, schools, parents, and the media.

As of 2013, technology-mediated violence against women has been acknowledged by the UN Commission on the Status of Women and by the UN General Assembly; other relevant public policy documents have shown concerning trends regarding the prevalence of violence against women, including technology-mediated violence. Substantial effort and resources have been directed towards ensuring children's safety online, in alignment with the protection dimension of the 1989 UN Convention on the Rights of the Child (UNCRC, 1989) — mainly concerning sexual online risks, and less in relation to opportunities for gender and sexual expression (Livingstone and Mason, 2015).

This dimension explores young people's experiences and perceptions of online violence, including harassment, discrimination, and dissemination of nude photos without consent, whether gender-specific or not, as well as its consequences and implications for boys and girls respectively.

Research Questions

Have young people experienced any type of problematic situation online, including harassment, discrimination, verbal violence (including being called names), dissemination of nude photos without consent, or slandering (e.g., being ridiculed online for not conforming to norms regarding physical beauty)? Are the issues they report gender-specific? What are the impacts for those who experience such situations? Does this differ for boys and girls? Whom do they consider responsible for such problematic situations, and how could they be avoided? How can they deal with these situations when they arise?

IMPLEMENTING THE RESEARCH FRAMEWORK: THE CASE OF YOUNG INTERNET USERS IN SAO PAULO, BRAZIL

Following a pilot phase, the research framework was implemented by Cetic.br in the metropolitan area of São Paulo, Brazil, in September 2016[56]. In this phase, the project was carried out in collaboration with Brazilian Center for Analysis and Planning (CEBRAP), and fieldwork was was conducted by the Brazilian Research Institute Ibope Inteligência. Fieldwork consisted of 16 single-sex focus groups[57] conducted with internet users aged 11–12, 13–14, and 15–17[58]. For these age ranges, consent was sought from both minors and adults to conduct the research. Also, data collection was preceded by a series of consultations with young people and with experts on topics related to gender, internet and media, and young people, from academia, government, and civil society, in

55 *EU Kids Online is a multinational research network that seeks to enhance knowledge of European children's online opportunities, risks, and safety. It uses multiple methods to map children's and parents' experience of the internet, in dialogue with national and European policy stakeholders. For more information see: http://www.lse.ac.uk/media-and-communications/research/research-projects/eu-kids-online.*

56 *The research framework was also implemented by FLACSO Argentina, and data was collected in Buenos Aires in 2016. Despite the methodological differences with the Brazilian approach (e.g., differences in criteria for sample selection), data was coded following the same codebook as used in Brazil, allowing for comparisons between the datasets.*

57 *Each focus group had five participants, with an average duration of 120 minutes, and was conducted by a professional moderator (same sex as the group). All the focus groups took place in a one-way mirror lab, with all discussions recorded and transcribed. All transcriptions were then coded, following a codebook for selected themes and dimensions, using NVivo software.*

58 *Internet users are defined as "individuals who used the Internet from any location in the last three months" (Manual for measuring ICT access and use by households and individuals, International Telecommunciations Union. Available at https://www.itu.int/dms_pub/itu-d/opb/ind/D-IND-ITCMEAS-2014-PDF-E.pdf). Other prerequisites were having used mobile phone and social networks in the three months prior to selection.*

order to map out topics to be addressed. Including young people in the process of designing the research questions conforms to the prerequisite of including young people in decision making processes that affect their lives, in keeping with the UN Convention on the Rights of the Child. Finally, four (out of sixteen) focus groups were composed exclusively of black young people. In-depth interviews were conducted with young people selected according to their self-identified gender identity and/or sexual orientation, recruited with the help of a local LGBTQ organisation.

Given that children's online experiences cannot be studied in isolation from their lives in general (Kardefelt-Winther, 2017), the sample selection criteria for the focus groups included: gender; racial and ethnic characteristics(according to the official Brazilian distribution, and following the classification established by the Brazilian Institute of Geography and Statistics); and type of school (public or private) — with additional sampling for socio-economic level (SEL)[59]. Information about religion was also collected, though not used as a sampling variable A thematic analysis was conducted; for this chapter, relevant quotes were translated by the authors, with attention to children's expressions and use of language.

For the purpose of this chapter, we present preliminary findings focusing on two broad dimensions of interest: (1) perceptions of privacy online, socialisation of privacy, and personal boundaries; and (2) online violence. This will allow a brief discussion on how young people reflect about privacy, how they manage information shared online, and how they deal with the issue of consent. Additionally, we discuss the perceived gender differences related to online privacy and risks — a topic that is deeply connected to experiences of online violence reported by the interviewees.

PRELIMINARY RESULTS: BRIEF DISCUSSION OF ONLINE PRIVACY AND VIOLENCE

The rise of social networking sites and their enthusiastic embrace by young people have posed new challenges regarding how they manage the information they share with different "networked publics" (Ito, 2008). As cultural assumptions and social norms around privacy, sharing, and visibility are revisited in the context of new technologies, youngsters appear to be using innovative mechanisms for dealing with these issues (Marwick & Livingstone, 2014).

59 *The socio-economic criteria adopted are the Brazilian Classification Criteria that classify households according consumer goods (avoiding the more sensitive question of income). For more information on the Brazilian Economic Classification Criteria, see www.abep.org/Servicos/Download.aspx?id=11.*

This is no different in Brazil: young internet users living in São Paulo claim to use SNS and their different functionalities to manage and select their intended audiences, according to which information they mean to share online and with whom. In this context, gendered norms of what is socially acceptable in terms of attitudes, appearances, and behaviours appear to be of relevance throughout this process.

When I post something, I block my entire family. Like, 'friends except family' … because they'll say 'what about those clothes you left the house wearing yesterday?'

– Girl, 15–17, private school

It is a very complicated selection process. You think of posting something, then you think of someone that will complain, so you give up.

— Girl, 11–12, public school

My [ex-boyfriend] sort of made me [share my SNS password with him]. I would delete all the messages I exchanged during the day.

— 13–14 year-old girls, private school

Privacy has been conceptualised as a process of managing the boundary between an individual and his or her social context, as well as deciding what information to share and who should have access to it (Altman, 1975; Westin, 1967). Although they often found it difficult to define in their own words when asked about the meaning of "privacy", many young Brazilians describe it in terms of its absence, with particular mention of perceived "invasion of privacy" regarding their online activities.

Adults often undermine the agency of the young population, by scrutinising their children's mobile phones and surveilling their activities online (Marwick & Livingstone, 2014). Moreover, Brazilian findings show that both boys and girls, from different age ranges, perceive parents as more controlling of girls' use of the internet. Attempts to explain this often suggest that girls are "naturally" more vulnerable, in particular with regard to their safety, in a context where the boundary between online and offline interaction becomes increasingly diffuse. Nevertheless, this practice may affect the unequal uptake of opportunity by boys and girls.

My dad always takes my mobile phone, and once I found him reading my conversations and I got very angry because if he asks me what's going on, I'll tell him. He takes it from my hand, he won't even let me block it.

— 13–14 year-old girls, private school

If my mom takes my mobile phone to check it and finds a photo or something, it's okay, I'm a boy, right, boys are like that, she'll understand, but if it's my sister, she's toast.

— 15–17 year-old boys, private school

My dad says that he gave my brother more freedom because I will always be daddy's girl and he will always be more cautious with me than my brother. That it is much more likely that something dangerous happens to me than my brother.

— Girl, 11–12, private school

Although a wide variety of problematic online situations were described by young Internet users, including racial discrimination and bullying, a striking and recurrent situation was the non-consensual disclosure of nude photos by a third party, usually after having been sent to a trusted person (such as an ex-partner or friend)[60]. This was reported in all focus groups conducted in São Paulo, in all age ranges, and was much more prevalent among girls. Overall, the consequences of these practices were also perceived as extremely problematic for girls; they ranged from having to change schools to depression and suicide attempts.

In my school there is a girl, she sent nude photos to a boy, he posted them and she had to move to another country; the girl's mom wanted to kill the boy and the girl wanted to kill herself and almost threw herself at the train tracks.

— 11–12 year-old girls, public school

My friend's [nude photo] was also shared without consent. Her boyfriend printed her photos and put them on the street poles, it was horrible and the police had to be involved.

— 13–14 year-old girls, private school

In face of such situations, a common reaction in the focus groups was to blame the girls for taking and sharing photos of themselves in the first place. Seldom was the perpetrator, who disclosed the photos without consent, accounted responsible.

She is also wrong to send [nudes] (...) because if someone sends it to me and I disclose it, the fault won't be mine, it will be hers. I think so.

— 13–14 year-old boys, public school

But, deep down, I think [the girls] want [the photo to be disclosed] because if she didn't, she wouldn't take the photo.

— 15–17 year-old boys, private school

I'd like to ask her something: was the girl forced to send the boy a photo [or] did she do it because she wanted to? She did it because she wanted to.

— 11–12 year-old girls, private school

A tension is reflected in the literature between the rights of youth — to sexual expression and privacy —and the need for child protection, as well as a discrepancy between how youngsters perceive these situations and what they are taught about them (Livingstone & Mason, 2015). As noted by Ringrose et al. (2013), discourses around sexting tend to reproduce moral norms of victim-blaming in cases of sexual assault (Salter et al., 2013, p. 312), instead of condemning the cultural sexism that endorses unauthorised and coercive distribution of girls' pictures (Salter et al., 2013, p. 307). Accordingly, these discourses on sexting present girls as sexual subjects to be controlled and their sexuality as something to be surveilled and regulated (Salter et al., 2013). The preliminary findings of this project highlight the relevance of detailed research that can address the issues of privacy and violence from a gender perspective, and their implications for the young population.

60 The practice of "sexting" is often referred to as "sending nudes" in the Brazilian context, that is, voluntarily sharing photos or videos of one's own body. This practice appears to be widespread in Brazil; here, it is not addressed as a problem in itself. This chapter refers to situations where such images have been shared with third parties without consent, a practice that is more prevalent with girls, often with serious consequences.

MOVING FORWARD: KEY RECOMMENDATIONS

- Engage key stakeholders in the ICT and gender debate; promote awareness-raising on the topic, giving voice to children and also involving parents, educators, the media, the private sector, and researchers.
- Promote more research to obtain timely, robust data on ICT use by children, through a gender perspective, to inform policymakers; use internationally agreed research frameworks (adapted locally) to allow cross-national comparisons.
    - Adopt a mixed-methods approach whenever possible, producing both quantitative and qualitative data.
    - Give special attention to data gaps: themes (e.g., privacy and violence); age ranges (e.g., young girls); and geographical scope (Global South, rural areas).
- Mainstream gender in both research and policymaking related to children's use of ICT; promote evidence-based policymaking in this field.

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4

ACCESSIBILITY, INTERSECTIONALITY, AND UNIVERSAL DESIGN: HOW OVERLAPPING FORMS OF DISCRIMINATION LIMIT ACCESS TO TECHNOLOGY FOR WOMEN WITH DISABILITIES

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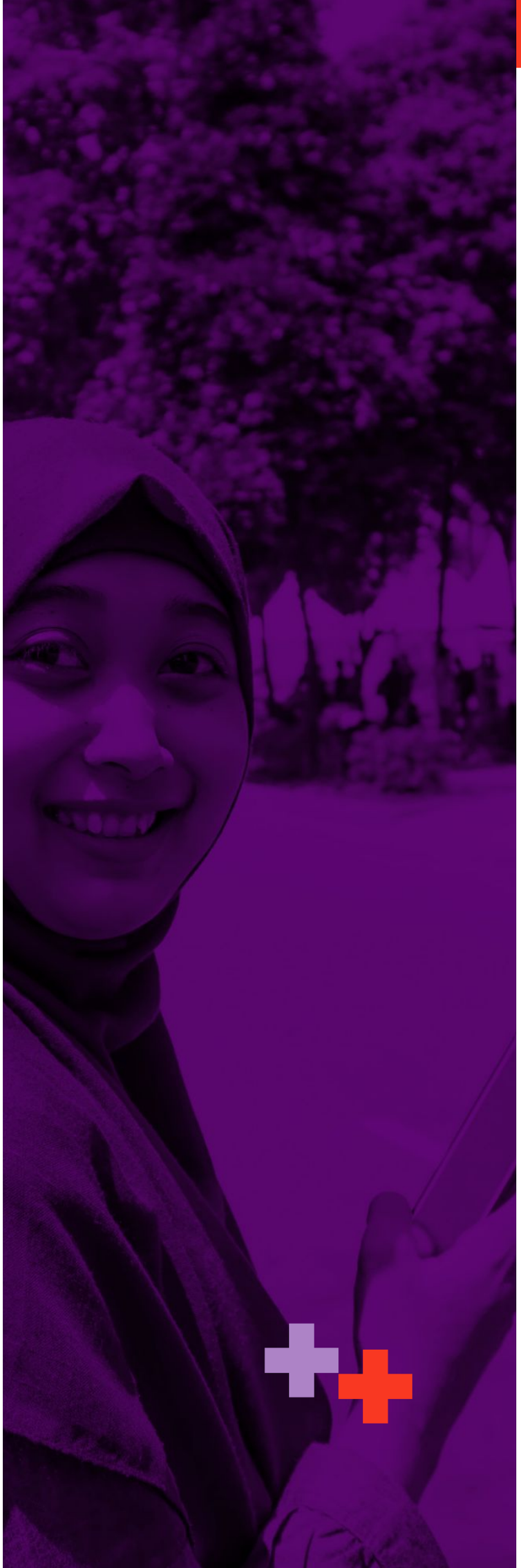

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ABSTRACT

This chapter focuses on the relationship between the digital gender gap and other forms of social disadvantage and discrimination. The United Nations (UN) Convention on the Rights of Persons with Disabilities (CRPD) recognises the relationship between gender and disability, stating that "women and girls with disabilities are subject to multiple discrimination"; it asserts that States Parties have an obligation — along with other requirements — to ensure access to information and communication technology (ICT), including the internet, to women with disabilities, on an equal basis with others. Borrowing from feminist legal scholarship, disability rights scholars have adopted the term intersectionality to describe the overlapping forms of discrimination and systematic injustice that affect women with disabilities. Since the 1990s, researchers in human-computer interaction, legal scholars, and industry practitioners have promoted ICT accessibility, striving to remove the barriers that persons with disabilities experience using ICT. Similarly, the UN has argued that under the CRPD, States Parties have an obligation to ensure that technology is usable for persons with disabilities. The UN also endorses universal design, which requires the design of ICT "to be usable by everyone to the greatest extent possible without the need for adaptation or specialised design". Universal design serves as a useful tool in promoting both ICT access and accessibility for women with disabilities, and it provides a useful framework for understanding the overlapping forms of discrimination that women with disabilities experience in accessing and using ICT.

KEY FINDINGS

- States have an obligation to ensure access to ICT, including the internet, to women with disabilities, on an equal basis with others.
- Universal design provides a useful tool for promoting both access and accessibility in ICT for women with disabilities; it provides a framework for understanding the overlapping forms of discrimination that women with disabilities experience in accessing and using ICT.
- Disability rights scholars have adopted the term intersectionality to describe the overlapping forms of discrimination and systematic injustice that affect women with disabilities.
- Since the 1990s, researchers in human-computer interaction, legal scholars, and industry practitioners have promoted ICT accessibility to remove the barriers that persons with disabilities experience using ICT.
- Research still needs to fully develop and operationalise universal design, to allow scholars and advocates to integrate an intersectional perspective in ICT. Scholars have yet to investigate in detail the experience of multiple socially marginalised groups in accessing and using ICTs.
- While ICT developers have made significant strides towards automatic detection of hate speech online, the implications for persons with intersectional identities have yet to be explored.
- Research on ICT accessibility has not yet fully examined the socio-economic and socio-political mechanisms that persons with disabilities experience accessing ICTs, particularly women with disabilities in the Global South. "Accessibility," as generally understood, is accessible for a small fraction of people with disabilities.

INTRODUCTION

The World Health Organisation (WHO) estimates that 15% of the world's population has experience of long-term disability (WHO, 2011), finding that the prevalence of disability is higher among women than men (WHO, 2016). Moreover, moderate to severe disability affects 67% of women with disability — slightly higher than the 65.3% of men with disability — and women with disabilities experience gender discrimination in addition to any disabling barriers (WHO, 2011). Accordingly, the effort to bridge the digital gender divide must take into account the experiences of women with disabilities. The European Union as well as the United Kingdom and other countries have recognised that women face multiple forms of discrimination, and that the rights of women do not exist in isolation from their rights as persons with disabilities. Indeed, women with disabilities may experience exacerbated rights violations, occasioned by their dual identity as women and as persons with a disability. In relation to access to ICT, women with disabilities experience unique barriers to ICT that need to be tackled as a whole rather than separately.

It is beyond the scope of this article to fully investigate the relationship between digital divides, disability, and gender. Digital divides are complex and multidimensional; they may include barriers in using ICT interfaces, barriers in accessing information, and barriers in acquiring digital competencies. Technical standards for designing technology that is accessible specifically to women with disabilities have yet to be developed, either by government or by industry. The specific barriers experienced by persons with disabilities in accessing and using ICT have been well documented in the literature (Dobransky & Hargittai, 2006). Since the emergence of the disability rights movement in the United States in the 1960s, research has provided examples as well as criteria for ensuring that ICT is accessible for persons with disabilities (Toboso, 2011). For example, persons with visual impairments may experience barriers accessing websites that are not compatible with assistive technologies such as screen readers (Brown & Hollier,

2015). Screen readers convert text into audio, but when images are posted without text alternatives, screen readers are not able to interpret the images, and persons with visual impairments experience barriers accessing web content. Similarly, persons with mobility, cognitive, and psychosocial disabilities may use a variety of input devices and may need and prefer content that is simple and understandable when accessing ICT, needs that must be considered by developers (Blanck, 2014).

Some potential design considerations for ICT developers emerge clearly from the hypothetical but realistic situation of women with disabilities trying to access information on the web about domestic abuse. A woman survivor of domestic abuse may experience barriers accessing information about domestic abuse on the web based on gender, disability, and possibly other social identities (racial, ethnic, socio-economic, etc.). First, the act of accessing information about domestic abuse may put the woman in a dangerous or threatening situation, if the web developers have not provided and highlighted understandable, easy-to-access, and discreet functionalities to clear the web browser's search history. Second, accessing information about domestic abuse may trigger feelings of doubt or self-blame, if the content developers are unaware that information on abuse can be presented in ways that promote self-esteem and perceived control. Third, imagery used on the website may contain problematic symbols that convey unintended, culturally inappropriate meanings, if the content developers have not considered the sociocultural background of the user (Rideout, et al., 2016). Fourth, the content of the website may alienate and exclude transgender women or women in a queer relationship, if developers have embedded cisgender and heteronormative design assumptions that diminish or marginalise the experiences of queer and transgender women (Shelton, 2017). Fifth, complex content and features of the website may be inaccessible for persons with cognitive disabilities, if the developers have not ensured that the website adheres to standards for web accessibility such as the Web Content Accessibility Guidelines (WCAG), which prescribe, among other things, the use of clear and understandable language and actions. Sixth, the content of the website may exclude women of a variety of cultural backgrounds due to the use of unfamiliar idioms and cultural references. Seventh, the content of the website may exacerbate issues related to low self-esteem, social stigma, and prejudice, if developers have not considered the experiences of women with cognitive and psychosocial disabilities who have survived systematic abuse (Meer & Combrinc, 2015). Finally, the content of a website may discourage a woman from seeking help if the content is intimidating and difficult to understand. The interaction between this hypothetical user and the design of the website inextricably links the woman's gender, sociocultural background, disability, and sexual orientation; web developers must consider these design choices holistically, to render the website accessible to women with disabilities.

This chapter has three parts. It presents research on marginalisation and discrimination in the use of ICT, including ICT accessibility for persons with disabilities and the less widely understood impact of intersectionality on ICT access. It then presents relevant research on universal design in ICT and its potential impact on ICT accessibility. Finally, it reviews the existing literature and the need for further research, before presenting recommendations for researchers and policy makers.

MARGINALISATION AND DISCRIMINATION IN ICT

Transnational feminism situates feminism within an international context, providing a useful basis for challenging the boundaries between nation-states and between social and cultural groups (Brenner, 2003). Transnational feminist scholars have argued that satellite and internet technologies have allowed ever greater volumes of media — especially visually-based imagery — to be promulgated around the world (Fernandes, 2013). These trends have contributed to destabilising structures of power that systematically oppress women, while also reinforcing stereotypical images of women based on their culture and traditions (Fernandes, 2013).

In a related field, research in science and technology studies have shown that efforts to combat the decline of women's' participation in the ICT field have had to engage with formative masculine perceptions of the field (Henwood, 2000). Over the last decades, scholars have challenged the prevailing assumption that technology is a gender-neutral domain (Ford & Wajcman, 2017). In practice, technology is defined by a culture of perceived "know-hows" vs. "know-nots". Because a majority culture defines how individuals interact with ICT and how ICT systems are developed and structured, these development processes and user-experience designs often exclude minority groups.

The experiences of minority groups in social media provide a useful example to illustrate the unintended results of excluding minority groups from ICT development processes and user-experience design. All users, particularly minority groups, have come to expect hate speech and other types of abuse on social media, and research suggests that minority groups may view hate speech as mostly inconsequential (Skjerve et. al., 2016). However, research also suggests that minority groups are rendered invisible in online debates, precisely for fear of such repercussions or real-world consequences (Skjerve et. al., 2016). In the initial design of many social media platforms, such as Twitter, developers apparently prioritised users' anonymity over their safety and security, a decision that has the effect of disenfranchising minority groups. One of the victims of Gamergate, an on-

going campaign of harassment that personally targets women in the video game industry, is Brianna Wu. She described, in a 2015 article, the experience of being a high-profile woman online: "You have to constantly ask yourself if your post will put you or your loved ones in danger" (Wu, 2016). Wu, who ran unsuccessfully for a seat in the U.S. Congress in 2018, continues to work in industries where one's social media presence and online network have a direct influence on their career. Wu's experience shows that excluding minority groups from ICT development processes and user-experience design can exacerbate the digital divides that constrain the participation of women and other minority groups in society. Research has yet to provide case studies or empirical evidence examining the overlapping forms of discrimination experienced by women with disabilities in accessing ICT, due to both disability and gender.

ICT ACCESSIBILITY

The development of ICT has produced a global digital divide due to the barriers that persons with disabilities experience accessing ICT (Goggin, 2016). The United Nations Convention on the Rights of Persons with Disabilities (CRPD) describes disability as "an evolving concept" that "results from the interaction between persons with impairments and attitudinal and environmental barriers that hinders their full and effective participation in society on an equal basis with others". A person with an impairment, i.e., a variation in body that affects the person's way of functioning, is not inherently disabled. While pain and other symptoms of an impairment might act as disabling factors, society's failure to accommodate a person's way of functioning and environmental barriers are equally factors that contribute to disability.

This reflects the shifting conceptualisation of "disability" away from an inherent deficiency on the part of an individual towards a recognition that designers typically embed assumptions of accessibility and functionality in developing social structures and built environments — assumptions that disadvantage some people (Shakespeare, 2006; Oliver & Barnes, 2012). Javier Romañach and Manual Lobato, at the 2005 Independent Living Forum in Spain, proposed the term functional diversity as an alternative to "disability", emphasising the role of the social and material environment in co-constructing what is considered "normal" functionality. Functional diversity broadly includes a person's individual characteristics and environmental context, as well as the micro-level interactions with ICT that mediate their lived experiences; within this layered construct, women with disabilities may experience unequal access to technology (Bøhler & Giannoumis, 2017; Sen, 1995; Toboso, 2011).

Ensuring accessibility aims to promote equality between ICT users with disabilities and those without, remediating the digital divide (Ellis & Kent, 2015; Goggin, 2015; Jaeger, 2015). With the early adoption of the web in the U.S. and Europe in the mid-1990s, the World Wide Web Consortium (W3C) established the Web Content Accessibility Guidelines (WCAG) as an international standard that aimed to provide clear criteria and guidance for developers to create web content that is accessible for persons with disabilities. WCAG soon spread internationally, as a practical and legal solution for achieving web accessibility (Giannoumis, 2015a). By the late 1990s, interest organisations had begun to invoke disability anti-discrimination legislation to take private enterprises to court over websites and ICT features that were inaccessible for persons with disabilities (Giannoumis, 2015b).

Research on web accessibility has focused on the outcomes of web accessibility policies, such as WCAG, in specific sectors: public libraries (Yu, 2002; Stewart et al., 2005; Tatomir & Durrance, 2010; Yi, 2015); education (Johnson & Ruppert, 2002; Klein et al., 2003, Green & Huprich, 2009); transport (Lazar et al., 2010); private enterprise (De Andrés et al., 2010); financial services (Williams & Rattray, 2003); and health services (Ritchie and Blanck 2003). In addition, research has assessed web accessibility in public services, including federal and regional governments in the United Kingdom (UK) and U.S. (Jaeger, 2004a-b; Jaeger, 2008; Rubaii-Barrett & Wise, 2008; Kuzma, 2010; Olalere & Lazar 2011; Bertot et al., 2012). The sum of this research shows that many private sector service providers have yet to remove barriers to accessing web content for persons with disabilities; and, although public and private sector organisations maintain a clear social — and often legal — responsibility for ensuring web accessibility, they have yet to remove such barriers.

INTERSECTIONALITY

Intersectionality provides a useful basis for examining the overlapping forms of discrimination that women with disabilities experience in accessing ICT. Intersectionality, as both a theory and a methodology, recognises that systems of oppression intersect with each other; thus, the sum of an individual's identity goes beyond separate components such as ethnicity, race, class, sexuality, age, ability, citizenship status, and gender (Collins & Bilge, 2016; Crenshaw, 1991). This has two main implications. First, no part of a person's identity can be isolated: a lack queer woman cannot isolate the Black or "queer" dimension from her gender identity. Second, measures adopted to improve access for white, cisgender, and straight women will not necessarily have the same benefits for a Black queer woman simply because they share the same gender identity. The intersection of different forms of social identity and social disadvantage impacts many issues. For example, studies on health care and pain management found that health care practitioners are more likely to ignore lack women with pain complaints than Bblack men or white women (Green et al., 2003). Regarding access to ICTs, a recent study by the Bill and Melinda Gates Foundation found that African-American parents are less likely to encourage their daughters to use ICTs than their sons (Rideout et al., 2016). This research reveals that, even if the general trend shows increased levels of ICT adoption among minorities, there could still exist great disparities for girls and women of color (Rideout et al., 2016).

An intersectionality perspective recognises that women with disabilities experience discrimination as women, as disabled individuals, and as women with disabilities (Lawson, 2016; P-RR-DIWOM, 2003). Beyond gender, other factors as well — race, sexual orientation, gender-identity, cultural context etc. — interact and affect the experience of a person living with disability (Chaudry, 2016; Moodley & Graham, 2015). Such intersecting hierarchies and structures of power can compound individual disadvantages (Crenshaw, 1991). Transnational feminism considers how different types of access to technologies and accommodations, as well as differing conceptualisations of disability, affect the ability of an individual woman to engage with ICT. For example, harassment and violence against persons with disabilities often reflect an intertwined (perceived) deviance from such norms as ability and gender (Meer & Combrinic, 2015; Barnett, 2017). Isolation of disability — the notion that disability exists alone and independently — affects access to and quality of education (Nguyen & Mitchell, 2014). Likewise, a failure to consider persons with disabilities in efforts to improve healthcare and economic conditions will limit, and sometimes exclude, persons with disabilities from participation: this was illustrated in the case of microfinance loans in India meant to empower women (Chaudhry, 2016). Finally, many U.S. military veterans with physical, cognitive, and/or psychosocial disabilities, who are increasingly women and minorities, experience barriers in accessing healthcare through the Department of Veterans' Affairs. The use of ICT, such as smartphone apps and online chat forums, may provide a useful approach for alleviating these barriers (Fortney et al., 2011). To realise the potential of these tools, however, it will be important to understand and address the barriers that women and minorities with disabilities experience accessing and using ICT.

Antidiscrimination law and policy have provided a useful basis for incentivising, and coercing, providers of goods and services to ensure access to ICT for persons with disabilities, but these laws do not fully comprehend the barriers that persons with intersectional identities experience in accessing ICT (Blanck, 2014). The 2010 Equality Act in the UK has provided protections for persons with multiple protected characteristics, such as disability, race, gender and sexuality. However, some research has found that the Equality Act has failed to accommodate instances of discrimination that have an intersectional nature (Solanke, 2011). As discussed in the following section, the Norwegian government has taken a different approach, requiring goods and service providers to ensure universal design of ICT (BLID, 2005).

UNIVERSAL DESIGN OF ICT

Universal design typically refers to the design of products and services to be usable by all persons to the greatest extent possible (UN, 2006). The Action Plan of the Norwegian Ministry of Children and Equality, in promoting universal design, asserts: "The government wants to get away from a way of thinking in which the individual is defined as the problem and in which special measures for people with disabilities are the main solution" (BLID, 2009). In principle, universal design may provide a mechanism for recognising the overlapping forms of discrimination that persons with intersectional identities experience. However, like the United Nations, the Norwegian government fails to recognise explicitly the application of universal design to persons with intersectional identities, such as women with disabilities; in this regard, the Norwegian legislation is vulnerable to the same criticism as the UK's Equality Act.

While ICT accessibility is typically associated with the removal of barriers, making ICT products usable by persons with disabilities, scholars have recently begun to adopt broader conceptualisations, which relate more closely to the concept of universal design (Giannoumis, 2016). Persson et al. (2014) define accessibility as "the extent to which products, systems, services, environments and facilities are able to be used by a population with the widest

range of characteristics and capabilities (e.g. physical, cognitive, financial, social and cultural, etc.), to achieve a specified goal in a specified context". Similarly, Petrie et al. (2015) pose a unified definition of web accessibility, arguing that web accessibility means that "all people, particularly disabled and older people, can use websites in a range of contexts of use, including mainstream and assistive technologies; to achieve this, websites need to be designed and developed to support usability across these contexts".

The scope of the definitions provided by Petrie et al. (2015) and Persson et al. (2014) are similar to the definition of universal design proposed in the CRPD. According to the CRPD, universal design "means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design". (We note that the caveat "to the greatest extent possible" echoes other limit-setting legal provisions, such as the phrase "undue burden" that appears in disability anti-discrimination legislation in the United States.)

While universal design may provide a useful basis for identifying and removing barriers that persons with intersectional identities, such as women with disabilities, experience in accessing and using ICT, the concept has not been fully analyzed and operationalised in a way that would allow scholars and advocates to integrate an intersectional perspective into the design and development of ICT. For example, research on universal design shows that persons with disabilities generally experience barriers in accessing information on the web. Other research shows that persons with disabilities are not seen as autonomous sexual beings (Shakespeare, Gillespie-Sells, & Davies, 1996). This suggests that a woman with a disability may experience overlapping barriers in attempting to access maternal health information on the web. The challenge remains for web content to be developed with consideration of the barriers that the individual may experience, based on the intersection of disability and gender.

GAPS IN THE LITERATURE

Research has yet to examine fully ICT accessibility and universal design. Existing studies need to be built upon, in four important directions.

