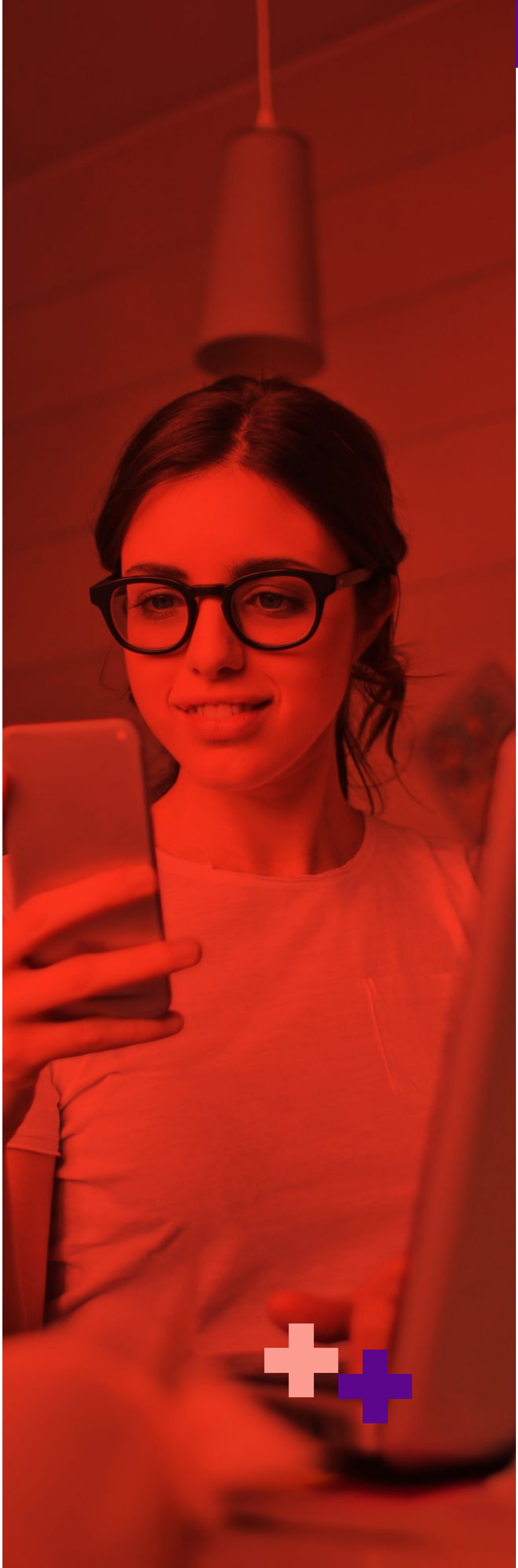
PART ONE: GLOBAL PERSPECTIVES 1

1

GENDER EQUALITY IN ICT ACCESS

AUTHOR:
DON RODNEY JUNIO (UNU-CS)



KEY FINDINGS

- Gender digital divides are not all the same. The gender digital divide persists irrespective of a country's overall ICT access levels, economic performance, income level or geographic location. Cultural and institutional constraints help shape how the gender digital divide manifests itself in a country. A one-size-fits-all approach to the issue will not be effective.
- The gender digital divide widens as technologies become more sophisticated and expensive, enabling more transformational use and impacts.
- Basic digital access and literacy are necessary but not sufficient conditions for women to meaningfully use ICTs.
- Use is not the same as ownership. As ITU begins to collect gender-disaggregated data around mobile phone use and ownership, the disparity between the two indicators appears to be key to understanding women's disadvantages in access to ICTs.
- The potential of mobile phones is under-realised. Despite its lower cost as compared to using a computer, the number of women using mobile internet remains substantially low relative to men. GSMA estimates that in low- and middle-income countries, women are 26% less likely to use mobile internet than men.

1.1 / INTRODUCTION

ICTs, including use of the internet and mobile technologies, expand opportunities and can potentially empower people who have access to them. Many believe that there is no longer a gender gap in ICT access, given the high levels of mobile phone adoption even in less developed regions. However, the latest data from the International Telecommunication Union (ITU) suggests that there are about 250 million fewer women online than men, and the problem is more pronounced in developing countries. Equality in ICT access involves more than mere availability and use of mobile phones. To what extent do women have equal access to devices other than mobile phones, as well as control over those devices and the ability to use the technology in beneficial ways? This chapter assesses data on a variety of indicators related to computer, mobile phone, and internet access, as well as use of digital financial services, to assess gender divides in these areas.

1.1.1 / WHY IS GENDER EQUALITY IN ICT ACCESS IMPORTANT?

A gender perspective on inequality in digital access is an analytical lens that puts structural issues and core concerns that women and girls face online at the centre of our understanding of the problem. Just learning that more than 3 billion people are offline suggests a different kind of policy response, as opposed to understanding that a majority of those who offline are women and girls. Closing this gender digital divide has the potential to empower women both online and offline, in various facets of their lives including their economic and social conditions. ICTs have the potential to alleviate some of the steep barriers faced by women, including illiteracy, poverty, time scarcity, barriers to mobility, and cultural and religious taboos (SIDA, 2015).

In addition to addressing the structural barriers that women face, closing the gender digital divide on basic access would profoundly affect other aspects of women's participation in the digital economy, including in knowledge creation and leadership. Meaningful participation in the digital economy requires unfettered access to ICT tools. Improving the economic standing of women requires equipping them with the tools and skills to adapt successfully to the evolving requirements of our increasingly knowledge-based and ICT-driven economies.

In recognition of the transformative potential of ICTs, closing the gender digital divide in access is included as part of the UN's Sustainable Development Goal (SDG) targets (Box 1.1).

Box 1.1
Women's ICT Access and the SDGs

To achieve the UN SDG targeting gender equality will necessitate a data regime and policy framework designed to monitor, track, and measure progress in closing the gender divide. To date, the lack of gender statistics and sex-disaggregated data often clouds the ability of policy makers to respond adequately to social problems that affect women and girls.
The SDGs spell out the following targets that, together, would enable greater and equal participation of women in the digital society:

Target 5B: Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women.

Target 9C: Significantly increase access to information and communications technology and strive to provide universal and affordable access to the internet in least developed countries by 2020.