First, while research on ICT accessibility has typically focused on the usability of web content for persons with specific impairments (e.g., the blind and partially sighted, or deaf and hard of hearing), scholars have yet to investigate extensively the experiences of persons belonging to multiple socially marginalised groups in accessing and using ICT (Skjerve, et al., 2016). In addition, while research has begun to explore the relationship between gender and disability in accessing and using ICT, few programmes exist that target access to ICT for women with disabilities (Adams & Kreps, 2006a, 2006b).

Second, while ICT developers have made significant strides towards the automatic detection of hate speech online, the implications of such technology for persons with intersectional identities have yet to be explored (Djuric et al., 2015; Gitari et al., 2015; Badjatiya, 2017).

Third, research on ICT accessibility has not yet fully examined the socio-economic and socio-political mechanisms that persons with disabilities experience accessing ICT, particularly women with disabilities in the Global South (Abascal et al., 2016). "Accessibility," as generally understood, is accessible for only a small fraction of people with disabilities.
Fourth, research in universal design, similarly, has yet to provide a useful theoretical framework or model that captures the experiences of persons with intersectional identities, such as women with disabilities (Lid, 2014).

RECOMMENDATIONS FOR RESEARCH AND PRACTICE

Research

Future research could usefully collect data on the experiences of women with disabilities, focusing especially on ICT barriers that are created at the intersection of such discriminating structures as racism, transphobia, sexism, homophobia, and xenophobia.

Universal Design has yet to establish its theoretical anchoring. Future research could bring interdisciplinary application of models and methods used in other fields, to inform further research and development within the field of Universal Design of ICT.

Researchers could usefully examine the experiences of women with disabilities across the gender diversity spectrum, in accessing and using ICT. Similarly, an intersectional perspective can better illuminate such highly salient topics as online privacy, child online protection, and cybersecurity.

Finally, future research could usefully employ culturally responsive computing (CRC) (Scott et al., 2015) to enrich computing education by focusing on an individual user's cultural and social contexts. This includes presenting content in a rich and culturally-embedded way rather than attempting to "sanitise" it, as well as framing technology use in innovative ways to invite broader active participation, rather than requiring users to separate themselves from their multiple identities.

Laws, Policies, and Technical Standards

National and international law and policies require systematic reform to incorporate an intersectional understanding of accessibility in technical guidelines, accessibility regulations, and antidiscrimination laws.

In order to ensure access to ICT for all persons, governments must recognise, under law, the experiences of persons with intersectional identities that are subject to multiple forms of discrimination (Solanke, 2011). Laws and policies offering legal protections only for single forms of discrimination may not provide a clear enough standard to ensure access to ICT for women with disabilities. To ensure ICT access to everyone, laws, policies, and standards must include requirements for ensuring the universal design of ICT, while recognising human diversity and the overlapping forms of discrimination and inaccessibility that exist at the intersection of different forms of social disadvantage.

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5

ICT IN A CHANGING CLIMATE: A PATH TO GENDER-TRANSFORMATIVE FOOD SECURITY

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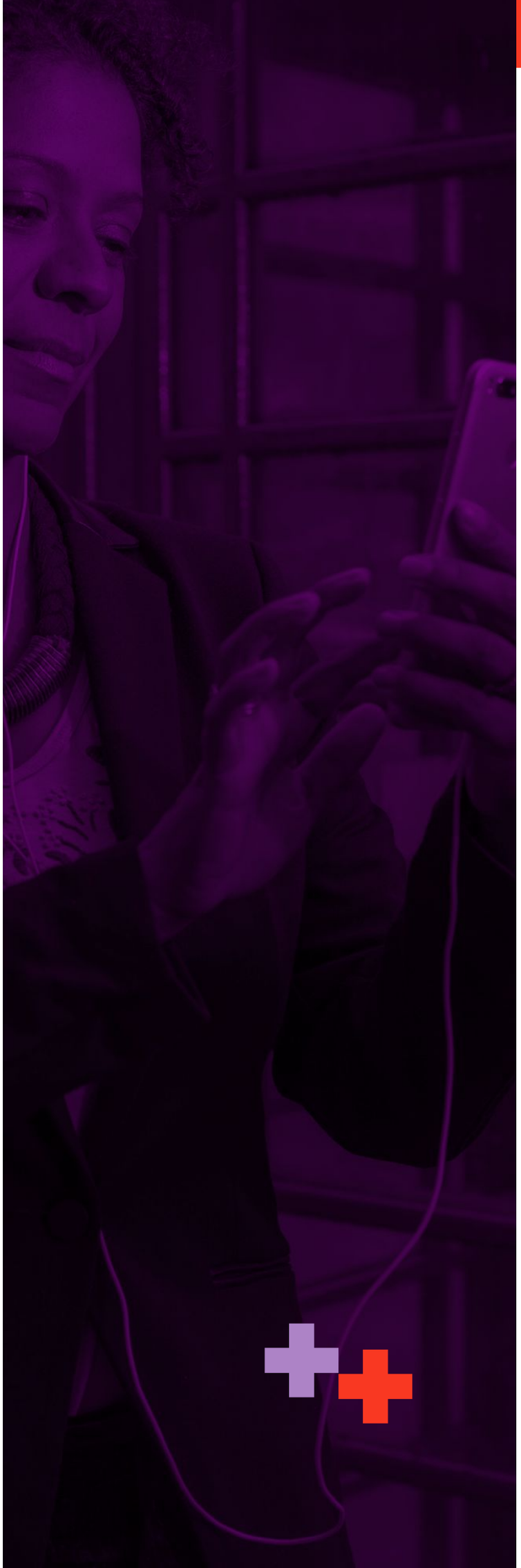

ABSTRACT

Women play a critical role in food security in the developing world, but their agricultural activities are often characterised by gaps in information and resource access, with deficiencies in several areas: land, labour, credit, information, extension, and technology. Increasing stresses on food security, brought about by a changing climate, call for the active contributions of women in agriculture. This will require equal participation in decision making, equal access to agricultural resources and services, institutions that address their concerns, and technologies and information that are useful to them. ICTs are so far not providing them with the information, services, and knowledge they need and want. Sufficient evidence and experience exist, however, to develop agricultural information strategies for food security that support women and promote gender equality. This chapter provides a review of women's access to and use of climate and agriculture information; it provides examples of successful strategies for reaching women, with suggestions for further research and programming to promote gender equality along with climate information..

KEY FINDINGS

- ICT and information services have the potential to promote gender equality and empowerment of rural women, if they contribute to needs and priorities of both women and men in rural areas and increase their resilience to cope with climate change. Currently, however, information is not reaching women farmers adequately.
- ICT can play an important role in facilitating support to women in the critical areas defined by FAO for supporting women's activities in food security: livelihood support, reducing women's workloads, ensuring protection from gender-based violence, and equitable access to resources and services.
- "Mixed" approaches may provide the most successful approaches to reach women with agriculture and climate information, in view of women's low resource access and the widespread gender norms that inhibit women's information access. Intermediary organisations, such as farmer associations and women's organisations, also serve as important avenues for women's information access.

GENDER AND FOOD SECURITY IN A CHANGING CLIMATE

ICTs have the potential to promote gender equality and empowerment of rural women in developing countries, while increasing food security, by decreasing workloads, increasing decision-making power, diversifying agricultural production, enhancing ability to respond to climate and weather variability, and improving livelihoods. Although ICT4D has a significant track record in development, the technology has not yet provided rural women in developing countries with the information, services, and knowledge they need and want — even as climate change has increased their need for innovative solutions. The problem lies in designing the transmission of information that women need in ways they can access readily. When this does happen, women have shown their readiness and eagerness to use and benefit from information through technology.

Women play a critical role in food security in the developing world. Their participation in the agricultural labour force in sub-Saharan Africa ranges from 60% to 80%; in least developed countries (LDCs), 80% of women list agriculture as their major employment sector. These percentages will increase in many countries, as rural women play a growing role in smallholder agriculture as a result of male out-migration to urban centres for employment (Doss, 2011; FAO, 2011; UN, 2015). However, women's agricultural activities are often characterised by gaps in information and resource access, with deficiencies in critical areas: land, labour, credit, information, extension, and technology (Huyer, 2016). The Food and Agriculture Organisation (FAO) has calculated that, if women farmers were to have the same access to resources and services as male farmers, their production would increase by 10–14%, with a resulting massive decrease — of up to 150 million — in the global population that experience hunger (2011). Women's vital contribution to food production, subsistence farming, and the agricultural labour force in the developing world means that strategies to promote gender equality and women's empowerment in ICT in agricultural development must be a priority for global food security. Such efforts are also central to a global development agenda based on human rights and the Sustainable Development Goals (SDGs).

Globally, rural women fare worse than either rural men, urban women, or urban men, on every gender and development indicator for which data are available; they show lower levels of health, education, employment, and decision-making power. They face higher levels of poverty and violence. Women and girls also face a higher risk of undernourishment — about 60% of people living in hunger are female (UN, 2010; UN, 2015; FAO, 2017). They are more affected by environmental deterioration and hazards, as they depend on, and have responsibility for, natural

resources. In 2010, an estimated 66% of households in sub-Saharan Africa, 55% in South and Southeast Asia, and 31% in Latin America relied on collected fuelwood for cooking, with women being primarily responsible for fuelwood collection. Rural women are at especially high risk of negative impacts from climate change, as their household responsibilities entail natural resource-based activities, including subsistence agriculture and fetching water and fuelwood. Increasing rates of male out-migration from rural areas means that women also take on additional work in agricultural production. For these reasons, environmental stress in farming systems (such as those imposed by climate change) intensifies women's workloads while decreasing the assets of poor households (Jost et al., 2016; Agwu & Okhimamwe, 2009).

Despite global gains in food production and reduction in poverty, the world faces a crisis: some 795 million people still suffer from hunger, and more than two billion experience either micronutrient deficiencies or some form of over-nourishment. Increasing pressures on natural resources due to population growth and resource extraction are exacerbated by climate change, natural disasters, and other shocks, which threaten the sustainability of food systems at large (FAO, 2017). Other major challenges include increasing urbanisation and demand for food, erratic food prices, conflict, population displacement, and continuing economic inequality. A transformation of rural development is required, if agriculture in the developing world is to cope (IFAD, 2016). Given women's role throughout food production, nutrition, environmental management, and social well-being, gender equality needs to be integral to this transformation.

Different social groups of course have varying socio-economic status, political participation, and access to resources, affecting their ability to cope with and respond to the effects of climate change. However, reflecting widespread social, political and economic inequalities, women are almost invariably at a greater disadvantage than men in the same social group, with less access to land, fewer resources and entitlements, more limited access to information and services, and less participation in decision-making (FAO, 2017). The gendered division of labour additionally means they work longer days than men, and new activities requiring additional labour are often allocated to already burdened women (Grassi et al., 2015; Beuchelt & Badtue, 2013). The latest IPCC assessment on social vulnerability makes clear that climate change will exacerbate these existing gender inequalities (IPCC, 2014).

At the same time, women's contributions to resilience building and peace processes are often overlooked; they are rarely represented in leadership and decision-making institutions, from local to national levels. As a result of these inequalities, women have less opportunity to influence policies, programmes, and decisions that affect their lives. The effects of climate variability, shocks, and extreme weather events are likely to increase the existing inequalities and vulnerabilities faced by women (Dankelman, 2010; Kakota et al., 2015; IPCC, 2014).

But women are also active agents for community and household resilience and in developing responses to the impacts of climate change (Denton, 2002; Dankelman, 2010). Rural women's local knowledge in areas of environment, soils, water, and production are valuable resources for reduction and adaptation strategies. Engaging women in technology design and management decisions can improve community outcomes, as shown in Honduras, where women have re-designed eco-stoves and developed improved agroforestry management systems (Hottle, 2015). Women identified changes in Fiji's coral reef, such as bleaching, changes in spawning periods of certain fish, and algal blooms. Women in Micronesia were able to identify locations for new wells based on their knowledge of local water tables (Lane & McNaught, 2009).

Food security in a changing climate requires the active participation of women, that will entail: equal participation in decision making and equal access to agricultural resources and services; institutions that address their concerns; and technologies and information that are useful to them. ICT and information services have the potential to promote gender equality and empowerment of rural women, if these technologies and services contribute to the needs and priorities of women and men in rural areas and increase their resilience to cope with effects of climate change. However, information currently is not reaching women farmers adequately. ICTs are not providing them with the information, services, and knowledge they need and want. Sufficient evidence and experience are already available to inform new agricultural information strategies for food security that at the same time support women and promote gender equality.

CLIMATE AND FOOD SECURITY INFORMATION IS NOT REACHING WOMEN

Access to ICTs — including ownership, control, and use — generally remains much lower for women than men in developing countries (ITU, 2016). Reasons for this include: lack of financial resources to secure the use of ICTs; lower levels of technological and language literacy among women and girls; norms that discourage women and girls from using technology; and lack of control over and ownership of technology (see Huyer & Hafkin, 2006). The resulting patterns of unequal access to climate information and advisory services determine which individuals can make use of such services to manage climate risk and strengthen their resilience at the farm level. The farmers who

tend to be most vulnerable to climate change stresses are resource-poor, female, and lower caste — individuals who are marginalised by their communities' sociocultural norms (Tall et al., 2014).

Reflecting the digital gender divide, as well as the general failure to recognise the full range of women's activities in agriculture (see FAO, 2017), women are consistently less considered in the design of agricultural information and extension services. A World Bank study investigated whether and how ICT can support women-managed agro-enterprises in Kenya and Zambia, concluding that women and men differ in their access to, use of, and need for ICT tools. It found high unmet demand for extension information among women farmers that ICT could help to fill (World Bank, 2015), since women's household responsibilities may prevent them from accessing radio programmes or extension sessions (Archer, 2003; Meinzen-Dick et al., 2010).

Agricultural extension and support services tend to be biased toward male farmers, particularly in cultures where women are responsible for household food production and men are responsible for commercial crops (World Bank, IFAD, & FAO, 2009; Meinzen-Dick et al., 2010). For example, in Ghana, women's lower use of fertiliser is related to their lack of access to agricultural extension (Emmanuel et al., 2016); in the developing world in general, information on nitrogen use has not been reaching women (Farnworth et al., 2017). In India, women-headed households with land are 25% less likely to receive an extension visit; and there is a gender gap in bank account ownership in most developing countries -- in Bangladesh, Pakistan, and Turkey the gap is nearly 30 percentage points (Demirgüç-Kunt et al., 2018). In one region in Kenya, whereas both husbands and wives had contact with extension officers during field visits, the husbands had more access to information on crop and livestock production and more access to other extension services than their wives (Ngigi et al., 2017).

A range of barriers constrain women's access to climate information related to agriculture: limited access to resources; gender norms relating to women's status, roles, and capabilities; and limited participation in household and community decision making. For example, although group communication processes have proven to be effective at enabling farmers to understand and act on climate-related information, culture-specific gender norms and power relations often inhibit women's attendance at community meetings (Roncoli et al., 2011). In South Asia, women farmers were unable to use advisories to inform their decision making due to inability to read the advisories, lack of time to watch radio or television, or low participation in community activities and meetings where the advisories were disseminated or discussed. The latter factor in turn reflects a number of obstacles: lack of time to attend meetings, childcare requirements, lack of transportation, or gender norms that prohibit women to participate in discussions attended by male farmers (Venkatasubramian et al., 2014; Roncoli et al., 2011). Women's information networks are often smaller than men's, and women tend not to have access to formal organisations, depending instead on informal networks such as family members, neighbours, and other traditional sources of information (Manfre & Nordehn, 2013). While women in rural farming communities largely depend on these informal sources for information, men are able to access information from agricultural extension services, NGOs, and community meetings (Kristjanson et al., 2015; Cramer et al., 2016; Perez et al., 2015).

Women also have fewer opportunities for learning about and taking up new productive and commercial opportunities (Sebstad & Manfre, 2011). In Southeast Asia, women and men played different roles in domestic labour, shaping their participation in agricultural production (Duong et al., 2017). Women were responsible for most meal preparation and daily care of children. With fewer domestic responsibilities, men had more time to engage in income streams outside of agriculture that are less weather-dependent and that generate higher levels of income, while women earned their income mainly through agriculture. Men also made most farm-related decisions, such as crop selection and application for loans. As a result, there were also gender differences in the effects of weather events: more women than men experienced major damage to their crops from natural disasters, such as prolonged rainy seasons, flooding, and temperature extremes. Contributing factors were differences in access to both information and resources to prevent weather-related damage, such as changing crop management strategies, investing in livestock vaccinations, stocking seed and animal feed, and buying new agricultural tools or equipment (Duong et al., 2017).

Women's different agricultural tasks and household responsibilities mean that they may require different information than men (Jost et al., 2016). Women farmers in Senegal, for example, need forecasts of rainfall cessation (rather than onset) and of dry periods, because they work their lands at different times than men (Tall et al., 2014b). In southern Mali, men are responsible for cultivating rain-fed staple grains, while women have more control over hand-irrigated garden crops. With little decision-making authority over rain-fed cereals, women have little interest in or ability to act on forecasts relevant to those crops (Carr et al., 2016). A failure to provide for women's priorities and needs may be one reason for their lower rates of access to formalised information channels: data collected in Uganda found that, although women are responsible for post-harvest handling of food, just over one-half of them received information related to these practices, reflecting lack of access to extension and other sources of information (Kristjanson et al., 2015). On the other hand, when the available information is valuable to women, they will pay the cost. In Rwanda, it was found that women lagged only slightly behind men in mobile use, and in emergency assistance for livestock, women

slightly predominated: they reported contacting veterinarians for livestock assistance on a regular basis. This assistance allowed them to save money on travel and to keep the livestock healthy in order to breed them successfully. Small livestock is often an area where women have decision-making power and can benefit from the proceeds, so they find it worthwhile to bear the cost of mobile phone use to improve results. (Martin & Abbott, 2011.)

In general, however, content addressing women's specific interests and priorities represents a large gap (Huyer, 2006; GSMA, 2012), particularly in the agricultural sector. Women seek out a wide range of information to support their household and farming activities, such as information on nutrition, reproductive health, education, and entrepreneurship, but much information is not readily available to them (Cramer et al., 2016; GSMA, 2012; Pshenichnaya, 2011; Caine et al., 2015).

DESIGNING CLIMATE INFORMATION FOR GENDER EMPOWERMENT

Ensuring that women have access to information and knowledge that they value and can use effectively represents an important step towards gender equality and women's empowerment (see Hafkin & Huyer, 2006). Research demonstrates that when women have access to information on agricultural technologies, along with the resources to implement it, they in fact implement the knowledge they have gained (Duong et al., 2016; Jost et al., 2016); the resilience of households, communities, and food systems are increased as a result (World Bank, FAO, & IFAD, 2009). Climate change, extreme weather events, and natural disasters make it even more important for farmers to have timely and accurate information on adaptive practices, inputs, and technologies, enabling them to take steps to minimise or prevent losses in agricultural production. Farmers need accurate climate information to help them cope with extreme weather events and variable rainfall patterns, including early warning systems, improved forecasting, and historical climate pattern information, as well as an extended range of options for adapting to changes in weather (Coffey et al., 2015).

FAO has identified four critical strategies to support women farmers in increasing food security: (1) practical measures to work towards greater equality, including livelihood support for women and girls; (2) reducing women's workloads; (3) ensuring protection from gender-based violence; and (4) equitable access to resources and services (FAO, 2016). ICT can play an important role in facilitating support to women in all four areas, by improving access to markets for livelihoods, easing work burdens through increased efficiency and information, increasing women's agricultural production, facilitating access to resources and services, and supporting women's leadership in their communities (Huyer, 2012).

In Congo, a group of women farmers used computers to access and exchange agricultural information over email and internet. They were able to source high-quality seeds from other countries and expand their information, networking, and market base. The increased income and status resulting from these benefits in turn increased their influence in the household and the community (APC, 2010). In Lesotho, cell phone use and reselling of airtime by women's farming cooperatives increased their income and public profile, enabling members to participate in agricultural shows, trainings, and conferences through national programmes to encourage small-scale farmers (Vincent et al., 2009).

Gender-specific information services take different forms. In relation to climate information, for example, efforts to involve rural women in the design of the services — adapting communication channels to take into account their concerns, responsibilities, travel and mobility, and schedules — can reduce the barriers women face in accessing these services (Tall et al., 2014a; Poulsen et al., 2015). Agricultural information can be incorporated into spaces and processes that are already part of women's routines and social networks, such as boreholes or women's groups (Tall et al., 2014a; Venkatasubramanian et al., 2014) — with transformative results. Social networks and community organisations, such as local women's organisations or health clinics, can play a crucial role in promoting women's access to information (Mooko, 2002). In Vietnam, intermediary organisations such as farmer associations and women's organisations played a central role in enabling women to access information on water-conserving agricultural production and to realise their personal goals (Farnworth et al., 2017). A survey in Uganda found that women preferred to receive climate information (in descending order of importance) via megaphones, letters, village leaders, farmers groups, school children, religious and social gatherings, and print media. They felt that information in these forms was useful since it was presented in the local language and was location-specific (McOmber et al., 2013).

In India, access to mobile-phone-based agricultural information has reduced knowledge gaps between large and small farmers as well as between women and men. The "listening rate" of women farmers was equivalent to that of men farmers; 70% of women farmers felt that the "agro advisories" had increased their knowledge about farming practices, increasing their yields as a result. At least 48% of the women farmers surveyed responded that the information helped them to reduce costs through more efficient input management, and 56% felt that the information helped them to reduce crop losses from rainfall. In one region, 83% of women farmers reported having taken action based on the information they received through

this service. Interestingly, women also felt that the information increased their participation in household decision making with their husbands (Mittal, 2016).

Another successful case of providing information to women is Shamba Shape-up in Kenya, a television programme on small-scale agriculture on the model of popular house makeover shows.
A survey found that most viewers of the show reported that the programme helped them improve the profitability of their enterprises and had a positive effect on their families' food security. It is estimated that 428,566 households made changes in their farming practices and/or reported increased income or food production as a result of watching the programme. The programme focused mainly on maize and dairy; survey results were sex-disaggregated. While both male and female maize farmers benefited from the changes they made on their farms, men benefited slightly more, increasing their consumed output by 58% compared to an increase for women of 23%. Similarly, output for sale doubled for men and increased by 83% for women. In dairy, although men farmers had greater returns than women, women dairy farmers experienced greater proportional returns: their production increased by 59%, compared to improvement for men of 41% (Africa Enterprise Challenge Fund & University of Reading, 2014).

Radio continues to be an effective transformation tool in many rural areas. In a village in Kenya, Kamba women were able to hear women like themselves on Radio Mang'elete, providing market information, notification of social events, discussion forums, and entertainment in the forms of radio vignettes and plays. They were able to interact with community leaders and programme hosts online to suggest programming and offer content, providing them an opportunity to speak out publicly and demand answers from local leaders. As a result, they experienced increased agency and positive self-perception while gaining recognition of their input from the larger community (Sterling & Huyer, 2009). Dimitra community listening clubs in Congo and Niger represent a gender-responsive participatory approach to information dissemination and gender empowerment. They facilitate dissemination and exchange of information on local issues such as agricultural practices, climate change, food and nutrition security, women's unequal workload, and access to water, land, sanitation, and health. Community members can request information on topics of interest. Information is disseminated using both new technologies (internet, on-line database, etc.) and more "traditional" means of communication (newsletter, brochures, and community radio). The experience of male-female interaction in a community forum allows the public airing and debate of many issues and has provided a platform for examination of gender roles. In one example, men in a rural community began to take on childcare duties, when their wives had responsibilities outside of the household (DIMITRA, 2013).

A more traditional approach to information dissemination, using training sessions, proved successful in serving women rice farmers in Vietnam, improving livelihoods and empowering participants. Their knowledge increased in almost all aspects of rice production: by obtaining better yields from the seeds they planted and using lower rates of inputs (such as seeds, fertiliser, and pesticides), they lowered their production costs. They enjoyed increased income from related farming activities, such as raising piglets using rice bran as feed. Women experienced increased participation in household decision-making related to farming decisions beyond animal rearing, on rice varietal choice, crop management, and post-harvest management. Further, women's decision-making authority increased on household finances, regarding "how much money to spend on food" and expenditures on children's education, as well as allocation of remittances received.

Three quarters of the women participants felt that their social position in the household and community improved. Most (84%) said that they were more highly respected by their husbands, children, and other family members because they contributed to higher rice yields and higher income. Men observed that after the training, women were able to discuss crop varieties and management practices (choice, timing, and amount of fertiliser) and that the trainings benefited the family; as a result, they encouraged their wives to attend agriculture training workshops. Fully 87% of participants experienced increased confidence in discussing rice technologies with their families, and 66% were more confident in interacting with agricultural extension services (Chi et al., 2015).

Successful approaches to reach women in the developing world with climate information most often consist of "mixed" approaches; unavailable resources as well as gender norms often inhibit women from interacting with formal and organised information channels and networks or from accessing certain communications technologies. Mixed modes or channels of communication can overcome the barriers faced by women at various points in the information dissemination process, taking advantage of existing communications networks and channels. For example, traditional local social networks can transmit information from mobile phones, producing a significant increase in the quality and speed of information delivery (Caine et al., 2015). Intermediaries (or "infomediaries") who are respected community members can pass on the information they receive on their mobiles to other members of the community. An example of this is the Community Knowledge Worker project in Uganda (World Bank, 2012). Similarly, mAgri initiatives have used farmer co-operatives to spread information to farmers through their existing social networks (Caine et al., 2015). Cherotich et al. (2012) suggest that a combination of extension agents, radio, and local administration is most effective for disseminating climate information and support services to vulnerable people in marginal areas.

Finally, the potential for women farmers to use and benefit from the newest technologies needs to be researched and supported. Technological approaches including drones, big data, smart farms, geo-intelligence, and bioinformatics will play an ever-increasing role in food production in the developing world.

Unfortunately, the representation of women in STEM fields is low in general, and particularly low in fields related to ICT, natural resources management, and agriculture. Women are not well-represented as researchers, agricultural extension agents, skilled workers, professionals, or decision-makers (Huyer, 2015; Akeredolu, 2008; World Bank & IFPRI, 2010). Remedying these glaring gaps must be an urgent priority: increasing the enrolment of women and girls in these subjects, employing non-formal educational approaches on the ground, promoting the employment and retention of women in these fields, and ensuring their representation in decision-making in these fields at all levels.

CONCLUSION AND RECOMMENDATIONS

ICT and information services have the potential to promote gender equality and empowerment of rural women while increasing food security, through decreased workloads, increased decision-making power, diversified agricultural production, ability to respond to climate and weather variability, and improved livelihoods. But these gains are possible only if information and knowledge are well designed to respond to women's situations, access to resources, and priorities. Information providers need to work with women's community organisations to develop communication channels that are adaptive to the obstacles women face. This will require a range of options and approaches, including: consultation with women to determine their information needs and priorities; mixed ICT approaches that combine different media with different intermediary groups or community structures; and tailored approaches based in local community contexts and realities.

Few ICT and agricultural technology providers have recognised the potential market represented by rural women as a group, with some exceptions (see Wilkes & van Dijk, 2017). GSMA found that in Madagascar both women and men were willing to pay for recorded information on gender and health, on dedicated voice information lines (GSMA, 2015). Targeting rural women in developing countries as information and technology consumers is an area with substantial potential requiring more research.

Experience and evidence suggest several promising avenues for promoting gender equality[62]:

- Consult with women and women's organisations in the development of ICT-enabled agricultural information, to ascertain their information needs and priorities.
- Assess climate information needs of women and men farmers separately, with further disaggregation — by male- or female-headed household, age, and socioeconomic status — or other factors that may shape roles, constraints, and information needs.
- Assess gender barriers in accessing ICT and information.
- Select or develop ICT services and channels in consultation with women's and community organisations.
- Consider providing a range of useful and affordable information services tailored to women's expressed interests, including nutrition, health, weather, and livelihood, in order to increase the value of these services to women.
- Assess the value of climate information services to women in terms of rate of access, use, and perceived benefits from use.
- Promote the participation of women and girls in STEM-related subjects, workforce, and decision-making at all levels.
- Work with the private sector to recognise the potential of women as a market for agricultural technologies, including ICT.
- Assess the value of climate information services to women in terms of rate of access, use, and perceived benefits from use.
- Assess impacts of key factors and strategies promoting women's empowerment in the use of climate information, including choice of content and channel.

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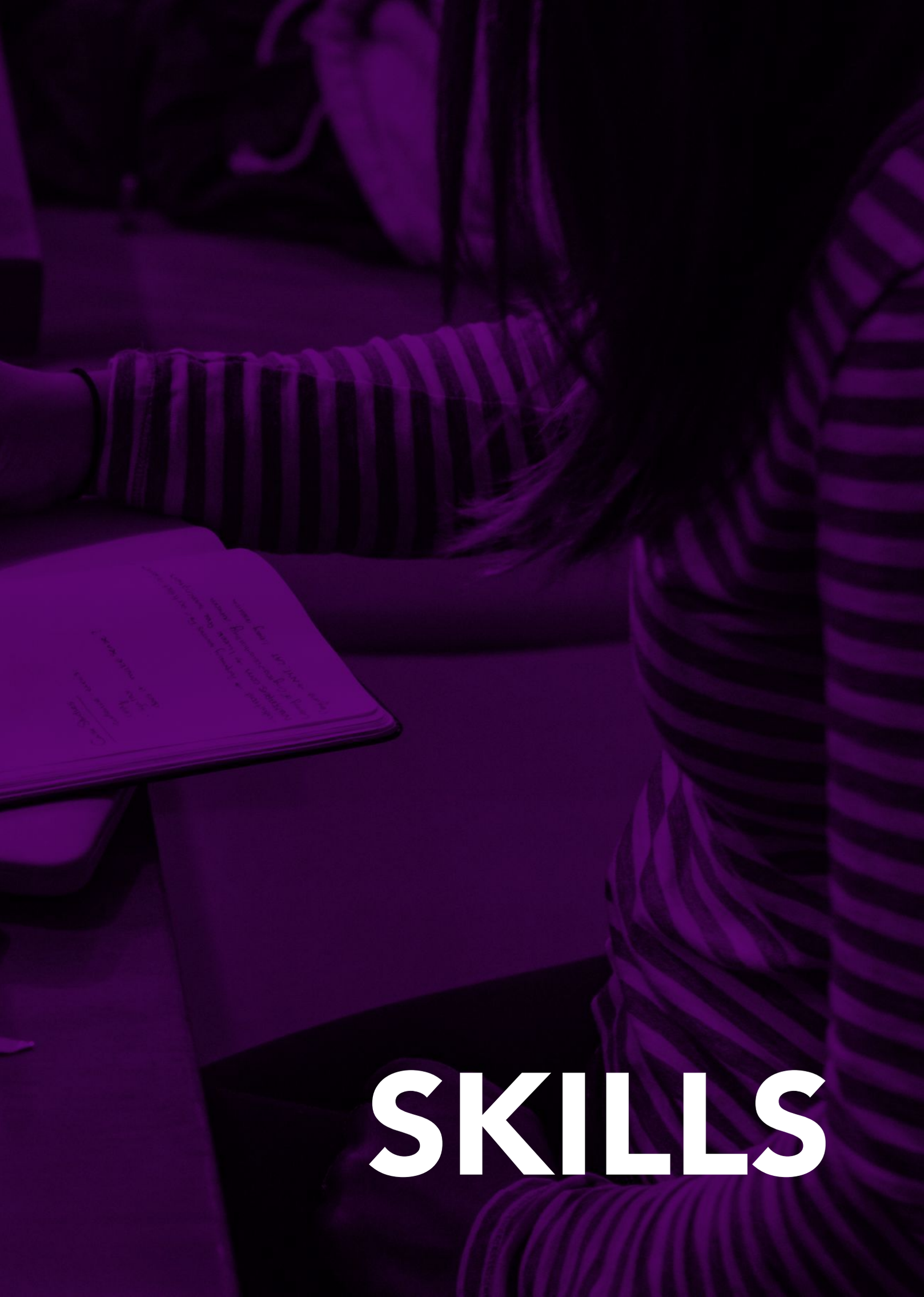

SKILLS

6

THE ROLE OF EDUCATIONAL INSTITUTIONS IN CLOSING STEM EDUCATION GAPS

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ABSTRACT

Several recent developments support the enrolment of women in STEM fields within educational institutions, including: educational institutions' adoption of policy frameworks advocating for increased STEM female participation; incentives for funding female STEM students; and criteria ensuring gender-sensitive institutional admissions. Curriculum design also has a role in increasing the representation of skilled females in STEM (Reyes, 2011), including viewing the humanities as representing critical skillsets relevant for STEM curriculum (Savaria & Monteiro, 2017). Such approaches also require complementary governance frameworks supporting female representation in STEM fields. Furthermore, organisations increasingly recognise the critical role of humanities in equipping the future STEM field workforce; the importance of human-centred skill sets has been recognised in the inclusion of arts skills into the STEM acronym, as STEAM. Today's workplace requirements include creative problem-solving skills as well as human-centred approaches to STEM challenges, prompting a discussion of the role of arts subjects within the field (Bequette & Bequette, 2013; Land, 2013). This chapter evaluates the role of higher learning institutions in improving female representation in STEM, by reviewing studies conducted globally in the period 2011–2017. It documents the lack of female representation in STEM fields and the role of new policy frameworks and practices in diversifying STEM student populations and workforces. The paper reviews lessons learnt from various countries' experiences and provide key recommendations for educational institutions to reduce the female student enrolment and human resources gap.

KEY FINDINGS

- The lack of female role models in STEM has been cited as a major factor in the low uptake of STEM programmes and courses by young girls in both elementary and higher educational institutions.
- The lack of a diverse academic and research STEM workforce in educational institutions, particularly in management roles, leads to perceptions of STEM as a male-dominated domain. Academic institutions thus find it difficult to attract and retain women both as students and as employees in STEM.
- Educational institutions have sought ways to improve the participation of women in STEM fields through student funding incentives, gender-sensitive institutional admission criteria, and gender-sensitive curriculum designs. These policies all have a role in increasing the representation of skilled women in STEM.

INTRODUCTION

The first industrial revolution introduced the use of mechanical power, complementing or replacing manual human labour to enable efficiency across industries; similarly, the second revolutionary industrial development, in the twentieth century, brought the use of electricity and wired communication. A third epoch of industrial change brought large-scale digitisation and advances in computing; in recent decades, further advances have produced a digital and cyber revolution that was designated as "the fourth Industrial Revolution" at the 2016 World Economic Forum (Schwab, 2016). This revolution will place major emphasis on skillsets in technology and engineering fields, including in areas such as robotics and artificial intelligence. Indeed, the fields of science, technology, engineering, and mathematics (STEM) prominently provide opportunities for young graduates to make significant contributions towards both economic growth and scientific research.

STEM skills are widely considered an essential skillset, particularly in the Global South, which suffers from a shortage of engineers, doctors, programmers, etc. However, many organisations have come to appreciate the importance of arts and human-centred skills in these fields. The acronym STEM has thus evolved further to include arts, to form the new name, STEAM.

Various studies have shown the importance of problem-solving inquiry skills such as novelty and ingenuity in addressing societal challenges, as well as compassion and related human-centred attributes; STEM academic programmes often neglect these key skills (Bequette & Bequette, 2013; Land, 2013; Saddiqui & Marcus, 2017). Addressing these human-centred skills can support the emphasis on equality of opportunity for female students. This chapter will examine these and other ways in which tertiary institutions play a role in improving female representation in STEM fields.

Institutions of higher learning have always played a vital role in encouraging the participation of women in the STEM fields, as key gateways to STEM employment. The higher education sector still struggles to achieve proportionate or even substantial representation of the female workforce. As a kind of snowball effect, with a disproportionately small number of women employed in STEM fields, their impact is limited as role models to women students. Similarly, higher education generally fails to challenge the dominant gender-stereotypical cultures and non-diverse workplace environments in STEM (Cheryan et al., 2016).

This chapter presents the following research question for evaluation: "What role can higher learning institutions play in improving the participation of females in STEM fields?"

THE ROLE OF INSTITUTIONS OF HIGHER LEARNING IN INCREASING STEM FEMALE PARTICIPATION

A range of factors contribute to strongly or disproportionately gendered STEM representation in higher learning institutions, including the following.

Standard STEM academic programmes. Traditional STEM offerings tend to focus narrowly on STEM majors and electives, with no attention to cultivating creativity and human-centred approaches in problem inquiry (Taylor & Taylor, 2017). While methods such as design thinking and co-design (Bequette & Bequette, 2012; Boy, 2013) are finding their way into some engineering and computing curriculums, STEM programmes' slowness in adapting means that fewer female students take STEM courses.

Cheryan, Ziegler and Montoya (2017) examined the relative prevalence of female students in the U.S. in biology, chemistry, and mathematics courses, in comparison to their numbers in engineering, computer science, and physical sciences courses. In addition to a dominating masculine culture, they point to a lack of practical opportunities for women in those fields, deterring women from enrolling as well as contributing to women leaving these programmes.

Pipeline factors. In countries where women's uptake of STEM academic programmes is especially low, the decline can be seen at the high-school level, when girls' interest in participating in mathematics and science subjects starts to decrease (Ellis et al., 2016; Shabangu, 2015; UNESCO, 2016a). Increased participation in higher learning institutions is unlikely, if learners have not acquired prerequisite skills at lower educational levels. The absence of primary female interaction in schools with the STEM subject field can also further affect the uptake of these programmes in higher learning institutions (Cheryan et al., 2016). While many higher learning institutions have created bridging opportunities to enable such learners to further their studies, continued focus is needed on basic education in mathematics and science. Additionally, in the OECD countries and the U.S., the cost of higher education puts it out of reach for many (Malsen, 2017).

Role models and stereotyping. In the UK, the Higher Education Statistics Agency (2016/2017) found that only 25% of professors are women, and only a fraction of them hold senior academic positions in STEM fields. Similar patterns hold in countries such as South Africa and the U.S., indicating a near-absence of women role models for students in STEM. More generally, gender stereotyping throughout society and the media has been identified as a contributing factor affecting the uptake of STEM studies in higher education (Wang and Degol, 2017).

Gendered content and programmes. School textbooks typically depict males dominating the science environment, while providing historical examples of men predominantly making significant contributions to the STEM field.

Lack of skilled teachers. To achieve SDG4, quality education, UNESCO has estimated the need for over 69 million teachers (UNESCO, 2016b). This need is particularly concentrated in mathematics and science-related subjects. Universities and vocational training institutions have a role to play in producing teachers with skills to meet the twenty-first century STEM demands, especially in countries where few women are engaged in STEM higher-learning institutions.

High gender equality and low uptake. Women may be underrepresented in STEM fields even in countries with high gender equality. Nordic countries that rank high in terms of gender equality were shown to have some of the lowest numbers of STEM female graduates in the world (Sossamon, 2018). Access to opportunities does not always mean guaranteed uptake of STEM subjects by young women. The lack of female representation in such resource-rich economies calls for further investigation into such factors as STEM role modelling, pipelining, and academic and workplace cultures in contributing to the lack of gender representation.

A UNESCO report on the levels of women's employment in STEM in Asia-Pacific countries found wide disparities: Japan at 15% and Korea at 18% of the STEM workforce, as compared to Kazakstan at 52% and Thailand at 53% (UNESCO, 2016a). Khazakstan and Thailand showed the highest participation of women in both higher learning institutions and the labour force. In the U.S., 14% of engineers are women, compared to 45% of mathematicians and 47% of employees in life sciences (UNESCO, 2016a). The fact that gender-sensitive policies do not always translate into increased participation of women in STEM fields can also be seen in the low participation levels in developed G20 countries compared to those in gender-conservative countries such as Algeria, Turkey, and the United Arab Emirates.
The role of higher learning institutions is fundamental to educating the labour force in STEM fields as well as producing researchers and entrepreneurs. Gender awareness needs to be incorporated as a critical factor in national science and technology programmes. In addition, efforts need to be focused at the local level to attain the SDGs (Miroux, 2011).

IMPACT OF STATE POLICY ON HIGHER EDUCATION

Policies affecting STEM in higher-learning institutions differ markedly from one country to another. In OECD countries, including Korea and Japan, STEM policies are aimed at broadly increasing the workforce to fill the demands of mature industries. In the BRIC nations (Brazil, Russia, India, and China), STEM policies are aimed at generally improving the education system, mindful of related socio-welfare issues, alongside the specific need to grow STEM industries. Countries which have prioritised the STEM sectors, as well as increased participation of women and youth in these fields, show significant progress as a result of targeted strategies of implementation and funding (Marginson et al., 2013).

Education and employment. Women represent 28% of personnel in science research and development globally (UNESCO, 2018). Tunisia has the highest representation of females in STEM research, at 55% of the workforce, followed by South Africa at 48%. South Africa increased from 43.7% in 2015 by prioritising women's empowerment across all relevant ministries; national STEM research centers — the South African National Research Foundation and the National Department of Science and Technology —prioritise women and girls for educational scholarships and employment opportunities. The African Union Agenda 2063 places focus on prioritising STEM education, with women as key STEM beneficiaries, both in education and business. Rwanda has also experienced a steady increase in women's participation in both primary and higher STEM education, owing to Rwanda Vision 2020, a governmental development programme that identifies women as the key beneficiaries of such funding increases.

Language inclusion. Several studies show that language can become a barrier in expanding STEM education and access to related opportunities. Inclusive language policies can therefore enhance STEM participation. Kenya supports the use of the mother tongue in primary education; China and Sweden have programmes designed for minority speakers; and Netherlands and Norway have programmes targeted to immigrant children.

Stoet and Geary (2018) used national data on secondary and tertiary education to evaluate the secondary school performance of females in STEM-related subject areas, and to evaluate gender representation among graduates and identify factors behind disparities between countries. They cited two key factors affecting female retention in STEM education: individual performance in the STEM subject areas, and the potential economic benefits associated with sought-after STEM skills. The study suggested that the greater the potential benefits, the more likely women would be to pursue STEM education, even in conservative countries. The study found notably high STEM graduate representation of women in Algeria, at 41%, in contrast to Finland and other countries highly ranked in the Global Gender Gap Index (Figure 6.1).

INCREASING FEMALE REPRESENTATION IN STEM EDUCATION

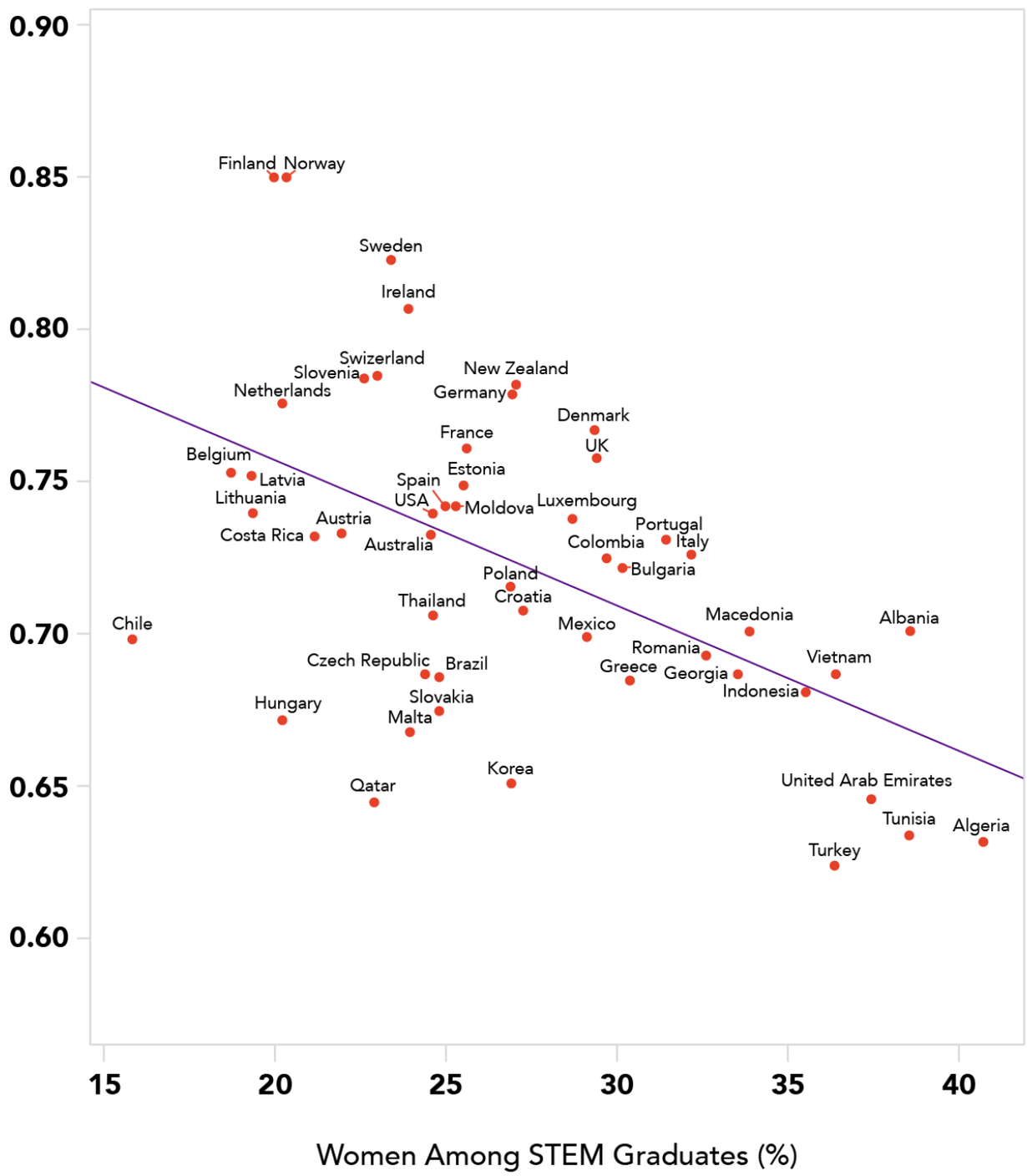
Higher learning institutions can encourage participation of women through various approaches, such as gender-sensitive funding and gender-focused academic programmes. National policies can motivate the schools to support girls to enter higher learning institutions. This section evaluates some of these efforts.

Mentoring and teacher programmes. The 2009 "Educate to Innovate" policy in the U.S. led funding programmes to focus on increasing STEM participation and representation. For example, the commitment to increase public-private partnership to fund STEM programmes enabled higher learning institutions to train over 10,000 STEM teachers (Burke & McNeill, 2011). Another initiative was the Bringing Up Girls in Science programme, funded by the U.S. National Science Foundation — an after-school science curriculum for girls that also linked school learners with university female mentors. A follow-up study found that the participants subsequently had a greater understanding and exposure to STEM fields (Wood et al., 2011).

Programmes such as the MIT Women's Initiative (MIT, 2018) present examples of partnerships between schools and higher learning institutions aimed at improving STEM participation. The MIT initiative assists teachers to create content tailored towards attracting young girls to STEM and helping them understand concepts in mathematics and science. Participants conduct a series of intriguing experiments and hear from university students about their experiences, giving them a better understanding of the work required for STEM participation.

Internationally, such initiatives have grown significantly. Developers in Vogue (Ghana) teaches young girls software development skills and links them to related work opportunities. Girl Hype (South Africa) is an entrepreneurship and coding academy giving women digital work skills. Feminist Approaches to Technology (India) educates young girls in using technology to empower themselves, to explore, and to develop leadership skills. Levers in Heels (Africa) introduces girl students to women in academia and STEM professions, and showcases research about women in STEM. WomenEng, a women-in-

Figure 6.1
Percentage of females among STEM graduates, by country



Source: Stoet and Geary, 2018, pp. 587.
Note: Y axis = country's percentage on the Global Gender Gap Index (higher percentage is more equal); X axis = country's percentage of female graduates

engineering organisation, provides engineering education programmes in Malawi, Mexico, Brazil, South Africa, and Kenya. The programmes are geared towards providing fellowships for young women in the engineering field, giving them theoretical instruction, practical experiences, and mentoring to pursue an engineering career.

Creating a community of female academics. Universities in the U.S. have created initiatives, such as Empowering Women in Science (Cornell) and Engineering Women (University of Minnesota), that showcase professional women in STEM research and facilitate seminars on positions and compensation in STEM (Sportelli, 2016). Cornell now observes an equal uptake of engineering programmes by male and female students as a result of intensive outreach[63]. Such programmes provide a network, enabling women students to become aware of opportunities in STEM and fostering relationships between senior and junior females in STEM fields. This approach also promotes the retention of young women in STEM through mentoring opportunities.

In Kenya, the Women for Science Working Group developed out of The Network of African Science Academies; it aims to enable a network of women in STEM fields, cultivating collaboration and sharing experiences among women in related research and academic institutions, with the aim of influencing priority areas of research. The network's publications showcase the contribution of African women in STEM fields. A growing number of awards recognise the contribution of women in STEM fields. The United Nations "Equals in Tech" Awards includes a skills and research category to recognise women in the STEM field; the African Union Kwame Nkrumah Awards for Scientific Excellence includes a category recognising women in STEM fields.

Funding. There has been a global increase in academic funding earmarked for outstanding women in STEM, such as the Graca Machel scholarship for women from the South African Development Community (SADC) region, the Anita Borg Global Scholarship, and L'Oréal-UNESCO Fellowships for Women in Science. Such initiatives enable talented females to pursue studies in STEM fields in prestigious academic institutions while growing their research expertise.

A South African example combines government policy with government and private sector funding. Ranked eighteenth on the World Economic Forum Global Gender Index, South Africa adopted targeted policies to increase representation of women in the STEM fields. Through a public-private partnership between the South African National Research Foundation (NRF) and the First Rand Foundation of the private banking sector, funding is earmarked to enable over 40 women in South Africa's higher learning institutions to focus on their research and ultimately to increase the number of female professors, particularly in the STEM field.

63 *https://i100rocks.com/news/025520-cornell-engineering-women/*

CONCLUSIONS AND FURTHER WORK

Institutions of higher learning play a critical role, both in training women as STEM employees and entrepreneurs and in conducting research in STEM. The lack of female academics in STEM fields means that girl students have few role models. Teaching and learning resources are rarely gender-sensitive, and examples from text books lack diverse gender representation. Language barriers can also place barriers in the teaching and learning process when female students are not first-language speakers of the language of instruction.

Exposure to STEM fields at an early age is a critical factor in the uptake of STEM courses. Programmes that encourage suitable teaching and learning environments for women in STEM have encouraged increased female representation across the field. Institutional initiatives can be further strengthened by national and regional policies as well as funding support. Further studies in this area might provide longitudinal findings on the success of initiatives from primary level through tertiary education to women's employment in STEM fields. Contextual and localised Massive Open Online Courses (MOOCs) as well as open educational resources can also introduce girls to basic STEM skills (ideally through accessible open platforms), enabling young women in almost any context to access educational resources of high value.

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7

THE GENDER WAGE GAP IN THE DIGITAL ERA: THE ROLE OF SKILLS

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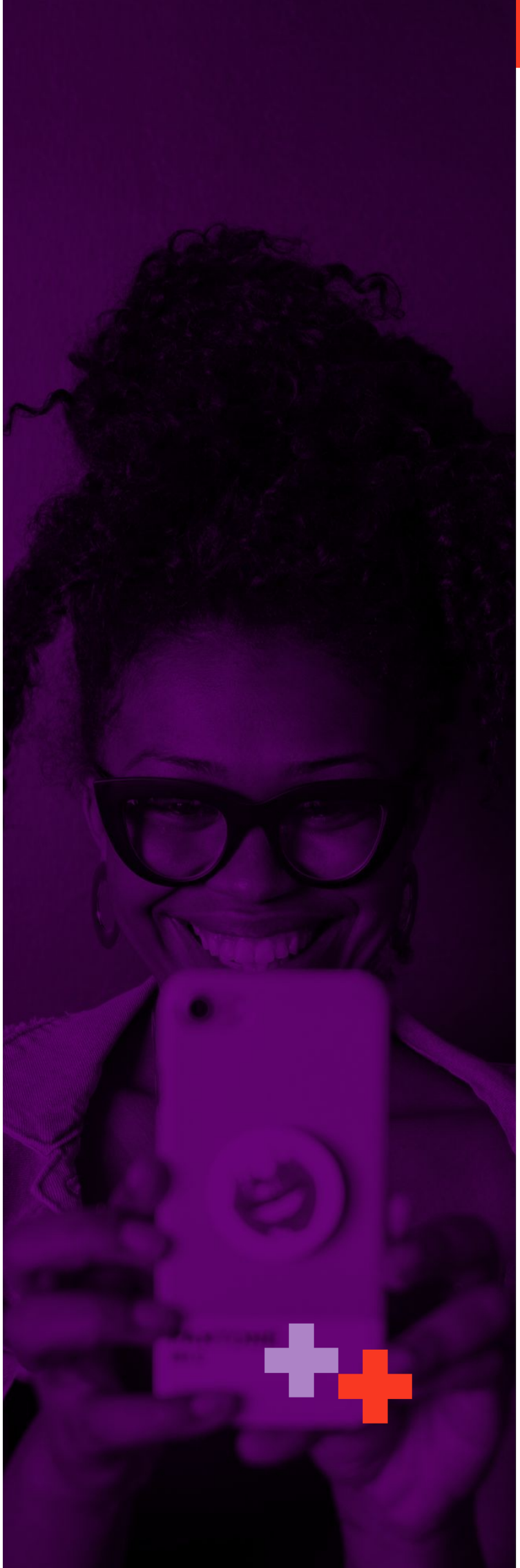


ABSTRACT

As the digital revolution contributes to changing the nature and content of jobs, the demand for skills also changes. This chapter addresses whether women are equipped with the skills needed to navigate the digital economy. It analyses data from 31 countries to compare the returns to skills for men and women in terms of wages, and how these returns vary between digital-intensive and other industries. If labour markets value different skills differently, with greater rewards to specific skills needed in the digital era, wage differences should highlight high-demand skills and show the degrees of wage variation in digital-intensive in comparison to other industries. Results show that the digital transformation may be contributing to widening the gender wage gap: digital-intensive sectors display greater gender wage disparities than less digital-intensive sectors, even after accounting for specific features of workers and places of employment.

KEY FINDINGS

- Variations in workers' skills, both cognitive and non-cognitive, explain only part of the gender wage gap, in 31 countries.
- Men on average are more likely than women to have the task-based skills that are most demanded in digital-intensive industries: managing and communication, self-organisation, and advanced numeracy skills.
- Men generally obtain higher returns than women for the same high-demand skills in digitally intensive sectors, but not in less digitally intensive industries.
- Women are more likely than men to have specific information and communication technology (ICT) task-based skills, and they are better rewarded for them, in both digital-intensive and less digital-intensive sectors.

A NARROWING GENDER WAGE GAP?

Significant progress has been made in recent years to reduce gender inequality along many dimensions. Young girls in OECD countries now out-perform boys at school and represent the majority of tertiary graduates (OECD, 2017a, 2017b). Gender gaps in employment also appear to have narrowed, although a 12-percentage point difference in labour market participation still exists, on average, across OECD countries. Importantly, gender inequality features among the top policy priorities of G20 and G7 countries; in 2014, G20 countries adopted as a key goal narrowing the gender gap in labour force participation by 25% by 2025[64].

Despite all this, there is still a long way to go to attain gender equality. In higher education, girls are not well represented in the scientific and technical disciplines, areas currently commanding high wages. In OECD countries, the gender wage gap still averages 14.3% across all sectors (OECD, 2017b). Women are scarce in senior management, public leadership, and entrepreneurship roles, accounting for only 4.8% of CEOs in 2016. It is likely that similar, if not greater, gender wage gaps exist in non-OECD countries.

The ongoing digital transformation is already affecting the life and work of women. On the one hand, the transformation can offer women new opportunities for economic empowerment, through new forms of work created by e-businesses, workspace platforms, and flexible working arrangements, for example. On the other hand, digital technologies may increase the gender divide, if women lack the needed skills or if flexible work arrangements mean low quality jobs.

This chapter points to specific policies which can ensure that women are equipped with the skills needed to thrive in the digital era. To what extent do skill differences between men and women contribute to the gender wage gap? What types of skills are in high demand in the digital era, and how do various industries reward them?[65] Econometric analysis allows us to explore the factors determining individual wages, in digital-intensive versus less digital-intensive sectors, with a focus on workers' skills. Data comes from the Programme for the International Assessment of Adult Skills (PIAAC) dataset, described below.

Skills are found to explain part — but not all — of the gender wage gap; differences emerge in the way digital-intensive and less digital-intensive sectors reward workers' skills. On average, men are more likely to have the skills most in demand in digital-intensive industries: managing and communication, self-organisation, and advanced numeracy skills, and are likely to obtain higher returns than women with the same skills in digitally-intensive sectors[66]. Women are more likely than men to have ICT task-based skills, and they are rewarded relatively more for them, in both digital-intensive and less digital-intensive sectors, than men with similar skills.

64 *http://www.g20.utoronto.ca/2014/2014-1116-communique.html*

65 *These skills need not perfectly coincide with "digital skills" as defined in different contexts (e.g., OECD, 2016; Carretero et al., 2017).*

66 *Self-organisation here relates to workers' ability to plan or decide the tasks to be carried out, the style and speed of work, and the possibility to plan working hours. Management and communication task-based skills relate to negotiating with people, planning the activities of others, and to instructing, advising, persuading or influencing others.*

Many factors, observable and unobservable, contribute to shape the gender wage gap, as reviewed in Blau and Kahn (2017). These can include: schooling, work experience, psycho-emotional characteristics, sector of employment, family responsibilities, and job characteristics, as well as cultural norms and discrimination. Gender may affect the specific tasks carried out on the job: women may be less able to commit to tasks requiring flexibility in working hours, or travelling on short notice (Goldin, 2014). This chapter finally takes note of how digital technologies are affecting some components of work.

THE GENDER WAGE GAP IN THE DIGITAL ERA: THE ROLE OF SKILLS

The last century saw narrowing differences between men and women in terms of labour force participation, paid hours of work, and hours devoted to household production, as well as in type of occupation, educational attainment, and choice of college majors (Goldin et al., 2006). Gender wage gaps also narrowed, to varying extent among different countries (OECD, 2017b). Examining the relationship between workers' wages and their competencies and skill use at work, we can assess the contribution of workers' skills to the gender wage gap. A novel OECD index shows the digital penetration of industries (Calvino, Criscuolo, Marcolin, & Squicciarini, 2018), allowing us to compare the wage gender gap and its determinants in digital-intensive as compared to less digital-intensive industries, while controlling for features such as workers' education and age and size of firm.

We rely on measures of the cognitive, non-cognitive, and social skills of workers for 31 countries, as extracted from the OECD Survey of Adult Skills (Programme for International Assessment of Adult Competencies, or PIAAC) (Grundke, Kalamova, Keslair, Jamet, & Squicciarini, 2017). PIAAC surveyed 154,293 individuals aged 16–65, between 2012 and 2015, in 31 countries (all but three OECD countries). In each country, the sample was chosen to be representative of the population (albeit with different sampling schemes). We combine the skills results with PIAAC-based information on labour market participation and the socio-economic background of workers[67]. The analysis assumes that work is composed of a set of tasks which workers are required to carry out on the job, and for which they are rewarded. This is in line with studies arguing that human capital needs are highly specific to the particular tasks carried out, and less determined by the occupation, industry, or firm (Gathman & Schoenberg, 2010; Gibbons & Waldman, 2004; Poletaev & Robinson, 2008)[68].

67 *OECD (2018c).*

68 *Several studies take a task perspective in assessing the returns to working in a given occupation, and how technological change affects them (e.g., Acemoglu & Autor, 2011; Acemoglu & Handel, 2013).*

Cognitive and socio-emotional skills are both considered in the analysis. Studies point to the role of social skills and personality traits in determining earnings (Heckman, Stixrud, & Urzua, 2006; Heckman & Kautz, 2012), and combinations of social and cognitive skills are seen to be especially rewarded (Deming & Kahn, 2017; Weinberger, 2014) — particularly in jobs that are more ICT-intensive (Deming, 2017).

AN EMPIRICAL ASSESSMENT OF THE RETURNS TO SKILLS IN DIGITAL-INTENSIVE AND LESS DIGITAL-INTENSIVE SECTORS

To understand how the digital transformation affects the demand for different types of skills — cognitive, non-cognitive, and social — we examine how workers' skills are rewarded and whether rewards vary according to the digital intensity of the sector. Valued skills in short supply should command higher returns. Higher returns in digital-intensive industries, accordingly, should point to the skills that are in relatively high demand in jobs that are more exposed to the digital transformation, and that may represent needed complements to the deployment of digital technologies at the workplace[69].

The analysis is carried out on data from the OECD Survey of Adult Skills (PIAAC), covering 31 countries. PIAAC provides a wealth of information about workers' skills, the tasks they perform on the job, and their workplace, making it possible to estimate the role of skills in determining wages with greater accuracy than in the past. Workers' cognitive skills (literacy, numeracy, and problem solving in technology-rich environments) are assessed through administered tests, limiting the risk of mismeasurement. By relying on the six task-based skill indicators identified in Grundke et al. (2017), it is possible to see how non-cognitive and social skills are rewarded in both digital and less digital-intensive industries.

Digital-intensive and less digital-intensive industries are identified on the basis of an OECD taxonomy (Calvino et al., 2018) that uses selected indicators to assess the degree of digital transformation of particular sectors. The authors have collected and cleaned data on several of these indicators of digital transformation, specifically targeting technological, market, and human capital components. The technological component is proxied by the sector's intensity in ICT investment, including purchases of intermediate ICT goods and services as well as robots. The human capital component is proxied by the share

69 *For a full description of the approach, see Grundke et al. (2018).*

of ICT specialists in the workforce. Digital marketing is proxied by the share of e-commerce. Sectors are ranked along each dimension, and the rankings are then aggregated to yield a single taxonomy of sectors by digital intensity[70]. (Sectors are defined according to the UN classification, published as the International Standard Industrial Classification (ISIC), Revision 4.)

We control for many characteristics relating to wage or skill levels (e.g. years of education, age, gender, as well as country, industry, and occupation. The analysis isolates variation of skills and wages within the same type of job and aims for an unbiased comparison between men's and women's earnings. Differences in the occupational composition of digital and less digital-intensive industries should not influence the findings on return to workers' skills in different industries.

Digital-intensive industries appear to pay better than less-digital intensive industries for workers with higher levels of managing and communication, self-organisation, and advanced numeracy skills[71]. These results may reflect characteristics of tasks in those industries: the need to operate in a more independent or decentralised fashion; to communicate across disciplinary boundaries and in diverse and decentralised teams; to perform more non-routine tasks; to be better matched with the tasks to be carried out; or to deal with continuously changing settings, for which self-organisation, management, and communication skills are important.
Do women possess the skills that are more in demand in the digital era? Do rewards for these skills differ between men and women? These questions are key to understanding whether the gender divide may widen with the ongoing digital transformation.