Target 5.2: Eliminate all forms of violence against all women and girls in public and private spheres.

1.1.2 / MEASURING THE GENDER DIVIDE IN ICT ACCESS

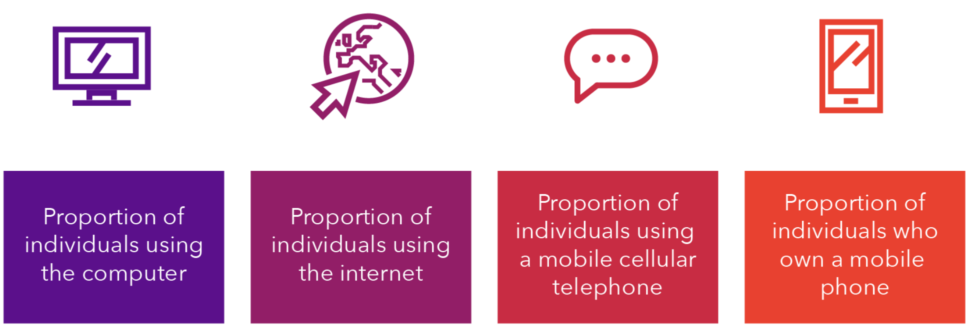
The success of current initiatives to address gender digital inequalities depends on understanding the forms and extent of the inequalities and why they exist. The starting point for policy makers and researchers is to re-examine how we define and measure ICT access. The definition of access to ICTs has evolved over the years and along with it, definitions of the digital divide (van Deursen & van Djik, 2014; van Djik, 2006). Increasingly, basic access now encompasses not only telephones and computers, but also access to mobile phones including smartphones, the internet, and specifically broadband internet (Tsetsi & Rains, 2017; Rice & Katz, 2003). In addition, the definition of access is being extended to issues of ownership and control over devices, as well as usage patterns and access to different types of content (Lee et.al, 2015; Schradie, 2011; Warschauer, 2003 among others). As new technologies emerge (e.g., artificial intelligence) it is likely that ICT access as a concept will continue to be a moving target. Bearing all this in mind, we focus on two aspects of ICT access — basic access and meaningful access — to capture a spectrum ranging from ability to get access to a device, to differences in the use of these devices. For basic access, we examine the gender digital divide around use of computers and internet and use and ownership of mobile phones. For meaningful use, we focus on the gender digital divide around access and use of digital financial services, as an aspect of meaningful use that has available sex-disaggregated data. The rest of the chapter discusses the state of knowledge on basic access and meaningful access, cognisant of the limited availability of gender-disaggregated data in general.

1.2 / BASIC ACCESS

The most reliable global data in relation to basic access can be culled from the database of the ITU. Since 2004, ITU have been working with National Statistics Offices from developing countries to improve the availability and quality of statistics that can be disaggregated by gender (among other individual or household dimensions). Despite having limited data available, ITU's basic access indicators illuminate existing gender digital divides.

The most common understanding of basic access is in reference to access to and use of ICT devices such as a computer or a mobile phone. This device-centric conceptualisation of basic access informs much of the current global data regime on basic ICT access indicators. With the use of internet increasingly seen as a prerequisite to participate in the digital economy, countries have also started collecting data to measure this aspect of access. For example, part of ITU's core list of indicators are gender-disaggregated as they relate to access, as shown in Figure 1.1.

Figure 1.1
Basic Access Indicators from ITU



While use of devices and internet are the most accepted way of measuring basic access, this tends to overlook power dynamics that may affect women specifically. It is important to frame "access" as relating to ownership and control as well as use. The indicator "proportion of individuals who own a mobile phone" is included as a factor in basic access, in recognition of the multidimensional aspect of ICT access — beyond measures of use. However, problems in global data coverage prevent us from drawing a global picture of ownership and control. In this section, we use the term "basic access" to refer to the following issues: (i) use of computer; (ii) use of the internet; (iii) use of a mobile phone; and (iv) mobile phone ownership. Appendix B presents the data in more detail at the country level.

1.2.1 / COMPUTER USE

The first step in bringing women online and enabling them to use the internet is ensuring that they have unfettered use of access devices such as computers. The gender gap in computer use varies across regions. Of the 78 economies with gender-disaggregated data on use of computer, the largest gap is in Asia — as is the country with the largest gender gap in favour of women. With the exception of Africa, all regions have at least one country where the gender gap favours women (Table 1.1).

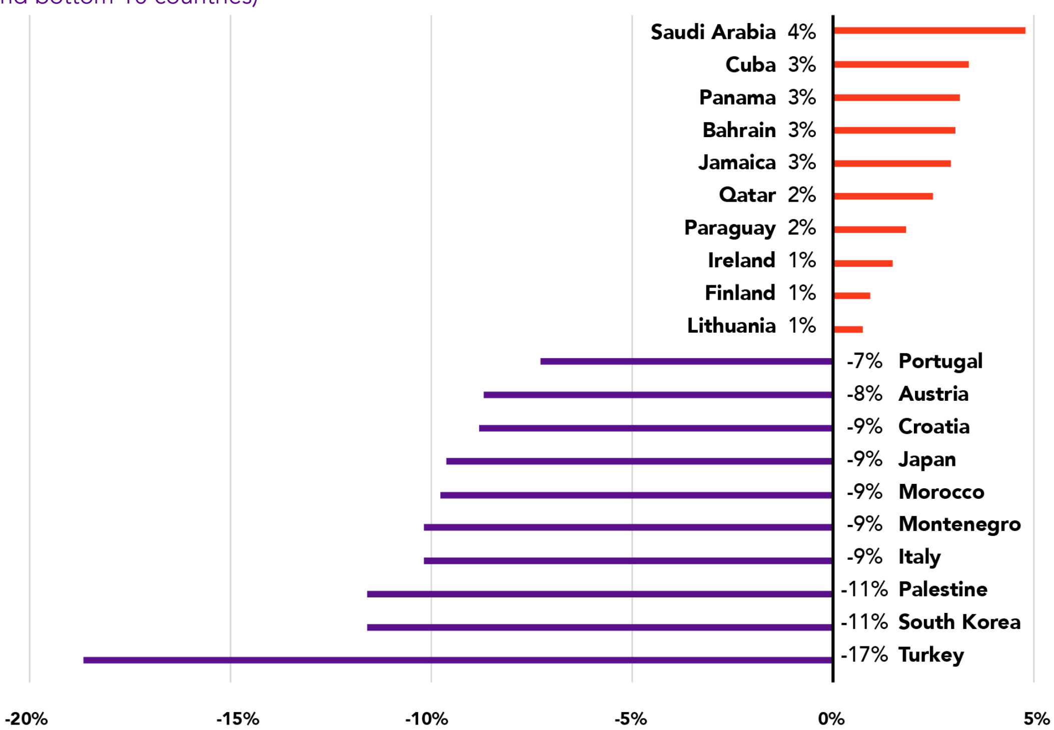
Table 1.1
Gender gap in computer use by region