70 *The dichotomy between digital and less digital-intensive sectors is an artefact used for analytical purposes. In reality, there is a distribution of digital intensity levels, both between and within sectors; moreover, specific employers may be more (or less) digitally intensive than their sector.*

71 *See Grundke et al. (2018) and OECD (2018c).*

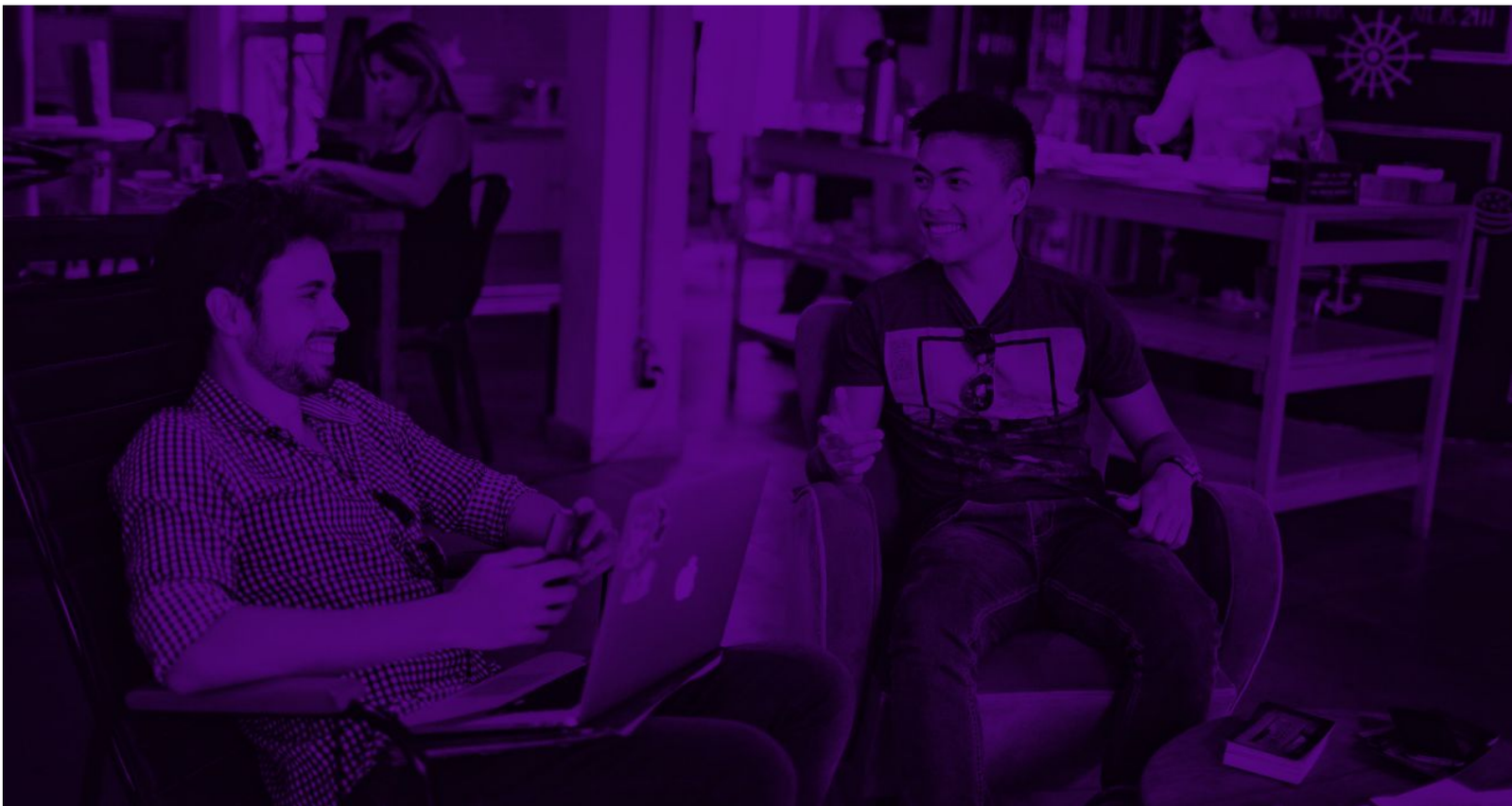
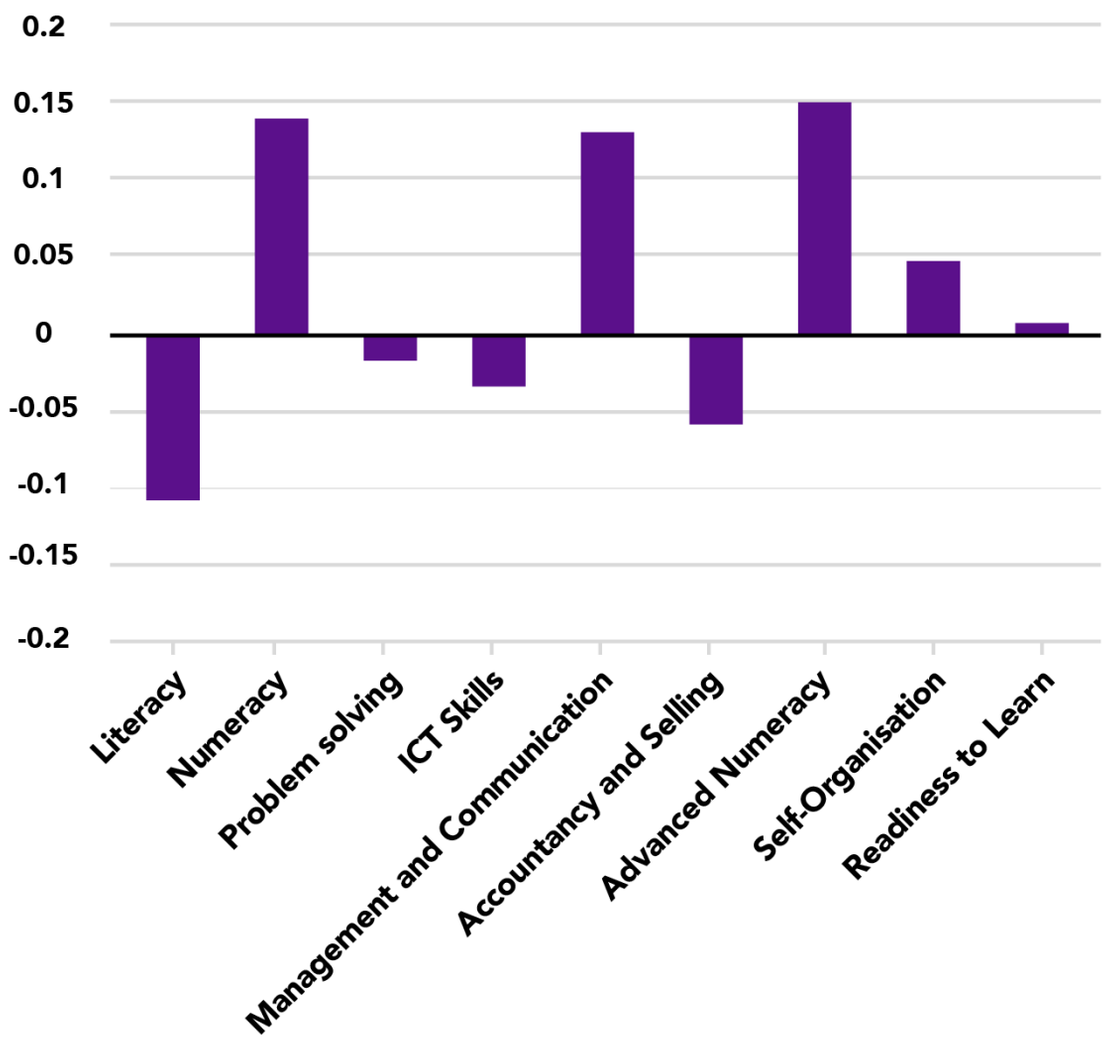


Figure 7.1
Difference in standardised skill scores between men and women
(conditional on covariates), 31 countries, 2012 or 2015



Source: OECD (2018c), based on PIAAC data.
Note: Differences in standardised skill scores between men and women are conditional on the covariates from the wage regressions. The skill measures are taken from Grundke et al. (2017). For each skill variable, OLS regressions of workers' skill endowment on the covariates from the wage regressions are estimated on the pooled set of 31 countries. For each of these regressions, the bars show the coefficients of the "male" variable, which takes value 1 if the individual is male and 0 if female. Striped bars signal that differences between men and women are not statistically significant at the 5% level. Bars above the x-axis represent the skills that men scored higher on; bars below the x-axis show skills that women scored higher on.

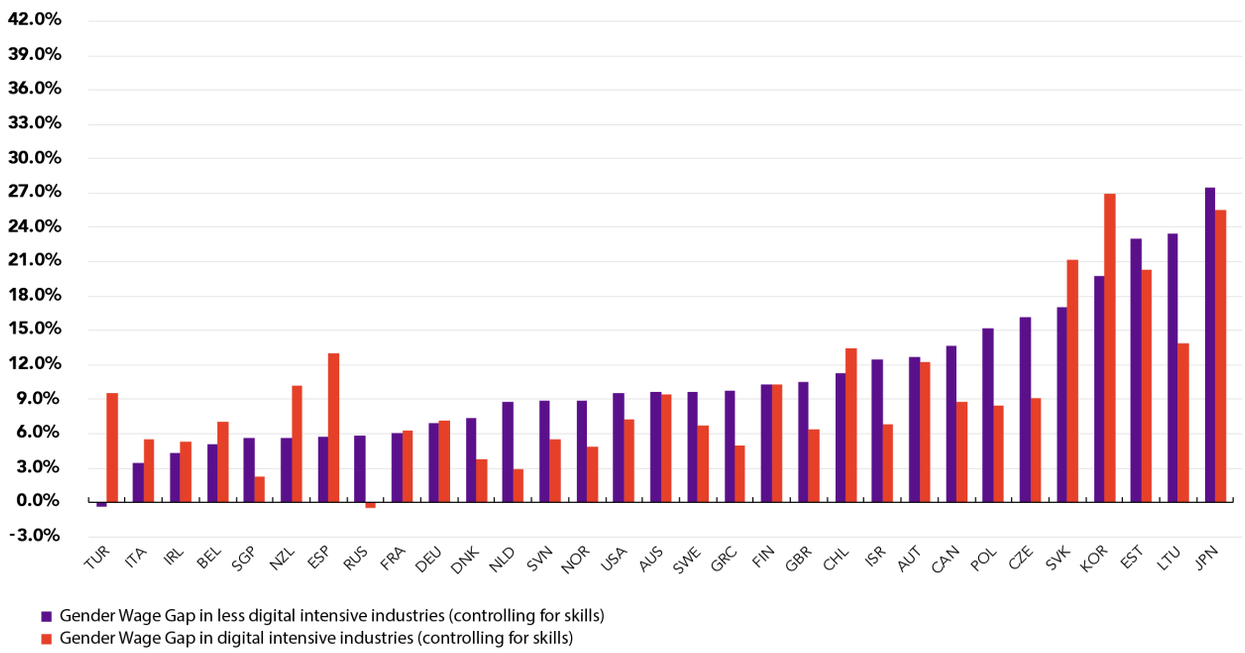
Figure 7.1 shows that men are generally more likely to possess the skills that command wage premiums in digital-intensive industries. Independent of age, education, occupation, country, industry, or size of firm, and whether full- or part-time, men overall have higher numeracy and advanced numeracy skills as well as higher task-based skills related to self-organisation, management, and communication[72].

These results are worrisome, especially because the digital transformation will ultimately affect all industries, including those that are less digital-intensive. Women's lower scores in the skills needed in the digital age may thus lead to increasing wage inequality between men and women. Additional results show that the gender wage gap is indeed higher in digital-intensive than in less digital-intensive industries (Figure 7.2). This is partly due to the different skills possessed by men and women: the

72 *See also OECD (2018c).*

Figure 7.2

Gender wage gap by country and industry (conditional difference in hourly wages for men and women, in %), 31 countries, 2012 or 2015



Source: OECD (2018c), based on PIAAC data.
Note: The figure shows the differences in hourly wages for men and women (in percentages) for employees in more and less digital-intensive industries. The estimates are based on OLS wage regressions, using data from the OECD Survey of Adult Skills (PIAAC), and control for the same covariates as in Figure 7.1 as well as for skills.

same graph displays larger gaps when not controlling for skills (results omitted here). (For more discussion, see OECD (2018c).) To address this effect of the digital transformation on gender-based income inequalities, governments need to ensure that women have opportunities to gain advanced numeracy skills and to develop management, communication, and self-organisation skills.

Nevertheless, women do not lag behind men across the whole spectrum of skills needed in the digital era. Women generally score better in literacy skills as well as in ICT, accountancy, and selling skills[73]. While women have higher ICT skills than men (and they conduct more ICT-related tasks than men in the same occupation), this may not be reflected in higher earnings. This study does not find higher returns to ICT skills in digital as compared to less digital-intensive industries, even though ICT skills are obviously important in the digital era. However, when we control for cognitive and task-based skills as well as country, industry, and occupation, we see ICT skills commanding the highest wage returns[74]. Possibly women's advantage in ICT skills may help to reduce gender-based wage inequality over time. Policy makers may therefore want to focus efforts on increasing ICT skills to reduce the gender wage gap.

Skill sets explain only part of the gender gap. When we control for cognitive, non-cognitive, and social skills, the gender wage gap is greater than can be explained by the difference in workers' skills[75]. In addition, the gap is considerably larger in digital-intensive industries than in less digital-intensive ones. Contributing factors may include women's longer out-of-work spells (e.g., for child-bearing), household duties, and gender-based roles and division of labour (Blau & Kahn 2017; Goldin, 2014). In addition to possible measurement issues, other factors in the wage gap may include gender discrimination. If digital-intensive industries reward men more than women for certain skills, more than is the case in less digital-intensive industries, the gender wage gap will be higher in digital-intensive industries even for workers with similar skills.

73 *ICT skills relate to the use of programming languages, emails, word processing software, and spreadsheets, as well as processing transactions through the internet.*

74 *See Grundke et al. (2018) and OECD (2018c).*

75 *See OECD (2018c).*

Figure 7.3 shows the skill returns for men and women in digital vs. less digital-intensive industries. Men obtain significantly higher returns than women for advanced numeracy and management and communication skills in digitally intensive industries (Figure 7.3a). The differences are not statistically significant in less digital-intensive industries (Figure 7.3b). However, for one of the key skills in the digital era — ICT skills — women obtain higher returns than men, in both digital-intensive and less digital-intensive industries. The analysis controlled for observable characteristics of the individual (age, education, part-time status) and for country, industry, occupation, and size of firm.

Factors that may contribute to the gender difference in earnings include: network effects among male colleagues; better wage bargaining outcomes stemming from the greater self-confidence of men (found, for instance, by Niederle & Vesterlund 2007); and proportionally higher bonuses associated with advanced numeracy and management and communication skills. Also, broader productivity effects may be a factor, if companies that are more productive require (and better reward) the skill sets more associated with men. Finally, if digital-intensive industries are more dynamic, they may require more competitive behaviours and stronger negotiation skills than less digital-intensive industries; this may hurt women, as studies have shown that women are less oriented to negotiating and competing than men and are more risk averse. For reviews, see Bertrand (2011) and Croson and Gneezy (2009).

Figure 7.3
Labour market returns to skills by gender across 31 countries, 2012 or 2015

Figure 7.3a
Digital-intensive industries

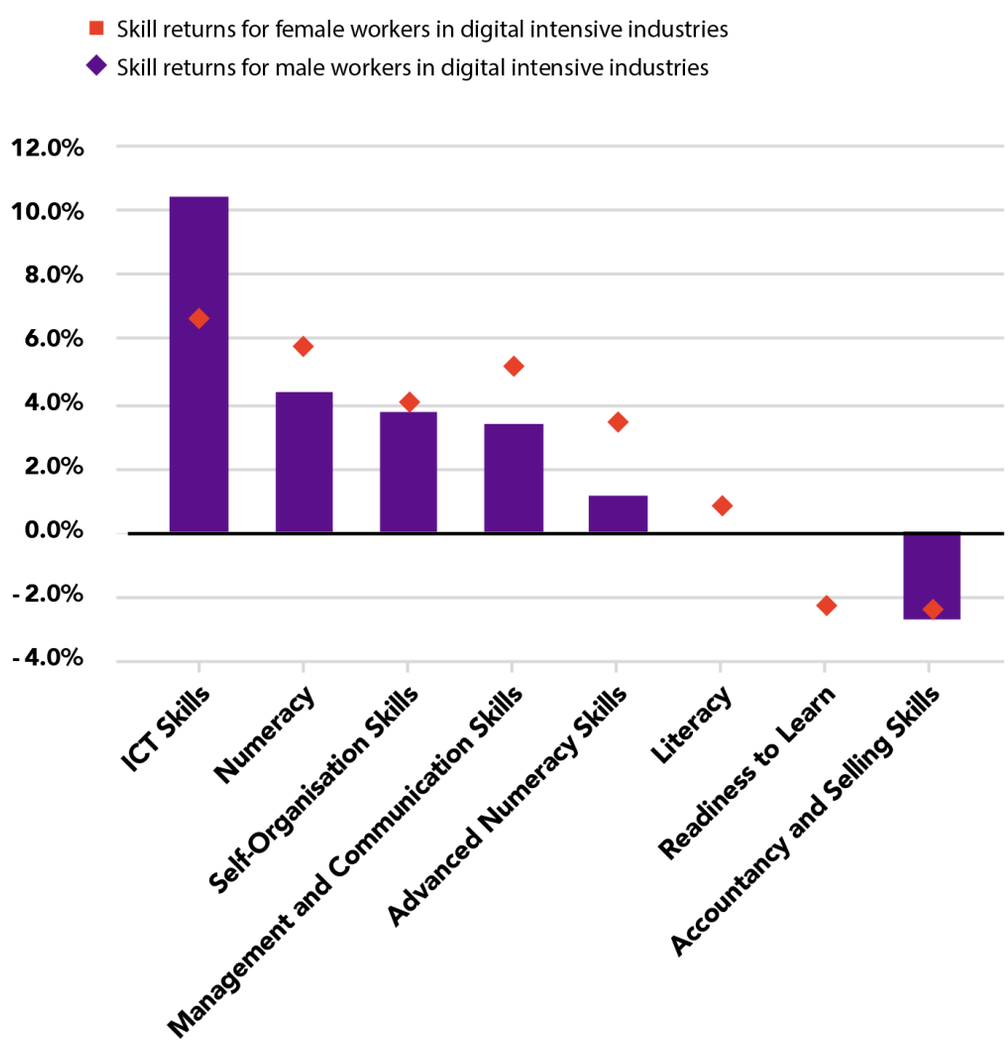
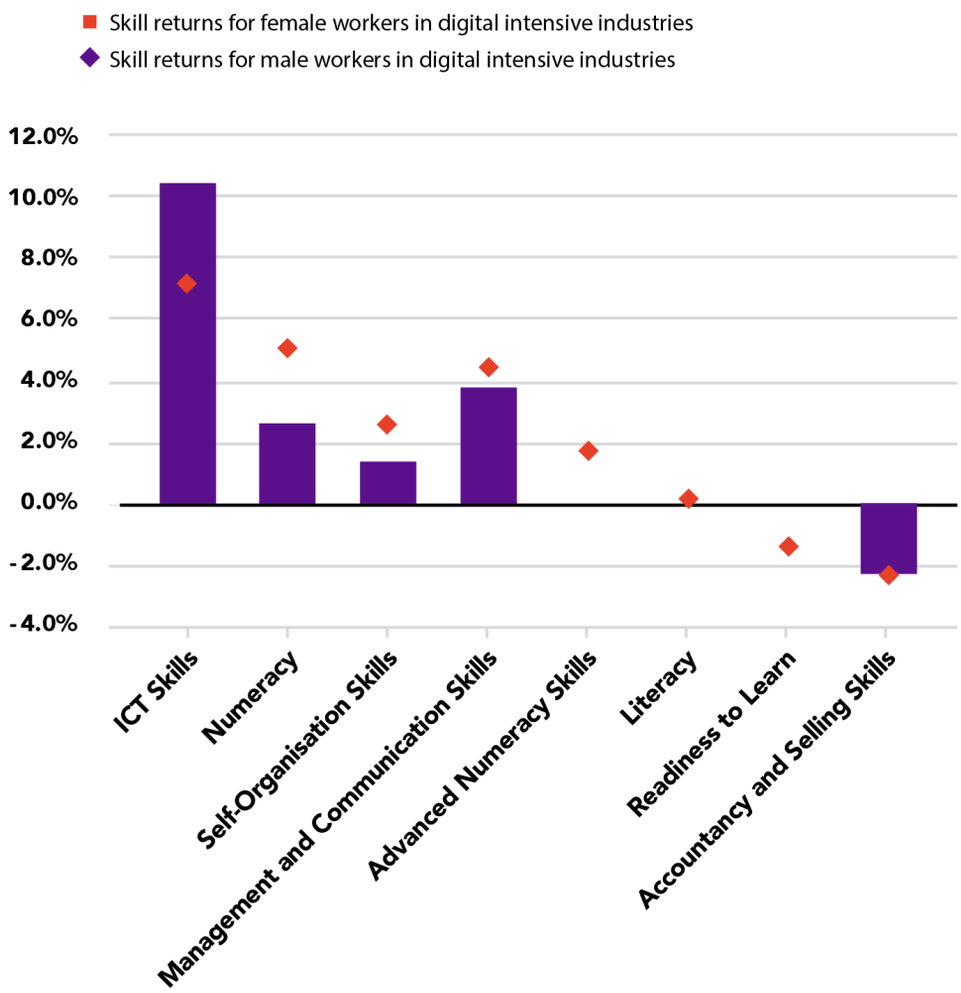


Figure 7.3b

Less digital-intensive industries



Source: OECD (2018c), based on PIAAC data.
Note: Results are based on OLS wage regressions pooling data for 31 countries. Digital-intensive industries are defined following Calvino et al. (2018). Skill measures are based on PIAAC and are taken from Grundke et al. (2017). The estimates by gender are obtained by including an interaction term of the skill variable and a variable taking value 1 if the individual is male and 0 if female. Wage regressions control for the same covariates as in the baseline analysis. The figure shows the percentage changes in wages determined by an increase in skills by one standard deviation. Striped diamonds and bars indicate results that are not statistically significant at the 5% level.

CONCLUSIONS AND POLICY IMPLICATIONS

The digital transformation is deeply transforming economies and societies, including disrupting labour markets: some occupations are disappearing and others are changing in nature, as is the demand profile for skills. The speed, scale, and scope of the ongoing transformation far outmatches the lengthy timeframe for building the human capital required, and the associated need to adapt education and training systems. Governments need to act promptly to ensure that workers, especially women, are not left behind due to lack of relevant skills.

The digital transformation is changing the demand for skills in both OECD and non-OECD countries. A wide range of skills appears to be required for firms and individuals to perform successfully in the digital era: foundational skills such as literacy and numeracy; and skills that are transferable across jobs, including technical and socio-emotional skills (including self-organisation, management, and communication). However, skill sets differ as between men and women, and different skills are rewarded in different ways for men and women, in digital and less digital-intensive industries.

LEARNING MATTERS: SHARING THE COST AND BENEFITS OF LIFE-LONG LEARNING

Making the digital transformation more gender-inclusive entails extending education and training to all, and especially to girls and women, both at a young age and later in life. Narrowing the gender wage gap further requires giving girls a solid educational foundation, especially in numeracy, to address early gender gaps. Education and training may need to become more flexible and adaptive: the digital transformation enhances opportunities to learn outside of working or school hours, and digital tools can help mitigate or overcome societal barriers and norms. As the digital transformation accentuates the need to continue learning throughout life, policy makers need to (re)design life-long learning systems: providing sound initial education, and fostering synergies among all stakeholders — individuals, governments, and the private sector — to further enhance human capital, especially of women[76]. The private sector of course benefits directly from a trained workforce and also provides training for workers.

TECHNOLOGY FOR LEARNING

Recent years have seen significant progress in women's education. In OECD countries, more women now achieve tertiary education than men (OECD, 2017a); across the 31 countries considered, the proportion of women engaging in on-the-job training is higher, on average, than that of men (OECD, 2018a). However, when workers' characteristics are taken into account (e.g., age, education, part-time contracts, industry, and occupation), men are found to receive 5% longer training than women. In many non-OECD countries, women's access to education still lags behind men's. Digital technologies can support more equitable access to education and training by lowering the direct cost of accessing educational material, or by allowing distance learning on a flexible schedule — important for women having to combine education and household duties. Governments should ensure that access to technologies such as mobile phones and broadband is universal and equitable. This may require investments in infrastructure deployment, especially in remote areas, or financial schemes to lower the costs of accessing such technologies, especially for low-income individuals.

FOCUS ON THE 'RIGHT' (SETS OF) SKILLS

The gender wage gap is related in part to the type of skills possessed by workers. Digital technologies display different degrees of complementarity and substitutability of skill sets. Interestingly, women perform ICT-related tasks slightly more frequently than men; moreover, they are rewarded significantly more for those tasks and skills. Policies to promote ICT skills for women can help to narrow the gender wage gap.

Advanced numeracy (STEM) skills are among the most demanded skills in digital-intensive sectors, and these skills are associated more with male than female workers, even within narrowly defined industries and occupations. Policies to enhance female workers' advanced numeracy skills will therefore be important to address the gender wage gap. As skill set differences are influenced by educational choices, and the decision to pursue fields such as ICT and STEM (OECD, 2017b), educational policies are important: encouraging girls' enrolment in STEM studies at young ages; creating single-sex classes where women feel freer of stereotypes (Booth, Cardona-Sosa, & Nolen, 2014; Dustmann, Ku, & Kwak, 2017); facilitating women's access to STEM-related apprenticeships; and addressing gender biases in education curricula, parental preferences, and social norms (OECD, 2018c)[77]. These policies are relevant to both OECD and non-OECD countries; of course, equal access to education is an essential first step. The private and non-governmental sectors can also be involved in this effort, influencing the public debate and leading by example.

PROMOTE WOMEN'S PARTICIPATION IN LABOUR MARKETS

The skills mix needed to succeed in digital-intensive sectors includes non-technical skills such as management, communication, and self-organisational skills. Women may be hindered from developing these skills by constrained access to the labour market. This problem can be addressed directly through training programmes, and indirectly by fostering women's labour market participation. Digital technologies can facilitate women participation in the labour market by offering new work opportunities (e.g., through e-commerce and digital platforms) and by making work more flexible[78]. Flexible working arrangements, powered by technology, can enable individuals living in remote areas and those with costly commutes to enter the labour market or extend their working

76 *Under the "SkillsFuture" programme in Singapore, employers provide input about the skills they believe will be required by workers in the near future (3–5 years). Students and workers are then given a government subsidy through their learning accounts; they receive a skill certification at the end of the training.*

77 *For example, U.S. schools participating to the Building, Recruiting and Inclusion for Diversity (BRAID) initiative commit to several actions, including increasing the number of female instructors, providing teachers with better computer science teaching skills, or promote female role-models in STEM.*

78 *Platforms are likely to affect participation of women to the labour market, by decreasing the entry cost and possibly limiting the role of cultural norms. So far, however, platform work has been difficult to measure. When possible (albeit with approximation), "gig" workers were found to display lower returns to skill than employees or other self-employed individuals, independently on gender (OECD, 2018c).*

hours. Flexible arrangements can also be valuable for individuals constrained by family duties — preponderantly women — and can thus enhance female participation in the labour market. This has the potential to help women build their confidence, experience, human capital, and networks, and thus to reduce the gender wage gap over time. However, flexible work arrangements may translate into low-quality jobs (OECD, 2017b); they may also entail longer working hours and little separation between work and personal life. Policies should ensure that "more flexible" also means "better". Ideally, women's increased labour market participation would need to be accompanied by greater gender equality in household and family-related duties.

IMPROVE THE (GENDER) FAIRNESS OF THE SYSTEM

Women's lower labour market participation can reflect the uneven burden of family duties. Government policies can expand the public provision of child care services; they can also support a redistribution of family duties, for instance through paid paternal leave. Within the workplace, affirmative action and even quotas can be considered to address discrimination, especially in filling leadership positions. Improving the (gender) fairness of the economic system may at times require imposing a minimum number of women in governing boards, parliaments, or policy cabinets. However, softer approaches — such as voluntary target setting and disclosure of existing gender outcomes, often initiated within the private sector itself — may be effective while avoiding triggering confrontational attitudes (OECD, 2017a).

Policy measures have little hope of success where gender discrimination is ingrained in culture and society. Social norms influence women's participation in the labour market, as well as the way they may own and manage economic resources — including technology. While the role of such norms in shaping the gender gaps resists empirical analysis, they certainly contribute to the "residual" gender wage gap that remains when other determinants have been accounted for.

The socio-economic change fostered by the digital transformation can influence cultural norms, challenge traditional ideas on the role of women in society, and help women form new or different aspirations. These changes can be supported by information campaigns to raise awareness on gender discrimination, promote more gender-balanced narratives, and dispel stereotypes.

A HOLISTIC POLICY APPROACH TO THE GENDER GAP

Closing the gender gap in skills and wages requires cross-cutting approaches that involve most, if not all, aspects of public policy and that include specific gender-related objectives (OECD, 2018b). Digital strategies will be especially important in this regard, to shape the interplay between digital technologies and workers' jobs and skills.

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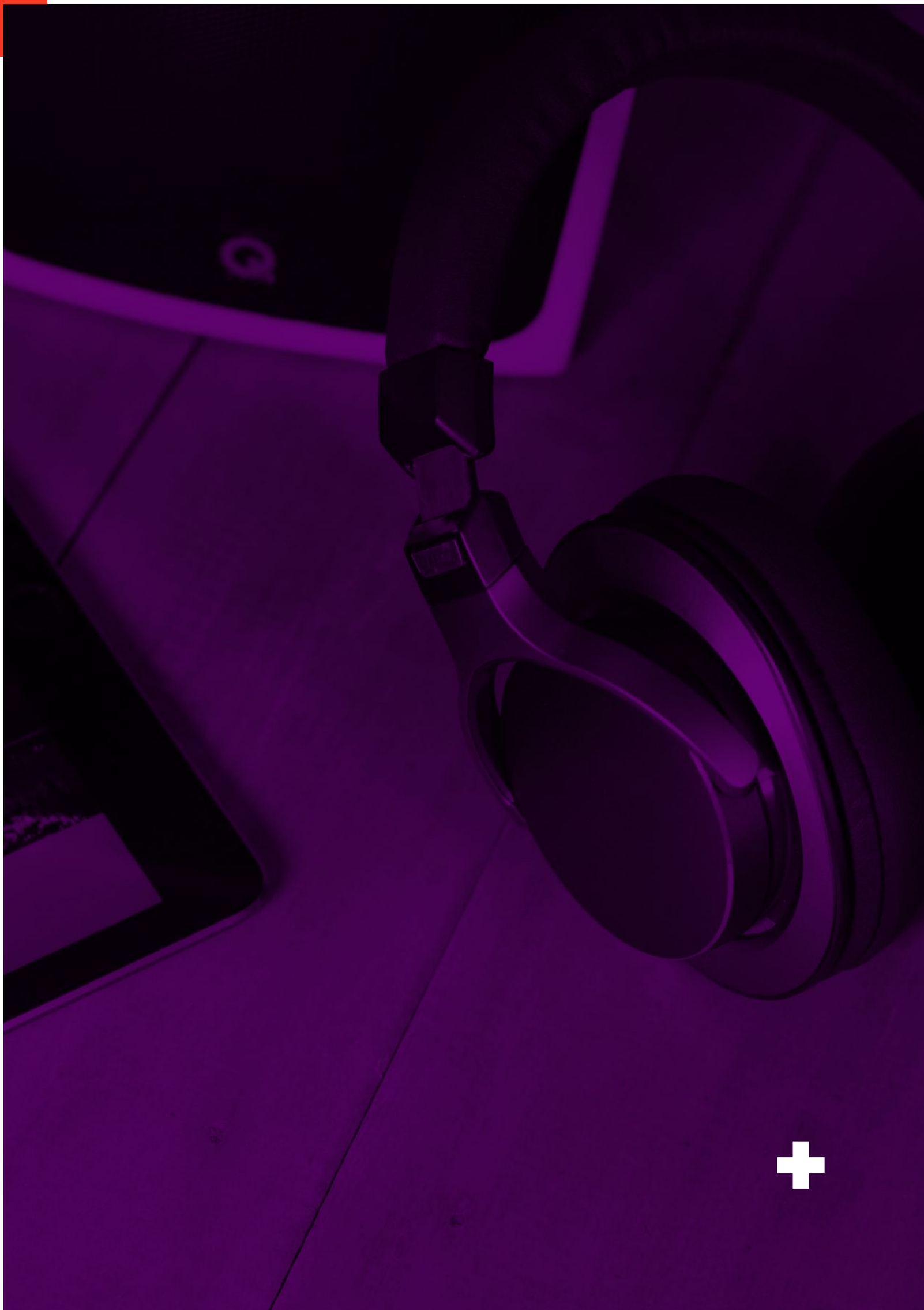

8

SKILLS DEVELOPMENT AND YOUNG WOMEN'S WORK IN THE CALL CENTRE INDUSTRY IN SOUTH AFRICA

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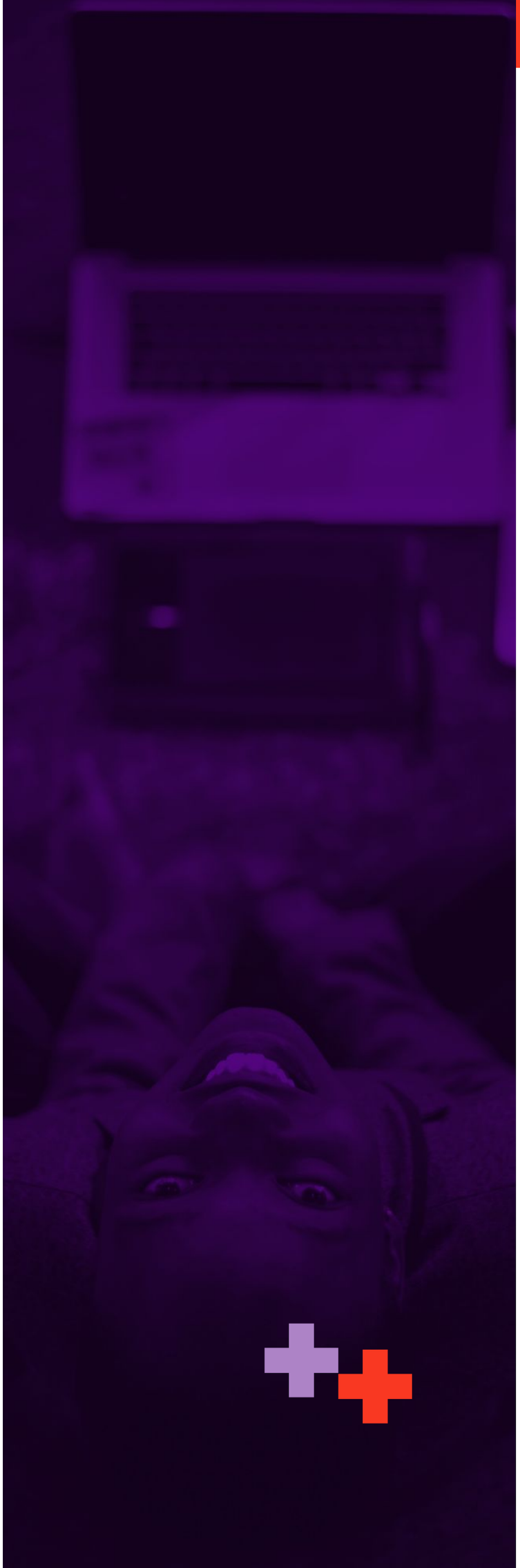

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ABSTRACT

The call centre industry continues to grow as a major business outsourcing avenue. National and international organisations are increasingly using call centres for marketing as well as for outsourcing customer services, often based in developing countries. The South African government supports such business outsourcing through prioritising call centres for investments and as job creation for its young people. A quarterly labour force survey (QLFS), released by Statistics South Africa in the last quarter of 2017, shows a national unemployment rate of 26.7%, with a high youth unemployment rate of 29.7% among 15- to 24-year olds. Such high youth unemployment rates make call centres especially attractive in South Africa. Empirical findings from this sector show that 75% of the employees in South African call centres are young women who have just finished school and female college students. An exploration of skills development in the call centre industry is therefore also an exploration of skills development for young women, who are the majority of workers. This chapter presents findings from qualitative focus group discussions and individual interviews conducted with young women who work as agents in call centres in Cape Town and Johannesburg. We conducted four focus group discussions of six to eight participants and 20 semi-structured individual interviews, with women aged 19–34 years working as agents in various call centres. All interview participants were recruited through convenience and snowball sampling. Focus groups and interview data was analysed through a qualitative thematic analysis.

KEY FINDINGS

- Training for key competencies varied from organisation to organisation, from a few days to several weeks. Training took different forms: brief teaching sessions followed by tests; memorising scripts to answer possible questions; basic keyboard skills, including word processing and speed typing; communication skills of pronunciation, phone etiquette, and voice demeanour.
- Some participants indicated that training consisted of hands-on experience on the shop floor, with minimal prior training. This included informal side-by-side coaching, or "buddying up" to understudy their fellow workers.
- Agents might be put under pressure designed to test their level of resistance.
- Much emphasis was put on the development of "people skills"; respondents considered call centres highly focused on developing people skills, more than any technical or digital skills, no matter what technological systems were adopted in training. They questioned call centres' capability to promote technical skills development.
- Skills developed in call centres were specific to work in call centres rather than transferable to other work.
- Few leadership positions were available, and there was a lack of personal growth.

INTRODUCTION

Numerous business organisations have begun to use call-centres in developing countries, through both onshoring and outsourcing services, taking advantage of their cheap labour and favourable labour attrition rates. Call centres operate on information communication technology (ICT) platforms that enable easy global access. Key destinations for global outsourcing call centres are India, the Philippines, and, of late, South Africa and Kenya. The South African Government prioritises call centres for investments and job creation (Banks & Roodt, 2011). As such, the industry has grown tremendously over the years, becoming a key source of employment for young people. A quarterly labour force survey (QLFS), released by Statistics South Africa in the last quarter of 2017, shows a national unemployment rate of 26.7%, and 29.7% for youth aged 15–24. Given high youth unemployment levels, it is not surprising that the government supports call centres to address the issue.

This chapter draws on a project that explored young women's work in call centres in the cities of Cape Town and Johannesburg in South Africa. Focus groups and individual interviews were conducted with young women who work in call centres, to explore the dynamics of skills development in this largely digitalised industry. The chapter evaluates the skills development of the young women workers, considering the link between the training and skills acquired on the job and advancement prospects for workers, in view of evolving information and communication technological systems. It begins by looking at the nature of call centre work in South Africa, followed by an exploration of women's work in call centres. The chapter then presents the voices of young women, capturing the experience of skills development of these young workers.

LOCATING SOUTH AFRICAN CALL CENTRES IN THE GLOBAL ECONOMY

The call centre industry in South Africa has grown immensely since the '80s, becoming a thriving domestic industry and a key employer of young people who would otherwise be unemployed. Banks and Roodt (2011) describe the industry as growing largely through business-owned centres, which incorporate call centres as part of their own business processes. They emphasise that call centres have "moved from occupying a relatively small niche to being a significant part of the global economy" (Banks & Roodt, 2011, p. 3). South African call centres are an integral part of the global market system based on neoliberal capitalism.

Neoliberalisation favors opening up international markets through easing trade and labour regulations. Firms can benefit from access to external labour and capital markets for outsourcing services, capitalising on cheap labour as well as on flexible ways to build capital. Raewyn Connell sees neoliberalism as "the agenda of economic and social transformation'' which dominates "global politics" and is systematically implemented in "institutions under neoliberal control" (Connell, 2014, pp. 5-6). The globalised economy entails outsourcing ancillary services, such as tele-marketing and service provision, to emerging markets (Panday & Rogerson, 2014). Of concern to feminist scholars is that these outsourced services mostly depend on women's cheap labour.

In South Africa, call centres emerged in the late '80s, growing rapidly in the '90s due to improved technology and lower communication costs (Benner, 2006; Holman; Batt & Holtgrewe, 2007; Panday & Rogerson, 2014). The industry has grown steadily since then and now serves both local and international markets. Research shows that more than two-thirds of call centre employees in South Africa are young people under age 35 (Cohen, 2013; Panday & Rogerson, 2014); approximately 75% of these young people are women (Benner, Lewis, & Omar, 2007). This employment pattern is also a common global trend (Belt, 2002; Bonds, 2006; Darsun & Bayram, 2014). Any investigation into call centre work is also an investigation into women's work, the concern of this chapter.

UNDERSTANDING THE CALL CENTRE INDUSTRY IN SOUTH AFRICA

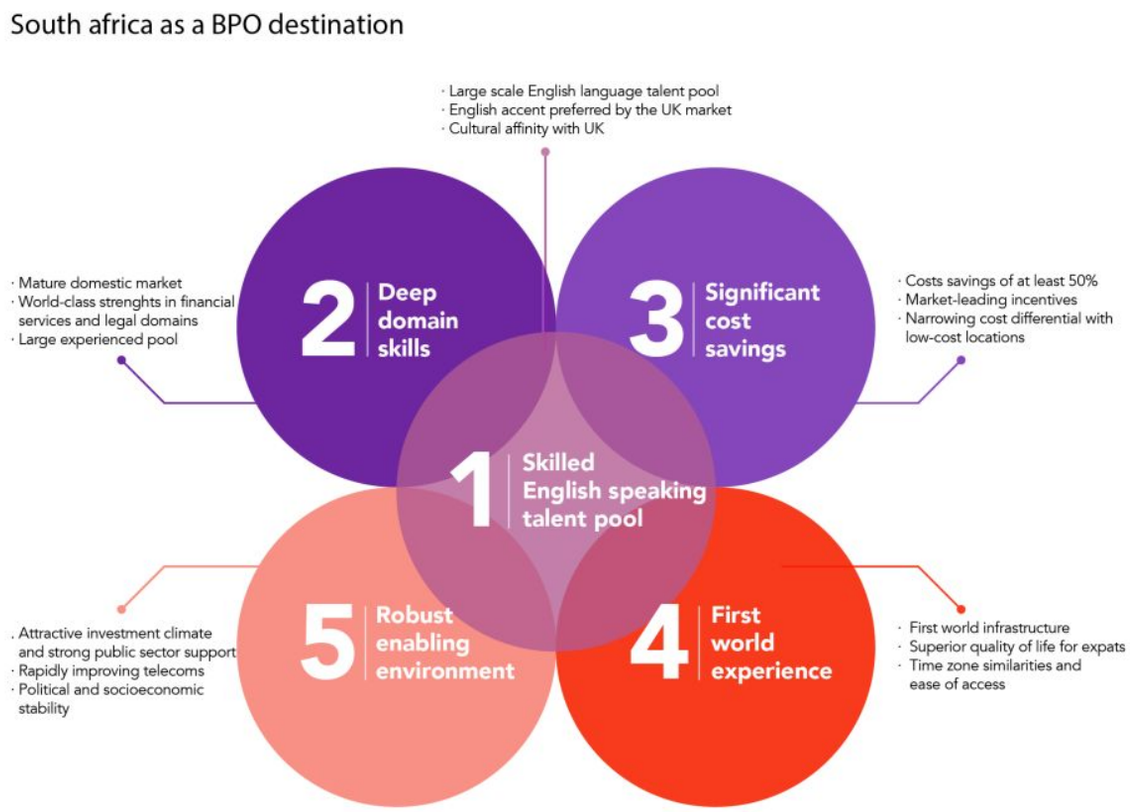
The South African government policy prioritising the call centre industry is focused on attracting international investors, a strategy that is emphasised in the recent Business Process Enabling South Africa (BPESA) Key Indicator Report (2016). The government Minister of Trade and Industry, Rob Davies, notes that South Africa was named the offshoring destination of the year at the Global Sourcing Association (GSA) awards in London in 2016, an award the country had also received in 2014 and 2012 (BPESA, 2016). Figure 8.1, from the BPESA report, illustrates some of South Africa's key strengths as a potential business outsourcing destination.

This strategic positioning of South Africa is widely documented (DTI, 2013; Hall, 2011). In line with neoliberal free market approaches, and to reduce unemployment, the South African Government is focused on strategies to develop a "sustainable skills" pool for its growing Business Processing Outsourcing (BPO) market (BPESA, 2016). Key strategies considered include the following (adapted from BPESA, 2016, p.9):

- extending BPO skills through development of industry-specific academies
- facilitating participation of government educational institutions in the BPO agenda
- addressing critical skills gaps
- building competence of team leaders and managers
- developing English and foreign language skills
- harnessing technology for skills development

It is still unclear how the South African government will translate this commitment into action, and what advantages and disadvantages it will entail for women working in this sector.

Figure 8.1
South Africa – strengths in business outsourcing



Source: BPESA, 2016, p. 6.

WOMEN'S WORK IN CALL CENTRES AND SOCIO-ECONOMIC TRENDS

South Africa serves as an ideal destination for BPO, particularly in the service sector. The growth of the service sector has seen a huge pool of women entering the global labour market (Gillard, Howcroft, Mitev, & Richardson, 2007; Eisenstein, 2009; Darsun & Bayram, 2014; Howcroft & Richardson, 2008), and the call centre industry is largely dependent on women's labour for both offshore and onshore services (Bonds, 2006). This global practice highlights the importance on women's labour as significant for global markets and international competition (Moghadom, 2000).

Scholars have viewed women's predominance in the call centre labour force in widely differing ways. On the positive side, some see the growth of the service sector resulting in substantial increases in the number of women in the labour force, especially in emerging markets. Labour force participation is seen as affording women economic independence, providing a basis for resisting patriarchy (Diane Wolf, cited in Eisenstein, 2009, p. 149); some endorse call centre jobs as decent work (Cohen, 2013). Other scholars argue that call centre work is service labour and thus likely to perpetuate the feminisation of labour (Standing, 1999; Howcroft & Robinson, 2008; Blin, 2010). Some scholars go further, accusing the governments of developing countries of being complicit in "offering up" their workforce as capable and affordable to a capitalist world largely driven by neoliberal market competition (Lacity & Wilcocks, 2013). Service provision jobs are criticised for centralising gendered notions of femininity, to justify women's participation in the labour force. These stereotypes are seen as contributing to the "devaluing" and "deskilling" of women's work, while promoting occupational segregation and polarisation (Bonds, 2006, p. 32). Such occupational segregation reinforces inequality in the labour force, since women in the call centres occupy the lower end of the employment spectrum.

The fact that women are the majority of workers in call centres also has clear economic implications: profit margins remain protected, or even increase, due to the devaluation of women's labour, which is always coupled with a reduction in labour costs (Gillard, et al. 2007). Furthermore, evidence shows that digital environments, such as that of the call centre industry, have the potential to "erode labour protection standards" (Gillwald, Mothobi & Schoentgen, 2017,

p. 2), especially because high levels of unionisation would deter investment. Eased labour protection standards can render women workers vulnerable to exploitation.

SKILLS DEVELOPMENT IN THE CALL CENTRE INDUSTRY

Scholarship on skills development in call centres is very limited. Evidence from sites that advertise call centre work shows that the industry does not routinely seek applicants with prior call centre skills, but rather offer their own training (see www.jobin.co.za). Recruitment efforts target marginalised, less-skilled young people, particularly women, who are either school leavers or college students (Benner, Lewis, & Omar, 2007). Call centres are highly routinised; the work requires little skills variety (Coetzee & Harry, 2015), and worker development is precluded by the flat organisational structure (Choi, S., Cheong & Feinberg, 2012). This research explores the implications of skills development for young women workers in South Africa, building on the body of scholarship on women's work in call centres in the Global South, particularly in the African context.

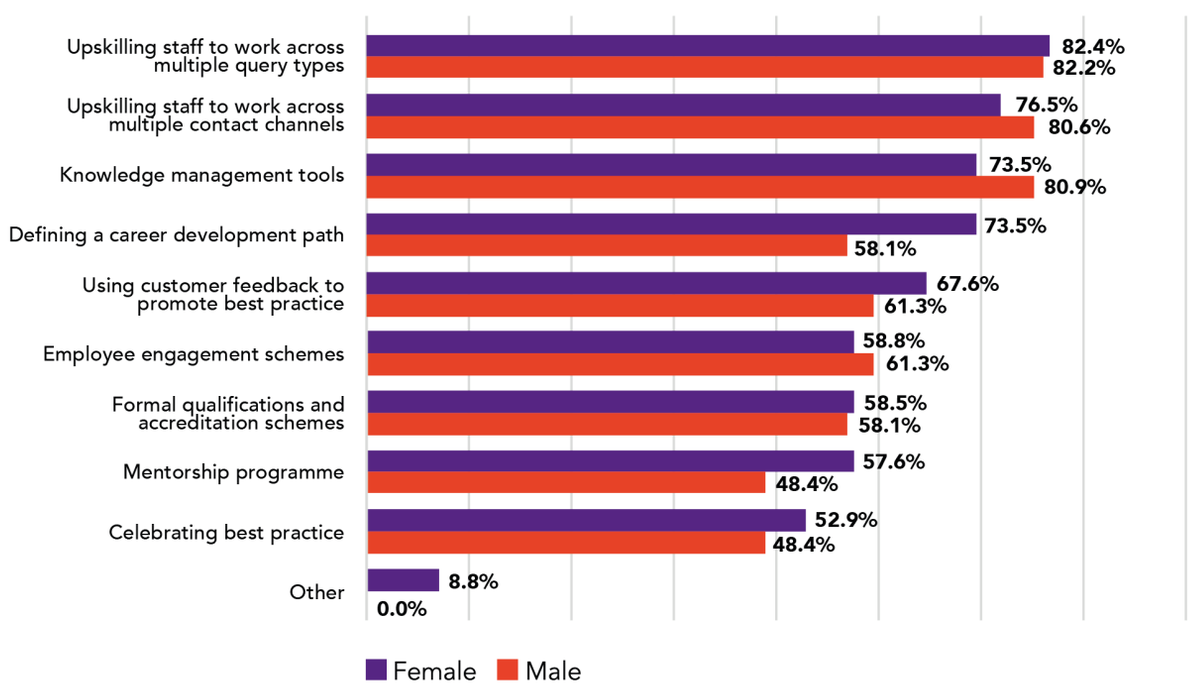
Figure 8.2 presents key skills-development approaches for managers in call centres in South Africa, as shown in the 2016 BPESA report. It shows that South African call centres pay significant attention to skills development, taking particular interest in upskilling staff.

METHODOLOGY

This chapter is based on a research project that investigated the participation of young women in the call centre industry in the cities of Cape Town and Johannesburg in South Africa, using surveys, focus group discussions, and individual interviews. Surveys noted demographic information on the participants as well as socio-economic and work-related factors. This paper draws particularly on the focus group discussions and individual interviews, to explore the impact of the call centre industry on skills development among these young women. Four focus group discussions of six to eight participants, as well as 20 semi-structured individual interviews, were conducted with young women aged 19–34 who currently worked as agents in different call centres. Participants included college students, school leavers, and other women. All interview participants were sampled through convenience and snowball sampling, and interview sessions took place in various settings where the participants would feel comfortable: at

Figure 8.2

Skills development in call centres in South Africa



Source: BPESA, 2016, p. 28.

their work place during breaks; at their homes or colleagues' homes; and at their colleges. Participation was voluntary, and all participants were informed that they could leave the study at any time without penalty. Focus group and interview data was analysed through a qualitative thematic analysis.

FINDINGS

The young women interviewed in this study included both part-time and full-time workers at call centres, which served British, American, and South African companies focusing on finance, telecoms, retail, data collection, and gaming. The interview questions concentrated on their experiences as workers, with particular reference to skills development. This section presents participants' perspectives and insights on skills acquisition for both job competency and career development.

SKILLS TRAINING FOR JOB COMPETENCY

Participants indicated that training took different forms that varied by organisation, with the initial training ranging from a few weeks to several months.

You get theory for like maybe 2 weeks, and then you are on the floor for another week.

The training was 3 months, and… you would need communication, interpersonal skills, be computer literate, patience, and I mean a lot of it, and then good listening skills.

You just get basic training on how to do the job: how to answer the phone, how to understand accents, how to operate their system and all that stuff. Their training is actually self-training, so you read stuff off the pc, then when you are done with that, they test you based on that and if you fail, they terminate your contract based on that.
There is a script that they give you that you memorise.

The training included teaching sessions followed by tests, that determined either progression to the floor or termination of contract. Agents also memorised scripts to master the questions they would have to answer on the shop floor. They were trained in basic keyboard skills, which included word processing and speed typing. They received training in communication skills: how to pronounce certain words, phone etiquette, and voice demeanour. Most of these skills have been labelled "effeminate" (Bonds, 2006) — and, scholars note, they are critical to these and similar industries that capitalise on women's biological and social characteristics to drive profits.

One participant touched on the issue of gendered recruitment when she emphasised how prospective employers considered it necessary to listen to her voice as part of training:

. . . so that my potential employers could hear the sound of my voice, whether my speech is slurred or… This is because call centres often want a voice that is pleasing and softer in terms of sound. Men are often linked to having voices that are rough and edgy, so maybe most men who apply do not get the job because of the sound of their voice, but I cannot be sure.

A number of participants felt that initial training sessions did not assist much in equipping them for their work, and that the most useful training occurred when they got to the shop floor.

INFORMAL TRAINING: 'WE LEARN ON THE FLOOR'

Some participants indicated that key readiness for tasks was developed only through hands-on experience on the shop floor. They spoke about side-by-side coaching, which they termed "buddying up", where they were assigned to understudy fellow workers or to be assisted by more experienced colleagues.

The first three days, you buddy up with someone else, you listen to their calls, you are with them as they take calls, you get to listen to the type of queries the clients raise, and you note how they are able to answer and then after that you go on your own.

You also have someone else buddying up with you. . . . It's the older people that come and listen in so if you're struggling and you need to ask something you can quickly ask to put the client on mute and in the meantime, you quickly find out the information that you require and then give it to the client. Then after that buddying up you're on your own.

They found this mode of training interesting and quite effective. Shop floor skills development was informal, however, and such informal processes do not secure skills recognition for career development, since they are not documented.

Training also involved putting agents under pressure to test their level of resistance, as one agent explained:

They suss up who can deal with high pressure situations and who can't — a lot of trainees leave at this point and do not return.

High pressure training was also linked to training towards achieving set targets that measure the worker's competency for the job.

The women workers admitted that all these forms of training and exposure provided them with some new skills. This chapter examines the nature of the skills acquired on the job and their value for career development.

THERE IS COMPANY GROWTH AND NO PERSONAL GROWTH: SKILLS TRAINING AND CAREER DEVELOPMENT

While some participants felt that the initial training improved their skills in some ways, others dismissed it as routine training that did not add to their skills. Respondents put emphasis on acquiring what are often called "people skills" (White & Roos, 2005), and agents believed they "picked up" these skills on the job.

I wouldn't say training empowered me with any skills but the work environment did. Having to deal with people, having to solve peoples' problems and having to think on your feet. It is the experience and not necessarily the training that matters. Training is just theory, information on the product the company offers and that is all. In most cases you forget those things, it's doing the work and you being active that gives you the training and experience that you take with you out of the call centre business, to other companies or to other aspects of your life where you will implement them.

I learnt to listen more attentively and work within very demanding circumstances. This job has also taught me to be very patient with the customers and use the different communication skills to connect with the customers.

So, what I am saying is that it's is not all bad, there is positivity in it. It will give you the opportunity and equip you for the future job that you want to do, it will give you soft skills, leadership skills, how to approach other situations as well.

Agents felt that call centre jobs developed soft skills and people skills more than technical or digital skills. While they appreciated developing people skills for personal growth, some questioned the importance of these skills for career growth.

Call centres are great, you meet people, acquire people skills, improve your communication skills, you improve yourself, you get promoted if you are lucky, to do the same thing anywhere —but the sad thing is that there is nowhere else you can fit with those skills. You have to work call centres or look for a job as a receptionist somewhere else! You can't take those skills anywhere.

The only skill you take across is moving to another call centre to do the same thing, agent or team leader.

I have only learnt to withstand pressure and to be confident and nothing else.

Agents also described the challenges of getting promoted, due to the limited availability of leadership positions as well as the intense competition for the limited positions of growth.

You find people "playing game of thrones" [back stabbing each other] to climb ladders that do not exist — there is company growth and no personal growth there.

I have been working here for four years now, and there are very limited positions to grow within the workplace. For years I have been doing the same thing on a daily basis, but there have been no promotions.

The ceiling is low, you rise and get stuck there, who wants to be a 50-year-old answering phones? Call centres kill your mind.

I see this job as limiting, people working in call centres always work at call centres, and they tend to not change jobs. One of my colleagues has been working with this company for six years, doing the same stuff every day and is still in the same position.

Call centres do not promote growth or any type of growth in terms of career prospects. The job is repetitive because every day I do the same thing and this can be quite frustrating if you want to express your talents and creativity.

Participants repeatedly discussed the lack of career growth, with some characterising the nature of call centre work as exploitative. In this view, they saw some centres capitalising on workers' vulnerability, arising from a lack of alternative employment.

I would say that call centres are exploitative. They use the basic work loss that we have here in South Africa. . . . It's cheaper over here to employ people than it is overseas . . . and someone did mention that you are easily replaceable in a call centre.

You are told straight out if you are not happy, it's fine, leave, there is someone that wants that job that you don't want. You are easily replaceable, you are not important. You are just a number in a lot of numbers they can easily get rid of.

Although not a common observation, one participant also raised what she saw as the gendered nature of promotion in her organisation.

I have learned a lot of skills such as communication skills, persuasiveness, conflict management, computer skills, and skills on sales. . . . But the thing is, even though I have learned all these skills at this job, I am still in the same position I started off with. I have never been promoted. They mostly promote guys. When we ask why it's only guys that get promoted, they say

it's because they perform and that's why they earn it. Surely there must be at least one girl who performs in this job.

DISCUSSION

Call centres largely provide service through use of digital technologies. Firms engaged in outsourcing have absorbed large numbers of young people, especially women, into various occupations (Belt, 2002; Taylor & Bain, 2005; Singh & Pandey, 2005). Call centres are not gender-neutral, as the industry is significantly driven by women's labour (Russell, 2008). The feedback of workers in the surveys and interviews cited above indicates that call centres do not focus on developing skills that lead to career development. The skills acquired by working in the industry do not add significant value to women's advancement in the labour market, keeping them on the lower rungs of the employment ladder (Ngabaza, 2017; Webster, 2004). Similarly, this study shows that the minimal skills developed in call centres are not intended to empower the women employees but rather to maintain profit margins. The absence of unions represents a business policy, as high levels of unionisation might drive away possible investors (Benner et al., 2007) — further compromising labour protection standards (Gillard, et al., 2007; Gillwald, et al., 2017).

Examining the intersection of skills development with the gendered dynamics of employment can provide a more complete understanding of the implications of skills development for women call centre workers. Research shows that ICT-driven work can reach marginalised and vulnerable communities (World Bank, 2016); indeed, call centres in South Africa mainly employ young women from such communities. Since ICTs are not gender-neutral but are "embedded in a range of social economic and political contexts" (Bonds, 2006, p. 31), it is important to interrogate the gender dynamics to understand what the skills development process implies for workers.

The recruitment process focuses on "feminine" skills: basic keyboard skills, phone etiquette, word processing, and voice demeanour. Workplace skills development focuses on effective service provision, not career growth. Workers develop their skills informally, coached by colleagues or memorising scripts. Scholars note, in similar contexts, that such informally obtained skills are not recognised as skills or considered in promotion prospects (Webster, 2004). While some participants valued the interpersonal skills they had acquired, they felt that these were of limited value to their career progression, and that they had not gained technical skills that could lead to further employment in the information sector.

The key competencies developed in the "skilling" of call centre agents have been linked to essentialist feminine skills. Young women in call centres remain the core drivers of this digital industry, in a global context that promotes economic growth without career development. Some study participants indicated that the focus of call centres was on organisational and economic growth, at the expense of skills development that might enhance their personal and career growth; some said they were reduced to a "lot of numbers" and were easily replaceable. Such contexts perpetuate gender inequality (Scholarios & Taylor, 2010).

While call centres have been instrumental in job creation in South Africa, where unemployment is a major issue, gender inequalities cannot be overlooked in assessing projects promoting economic growth and job creation opportunities. Moghadam (2000) has shown how global neoliberal trade regimes and competition have capitalised on women's labour. More than a decade later, the same process is replicated in call centres, which embody the "feminisation of production in the new information economy" (Bonds, 2006, p. 32). Young women are marginalised for corporate profits in this digitally-anchored industry; their labour is a source of global economic growth, as companies compete for the best outsourcing destinations in new emerging markets. Many of the young women participants were aware of this exploitation, emphasising that call centre work was "part-time work" while focusing on building other skills for their careers. However, they were also aware of the strain of juggling call centre work and other areas of personal development, especially for those who were still studying. In spite of being based in information technologies, call centres remain limited in equipping their workers — especially the young women who represent the majority — with valuable skills for career growth.