REGION	NUMBER OF REPORTING ECONOMIES	PERCENTAGE OF LARGEST GAP	PERCENTAGE OF SMALLEST GAP
Africa	6	-8.9	-0.7
Americas	13	-5	3.1
Asia	25	-17	4.3
Europe	34	-9.3	1.4

Source: ITU WTI Database 2017

Countries in the Middle East and Latin America dominate the group with a higher proportion of women than men who use a computer. Countries in the bottom 10 in women's computer use include some that are associated with a highly developed ICT infrastructure, such as Japan and South Korea (Figure 1.2).

Figure 1.2
Difference between male and female computer use (top 10 and bottom 10 countries)

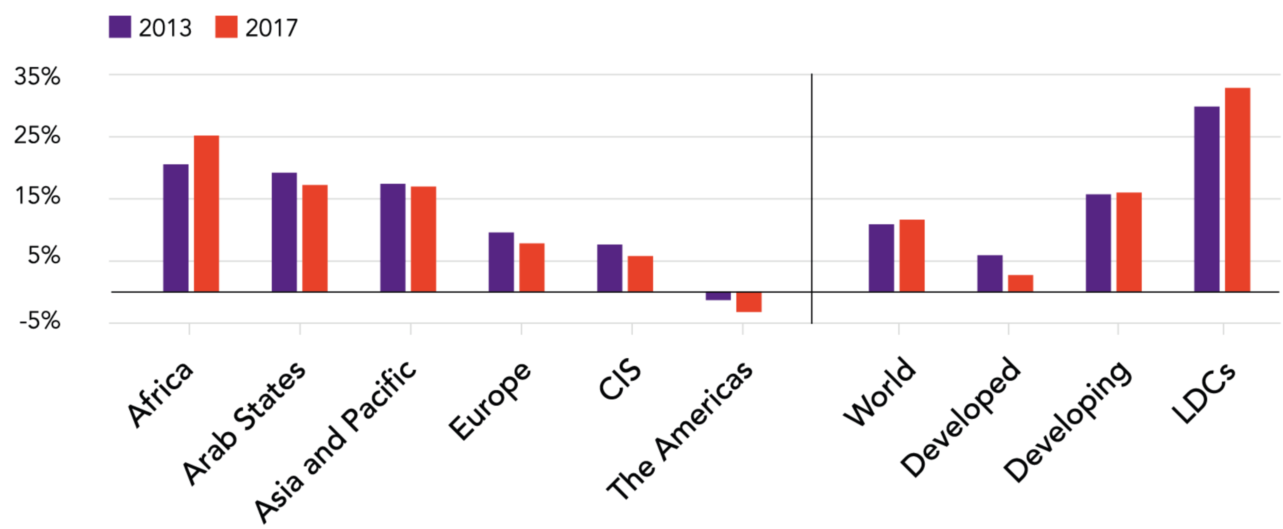


Source: ITU WTI Database 2017
Note: Positive value means more women than men.

1.2.2 / INTERNET ACCESS

ITU's latest flagship annual report, Measuring the Information Society 2017, notes that the global gender gap in internet access has increased from 2013 to 2017 (Figure 1.3). In 2017, there are 250 million fewer women online. Regional variations exist: least developed countries show a substantial gap, while the gender gap has decreased in developed countries. The internet user gender gap increased in Africa, even while it decreased in other regions. With the sole exception of the Americas, there are more men online than women in every region.

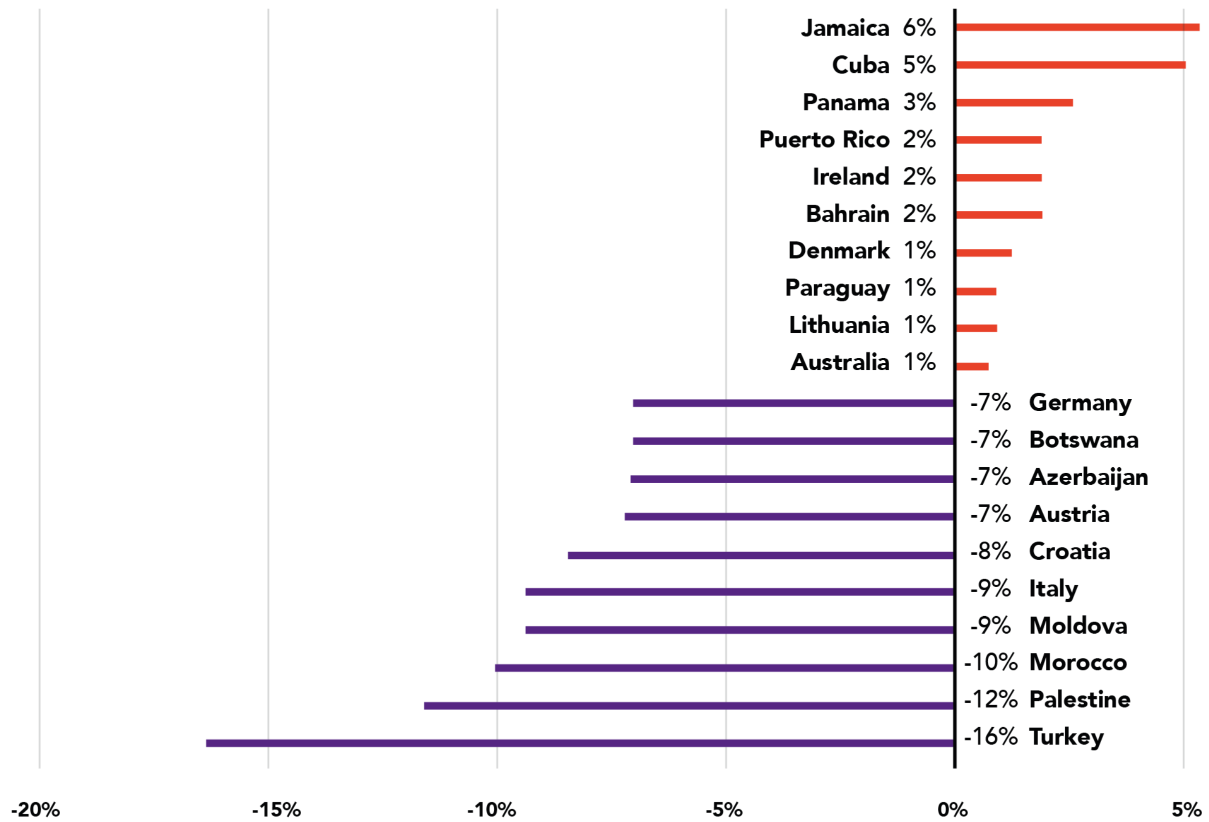
Figure 1.3
Gender gap in internet users in 2013 and 2017



Source: ITU MIS 2017 Report
Note: The gender gap represents the difference between the internet use rates for males and females relative to the internet use rate for males, expressed as a percentage.

Looking at the top 10 and bottom 10 countries in terms of difference in percentage between women and men, the results are more varied, with the gender gap ranging from +6% to -16% (Figure 1.4). Countries in Latin America and Europe dominate the list of countries in the top 10, showing a gender gap in favour of women. However, there are also a number of European countries in the bottom 10 of countries, where the gender gap favours men, as in Germany and Austria. In this sense, the gender gap does not neatly correlate with the degree of economic development of the country.

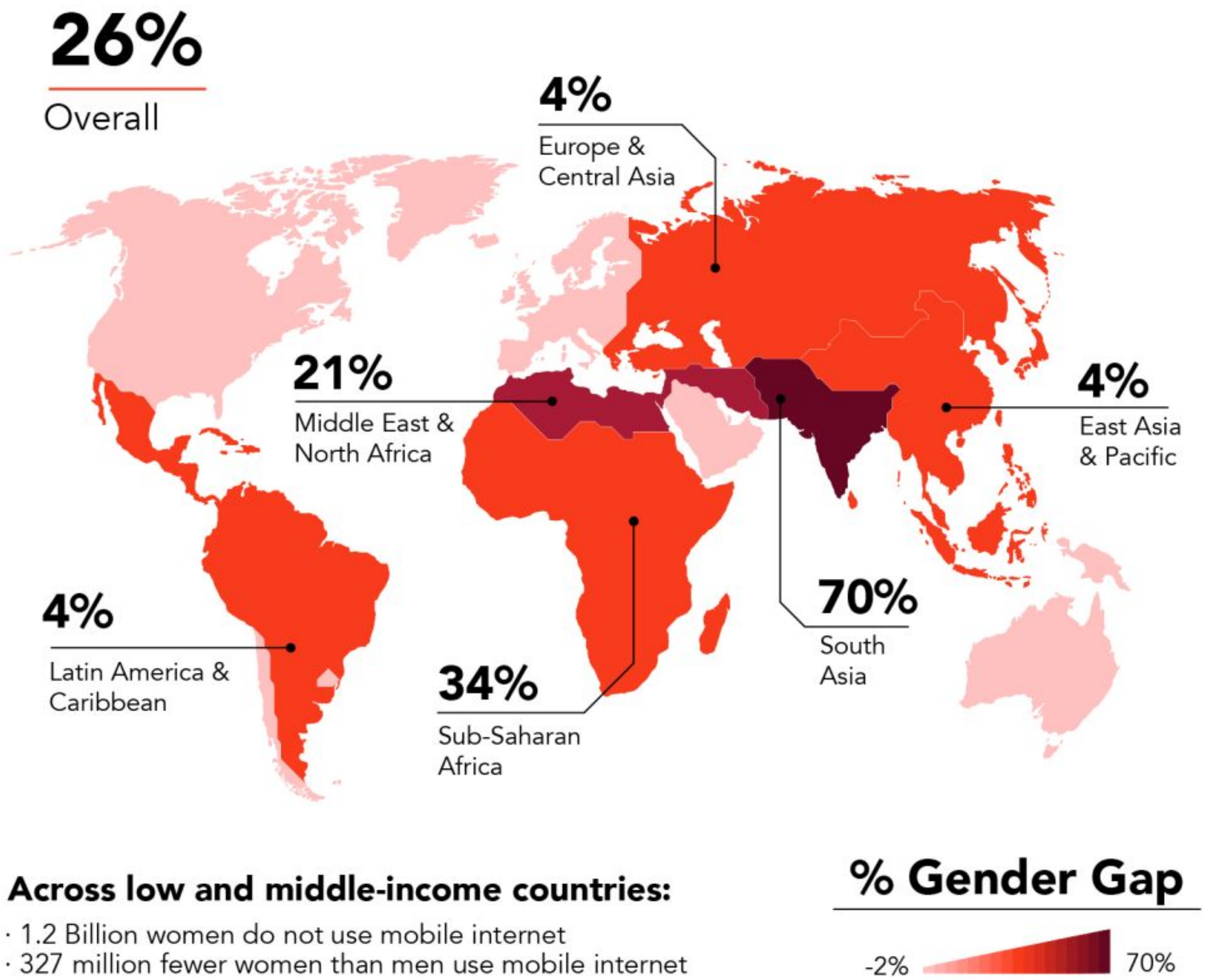
Figure 1.4
Difference between male and female internet use (top 10 and bottom 10 countries)



Source: ITU WTI Database 2017.
Note: Data obtained by subtracting female percentage from male percentage in internet use. Positive value implies more women using the internet than men.