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9

A GENDER PERSPECTIVE ON SECURITY AND PRIVACY IN THE DIGITAL AGE

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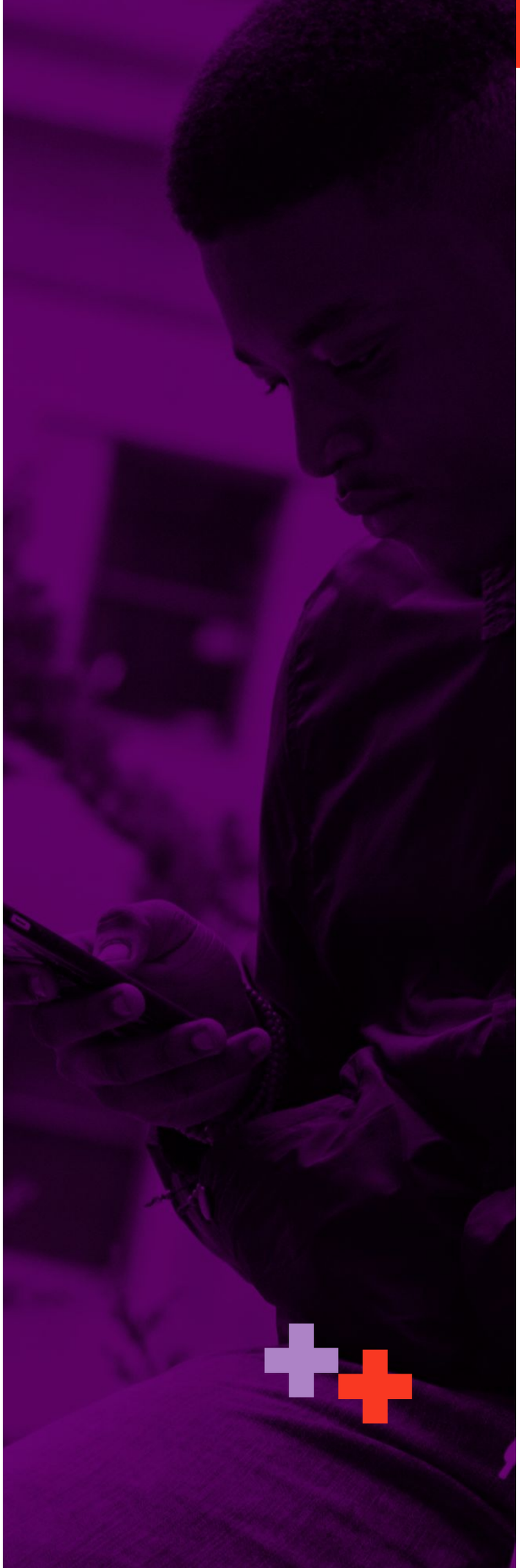

ABSTRACT

This chapter explores the fundamental notions of digital security and privacy from a gender perspective. In a world that is increasingly relying on digital technologies, learning how to be safe when online is of paramount importance. Studies show that, as much as digital technologies represent an undeniable opportunity for growth and change, they also offer a larger platform for abuse. The Association for Progressive Communication has pointed out that cyberstalking, online harassment, image manipulation, and privacy violations have compromised women and girls' safety both online and off-line, in many countries (APC, 2015). This disturbing behaviour extends to geo-tracking and surveillance, in some extreme cases. Equipping women with adequate digital knowledge and skills to ensure a more secure and private online experience can help to limit this kind of abuse. Going further, however, we advocate women's involvement in fundamentally rethinking security research and design in terms of gender. Security technology (including cryptography) is not gender-neutral; to date, it has been proposed and designed by a specific, non-diverse community, which has shaped its development. Specific trust assumptions, security models, and the technical language of security — using such terms as attacks and adversaries — that underpin contemporary security research appear to be male-driven and male-oriented. However, there is growing awareness that security solutions need to be designed in, and for, a specific context, and that they need to take incorporate diverse, context-sensitive design principles. This goal requires reducing the gender gap in digital literacy, ensuring that women have the necessary skills to experience technology in a private and secure way (for instance, with better understanding of password use, encryption functionality, and data integrity). Women's greater involvement in the design of security and cryptographic solutions is key to safer integration of digital technologies in our lives.

KEY FINDINGS

- Technology unfortunately provides a wider platform for abuse towards women. The solution requires both individual digital skills to enhance personal security and privacy, and women's participation in design and development of security and privacy technologies.
- In the field of Information Security, women are largely underrepresented: globally, women account for just 11% of the cyber security workforce, mainly in non-managerial positions.
- Security technology is gendered; cryptography incorporates gendered assumptions relating to sources of threat, potential "trusted" allies, and resource availability. More diverse design principles need to be developed.

INTRODUCTION

This chapter details how the lack of knowledge of online security and privacy can have a deeply negative effect on technology users, especially women. A straightforward solution to this problem is to equip women with the necessary skills, so the chapter then examines women's involvement in the area of information security. Finally, we note that this imbalance in skills has led to a lack of diversity in the design and development of security solutions, and in particular of even basic cryptographic concepts. In view of the fundamental role of digital security in the adoption of technology in our lives, reducing the gender gap in this field is of paramount importance.

SECURITY AND PRIVACY CONCERNS FOR WOMEN IN THE DIGITAL AGE

Technology is generally considered a fundamental driver of development and social change, not only in economic aspects but also for human development, abilities, and freedom (Deneulin & Shahani, 2009). Digital technology, in particular, has great potential to promote the advancement of women's economic opportunities as well as the equality of women and men. However, digital technology cannot be considered a mechanism in itself for promoting development and equality, but rather a contribution to that process, by highlighting, extending, and magnifying communicative and sharing capabilities (Sey, 2011).

Indeed, the digital age has proven, in some respects, to be liberating for women; access to technologies and the internet can be very empowering. Judy Wajcman, in TechnoFeminism (Wajcman, 2004), surveys feminist theories regarding the interplay between gender and technology. In the utopian views of cyberfeminists, technology will allow us to break free from the gender-based roles and restrictions that define us in the real world, because, in the digital world, women can be whoever they want. (Wajcman, 2004, pp. 56-77).

Society is immersing itself in the digital world. At the end of 2015, it was estimated that there were 3.2 billion people online (Internet Society, 2016); similarly, in 2016, it was estimated that 47% of the world's population is online (World Wide Web Foundation, 2016). To varying extent, women are accessing the internet, ranging from 76.3% in Europe, to 18.6% in Africa (Statista, 2017a); (ITU, 2017). (For some countries, these statistics are unavailable.) In social media access, 52% of Facebook users in the U.S. are female, as are 44% of Facebook users worldwide (Statista, 2018a).

Mobile phone usage is also growing. In the U.S., 94% of women own a mobile phone and 75% own a smartphone (Pew Research Center, 2018). These numbers are significantly lower in the Global South: in low- and middle-income countries (LMICs), the percentage of women owning a mobile phone was 41% in 2015 (GSMA, 2015). Pay-as-you-go mobile phones have been important in enabling women in LMICs to get connected (Wajcman, 2004, p. 120). In 2017, 36% of women were using, or had previously used, online dating sites or apps (Statista, 2017b).

What security and privacy concerns does such connectivity entail? The advent of mobile technology has enabled significant economic and social changes, especially in LMICs. Innovations include branchless and mobile banking, farming apps, and health-related applications (including home-based care, medical advice, counseling for HIV/AIDS patients, and anti-counterfeit checking of pharmaceuticals).

However, mobile technology can reveal tensions and complex relations between technological mobility and social—especially gender-based—restrictions. The generalisation that technology increases economic and social advances is too simplistic. An ethnographic study in India, conducted by Jo Tacchi, shows that in some households men control technology (phones in particular), believing that technology has a corrupting influence on women. However, when the power structure changes in a household (due to a death, for example), the constraints and restrictions on technology also shift (Tacchi, 2014). The use of mobile technology to control or track a daughter's movements, described in the same study, can be seen as either oppressive or protective, depending on the participant.

Social control can be exerted through simple calls and text messages, or it can be amplified through apps such as Phone Tracker and Find My Friends, which allow a user to follow a spouse or partner, for example. This can allow abusive partners to exert more control — particularly troubling when we consider that 35% of women worldwide have experienced physical or sexual violence (World Health Organisation, 2017).

Security and privacy may be even more at risk in the online world. American women are more likely than men to seek healthcare advice online (eMarketer, 2013). Women in the UK are reportedly seeking illegal abortions online, even though abortion in the UK is legal and publicly funded (New Scientist, 2017). Whether or not this indicates a problem in accessing abortion services, there is certainly some danger in seeking out medical help online. Illegal healthcare creates a security issue, placing women in danger, particularly with regard to reproductive health and abortion services; they may receive incorrect medical information or be given medications that, at best, do not work or, at worst, are dangerous.

The problems and dangers that may be encountered by women seeking health and human services on the internet include: difficulties in ascertaining the credentials and identity of service providers; accessing inaccurate information; reliance on untested methods; difficulties in online assessment; exposure to disinhibited communication; development of inappropriate online relationships; and lack of standards or regulation regarding online human service practice. In addition there is the possibility of victimisation through loss of privacy, cyberstalking, and identity theft (Finn & Banach, 2000).

Overall, use of these new technologies may expose users to an unprecedented level of threats, such as control, abuse, and theft of sensitive data, reflecting the lack of certain security properties (Quaglia & Heath, 2017). One solution is to equip women with digital knowledge and skills to ensure a more secure and private online experience, as well as greater agency in navigating information security.

This highlights the need for progress in increasing both the digital skillset required for personal security and privacy (for which training and schools are being developed), as well as women's participation in the design and development of security and privacy technologies. (We note that there is also the dual need to restrict and punish the abusers and perpetrators of online crime). This often comes in the form of calls for better and more balanced laws to prevent cyber-crime, online harassment, however this will not be the focus of our study). We focus on the need to increase women's participation in InfoSec, since this has received less attention in the literature so far.

WOMEN IN INFORMATION SECURITY

Globally, women only account for 11% of the cyber security workforce, and they are likely to hold non-managerial and entry-level positions. Men are much more likely than women to hold a C-level or executive management position. The prevalence of women in information security professions varies by region, ranging from 5% of the workforce in the Middle East to 14% in the U.S., but women are underrepresented globally (Executive Women's Forum, 2017).

Accordingly, decision making in information security is disproportionately carried out by men.

One reason for this gender gap is that women are less likely to interact with STEM subjects (i.e., science, technology, engineering, and mathematics). STEM background appears critical: 61% of women entering the information security workforce have a degree in a STEM subject, as do 74% of men (Executive Women's Forum, 2017). However, girls' uptake of STEM subjects in schools is low. For 16-year-olds in the UK, only 35% of girls choose to study a STEM subject, compared to 94% of boys (Wise, 2017). Jane Frankland points out that large numbers of women were engaged in STEM subjects throughout WWII, followed by a sudden drop-off. One factor, Frankland argues, may be media portrayal of STEM subjects as masculine areas of study; she cites examples of movies and popular media showing males interested in information security (Frankland, 2017, pp. 143-4). Another factor is misconceptions about gender, and gender bias. Gender bias can appear in many forms, from unequal pay to more subtle issues, such as asking women to perform different duties than men, influenced by gender norms (TechRepublic, 2015). Biases against women in the workplace include assumptions such as that a woman will leave to have children, or that she will not want to travel (Frankland, 2017).

Globally, 39% of women in information security do not come from a STEM background (Executive Women's Forum, 2017), compared to 30% of information security professionals overall (Alta Associates, 2017). Since women are more likely to enter the information security profession from a non-technical background, Frankland points to the importance of non-traditional (i.e., non-STEM) routes into cybersecurity; she prefers to refer to STEAM (science, technology, engineering, arts, and mathematics) (Frankland, 2017, pp. 87-88). Women are more likely to have interdisciplinary skills, and employers should consider the benefits this can bring to a workforce (Executive Women's Forum, 2017).

Programs that target information security initiatives at girls can help to raise awareness as well as increase digital skills. Girls Who Code operates across the U.S. and the UK (Girls who code, n.d.). IBM run the Women in Security Excelling Initiative (WISE), launching a 2016 programme called Cyber Day 4 Girls to teach girls in the U.S. and Canada cyber security awareness (IBM, 2016). Google launched a website in 2014, "Made with Code", that includes coding projects aimed at girls (Time, 2014). Government initiatives also exist, such as CyberFirst (CyberFirst, n.d.), run by the National Cyber Security Centre in the UK, that provides courses and competitions that aim to nurture talent. In the U.S., GenCyber is a free summer camp for students and teachers (GenCyber, n.d.). Many initiatives around the world relate to STEM participation more broadly (Mashable, 2016), as demonstrated in the EQUALS mapping initiative (https://www.equals.org/actionmap).

In order to address gender bias, employers must first be aware of possible bias and take positive action to prevent women being discriminated against. For example, since women are often disadvantaged for having children (Frankland, 2017, pp. 4-8), Google increased maternity leave for new mothers. By reducing the number of new mothers leaving the company, this step was also cost-efficient, saving costs of recruitment and training (Quartz, 2016).

While women's input to technological progress has been overlooked in the past (Wajcman, 2004, p. 13), their role in the history of technology is now being presented in popular media. Notably, the 2016 movie Hidden Figures documented the little-known role of African American female mathematicians in the U.S. space programme in the 1960s. Women's issues are widely covered, and campaigns against stereotypes of women in industry are reported in the media (BBC News, 2015). Women in different industries fight against gender inequality, using social media to highlight issues; the MeToo (Wikipedia, n.d.) and TimesUp (Wikipedia, n.d.) campaigns showed the power of online action.

GENDERED SECURITY

Radical feminists see all technology as intrinsically patriarchal, that is, as part of a system controlled by men to further male goals. These arguments are explored in (Wajcman, 2004, pp. 10-31). This argument can also apply to digital security and privacy: as part of the technology, security and privacy can also be considered to be gendered.

Cryptography focuses on enabling secure communication over an insecure channel, such as the internet. This is typically done by means of cryptographic primitives — basic algoriths, such as encryption and digital signature schemes — designed and tested by cryptographers.

In order to test that a system is secure, researchers adopt rigorous and precise definitions of security, modelling properties such as confidentiality, integrity, and anonymity. Each definition is carefully designed to capture a particular security property, under detailed assumptions about resources, required trust, network availability, and even the notion of identity.

As noted in Quaglia and Heath (2017), the assumptions regarding available resources (e.g., technology used and network access), as well as notions of identity and trust, can strongly influence the cryptographic solution design. In our experience, most assumptions are developed and tested exclusively in the (male) global north. Cryptography is not a neutral terrain. Even its language can embody masculine themes, as in expressions such as penetration testing (in the secure testing domain), and man-in-the-middle attack

(a classic attack against cryptographic protocols). More significantly, perhaps, cryptographic models make assumptions that may not be relevant to gender-specific threats.

The model of cryptographic threat incorporates the notion of attacker/adversary, which is often assumed to refer to a distant and unseen third party with malicious intentions. As discussed in Part 1, the malicious intentions towards women's security and privacy often originate from the domestic environment, and the assumption of a distant adversary appears irrelevant. Similarly, the trust assumptions made in these models often assume the existence of a trusted institution, such as a bank, a company, or the government, which can be fully relied on and considered benign. In countries where important institutions are male-dominated or male-oriented, such assumptions of trust could be detrimental to the security of women. Finally, even assumptions regarding resources can be considered biased: if a cryptographic solution is proved to be secure under specific resource requirements (e.g., power and network availability, computing capacity), when such requirements are not met security cannot be guaranteed. Given that women around the world tend to have limited access to resources, this basic assumption cannot be considered gender-neutral. These and related considerations need further research, to serve women's unique and urgent security and privacy concerns.

CONCLUDING REMARKS

This issue has not been raised before in the context of cryptography, as the analysis of security in general has been heavily influenced by gender. Feminist security studies have proposed a more people-centered notion of security, in which people contribute to and become part of the definition of security. Quaglia and Heath (2017) describe a growing awareness that technology needs to be designed for a cultural and societal context. Seminal work by Hall, Heath, and Coles-Kemp (2015) describes how visualising security with the use of LEGO bricks enables participants to question traditional notions of security (such as the one user/one password paradigm).

Rethinking security through a gender lens is a necessary step to ensure women's greater involvement in the design of security and, in particular, cryptographic solutions, enabling a successful integration of digital technologies in our everyday lives. There are some limitations to our considerations so far: for instance, we have not extensively covered issues of security and privacy globally, and we have not addressed intersectionality. This paper should represent a starting point for further detailed studies and research.

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PATHWAYS

10

INVESTIGATING EMPOWERING NARRATIVES AROUND WOMEN, WORK, AND TECHNOLOGY

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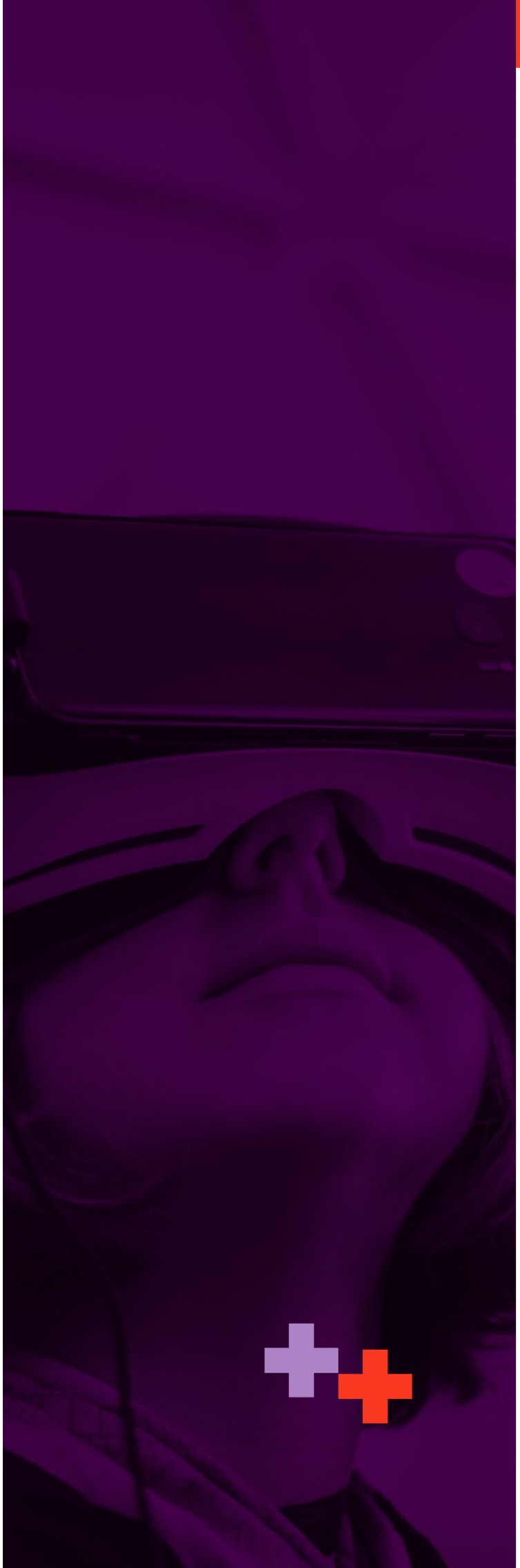

ABSTRACT

Despite many efforts, women's participation in STEM fields and representation in the tech workforce remains low in many places, made more difficult by gender prejudice in education as well as work. Women's work in technology-related fields has been historically and structurally devalued. With a focus on women's work in information and communications technology (ICT), this chapter reviews feminist literature on women and technology and discusses gaps in the current narrative of the empowering potential of technology. We explore two areas of existing research: literature on women's work in ICT, especially intersectional and global literature; and a specific literature that reframes data production as labour, with reference to the influence of feminist literature on these arguments. We provide some recommendations for incorporating this perspective in research agendas on women in ICT and STEM.

KEY FINDINGS

- A more diverse literature on women and work in ICT and STEM should incorporate a more global analysis that takes into account women's experiences of work in these sectors.
- Early writings on the impacts of technology assumed gender-neutral effects, as if technology is created outside social constructs and limitations. The potential benefits of ICT need to be viewed in the context of women's lived experiences of these technologies.
- Historically, when women have been engaged in fields using technology, those fields of employment are defined as low-skilled and low-prestige (e.g., textile production). Similarly today, although women are actively involved in digital technology production, their contribution is undervalued and the fields where they work become less attractive.
- Online activities create valuable data and might be understood as work that should be compensated. Nevertheless, this work is often undervalued, invisible, and regarded as unskilled.

INTRODUCTION

There has been a push to make the field of digital technologies a safer and a more inclusive workplace for women over the last decade. Nevertheless, women across the globe continue to face discrimination both online and offline, as do other marginalised groups and individuals. Women's participation in STEM fields remains quantitatively low, with women facing prejudice in education and work. Representation in the workforce in STEM and other technology-heavy areas is especially lacking. This is consistent with a history of women's work often being structurally devalued, with women being viewed as less valuable workers (Seguino, 2000; Elson & Pearson, 1982).

This chapter focuses on women, technology, and women's work in technology. We examine the gendered ways in which women's engagement with technology is portrayed and we investigate the view (known as technological determinism) that technology is automatically bringing about progress and benefits for women. We address how women's work has historically been undervalued, whether it was housework, textile manufacturing, or women's crucial contribution to programming — which was disregarded as "clerical" work. Women's work has often not been acknowledged as "work", or their skillful contribution has been ignored as low-skilled. We draw from a range of literature: on housework, care work, and affective labour; on the feminisation of labuor; and on deskilling. Our chapter also joins the conversation on how to close the digital gender gap, which generally focuses on promoting skill development and self-confidence in women and girls. We argue that a wider effort is also needed, to reexamine how women's skills and contributions to technology have traditionally been undervalued.

The chapter has three sections. Section one discusses technological determinism — the view that technology drives progress — contrasting its assumptions with women's global experiences with technologies. Section two explores narratives on two areas of women's work relevant to the digital era: women producing ICTs, and women producing data and content. Finally, we make recommendations on the current research agenda, including expansion to include, as a default, a diversity of experiences from the Global South.

TECHNOLOGICAL DETERMINISM AND WOMEN

Since the 1850s, technology and its potential for positive change have captured the minds of scholars as well as politicians. When the first transatlantic cable was installed, it was hoped to connect "all the nations of the earth" and make it impossible for "old prejudices and hostilities" to exist (boyd, 2014, p. 156). The birth of the internet was heralded with similar hopes and dreams, as a new place that "allegedly freed users from the limitations of their bodies, particularly the limitations stemming from their race, class, and sex" (Chun, 2006, p. 2).

THE LITERATURE

Guillermo Gómez-Peña (1997), an early critic of that utopian rhetoric, describes how American digital artists viewed "the net" or "cyberspace" in the 1990s: they "spoke of a politically neutral/race-less/gender-less and classless 'territory' which provided us all with 'equal access,' and unlimited possibilities of participation, interaction and belonging" (Gómez-Peña, 1997). In reality, he observes, this "territory" had a "digital border", and on the other side "there lived all the techno-illiterate artists, along with most women, Chicanos, Afro-Americans and Native Americans in the U.S. and Canada, not to mention the artists living in so called 'Third World' countries" (Gómez-Peña, 1997).

Even at the beginning of the internet age, therefore, despite many people's attempts to make the web as inclusive as possible, its empowering potential was already limited and exclusive. Nevertheless, such utopian claims still influence the discourse around access and use of ICTs (boyd, 2014, p. 158). According to danah boyd, technological determinism is the belief that "technologies possess intrinsic powers that affect all people in all situations the same way" (boyd, 2014, p. 15). The larger literature on technological determinism investigates the relationship between technologies and societies and theorises how societies respond to technologies. The core tenets of technological determinism hold that technology is created outside social constructs and limitations, and that technology drives (socio-economic) change.

Lelia Green (2001, p. 3) argues that early representatives of this view perceived technology "as being outside society, . . . as neutral. It was as if technological progress and development were inevitable." The assumption is that technology is created in a vacuum; technology itself determines how society uses it. Indeed, it is seen as society's role to "adapt to (and benefit from) technological change" (Green, 2001, p. 2). Technological determinism still pervades today's discourses about technologies and their progressive potential for society (Wyatt, 2008).

A crucial, early piece of literature argued the opposite: that technology is imbued with its creators' biases. This was Langdon Winner's 1980 article, "Do Artifacts Have Politics?" He used the case of city planning in New York City to argue that the urban planner's privileged and advantaged position led him to design a city less accessible to marginalised groups, including bridges under which public buses were unable to pass. Winner's article contributed to the larger debate around technologies (i.e., "artifacts") and whether social, political, economic, and cultural biases influence technology production and innovation.

Relevant for this chapter is the determinist argument that technology drives progress for all of society, including women. Donald MacKenzie and Judy Wajcman (1999 [1985]) contend that social circumstance, rather than technology itself, determine its adoption, use, and consequences. Lelia Green builds on these insights, arguing that armed forces, bureaucracies, and corporate power mainly determine technological progress. Development of technology "represents the priorities of the elites which sponsor it, rather than representing the society as a whole" (Green, 2001, p. 10).

Many observers highlight the overall positive potential for women in ICT. Debra Howcroft and Helen Richardson (2017) argue that women's work in Information Technology Enabled Services (ITES) is often an opportunity to reduce inequities and provide economic autonomy. They outline three reasons for this optimism: this work can offer financial independence; ICT-enabled work is not always bound by time or location, which allows women flexibility for their care responsibilities; and the common association of the "information age" with teamwork rather than competition could translate to more women in executive positions (Howcroft & Richardson, 2017). The potential benefits nevertheless need to be viewed in the context of women's lived experiences of technology, which are much more complex than technological determinism suggests.

RE-FRAMING WOMEN'S GENDERED EXPERIENCE OF THE FIELD OF TECHNOLOGY

Although women have long been living and working with technologies, their engagement with technology has often been framed as non-technical. Judy Wajcman's influential book, Feminism Confronts Technology, investigates this bias around technology in the Global North, arguing that technological competence as commonly understood is interwoven with masculinity (Wajcman, 1991). Activities such as knitting, sewing, or gardening are assumed not to require technological competence (as holds true

for many other traditionally female skills). Moreover, when women gain knowledge of other technologies (cars, microwaves, washing machines), this use knowledge is not seen as technological competence — unlike the maintenance of these technologies, which is usually handled by men (Wacjman, 1991). Women's engagement with technology is reframed as housework or regarded as requiring little expertise. The very definition of "working with or in technology" is imbued with gender.

Wacjman further argues that the process of displacing formerly "leading-edge" technology in favor of newer technology occurs precisely through feminisation and democratisation of that technology — e.g., as more and more women use microwave ovens. Thus, even when women adopt new technologies or ICT skills, these become less valuable in the process (Wajcman, 1991). A similar process is identified by Jennifer Light. She explains how the complex work of inventing a programming language for ENIAC, America's first computer — work that is highly regarded today, as the "complex artful work of computer nerds" — was disregarded at the time as mere "feminised clerical labour" (Light, 1990, p. 455) and thus rendered invisible in popular perception.

Marie Hicks investigates the experience of women workers in computing in Britain in the 1950s–1970s. Hicks finds that stereotypes were used in advertisements and the media, downgrading women's labour, which reinforced perceptions of their skilled, complex tasks as relatively unskilled and low-cost (Hicks, 2010, p. 6). She notes that these jobs of programming and data processing were later institutionalised as the field of computing professionals. "Both in image and reality, it was nearly impossible for women workers, in the aggregate, to shake the expectation that they were low- cost, high-turnover, and low-skill" (Hicks, 2010, p. 11).

Historically and today, women's engagement with technology is routinely portrayed as requiring little technological expertise; women working in jobs requiring technical skill and qualifications are portrayed as unskilled and therefore low-cost labour. This phenomenon affects fields traditionally regarded as technological, such as STEM or ICT, and fields that have been redefined as technological by feminist theorists, such as sewing (with machines), agriculture, or housework.

In the global manufacturing industry, Elson and Pearson (1982) note that women are seen as naturally docile, disciplined, and predisposed to repetitious tasks. They argue that what is defined as "unskilled" work is often the work that is seen as socially appropriate for women, such as sewing. "Women do not do 'unskilled' jobs because they are the bearers of inferior labour; rather, the jobs they do are 'unskilled' because women enter them already determined as inferior bearers of labour" (Elson & Pearson, 1982, p. 94). Such feminised labour has continued to be associated with lower wages and flexibility in work hours and employment. Analyzing economic growth in Asia, Stephanie Seguino (2000) argues that wage differentials reflect levels of discrimination against women. Martha Chen (2008) concludes, in her analysis of global poverty reduction programmes, that women are over-represented in lower-quality employment.

David Hesmondhalgh and Sarah Baker (2015) identify similar dynamics. They explore job segregation as a relative concept, with certain occupations being strongly associated with either women or men: while women mostly work in coordination, men occupy more prestigious, more creative, and more "technical" positions. Occupations become "feminised" with a growing concentration of women working in them (though not necessarily the majority). This process is linked to inequality in three critical ways: feminised occupations tend to pay less; job segregation hinders women in pursuing masculine occupations for which they are qualified; and it makes it more difficult for women to find an occupation that matches their talents (Hesmondhalgh & Baker, 2015). Overall, women in feminised industries tend to work less, be paid less, and report less job satisfaction.

Efforts to promote girls' and women's skill development need to go hand in hand with a broader reassessment of how women's skills are commonly valued and regarded.

EXPERIENCES OF WOMEN'S WORK WITH DIGITAL TECHNOLOGY

In this section, we consider the experiences of women both in producing physical ICTs and software and in providing the intangible services that create content and data. Several characteristics of feminised labour remain relevant, with striking variations that call for context-specific analysis. We also question narratives about technologies that are based on the specific histories of the Global North: the overly positive portrayals of the potential of ICT often ignores how this technology is produced.

Melissa Gregg (2008) and Wendy Chun (2006) argue that the freedom of working in the global information economy offered to some women masks dangerous work that other women undertake in producing software and hardware — often, Asian and Asian American immigrant women workers. We therefore use a broader definition of work in or with ICT and STEM that incorporates this contradiction. We follow Christian Fuchs and Marisol Sandoval in defining digital workers as those involved in the production, circulation, and use of digital media (Fuchs and Sandoval 2014). Fuchs illustrates the diffusion of the digital production process, encompassing mineral extraction, manufacturing and assemblage, and software engineering, but also including the work of

cell centers and internet "prosumers" (Fuchs 2013). In this way, digital labour is understood as a process that is geographically situated and contingent on local and global power structures.

WOMEN IN ICT PRODUCTION AND PROGRAMMING

The examples below provide a global perspective on narratives about women and technology. To quote Ulf Mellström, this section seeks to question "the notion that an all-encompassing masculine culture of science and engineering transcends time and space" (2009, p. 903). We show that, contrary to narratives in the Global North, women are in fact very actively involved in technology production.

Masculine and hyper-masculine spaces in technology are well documented. Fox and Tang chronicle women's toxic experiences of online gaming (2016), and Marie Hicks has written about brogramming culture in Silicon Valley (2013). The view of technology as a masculine field conceals not only women's contributions but also global realities. Nevertheless, this assumption is often cited to explain why women may not choose to pursue computer science, in the Global North and in other contexts.

Other authors point to different experiences in the Global South, where computer science spaces are not considered masculine, but where working conditions still may be less than ideal (Gupta, 2015; Mellstrom, 2009; Lagesen, 2008; Wajcman & Anh Pham Lobb, 2007; Saloma-Akpedonu, 2005). Namrata Gupta questions the universality of the Western experience of gender and technology, arguing that the local context has a large role in shaping the relationship between gender and technology. In India, the large number of women in tech is due to its "women-friendly" image, based on gendered assumptions regarding the field — including that it is "safe" for women (Gupta, 2015).

While opportunities for women have increased, Gupta argues that women's presence should not be interpreted as a "radical revolution in gender relations in society"; sexist assumptions and gendered job segregation continue (Gupta, 2015, p. 661). Hiring in these sectors still carries assumptions of care work and domestic responsibilities, and careerism is frowned upon. Further, women in the tech sector are concentrated in routine jobs that require technical skills but not expertise (Mitter & Sen, 2000, cited in Gupta, 2015). Other research suggests that women's professional lives working in tech fields tend to be short, ending abruptly after marriage (Toyama et al., 2018).