While the internet is increasingly being accessed over mobile devices, data on use of mobile internet is not one of the indicators that ITU regularly collates. The private sector is taking the lead in measuring the gender gap in this area: the GSMA conducts surveys across different countries; it creates models to estimate the gender digital gap in mobile internet use, even in countries where a survey was not conducted. GSMA's Mobile Gender Gap Report 2018 (GSMA, 2018) notes that there are about 1.2 billion women in low- and middle-income countries that do not use mobile internet; on average, women are 26% less likely to use mobile internet than men. The report also notes regional differences across low- and middle-income countries, ranging as high as 70% in South Asia to as low as 4% in East Asia & Pacific and Latin America & Caribbean (Figure 1.5).

Figure 1.5
Gender gap in mobile internet use in low and middle-income countries by region



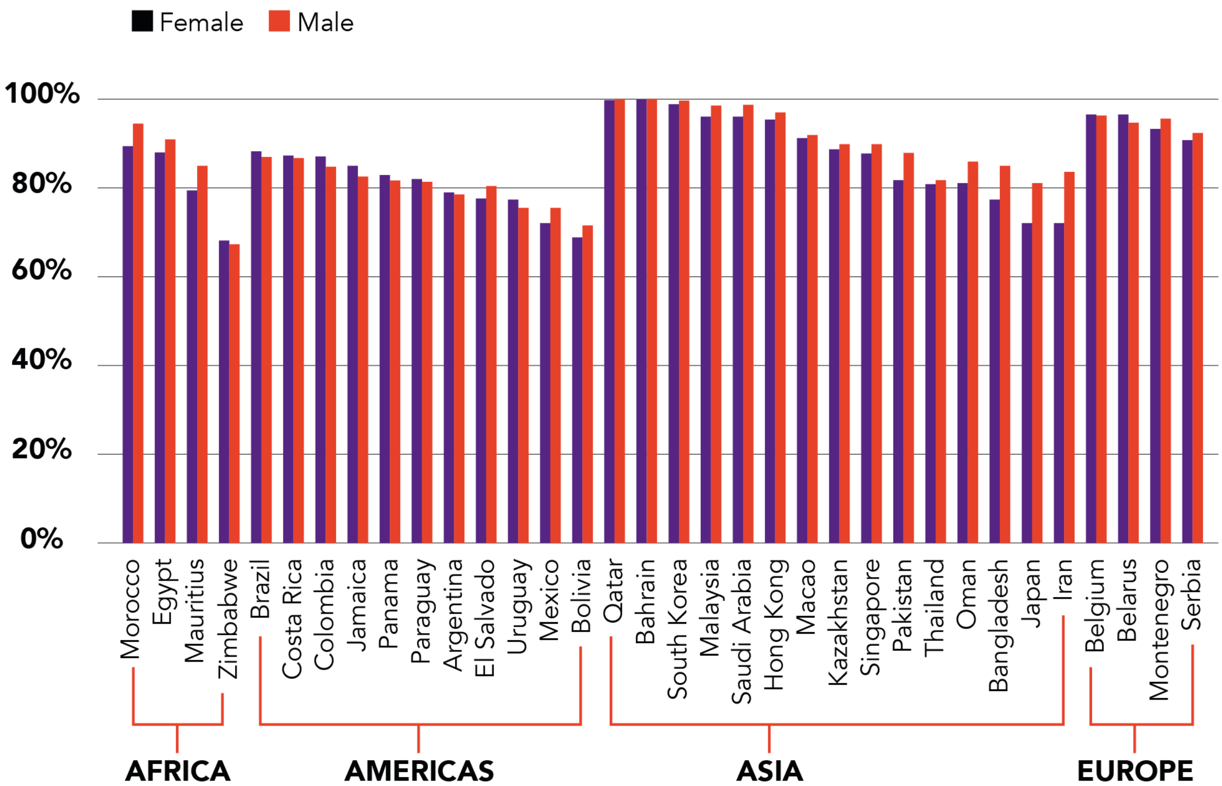
Source: GSMA Mobile Gender Gap Report 2018.
Note: GSMA calculates the gender gap by subtracting male users/owners (% of male population) from female owners/users (% of female population) divided by male owners/users.

1.2.3 / MOBILE PHONE USE

Access to and use of mobile phones have increased over the years, reflecting a combination of factors, including reduction in cost of ownership. Data collated by ITU shows that, for all 34 economies with gender disaggregated data, more than half of the population already use a mobile phone; the lowest percentage for females, in Zimbabwe, is 68.5% (Figure 1.6). Figure 1.7 shows the top 10 and bottom 10 countries, in terms of difference between percentages of female and percentages of male for mobile phone use. Many developing countries are represented in the top 10, i.e., where more women than men are using a mobile phone. Among the bottom 10 countries, in terms of women's use of mobile phones, are both developing countries and developed countries, such as Japan (Figure 1.7).

Figure 1.6

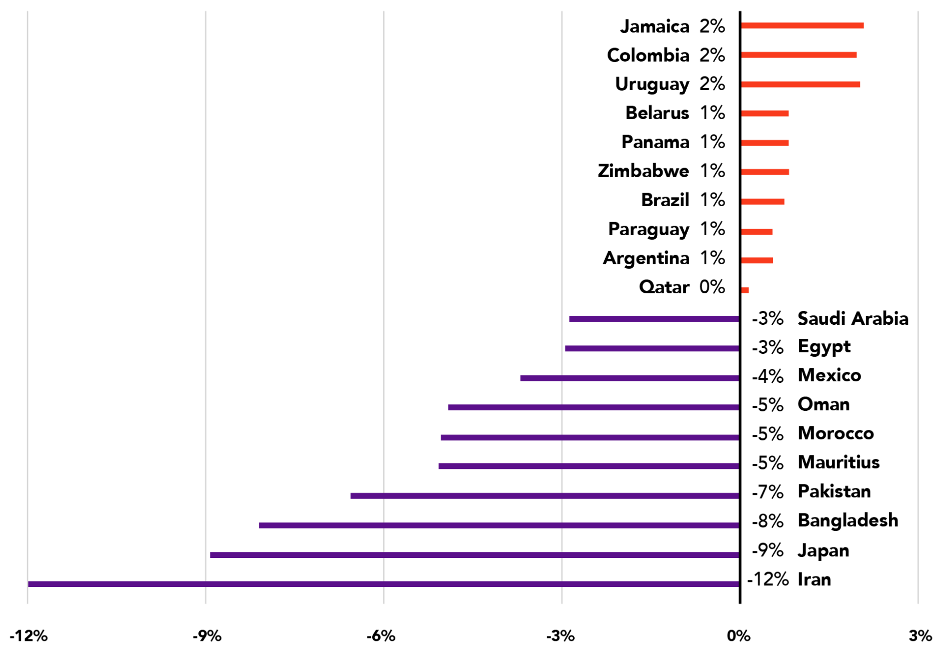
Percentage of individuals using a mobile cellular telephone by gender



Source: ITU WTI Database 2017.

Figure 1.7

Difference between male and female use of mobile phone (top 10 and bottom 10 countries)

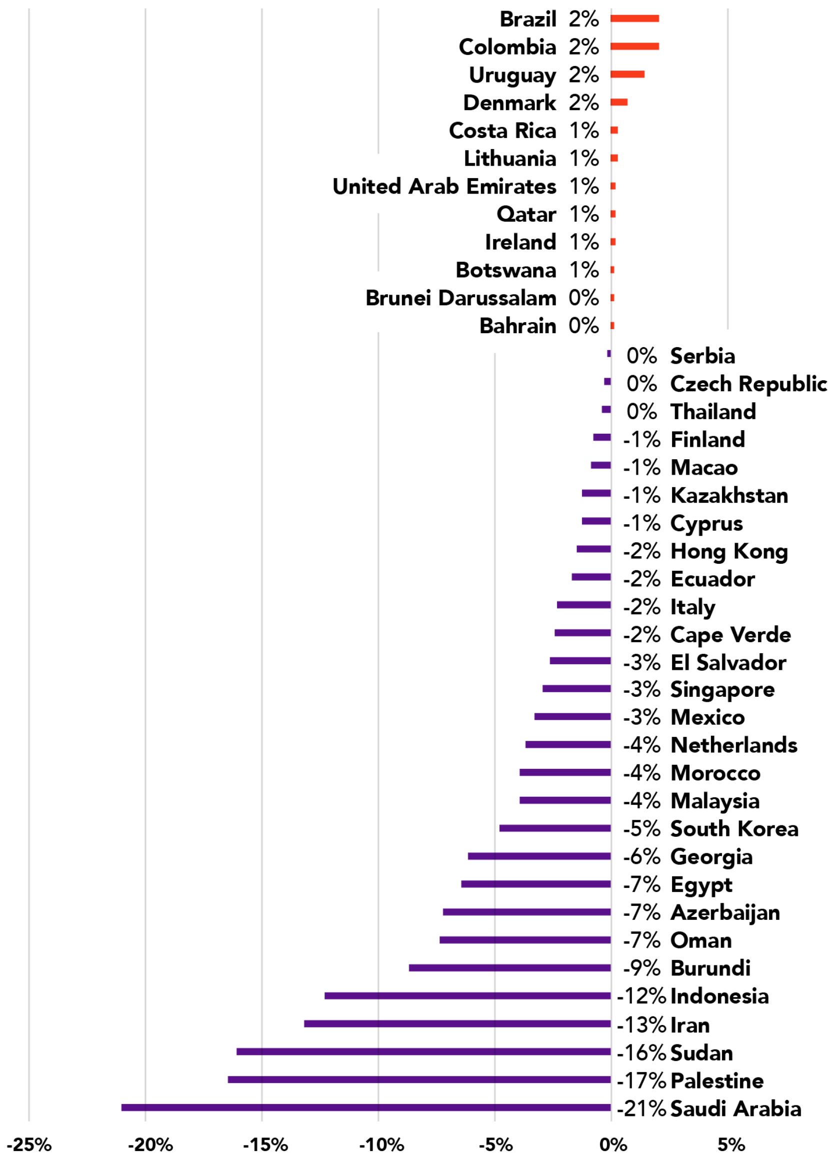


Source: ITU, WTI Database 2017.
Note: Data obtained from subtracting female percentage to male percentage mobile phone use. Positive value implies more women using mobile phones than men.

1.2.4 / MOBILE PHONE OWNERSHIP

ITU has recently started collecting data related to mobile phone ownership. In the latest version of the World Telecommunication and ICT Indicators Database 2017, 40 economies show gender-disaggregated data on mobile phone ownership. With the exception of Burundi, which reported female ownership at 7.3%, all other countries reported more than 50% of women owning a mobile phone. For countries with available data, we can see that mobile phone ownership is generally higher among men than women (Figure 1.8).

Figure 1.8
Difference between male and female mobile phone ownership



Source: GSMA Mobile Gender Gap Report 2018.
Note: GSMA calculates the gender gap by subtracting male users/owners (% of male population) from female owners/users (% of female population) divided by male owners/users.

GSMA's Mobile Gender Gap Report 2018 similarly notes this gender gap in mobile phone ownership. According to their estimates, there are 184 million fewer women owning a mobile phone than men. There are also regional differences: for example, women in South Asia are 26% less likely than men to own a mobile phone; while in East Asia and Pacific, women are only 2% less likely than men to own a mobile phonel.

1.3 / MEANINGFUL ACCESS

Once online, there may be noticeable differences in usage patterns between men and women. There is growing recognition that basic access to ICTs is not enough to empower women. For both mobile and internet use, the gender digital divide widens as the technology gets more sophisticated and expensive (Highet, 2017; Deen-Swarray et al., 2012). GSMA (2018) notes that the gender gap does not end at mobile phone ownership but increases when we look at usage patterns, especially for more transformational services. As Chapters 8 and 10 demonstrate, intersecting identities (such as gender, age, socio-economic status, or disability) can exacerbate exclusion from both access and meaningful use of ICTs.

Meaningful access refers to digital competencies and applications that have the potential to transform individuals' activities, opportunities and outcomes. Case Study 1.1 describes an example of promoting meaningful ICT use for entrepreneurial activity; Chapter 11 discusses meaningful use in the context of gender and food security. However, existing quantitative measures for estimating meaningful use are limited to reports on women's basic ICT or digital skills, and their use of digital financial services. Meaningful use encompasses more than these two aspects, but lack of data obscures other dimensions of meaningful use, such as women's ability to produce content and disseminate it online.