Perceptions of gender and computing in Malaysia also contradict the masculine image described in Western contexts. Vivian Anette Lagesen explores perceptions of Malaysian women computer science students, describing a "coproduction of gender and computer science that appears different, more complex, and less stereotypical than implicated by the main body of Western research" (Lagesen, 2008, p. 22). Computing was not considered masculine, although gendered assumptions of the nature of women still prescribed specific activities. Software engineering and programming were seen as "theoretical", suited to women, in contrast to electronics and mechanical engineering which were considered "physical" and better suited for men (Lagesen, 2008).

Also in Malaysia, Ulf Mellström (2009) similarly questions notions of a global masculine culture around science and engineering, favoring an intersectional approach that considers race, class, and age as well as the conceptualisation of masculinity and femininity across cultures. Mallström argues that in the Malaysian context, class and race inequalities may be as pertinent as gender. Women make up higher percentages of both students and professionals in computer science and IT; and, in contrast to many other places, several women are found in executive positions (Mellström 2009). Gender assumptions here as well posit indoor work as suitable for women. Nonetheless, women are also found in different types of work: "On the one hand, there is low-skilled technology employment, consistent with the image of the 'nimble-fingered' docile female worker, and on the other there is the female professional IT worker and academic" (Mellström, 2009, p. 896). He traces the current feminisation of labour to deliberate recruiting of rural women for work in the early electronics industrial sector. The history of women's integration into the sector continues into their present low status.

Czarina Saloma-Akpedonu's research on gender in the ICT industry in the Philippines points to the importance of the history of the field. As the sector developed it included systems analysis as part of software development, which required a business background. Accordingly, Saloma-Akpedonu argues, women's presence in certain ICT fields did not result in the devaluation of their labour. In this instance, the soft skills that are associated with women were not devalued, as the ICT field in the Philippines valued these skills as a core part of the industry.

In Vietnam, very differently, gender segregation in the software workforce has been shown to be significant, with systemic undervaluation of women's work. In production, women are concentrated in the testing phase, while men work in the specification and design phases — despite the strong link and overlap between the two phases. Indeed, women testers often "need to write another software programme to test a software programme" (Wajcman & Ahn Pham Lobb, 2007, p. 21). No gendered gaps in qualifications or experience were noted. This reinforces Wajcman's earlier argument that perceived skills can be based on ideologies and social constructs of gender, rather than on actual technical capacities (Wajcman, 1991). Wajcman and Anh Pham Lobb's study notes the contrast with Saloma- Akpedonu's work on the

Philippines, arguing that that analysis is based on a differential skill set between women and men.

Melissa Gregg analyses "creative" information jobs in Australia and finds that most are advertised as flexible, with the opportunity to balance work and home responsibilities. She argues that they disguise both a long history of women's unrecognised labour in the home, and the flexible labour that "other" women around the world contribute (Gregg, 2008). Brooke Erin Duffy and Becca Schwartz explore the feminisation of social media employment, where advertisements construct features of sociability, emotional management, and flexibility. "This catalogue of traits presents an archetype of a worker who is sociable, emotive, and flexible — features we attribute to the social media profession's ostensible feminisation" (Duffy & Schwartz, 2017, p. 7, emphasis in original).

Rosalind Gill surveys the new media sector in six countries in Europe. She argues that despite its image as "cool, non-hierarchical and egalitarian", gendered inequality persists (Gill, 2002, p. 70). Women tend to work on fewer projects, becoming de facto part-time workers who are more likely to work from home. These findings echo many of the traits of feminised work as undervalued. Other experiences elsewhere echo feminisation to different degrees and in different ways.

The literature challenges a Western-centric view and emphasises that gendered assumptions of work play out differently under varying contexts. Invariably, undervalued work leads to pay gaps, lack of retention, and low advancement in careers for women. Even when working conditions do not reflect these disadvantages, gendered assumptions can be inhibiting for those who do not "fit in". Mellström (2009, p. 902) concludes that both "gender and technology studies need to pay more attention to culturally situated analyses that bring local gender discourses into the picture". Recommendations moving forward must consider specific context and be prepared to accept a wide range of realities, gender constructs, and experiences. Overall, research needs to move towards considering technologies as fluid and historically situated.

ONLINE ACTIVITIES AS WORK

It has become a widely shared insight that the business model of many large internet-based companies, such as Google or Facebook, is to either sell (and resell) user data or to monetise it through data analysis (Jarrett, 2016; Fuchs, 2013; Lessig, 2002; Fisher, 2016; Gurumurthy & Chami, 2016; Abreu, 2014; Jarrett & Wittkower, 2016). With the recent buzz around machine learning and artificial intelligence, data has become one of the most valued commodities in the digital economy (Ibarra et al., 2018). Researchers have begun analyzing this phenomenon from a labour perspective, investigating different ways to conceptualise the relationships between companies, people, their online activities, and the resulting data.

Christian Fuchs's extensive work (2008; 2011; 2014a; 2014b) has been extremely influential, constituting what Jarrett and Wittkower (2016) have called an "'economic turn' in Internet research". Building on Dallas Smythe's (1977; 1981) discussion of the "audience commodity" in media studies, Fuchs argues that in the business model of selling data to advertisers, the key product, or commodity, is data produced — that is, created — by users. "Commodities have producers who create them, otherwise they cannot exist. So, if the commodity of internet platforms is user data, then the process of creating this data must be considered to be value-generating labour" (Fuchs, 2013, pp. 19-20).

Fuchs builds on feminist literature on domestic and affective labour, comparing this data production to housework (Fuchs, 2013). Feminist theory has been seminal in arguing that housework is in fact labour (Mies, 1986). Fuchs uses those insights to draw comparisons with digital labour: both have "no wages"; they predominantly take place "during spare time"; they have no labour unions and are "difficult to perceive as being labour"; and, much like housework, which is coerced by affective relationships within the family, the monopolised status of social media platforms subtly coerces people to participate (Fuchs, 2013, p. 20). This literature again illustrates that women's engagement with technology is not regarded as such.

Kylie Jarrett points out that using the framework of work might imply that the online "labourer" is someone "who is directly and knowingly employed by the exhibitor" (Jarrett 2016, p. 2). Today's internet users experience their online activities as pleasure and not work. Conversely, she observes, "even the repetitive, physical, menial chores of housework are often driven by, or serve as expressions of, the immaterial values of care-work. This work also produces immaterial products such as health, dispositions or esteem" (Jarrett, 2016, p. 3). Both domestic and online labour, and women's work in technology sectors overall, are often undervalued and unpaid, while their contributions to the economic system are crucial (Jarrett, 2016).

In the field of economics, Ibarra et al. examine the consequences of the online "culture of 'free'" — where users neither pay for the services they receive nor are paid for the contributions they make. They point to the consequences: "the lack of targeting of incentives undermines market principles of evaluation, skews distribution of financial returns from the data economy and stops users from developing themselves into 'first-class digital citizens'" (Ibarra et al., 2018, p. 1). They seek to balance the potential of the digital economy, as a source of innovation and benefits, with people's concerns over privacy and fears of being replaced by automation. Their solution is that data should be considered labour, and they call for a "fair

and vibrant market for data labour" (Ibarra et al., 2018, p. 3). That argument goes against most social science analysis, which criticise the commodification of data and the exploitation of invisible work. Moreover, details are lacking on the frameworks that need to be in place to ensure such a data labour market would be fair. This could prove especially difficult, keeping in mind the needs of groups marginalised based on gender, race, or class, and the contrasting situation of countries in the Global North and South.

Anita Gurumurthy and Nandini Chami have provided an attempt to answer these important questions, asking, "How must feminism take on the challenge of a datafied world?" They point out how people's online "immaterial labour" — often, acts of caring and expressions of connection — are captured in behavioural data sets and then monetised by companies. But they add that this "datafication", and the connectivity it produces in the sharing economy, obfuscates the production of technology and data, which often takes place in the Global South (Gurumurthy & Chami, 2016). In order to counteract the skewed power dynamics between data producers and users, they support the solution of a "data commons", but they warn that "it must correspond to the hope and outrage of the most marginalised women and gender minorities, bringing data to the service of a new civic intelligence that privileges their autonomy and self-determination in all spheres of life" (Gurumurthy & Chami, 2016).

If online activities can be understood as work, this work is often immaterial, undervalued, invisible, and regarded as unskilled. More research on the gendered dimensions of data production as work is needed, to point to collective models for using data that do not devalue its producers.

CONCLUSION AND RECOMMENDATIONS

While technology can hold positive consequences for some women, for other women — especially women of color, women in the Global South, and other marginalised women — this experience is different. Similarly, in the Global North, technology is constructed as a masculine domain, while in much of the Global South, women predominantly work in technology but often in harsh conditions of technology production. Nevertheless, in many (or most) countries, women's work in and with technologies is rendered invisible and regarded as unskilled, or their technical skills are explained away through gendered perceptions. Finally, research framing a broader definition of work conceptualises online activities as labour.

It is crucial to provide further and more detailed research on the experiences of women (and other marginalised groups) outside the Global North, to avoid further deepening existing gender gaps. While asking how women and marginalised groups can be introduced to ICT, we also need to investigate the ways in which their valuable contributions to ICT, technology, and the digital economy are often rendered invisible or overlooked.

Three recommendations are central to make the current research agenda more inclusive.

1. Further detailed research is needed on documenting the experiences of women working with technology in different contexts. Studies should pay close attention to intersectional approaches accounting for gender, class, race, and age.
3. More case studies on experiences from the Global South should be undertaken, for a better understanding of how women's work with technology becomes defined as feminised labour.
4. Research on online data-producing activities should be guided by principles of intersectional feminist approaches, to identify which groups are more at risk and which groups have the means to protect their rights or participate in market-based approaches.
5. Research should not only focus on trying to increase women's access to technology but on understanding and highlighting women's existing contributions to technology, in their many shapes and forms.

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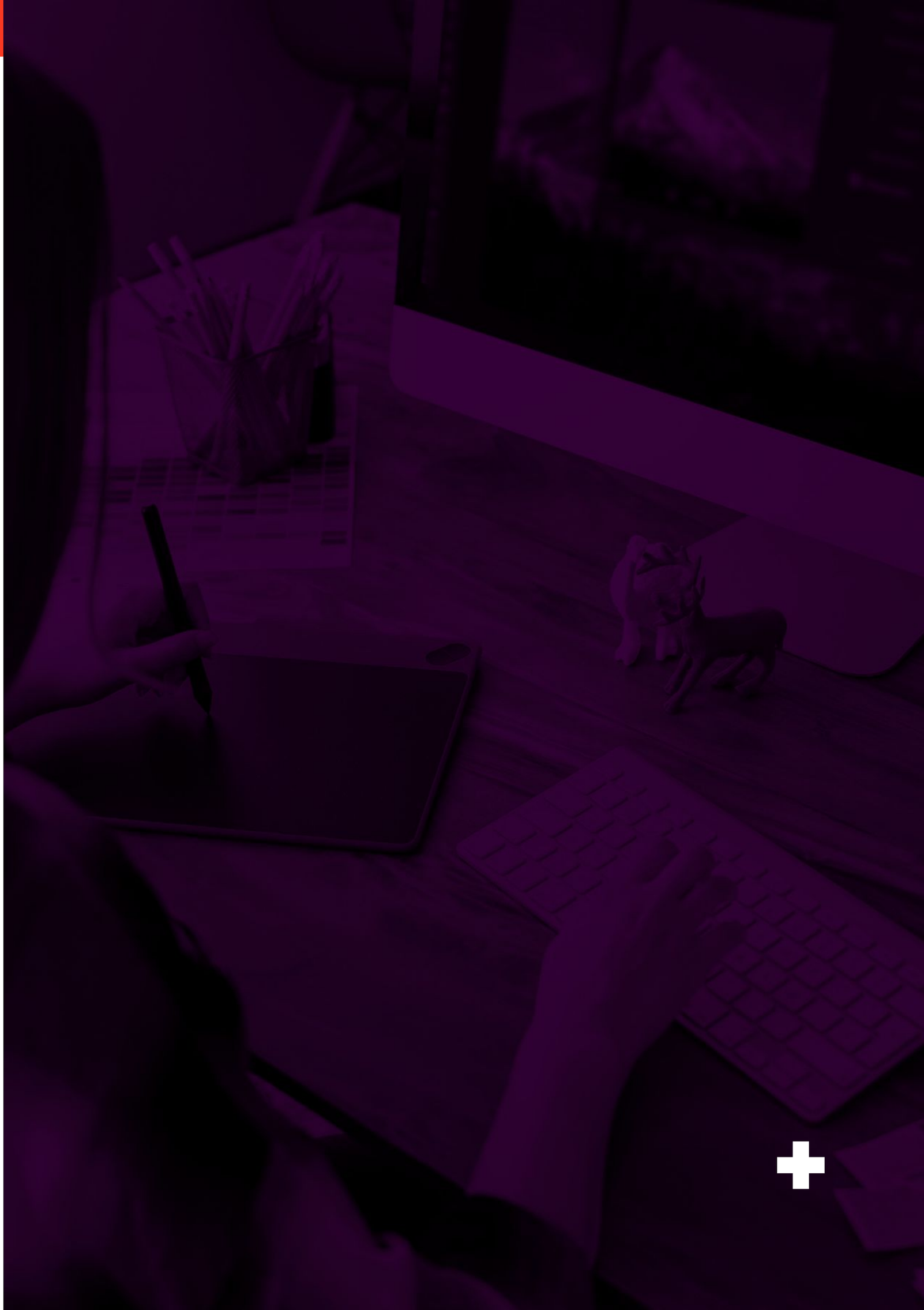

11

A GENDER PERSPECTIVE ON TECHNOLOGY TRANSFER AND WEALTH CREATION

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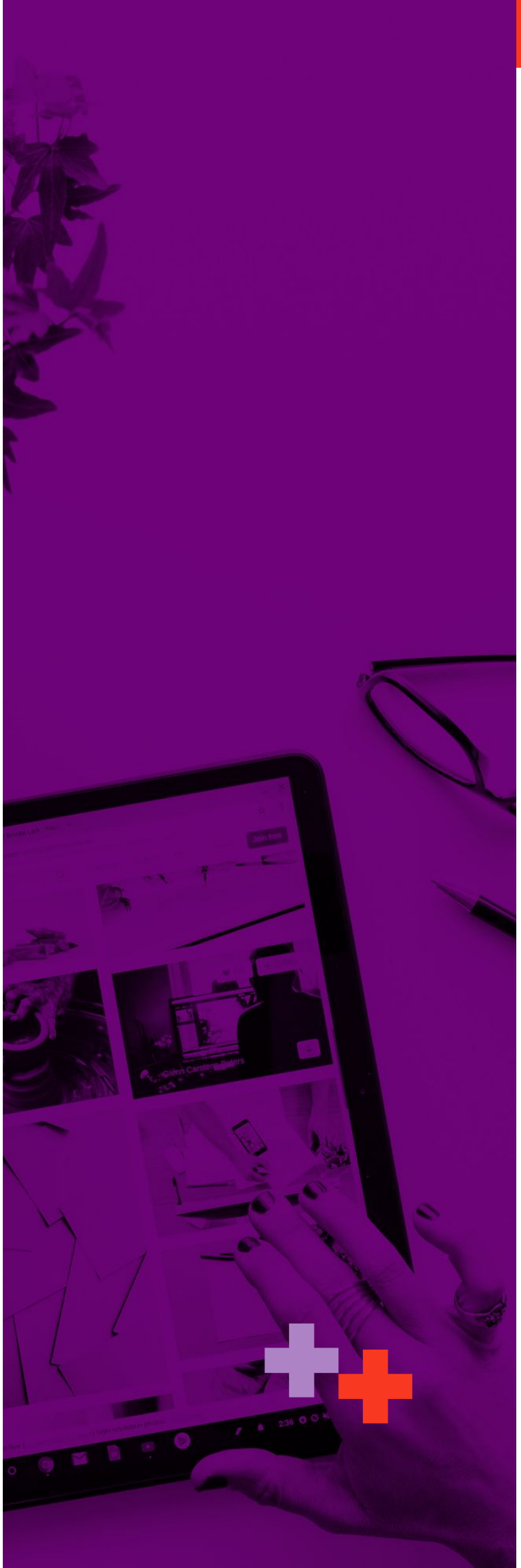

ABSTRACT

More than 40% of the world's population now has access to the internet, with new users coming online every day, while today the poorest households are more likely to have access to mobile phones than to toilets or clean water. In spite of these advances in technology, many are left behind from the wealth creation spurred by new technologies in the innovation economy. A new wave of innovation has the potential to give women a unique opportunity to reap the advantages of wealth creation from the digitised economy, to leverage women's potential for technical innovation and to create new female ecosystems linking science, start-ups, and industry. Alternatively — as seen in the gender digital divide more broadly — this new wave of innovation could leave female inventors behind. "Technology transfer" refers to the process of developing and commercialising innovations, as typically reflected in intellectual property rights, patents, and copyrights. Supporting girls' digital literacy through the entire educational spectrum of science, technology, engineering, and mathematics (STEM), including participation in research and development and ultimately technology transfer, is a long-term investment that could potentially result in an exponential increase of wealth creation for women. This chapter examines the current patent shortage among women, and explores how social innovation and support from NGOs and global development organisations can work to make tech-transfer more gender inclusive. We need to be as ambitious in support of gender equity in technology transfer as in STEM education and workforce development.

KEY FINDINGS

- Women with STEM degrees are only slightly more likely to patent an innovation than women who lack them.
- The most significant determinant in the gender gap in technology transfer is women's underrepresentation in patent-intensive fields (especially electrical and mechanical engineering), and in patent-intensive jobs (especially development and design).
- The lack of gender-disaggregated data for technology transfer (such as patents and copyrights) reflects the absence of any global organisation to track trends in gender balance in tech transfer.
- Virtually all indicators related to gender balance in the World Intellectual Property Organisation Patent Cooperation Treaty (PCT) or patent system show some degree of progress toward gender parity in recent decades.
- Based on current rates of progress, gender balance in patenting would not occur until 2070.

INTRODUCTION

Technology transfer (tech-transfer, or TT) represents the successful transformation of good research into good business, according to Alunni (2019), as well as the formal and informal movement of know-how, skills, technical knowledge, or technology from one organisational setting to another (Roessner, 2000). Both sources point to the importance of tech-transfer in aligning stakeholders to support researchers/inventors in the daunting project of moving a protected idea (i.e., intellectual property) successfully into the market. TT has become central in university research, and it presents challenges and opportunities — both for individual inventors and for efforts to address old and new problems.

A successful TT process needs four essential elements: 1) strong research to generate a sound IP portfolio; 2) a dedicated supportive Technology Transfer Office (TTO), as a meeting point of science and business; 3) a team of highly skilled Technology Transfer Managers (TTMs) who understand the languages of science and business; and 4) an entrepreneurial ecosystem capable of absorbing innovation and providing ancillary services (Sharma, Kumar, & Lalande, 2006). Additionally, these resources must be available at the right level and must be managed efficiently.

Experts of the field proclaim that human progress is manifested and occurs through use of technology and that without technological progress there would be no economic development. However, as Jacobsen (2011) observes, while human progress cannot occur without technological innovation and diffusion, it is unlikely that technology affects all groups and genders equally.

WHY IS TECHNOLOGY TRANSFER IMPORTANT FOR GENDER INEQUALITY?

As technological innovation and diffusion accelerate, little attention has been paid to the potential social impact of equality for technology transfer and wealth creation. One of the main challenges in the complex process of commercialising intellectual property (IP), according to EUIPO, is that the great majority of ideas (whether protected or not) never make it to the marketplace (Campinos, 2018). Experts on feminism and technology point to the scant proportion of women obtaining patents globally, which is even less than the already small proportion of women in the field of STEM (Rosser, 2009).

The question of gender in technology transfer can thus be usefully addressed on two levels: How does technology transfer work in practice? And how are women either involved in or excluded from

the process? Literature on technology transfer and innovation can shed light on how prominent centres of research (as well as leading intellectual property bodies) attract women innovators and how existing mechanisms affect women's involvement or exclusion in technology transfer.

Some researchers point to a lack of diversity in the process of developing new technologies, and to the lack of commitment by prominent research centers to attract women inventors. Only 15% of patents are filed by women (Jensen, Kovacs, & Sorenson, 2018). Others point to gaps in relevant skills and impact funding at the early stages of proof-of-concept, prototyping, and demonstration (Alunni, 2019).

Missing in the literature is a critical analysis of technology transfer in terms of gender. While feminists have questioned the implications of the low percentage of women in STEM for our understanding of gender in innovation (Schiebinger, 2008), there is less work on the gendered implications of current technology transfer implementation (Phan & Siegel, 2006), although the issue of implicit bias in technology transfer has long been recognised. Writing over 30 years ago, radical feminists and ecofeminists initiated a critique of the inherently patriarchal nature of technology, and of technoscience more generally, questioning "best practices" that themselves may be flawed (Oakley, 1974; Cockburn, 1983; Corea et al., 1985; Kramarae et al., 1988; Wajcman (1991) as cited by Bray, 2007).

KEY CONCEPTS: HOW DO TT AND GENDER INTERCONNECT?

The development of technology draws upon many fields of knowledge — scientific, engineering, mathematical, linguistic, and historical — to achieve some practical result (Pacey, 1992). Technology transfer is not a novel concept: it can be defined as an emerging process going back to the mechanical age (Bessant & Rush, 1995). Nevertheless, it would take many centuries after the first patent legislation in Venice in 1474 (Penrose & Zamora, 1974) for European and U.S. universities to begin to bring new inventions to society. With the enactment of the Bayh Dole Act in 1980, U.S. universities started to patent and license scientific discoveries. Since then, technology transfer has evolved to become a political and corporate mantra, promising significant change based on both better and more technology (Slaughter & Leslie, 1997).

The goal of technology transfer is to take sound scientific ideas to the market successfully (Bercovitz & Feldman, 2006). It is important to understand how technology transfer works in practice, to help women inventors protect their scientific ideas and increase their participation in the process.

Two complementary aspects are critical in increasing the role of women in the development of new technologies. First, university policies need to attract, support, and reward women inventors. Second, the barriers need to be addressed that may prevent female inventors from commercialising their scientific ideas or inhibit their professional advancement. If female inventors are accorded unbiased support to protect and prototype their scientific ideas, technology transfer will play a part in increasing gender equality.

Young (2007, p. 545) posits that "technology transfer does not just happen". Transferring knowledge and innovation from a public research organisation to the private sector for commercial application and public benefit requires a formal mechanism — a technology transfer office (TTO) — to help inventors protect and license intellectual property. In order to promote inclusive innovation, this mechanism must be unbiased and committed to support men and women inventors equally, in each stage of the process (Siegel, Veugelers, & Wright, 2007).

The rapidly changing landscape of innovation requires a major effort to equip female participants (scientists, engineers, researchers) with the necessary resources (such as TTOs, incubators, accelerators, and service providers) to ensure their success. Moreover, women need not only training and qualifications to shape the right skills, but also accessible mechanisms for funding in the crucial proof-of-concept and demonstration phases (Etzkowitz & Goktepe-Hulten, 2009). The traditional activities of technology transfer offices (TTOs) include identifying promising research results from the university setting and transferring them to market agents. A TTO depends on access to an active university and researchers, industrial absorptive capacity, and investors. TTOs serve effectively, bridging these three factors, only when they are able to provide the missing pieces in the technology transfer process. A passive TTO may fail in the mission to promote technology transfer.

Advanced TTOs are mainly attached to more entrepreneurial universities in high-income countries; they offer effective support to researchers, inventors, and entrepreneurs by taking a proactive role to help them to cross the "valleys of death" in the process of starting a new venture. World-class TTOs normally offer ten standard support services: invention disclosure, invention assessment, idea protection, proof of concept, IP commercialisation, start-up formation, licensing to existing business partners, legal support, commercialisation after licensing, and licensing revenue distribution (Debackere & Veugelers, 2005). This expensive and time-consuming process has become a high priority on university policy agendas, as the key to effective technology transfer mechanisms.

IS TECHNOLOGY TRANSFER GENDER-NEUTRAL?

For many people, technology transfer has no implication for gender, suggesting that TT is therefore gender-neutral. In fact, gender-based disparities have been found in many areas of technology transfer, though the mechanisms are often still little known.

Successful women professionals, in science, technology, and allied fields, tend to refer to meritocratic ideologies rather than structural factors to explain inequality (Cech & Blair-Loy, 2010). Business education experts are likely to invoke deficiencies in women's human capital or motivation, even though systematic structural obstacles (such as glass ceilings) are widely considered the main cause of gender inequality in science and technology (Tan, 2008).

One source of structural bias lies in unequal access to university support. In emerging science and technology-related areas, women's participation, advancement, and recognition often seem to suffer from the same discriminatory gender patterns identified elsewhere in academia (Etzkowitz, Kemelgor, and Uzzi, 2000). The Women Inventors Committee of the Association of University Technology Managers' (AUTM) states that the professionals working across continents to facilitate technology transfer all share one common challenge: a lack of women's participation in several aspects of the process (WIC, 2018). The Association attributes this gap to the lack of university commitment to educate female university scientists about the impediments and barriers women face when attempting to become inventors and entrepreneurs. The report suggests action steps toward the goal of including more women scientists and engineers in successful technology transfer and business creation.

In the university environment, there are no explicit rules that position men and women inventors differently. The slow progress toward gender equality nevertheless reflects obvious discrimination and invisible barriers built into male-gendered systems (Ranga & Etzkowitz, 2010). For example, discrimination against women scientists, researchers, innovators or entrepreneurs occurs when — by default — men are over-ascribed for performing traditional female roles and women are under-credited for performing traditional male roles. Ranga and Etzkowitz also observe that most efforts for gender equality tend to focus on women's recruitment rather than retention and advancement, reflecting false expectations that upward movement would take care of itself once entry was assured. It comes as no surprise that disproportionate numbers of women remain in low-level positions in academia, even after many years of contributions. Handelsman et al. (2005) suggest that universities are failing to take advantage of an available resource, noting that the presence of women scientists in a particular field determines the proportion of women in faculty positions, and that this ratio lags far behind the proportion of Ph.D.s granted to women. They identify, as reasons for this disparity, the impediments to recruitment, retention, and advancement of outstanding women scientists. Similarly, AUTM suggests that many of these barriers reflect unconscious bias by all involved in the system, including the women faculty members themselves; the Association seeks to educate female inventors and relevant institutions to address these goals. It further recommends empowering more women to take leadership roles in all stages of transferring new discoveries to the market (WIC, 2018).

Several mechanisms have enhanced women's involvement in TT. In 2011, MIT instituted an awards programme called ADVANCE, at a funding level of $19 million, to support efforts by institutions and individuals to empower women to participate fully in science and technology. The Institute cited an "increasing recognition that the lack of women's full participation at the senior level of academe is often a systemic consequence of academic culture" (Rosser, 2003, p. 6). This programme led to a common statement by nine U.S. research universities, recognising that institutional barriers have prevented women scientists and engineers from having a level playing field in their professions; the signatories were the California Institute of Technology; MIT; Harvard, Princeton, Stanford, and Yale universities; and the universities of Michigan, Pennsylvania, and California, Berkeley.

Many of the studies of technology transfer processes and implications focus mainly on the prominent research centres in high-income countries (such as Harvard and MIT in the U.S., Oxford and Cambridge in the UK, and institutes in Japan, South Korea, Israel, and others). Research is badly needed to examine the global implications of boosting women's participation in wealth creation through research discoveries and knowledge transfer to industry.

A second source of gender bias arises from the structural constraints of the IP filing system, including how patents are obtained and maintained over time. Jensen, Kovács, and Sorenson (2018) analysed a recent IP filing bulk data release with the histories of 2.7 million patents issued in the U.S. between 2001 and 2014. Their analysis reveals how patent claims can be altered during the process of filing, depending on the gender of the inventors. Overall, women inventors' patents were more likely to be rejected than those filed by teams of men; even when applications were granted, women's patents progressed poorly and fewer were maintained, because they received fewer citations by other inventors and from patent examiners (Jensen, Kovács, & Sorenson, 2018). This helps explain why, although women earn roughly 50% of the doctoral degrees in science and engineering in the U.S., when it comes to patenting their inventions, they trail far behind men: only 10% of patent-holders are women. Even in the life sciences, where women earn more than half of new Ph.D.s, only 15% of inventors listed on patents are women.

Rosser (2009) argues that, if women scientists and engineers face difficulties in obtaining patents, then woman are not equal participants in the newest areas and of science and technology; they are unable to serve as leaders in their fields, and they lose opportunities to profit both financially and through professional advancement. Of course, commercialisation of science can be extremely lucrative, if the patent results in a product that is developed and brought to market successfully. Research is therefore in order to find ways to mask the applicant's identity and gender. One potential solution would be to make the IP filing process more anonymous, for example by listing only the inventors' initials; further exchanges between the applicants and the examiners could be restricted to a platform that ensures anonymity.

Creating an equal playing field in the patent process will not only benefit women. Technical progress is one of the primary drivers of economic growth, and it is boosted when inventors can lay legal claim to their innovations and profit from them, and when others can build on an existing patent. Increasing fairness in the patent system, and thus bringing more good inventions to realisation, has the potential to create wealth and promote economic development.

A third source of bias is embedded in the financial environment. Registering and protecting scientific ideas as intellectual property (IP) is an essential step toward marketing an invention, but it is only the beginning of the process. Regardless of their potential, many scientific ideas — up to 95% in the U.S. — never progress beyond this protection or patenting stage. Proof of concept (POC) is usually the next step toward marketing, allowing the inventor, as well as potential investors, to identify marketable value in a timely fashion. Funding for POC helps inventors to prototype the idea and show prospective clients a real version of the product, before commercialisation (Upton, 2010).

As useful as POC and prototyping can be, investors tend to be reluctant to fund prototyping ventures (Portilla, Evans, Eng, & Fadem, 2010) — a factor that also affects female inventors. In general, even though POC is vital to a successful tech-transfer process (Alunni, 2019), it is the least attractive phase to private finance, despite the small amounts required per project. Providing POC is therefore a difficult task for most technology transfer offices, especially on behalf of female inventors. Hill, Leitch, and Harrison (2006) show that women get a small fraction of the venture capital allocated to men; despite heightened attention to the problem, the newest data suggests the problem could be getting worse. Indeed, Bosse and Taylor (2012) suggest that a "glass ceiling" prevents women entrepreneurs and small business owners from accessing the financial capital they need, to start a new firm or fuel the growth of an existing small firm.

Moreover, embryonic scientific ideas usually need further development before they can be fully protected as intellectual property in any form (by patents, copyright, etc.). This early process normally has costs, and although the amounts are not large, they may prevent women from advancing the idea to the POC phase. Universities and other innovation agencies could provide impact acceleration funds to support this essential step for women inventors. Significant research has been carried out through the U.S. government's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programmes. All federal research and development (R&D) grants to technology ventures for the decade 2001–2011 were tracked by grantees' demographic classification, to assess demographic patterns in successfully obtaining follow-on R&D grants. The study analysed 52,126 initial (Phase I) awards, granted by 11 federal agencies through SBIR/STTR, which might or might not be followed up with a Phase II award. Results showed a positive association between agency workforce diversity and Phase II funding for women Phase I grantees; however, minority and women technology entrepreneurs were less likely to receive Phase II funding than their non-minority and male counterparts. A preliminary conclusion indicates that the agencies that value workforce ethnic diversity were more likely to grant women technology entrepreneurs Phase II funding. Mollick and Robb (2016) observe that women with higher levels of education may increase their likelihood of obtaining funding, but they also argue that, in the initial "bootstrap" phase, utilising social capital may improve women's chances.