Beyond differences in access and usage patterns, researchers have also started to examine a third-level digital divide: "disparities in the returns from internet use, within populations of users who exhibit broadly similar usage profiles and enjoy relatively autonomous and unfettered access to ICTs and the internet infrastructure" (Helsper & van Deursen, 2015). In other words, even if people have equal computer access and skills, they may not experience equal material outcomes. However, research on the third-level digital divide is still at its early stage (Scheerder et al., 2017), and converting these various conceptions of ICT use to measurable indicators has yet to be realised.

Case Study 1.1

SheTrades — Empowering Women Entrepreneurs with Digital Skills

Author: Poonam Watine
(International Trade Centre)

In line with the EQUALS Global partnership, the SheTrades Initiative responds to global issues surrounding women and trade, including digital gender-inequality, with a goal of connecting 3 million women entrepreneurs and women-owned businesses to international markets by 2020. SheTrades completed a project with the Indian Ocean Rim Association (IORA), funded by the Australian Department of Foreign Affairs, to support women-owned and led enterprises operating in the services sector in three countries (Jan. 2016–June 2018). IT and ITES (information Technology-Enabled Skills) were the focus in Indonesia and Kenya. The project established networks with private sector, women business associations, and relevant trade and investment support institutions. One key outcome was to increase competitiveness of women entrepreneurs through capacity-building activities, with face-to-face and online trainings geared towards digital marketing, social media, and e-commerce.

Ms. Evelyn M. Kasina, CEO, Eveminet Communication Solutions Ltd.
Evelyn Kasina's information technology firm specialises in digital intelligence for children, including girls. In its third year, the company is working with corporate employers to equip them with essential digital intelligence skills and cyber security solutions.
With support from the SheTrades IORA project, Eveminet Communication Solutions Ltd. participated in several major trade fairs. The company generated almost $5000 in sales and has been chosen as a supplier for Safaricom, a leading mobile network operator in Kenya.

In 2018, Ms. Kasina registered a social enterprise focused on digital literacy and data mining to assist children and youth, providing a digital hub for government resources, supporting women's economic empowerment, and creating an e-commerce platform for markets and trade.
Her vision is to "see the young generation become digitally intelligent citizens, leveraging technology and its opportunities."

Short-term outcomes include supporting over 250 women-owned and -led firms (213 SMEs in Indonesia and 165 in Kenya). Over 47 SMEs under the project have established sizable contracts, totaling around $2.3 million. Collaboration with Facebook Asia Pacific and their #SheMeansBusiness initiative helped women entrepreneurs from Indonesia broaden their knowledge on Facebook and Instagram marketing. The firms were surveyed on their digital literacy and ICT competency. One key finding was that many firms use social media to market their services, due to the low cost. A database was developed to help track the firms' sales.

Key Lessons

- Collaborative partnerships with the private sector can result in potential sales with buyers for beneficiaries.
- Online trainings and webinars helped to minimise the cost for capacity-building activities.
- Focusing on select countries and the services sector allowed a tighter and stronger delivery.

1.3.1 / DIGITAL FINANCIAL TRANSACTIONS

One area of meaningful use that has received considerable attention is the use of ICT tools for financial transactions, and the potential to include the unbanked and underbanked in the formal financial system. Data on some aspects of women's use of digital financial services are available through the World Bank's Global Financial Inclusion Database (Global Findex), which contains modules on topics related to digital payments, mobile money, and making online transactions. Launched in 2011 and updated every three years, the Global Findex contains nationally representative data on access and use of formal and informal financial services by different demographics, including gender (Figure 1.9).

Figure 1.9
World Bank Findex Indicators on Access and Use of Digital Financial Services

Multistakeholder partnerships and deeper private sector engagement have provided the needed visibility to help widen the reach of mobile financial services. Case Study 1.2 illustrates how the private sector can play a significant role in bridging the gender digital divide in mobile money uptake and even mobile internet use, across different countries in Africa, Asia, and Latin America.

Case Study 1.2

GSMA Connected Women Initiative: bridging the mobile gender gap

Author: Mariana Lopez (GSMA)

1. Context

Mobile can help empower women, providing access to information, services, and life-enhancing opportunities. However, GSMA Connected Women research estimates that women in low- and middle-income countries are, on average, 10% less likely to own a mobile phone than men — which translates into 184 million fewer women owning mobile phones.[1]

Women who own a mobile phone often report using phones less frequently and intensively than men, especially for transformative services such as mobile internet. We estimate that women are on average 26% less likely to use mobile internet than men; in countries covered by the World Bank's Global Findex database, women are on average 33% less likely to use mobile money. Women in South Asia are 26% less likely to own a mobile than men, and 70% less likely to use mobile internet. Closing the gender gap in mobile ownership and mobile internet use would generate an estimated incremental revenue of $15 billion over the coming year.[2]

2. Project description

Through the Connected Women Commitment initiative, mobile operators can set defined targets to reduce the gender gap in their mobile money or mobile internet customer base by 2020. As of December 2018, 37 operators across Africa, Asia, and Latin America have made 52 such commitments. Activities include, for example, increasing the number of female agents, improving the mobile data top-up process to be safer and more appealing to women, improving digital literacy among women through educational programmes and interactive content, and developing and marketing use cases designed to appeal to women. To date, since they committed to the Connected Women Initiative, mobile operators have reached over 12 million new women with mobile money or mobile internet services.[3]

3. Challenges and Key Lessons

Targeted intervention is urgently needed from a wide range of stakeholders to overcome the barriers women face to mobile ownership and use. Based on based on their research and experience working with operators across Africa and Asia, GSMA Connected Women developed a framework to guide mobile operators (Figure 1.10).[4]

1 *'Mobile' or 'mobile phone' ownership refers to personally owning a SIM card, or a mobile phone which does not require a SIM, and using it at least once a month.*