Indeed, researchers and TTOs in high-income countries are already trying to address the problem of finance to advance more women's scientific ideas to the market. In 1999, the Oxford University Innovation TTO set up early-stage funds for POC applications using a gender-unbiased funding mechanism, called the Oxford University Challenge Seed Fund (UCSF). It has provided funds of over £8.2 million across 150 projects from 200 applications — successfully using this unbiased mechanism to award similar levels of funding for projects led by male and female applicants (Alunni, 2019).

The advantages from such gender-friendly funding mechanisms go beyond generating value from tech-transfer; the potential benefits also include diversity for excellence, follow-up grants, industry-sponsored research, and an enhanced reputation, as well as broader educational experience through working relationships with female-led start-ups and SMEs (Cronin, Prakash & Mehta, 2015). Social inclusiveness becomes especially relevant for TTOs with a longer investment time horizon, to align with university vision and to promote growth through equal participation opportunities for male and female scientists.

CAN TT BENEFIT WOMEN?

Despite the role women play in job creation, economic growth, and society revitalisation, especially in economies undergoing fundamental transformations, women in entrepreneurship have not received adequate attention in academic research (Tan, 2007). As a result, our understanding of women's opportunities in non-traditional industries is limited.

Broader innovation depends on a concerted effort to share skills, knowledge, technologies, and facilities, through gender-unbiased mechanisms, ensuring that novel ideas become accessible to a wider range of users in the form of new products, processes, applications, materials, and services. Research findings, skills, expertise, and technology must be transformed into repeatable processes, products, and programmes to fuel wealth creation and benefit consumers (Grosse, 1996).

A new wave of technical innovation will bring huge opportunities to women in global industry. Some refer to Industry 4.0, or "deep tech", or (in Japan) Society 5.0. All envision a merging of physical and digital technologies that will fundamentally change most, if not all, industrial sectors. As suggested by Heeks (2008), the next innovation wave presents a unique opportunity for women in industry: to leverage women's science and technology potential and to create new gender-friendly ecosystems comprising science, start-ups, and industry. For this next wave of innovation, women's scientific strengths will be a huge asset.

Two social innovation projects illustrate this potential.

A civil engineer and her business partner from the Gaza Strip found a way to turn ash into bricks. These bricks are eco-friendly and affordable, and they use less cement than regular bricks. The innovation helped solve a local problem for thousands of people after losing their homes.

The GlamOre digital platform was created by graduate students at Oxford University, out of the belief that talent is equally distributed but opportunity is not. The platform gives women opportunities to work for international companies, by sourcing data projects for some of the world's largest commodity companies. GlamOre is a pioneer in the field of impact sourcing — the practice of hiring people from the bottom of the pyramid to enter digital work, with the help of established professionals.

Innovations such as artificial intelligence, biotech, and two-dimensional materials all require cutting-edge science, based on "all-hands-on-deck" diversity. We need to be as ambitious in technology transfer as in teaching and research. This is in line with the increasing emphasis on supporting creativity, as part of the United Nations agenda for "smart, sustainable and inclusive growth" (Cooke & De Propris, 2011).

Gender biases in the technology transfer process have not received adequate attention by ancillary institutions, prompting proposals to create a Global Female Innovation Council (GFIC). The council would operate as a Global Technology Transfer Office, providing assistance to female inventors who are interested in presenting scientific ideas for IP filing or commercialisation. In addition, it would serve as a safe and confidential channel for advancing innovative ideas, without fear of IP theft — a major deterrent for new inventors.

To generate global wealth with strong female participation, it is necessary to foster education and inclusiveness across countries and continents. Innovation more than ever requires female talent, motivation, and new skills to generate valuable ideas to tackle global problems. Untapped female resources should be channelled in all ways possible between science and business to reach optimum social benefit (Ong, 2005).

RECOMMENDATIONS FOR POLICY MAKERS

Supporting gender inclusion in technology transfer cannot be achieved by the sole effort of universities (Rampersad, Plewa, & Troshani, 2012). Other stakeholders, such as venture capitalists, business angels, alumni, industrialists, and other professionals, should be engaged to identify and nurture gender inclusion in technology development.

A handful prominent universities have developed initiatives to attract women and reward institutions working to increase women's involvement. However, most universities in both developed and developing countries still lack a well thought-out support programme (AUTM, 2018). More broadly, STEM fields in education need to become more inclusive of women.

There is a need to create more gender-diverse networks to pool talents, knowledge, money, and ideas. Professional women can be encouraged to develop networks around tech-transfer management, as a high-value profession for female scientists. Addressing the gender gap in decision-making positions may require a new generation of female technology transfer managers (TTMs) with business school background. These new leaders may help to build consensus to establish a Global Female Innovation Council (GFIC) and to build trust in women's potential role in technology transfer.

To get more women involved in the process of technology transfer at every level — from idea generation, through research and discovery, to patenting and licensing to new or established companies — these ideas should be considered:

- Women in tech can be socialised in TT via classroom learning, e-learning tutorials, and training workshops, reinforced with internships and mentoring to help them build working relationships and career prospects.
- Women's qualifications can include socialisation into different cultures (academic or business) and learning through experience.
- Women participating in the technology transfer process need a fuller understanding of the challenges in the IP filing process; they may need to campaign for better support to neutralise existing barriers.
- Universities should encourage and support promising female innovators to share their ideas, and help to mitigate the risk involved — particularly if they are radically innovative and have the potential to scale internationally.
    - Initiatives to encourage idea-sharing include informative campaigns, summer workshops, mentorship, and networking.
    - Trainings can use open data to allow those giving and receiving training to share information on policies and procedures and suggest improvements.
- An idea conceived at the first EUIPO workshop on technology transfer (2018) is to create a clearinghouse, specifically to identify and track female talent.
- Dedicated government policies are needed to encourage unbiased financing schemes to incubate female-driven technologies before venture capital firms and other investors become interested.
    - Provide impact finance to support ideas presented in scientific papers or early IP filings, to facilitate women's engagement in the TT process.
    - Universities and other innovation agencies could provide impact acceleration funds to support prototype development by women inventors.
    - Conduct research on the constraints that disproportionately affect women in attracting private sector funding for the POC process.
    - Focus on start-ups and small and medium enterprises (SMEs), strengthening the tech-transfer scientific ecosystem where the greatest potential for female breakthrough innovation lies.

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12

"HELLO SIRI, HOW DOES THE PATRIARCHY INFLUENCE YOU?" — UNDERSTANDING ARTIFICIAL INTELLIGENCE AND GENDER INEQUALITY

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ABSTRACT

As artificial intelligence (AI) systems become more widespread, we see increasing attempts to understand the social, economic, and political implications of these technologies. One significant gap in this work is a critical analysis of AI in terms of gender. This chapter examines the gendered implications of AI, especially in the Global South (focusing on low- and middle-income countries in Latin America and the Caribbean, Africa, and Asia). We identify the ways in which AI shapes gender relationships — and vice versa — by exploring examples of AI applications from various disciplinary fields. Where examples do not yet exist, we focus on anticipating and preventing the negative impacts of potentially biased AI applications. At a minimum, we need to ensure that AI does not exacerbate existing gender inequalities. We therefore propose steps that industry, civil society, and policy-makers can take to achieve this goal.

KEY FINDINGS

- AI development is likely to encode patterns of bias and discrimination against women, unless intentionally directed otherwise.
- Far from being neutral, AI-based applications are gendered from their creation — by the inherent bias of their creators, or through bias in the data they rely on.
- AI can actually exacerbate existing gender inequalities; the lack of women working in the field contributes to inequality and bias.
    - The training data used for machine learning may under-represent women and lead to skewed results.
    - Advertising may reward the targeting of men more than women; ride-sharing algorithms may pay men more than women.
    - AI systems typically replicate the way their designers view language (usually from a male perspective).
- AI can also directly impact women by infringing on their rights and liberties.
    - Machine learning tools are being used to create very realistic but computer-generated pornographic media, using images of women without their consent.
    - The demand for more data (for training machine learning models) may ignore the need for informed consent. Such data can also be used to target women's groups or individual women.

INTRODUCTION

Artificial Intelligence (AI) as a discipline has been around for decades, but it nevertheless offers tremendous opportunities for social and economic change. As AI systems become more widespread, there has been a concomitant interest in discerning the social, economic, and political implications of these technologies. We can consider AI's implications on two interrelated levels: first, how such technologies are developed; and second, the kind of impacts AI can have on society.

Drawing on research in the United States and other high-income countries, some have pointed to the lack of diversity in the development of AI applications as well as specific evidence of gender, racial, and other biases (Bryson & Narayanan, 2016; Buolamwini & Gebru, 2018; Caliskan-Islam et al., 2016; Crawford, 2016). More broadly, researchers, civil society groups, and governments in high-income countries are trying to address the socio-economic implications of AI: for example, they point to due process and ethical concerns in the use of AI by government agencies and the approach to developing AI supported systems in the private sector (Campolo, Sanfilippo, Whittaker, & Crawford, 2017).

One significant gap in this work is a critical, gendered analysis of AI. While feminists have questioned the implications of AI for gender for some time now (Halberstam, 1991; Haraway, 1985), there is less work on the gendered implications of recent applications of AI. This is particularly important given the proposed and actual use-cases of AI across sectors. This chapter attempts to help fill this gap by examining the gendered implications of AI with an emphasis on countries in the Global South, where there is currently only limited research on this topic (e.g., Web Foundation, 2017a; IDRC, 2018)[80].

Given the potentially broad gendered impacts of AI, it is important to take an interdisciplinary approach. We first examine research from fields including gender studies, innovation studies, sociology, law, and information and communications technology for development (ICT4D), drawing on literature that critiques ICT4D researchers and practitioners from a gender perspective. We identify the ways in which AI shapes gender relationships, and vice versa, based on examples in the literature as well as on examples of AI applications reported from a few countries in the Global South. In cases where real-world examples do not yet exist, our arguments focus on preventing the potentially negative impacts of biased AI applications. There is a responsibility to ensure that, at a minimum, AI does not exacerbate existing gender inequalities. We therefore propose steps that industry, civil society, and policy-makers can take to achieve this goal.

80 *The Global South is defined here as low and middle-income countries in Latin America and the Caribbean, Africa, and Asia.*

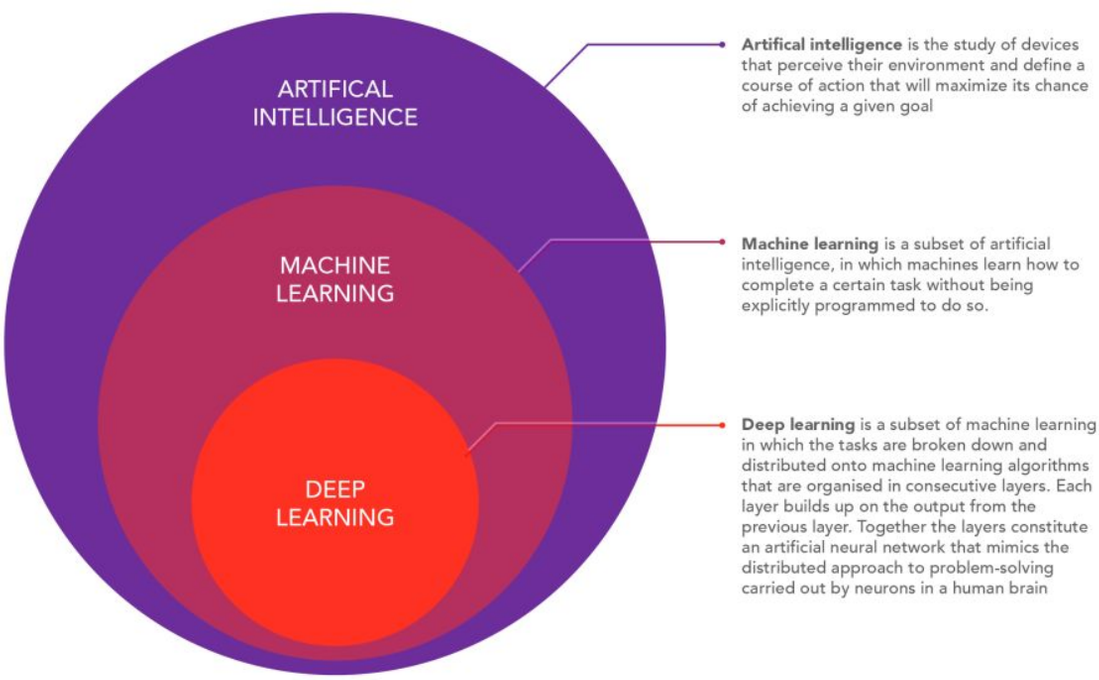
In the next section we discuss what we mean by AI and gender and how patriarchy mediates the relationship between the two. We then review possible impacts, by first reviewing the potential for AI to reduce gender inequalities, and then addressing the ways in which it might exacerbate such inequalities. Finally, we conclude with policy and other recommendations.

KEY CONCEPTS – HOW DO GENDER AND AI INTERSECT?

Like most social science researchers on this topic, we take a broad view of AI. Nilsson (2009) posits that AI is about making machines intelligent — or designing them to have the ability to develop the right decisions in a given environment, with foresight. As Stone et al. (2016) note, there is a broad spectrum of systems, differentiated by scale, speed, and degree of autonomy. Another way to classify AI is in terms of the scope of the tasks undertaken, including machine learning and deep learning (Figure 12.1).

AI is not simply a novel technology with interesting applications. It can be defined as an emerging technology, particularly as a field in the Global South. Emerging technologies embody a process that updates existing techniques, tools, professions, organisational structures, and industries with new capabilities and rearranges them in new ways. Crucially, however, these technologies co-evolve with existing inequalities (Cozzens & Thakur, 2014). In fact, some inequalities are sustained over time and even worsen — such as the gender wage gap (WEF, 2018) — as reinforcing an entrenched form of power.

Figure 12.1
Relationship between AI, machine learning, and deep learning



Source: Web Foundation, 2017a.

In this chapter, we view gender as a range of characteristics defined by society to differentiate men from women[81]. Based on this gender differentiation, a patriarchal system creates and maintains social and economic structures that reserve most power to men in society, institutionalising gender inequality. As emerging technologies, such as AI, evolve, we argue that they will replicate existing patterns of bias and discrimination against women, unless intentionally directed otherwise.

Many people assume that technology has no clear link to gender, and that the application of technologies such as AI will therefore be gender-neutral. Far from being neutral, however, AI-based applications are gendered from the context of their creation. One example is the almost universal use of female voices, by default, for such AI-powered digital assistants as Google Assistant, Apple's Siri, and Microsoft's Cortana (Adrienne, 2016). The few existing examples in the Global South are also feminised: in Lagos, Nigeria, lara.ng[82] provides public transportation information using a chatbot with a female identity; and when Micromax in India launched the mobile voice assistant AISHA in 2012, it also had a female identity. (We note the explicit sexual reference in the TV ad: a man in a swimming pool tells a bikini-clad AISHA, "I can sleep with you, but I can't marry you." To which she responds, "that's OK, I can find you a girl in the matrimonials"[83].) A range of less obvious, but more consequential, gender implications is discussed in the following sections.

The discourse around AI is also shaped by gender. For example, in Western countries, much of the male-dominated focus around the impact of AI is on job losses (Crawford, 2016). In some African countries it is often about how to improve socio-economic outcomes (Brandusescu, Ortiz, & Thakur, 2017), but for marginalised groups (including women) it will focus on issues of bias and discrimination (Buolamwini & Gebru, 2018). This chapter examines how emerging technology, such as AI, can serve to reinforce gender inequality, and what measures are needed to mitigate these trends.

THE PROMISES AND POTENTIAL FOR AI AND GENDER EQUALITY

One area of concern is the gender imbalance in technology fields such as AI, where men dominate in both the Global North (EU, 2018) and Global South (WEF, 2018; Brandusescu et al., 2017). Some developers believe that AI can improve some forms of human decision-making that are distorted by, for example, discrimination against women that perpetuates gender gaps in the workplace. For example, Google has used AI to identify reasons for higher female staff turnover in its workforce (Bohnet, 2016, p. 105). Other developers focus on reducing discrimination in the recruitment process, including in technology firms (Shah, 2016). These tools examine the wording of job postings and use internal staff surveys to identify prejudices against women. Other machine learning tools examine salary comparisons between men and women, as well as perceived differences in workplace opportunities and benefits, to highlight gender gaps (Captain, 2015).

Some have expressed optimism about these applications of AI (for example, Singh, 2017). But technological solutions by themselves cannot resolve issues that reflect an underlying power dynamic of gender inequality. This caveat is often repeated (but not always heeded) in the field of information and communications technology for development (ICT4D). Hafkin and Huyer (2006) argue that, in relation to ICT4D and gender, the focus should be on ways to improve women's lives with the aid of technology; we cannot assume that technology is a necessary or effective means to achieve this end. Most simply, to what extent can technology support women's self-determination and agency (Web Foundation, 2015)?

It is especially important to examine patterns in ICT4D, as a related discipline, because of the potential applications of AI in the Global South. Within a few years, we expect that ICT4D researchers and practitioners will routinely focus on AI in their work (in the form of AI for Development, or AI4D). In Africa, much of the focus is already on solutions to address local and national development challenges, such as improving health outcomes, public transportation, agricultural productivity, and access to financial services (Brandusescu et al., 2017). In the Global South more generally, potential developmental impacts of AI include creating new business opportunities for small and medium enterprises, preventing disease, deploying emergency services more efficiently, reducing illegal wildlife poaching, and improving mechanisms for public consultation and decision-making (IDRC, 2018; Web Foundation, 2017a).

As Buskens and Webb (2009) note, these uses of technologies can help individual women transform their situations, but they do not address social systems of inequity. Truly comprehensive AI-based interventions, that aim to solve development challenges while improving outcomes for women more broadly, must begin by considering the inherent gender inequalities that underpin the social and political context in which these technologies will be used. A starting point for this mission is to understand how AI, if it is not strategically deployed, can in fact exacerbate existing gender inequalities.

81 *This socially dictated, binary definition of gender as female and male unfortunately precludes other types of gender in this analysis. This simplified view also excludes analysis based on intersectionality, such as women and men of different income groups, race, ethnicities, class, caste, etc.*

82 *See https://lara.ng/. Accessed March 2018.*

83 *https://www.youtube.com/watch?v=lHQMJ-1KV00. Accessed March 2018.*

HOW AI CHALLENGES GENDER EQUALITY

One of the major challenges is the low level of women's participation in the field of AI. The resulting lack of diversity in design can produce AI applications that (a) fail to meet the needs of all, and (b) magnify existing inequalities, through uneven access and use of the application. For countries in the Global South this means not only that local AI applications are mainly designed and produced by men (Brandusescu et al., 2017; Web Foundation, 2017a), but also that — given the global dominance of U.S.-based technology companies — the imported AI applications (from firms such as Google) are most likely produced by "affluent white men" (Crawford, 2016).

One of the consequences of this exclusion of women is various forms of discrimination (Buolamwini & Gebru, 2018). The fact that, in almost all the cases described below, these forms of discrimination are not overt further complicates the discussion.

It is useful to distinguish between overt and implicit discrimination. In some countries, overt and legally sanctioned discrimination against women does exist. For example, a World Bank study that examined 189 countries found that in 37 countries it was harder for a woman to legally apply for a passport than a man, and 104 countries had restrictions on the kinds of jobs women can take (World Bank, 2018). Implicit forms of bias and discrimination against women are much more difficult to document, but their effect can be pervasive. They are built into interpersonal relationships as well as within institutional structures (rules and norms), and they are prevalent almost everywhere. Nevertheless, many in the field argue that such discrimination does not exist — or, if it does, it is not intentional. It is important to understand that systemic and institutional bias can operate regardless of individuals' intention; the important feature of bias is its impact, not its motivation.

In reviewing evidence of AI-based bias and discrimination, we find three distinct categories:

- technical — how AI applications are designed and constructed
- economic contexts — realities that influence outcomes
- social norms and language — interactions that lead to discriminatory outcomes

IMPLICIT SOURCES OF DISCRIMINATION: TECHNICAL

The issue of implicit bias and discrimination in computer systems has long been recognised. Over 20 years ago, Friedman and Nissenbaum (1996) noted that this concern was not new; the most serious types of discrimination were systematic (not random), leading to unfair outcomes. Technical discrimination is based on the structural constraints of a system. For example, since AI is meant to mimic the appearance of human intelligence, it is therefore based on how its designers think, and their outlook on the world (Adam, 2006). Machine learning algorithms rely on training data in order to develop "appropriate" solutions. In a review of different kinds of facial recognition algorithms, Buolamwini and Gebru (2018) found that those algorithms were more likely to accurately identify "lighter-skinned" people, especially men, and were much less likely to identify "darker-skinned" persons, particularly women. They argue that part of the problem is the lack of demographic diversity and representation in the many of the datasets used to train these algorithms[84]. Discrimination in this case, though unintended, may be a reflection of datasets that lack representation of certain groups of people.

Disconcertingly, as Lohr (2018) notes, these kinds of facial recognition systems are already being used in multiple sectors across several countries. This points to the challenges that people in the Global South (particularly women) will face, as new datasets are collated — still encoding these existing inequalities. For example, men are much more likely to use the internet than women in these countries (ITU, 2017; Web Foundation, 2015); therefore, collating photos using online sources may offer far greater representation of men.

IMPLICIT SOURCES OF DISCRIMINATION: ECONOMIC CONTEXTS

A second source of discrimination is the economic environment in which the AI application is meant to operate, even where no explicit rules underly the discriminatory treatment of women. In one study, experiments were conducted using the Times of India website to identify differences in how Google ads were presented to users. The authors found that women users were less likely than men to see advertisements for high-paying jobs, for no discernible reason (Datta, Tschantz, & Datta, 2015). In a related study, Lambrecht and Tucker (2018) found that algorithms designed to show online ads to both men and women (in over 191 countries) ended up showing the ads to more men than women, even though women were in fact more likely than men to click on

84 *See also "AI, Ain't I A Woman?" https://www.youtube.com/watch?v=QxuyfWoVV98 Accessed July 2018.*

the advertisements. The underlying problem was not algorithmic discrimination. Instead, it was a business model that, ironically, placed a premium on targeting women (young women in particular); as a result, it was less expensive and more economical to show the ad to men.

In many countries, the companies deploying AI applications operate in a non-competitive context, and in some cases amount to a near-monopoly. In such contexts, algorithms increasingly act as gatekeepers of knowledge, essentially determining what kinds of information and news people receive (Tufekci, 2015). Survey data from six African countries found that on average 86% of those who use the internet regularly (at least a few times per month) also regularly use social media as a source of news[85]. With few choices for the consumer, these monopolistic platforms and their algorithms can have a significant impact on sources of information for many people, and may have significant implications for gender equality. Whether or not these gatekeeper algorithms intentionally diffuse discriminatory content against women (although this happens), the lack of gender awareness or gender-critical content can propagate distortions, replicating patriarchal norms and undermining women's agency.

IMPLICIT SOURCES OF DISCRIMINATION: SOCIAL NORMS AND LANGUAGE

Prevailing social norms and language usage tend to replicate the pre-existing biases that humans inevitably have. Feminists have long argued that language is a means by which women's inferior position is enforced (Adam, 2006). AI systems typically replicate the way their designers view language (i.e., from a male perspective), both in how these systems are designed to interact with humans and in their subsequent "learning" based on the analysis of written texts (Caliskan-Islam et al., 2016). As Sonnad (2017) notes, tools such as Google Translate often interpret gender-neutral pronouns to default to the male form in English.

While that may be the result of a flawed dataset (i.e., the gender bias embedded in written texts), machine learning systems may also learn to use discriminatory language when interacting with users on-line. Microsoft's short-lived AI chatbot, Tay, after a few hours of interaction with users on Twitter started to tweet racist comments and engage in harassment of women (Neff & Nagy, 2016). (Like many other AI entities, Tay was given the personality of a young woman.)

EXPLICIT SOURCES OF DISCRIMINATION: RIGHTS

AI applications can have impacts on women's rights and liberties. Online (and offline) gender-based violence is a problem for women globally (Gurumurthy & Menon, 2009; Web Foundation, 2015)[86]. A related problem is the use of increasingly accessible machine-learning tools to create realistic, computer-generated pornographic media that uses images of identifiable women without their consent. This practice initially gained notoriety in the U.S., and there are also cases of such videos in India (Sharma, 2018).

The increased demand for AI-based solutions drives the need to build bigger and more comprehensive data sets. Ominously, the effect of collecting this data from a range of disparate sources is to solidify existing patterns of control; women and other groups who lack the privilege or means to opt out are the focus of that control (Shephard, 2016). While many countries need better data protection frameworks, the problem is more acute in the Global South (Web Foundation, 2017b). As a result of the increased demand, most recently from AI developers, harvesting personal data has become more and more lucrative; an increasing number of (unregulated) data brokers compile and sell data profiles of individuals to various organisations (O'Neil, 2017). Such data can be used to target women's groups or individual women, as well as marginalised groups, without their consent. In addition, there is the potential for accessing these user profiles for political or sexual harassment or other kinds of online abuse.

Privacy is relevant also in the use of an AI application, as in the case of AI chatbots. One example, to be further researched, is SophieBot[87], developed by, and primarily targeted at, Kenyans. This is a free AI chatbot that works on several messaging platforms and provides information on sexual and reproductive health. It is important to assess the extent to which it harvests and utilises user data, an aspect that was not made clear in our interaction with the chatbot.

RECOMMENDATIONS

The challenges examined here are immense, but strategic interventions by both policy-makers and AI researchers can make a difference. We present five key recommendations.

Policy formulation. Policies for AI need to recognise that no technology, including AI, is gender-neutral (Alozie & Akpan-Obong, 2017; Nass et al., 1997; Wajcman, 1991). Developing gender-responsive AI

85 *See the Afrobarometer Survey (R7 2016/2018) - http://afrobarometer.org/ (Accessed March 2018). The eight countries are Benin, Côte d'Ivoire, Kenya, Malawi, Mali, Uganda, Zambia, and Zimbabwe. Chi-square test is significant at the 99% level.*

86 *Also see https://www.genderit.org/onlinevaw/ Accessed March 2018.*

87 *See http://sophiebot.ml/ Accessed March 2018.*

policy is important to ensure that the impacts of AI on both women and men are critically assessed. A comprehensive gender-responsive AI policy (as with any technology policy) would create a broad understanding of how gender-based inequalities are maintained in society. Awareness can start with conversations about the roles of men and women in society and the kinds of inequalities women face, particularly through indirect and systemic forms of discrimination. The government can initiate these discussions in the public sector through consultations, workshops, and internal gender audits[88].

Multi-stakeholder partnerships. Governments should coordinate with industry groups and others to generate accurate and timely data on the participation of women in the field (Campolo et al., 2017). Governments should also work with industry and other partners to fund women-owned firms working on AI, and to incentivise firms generally to have more diverse staff at all levels (Web Foundation, 2018). Other public-private investments can support interdisciplinary research on career development in the field of AI (including gender inequalities), and sponsor STEM training and development programmes targeting women and girls. It is also important to promote networking and mentoring support for women and girls through outreach. In Nigeria, for example, the Meet-Up for Women in Machine Learning and Data Science operates in Lagos and Abuja[89], providing spaces to promote participation of women in AI.

Improving the research agenda and design process. The design challenge for AI represents an opportunity in "AI for development", one that is driven by actors in the Global South, who will also lead in identifying and implementing solutions to local challenges including gender inequality (Escobar, 2011). Design decisions are critically important to avoid repeating the pattern seen in ICT4D, for example, as a field that has often excluded gender (Hafkin & Huyer, 2006). AI developers should start by asking how their solution serves to maintain gender inequality — or even make it worse. Developers need to employ a "discrimination-conscious by-design" approach (Hajian, Bonchi, & Castillo, 2016). The members of the AI scientific community in a particular country should collaborate on developing such an approach (and by building on research networks in the Global South and elsewhere). Participatory design requires the inclusion of diverse groups (including diverse groups of women) throughout the design process.

Address direct potential harm from AI. Data and privacy protection can be critical for women's safety, online and offline. Having clear and understandable terms of service and privacy policy is important for all services, including AI-based applications. These safeguards will also require adequate data protection laws, which are currently lacking in many countries in the Global South. In addition, in most of those countries, much of the personal data comes through mobile internet. Government through telecommunications and consumer protection regulators should work with mobile network operators to promote transparency in data collection and ensure they adhere to data protection rules. Another way of reducing potential harm is improving the quality of training datasets. Where possible, using open data — freely accessible and shareable data, in a machine-readable format (such as a CSV file)[90] (Brandusescu et al., 2017). Transparent reporting is needed on how the training data was created, and the methods of aggregation and classification used (Campolo et al., 2017).

Grievance redress mechanism. The typical route for recourse in situations of harm is via the courts. As in the examples mentioned above, there are several possible scenarios where a woman may want to bring legal action against a party because of gender-based discrimination. However, most legal systems require evidence of intent to discriminate, in order to rule against the discriminating party, and as we already noted, many of the effects of AI-based discrimination are unintentional (Barocas & Selbst, 2016). Recognising the limitations of their legal systems in providing recourse for these types of discrimination, governments will have to develop alternatives for women and others in these situations. This can include for example, mandatory bias audits for consequential decision-making algorithms.

CONCLUSIONS

Emerging technologies such as AI will co-evolve with existing inequalities, particularly for countries in the Global South. How might AI improve or worsen gender equality? Most of the evidence suggests that AI applications are indirectly or directly exacerbating existing gender inequalities. Even where there is no harm or discrimination created by the application itself, its interaction with the wider environment leads to disproportionately negative impacts on women.

This points to the importance of acting now, for policy-makers, practitioners, and researchers. A starting point is to discard the notion that AI is gender-neutral, and rather to acknowledge and incorporate analysis on gender throughout the AI policy process. Research is necessary to build an evidence base on the relationships between diffusion of AI and gender and other inequalities. The various examples highlighted throughout the chapter point to a broad range of research needs, both for those working in the field of AI and those studying its impacts.

88 *On gender audits in public sector agencies, see for example http://webfoundation.org/docs/2018/03/Using-USAFs-to-Close-the-Gender-Digital-Divide-in-Africa.pdf p. 16. Accessed July 2018.*

89 *https://www.meetup.com/Lagos-Women-in-Machine-Learning-Data-Science/ and https://www.meetup.com/Abuja-Women-in-Machine-Learning-and-Data-Science/ Accessed March 2018.*

90 *See also http://opendefinition.org/od/2.1/en/ Accessed March 2018.*

While recognising the impact that AI is already having globally, and more specifically in the Global South, we have put forward recommendations in five key areas. Much of this impact can be negative, as our examples illustrate. However, problems linked to gender inequalities may be overlooked in societies where dominant narratives focus on those in power, namely men. Policy-makers and researchers everywhere must recognise, and be prepared to articulate, that no country can achieve its national development goals as long as gender inequality persists.

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