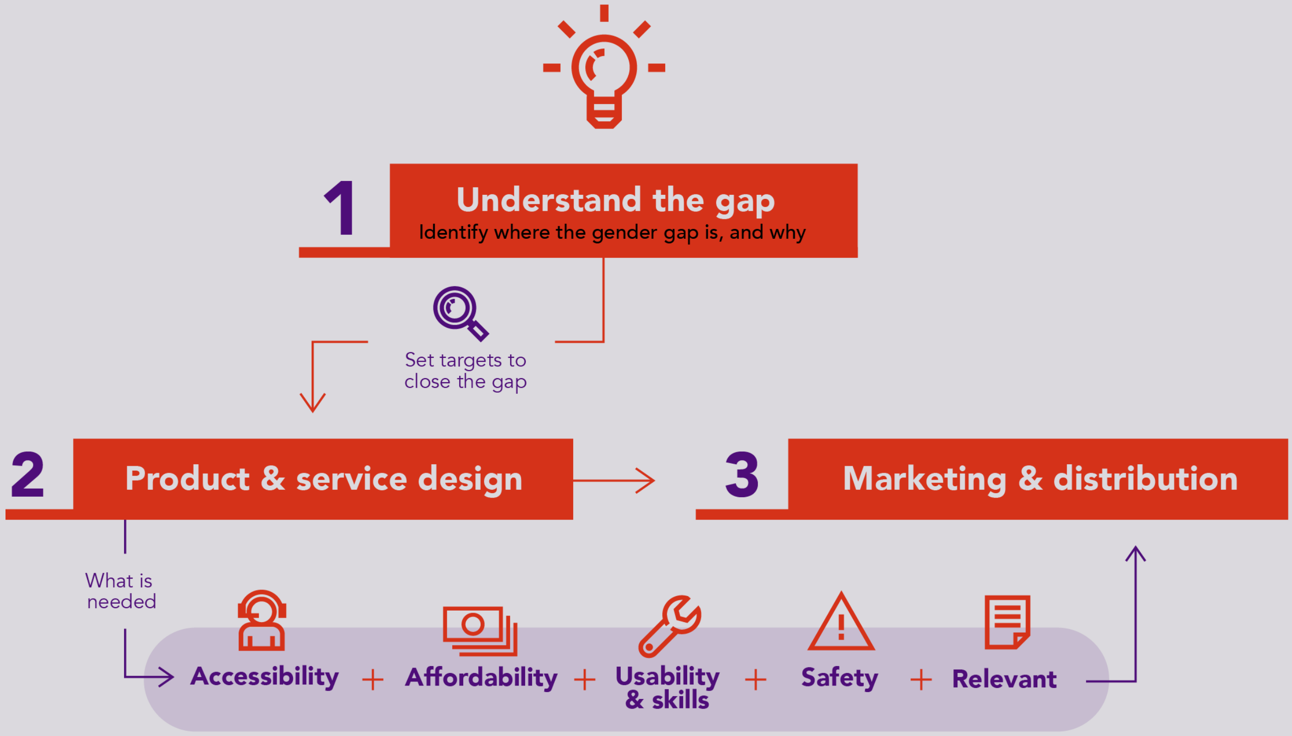
2 *The $15 billion estimate assumes that the gender gap in mobile ownership and mobile internet use would be closed during 2018, and represents the subsequent 12-month incremental revenue opportunity.*

3 *Connected Women also supports GSMA as lead of the Access Coalition of EQUALS, the global partnership to bridge the digital gender divide.*

4 *The complete framework can be found at: https://www.gsma.com/mobilefordevelopment/programme/connected-women/framework-mobile-operatorsclose-gender-gap/*

Figure 1.10
GSMA Connected Women Framework to promote women's use of mobile services

WHAT OPERATORS SHOULD DO TO CLOSE THE GENDER GAP



Recommendations for operators and other stakeholders to address the gender gap

1. Understand the gap
Operators need to understand where the gender gap is in their customer base, and why, by analysing their customer data and supplementary field research.

2. Set targets
Set targets and KPIs to increase the proportion of women in the mobile internet and/or mobile money customer base from x% to y% by 2020.

3. Address the barriers women face
Accessibility. Women are less likely than men to have access to quality network coverage, handsets, electricity, agents, and identification documents.

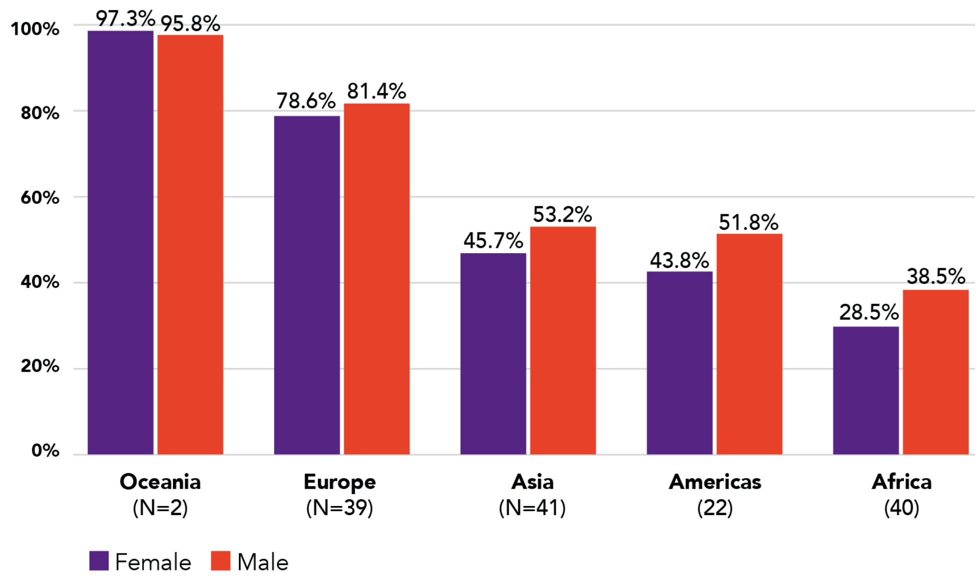
- Affordability. The cost of handsets, tariffs, data plans, and transaction fees need to be affordable for women as well as men.
- Usability and skills. The usability of handsets and services must be improved, along with the ability and confidence of women to use them.
- Safety and security. Women must feel safe when using a mobile phone.
- Relevance. Products and services need to meet women's needs as well as men's.

To close the gender gap, operators and other stakeholders need to ensure that their products and services, as well as marketing and distribution approaches, consider women's needs for these five themes. Initiatives need to be socially impactful and commercially sustainable to succeed over the long term.

1.3.2 / DIGITAL PAYMENT TRANSACTIONS

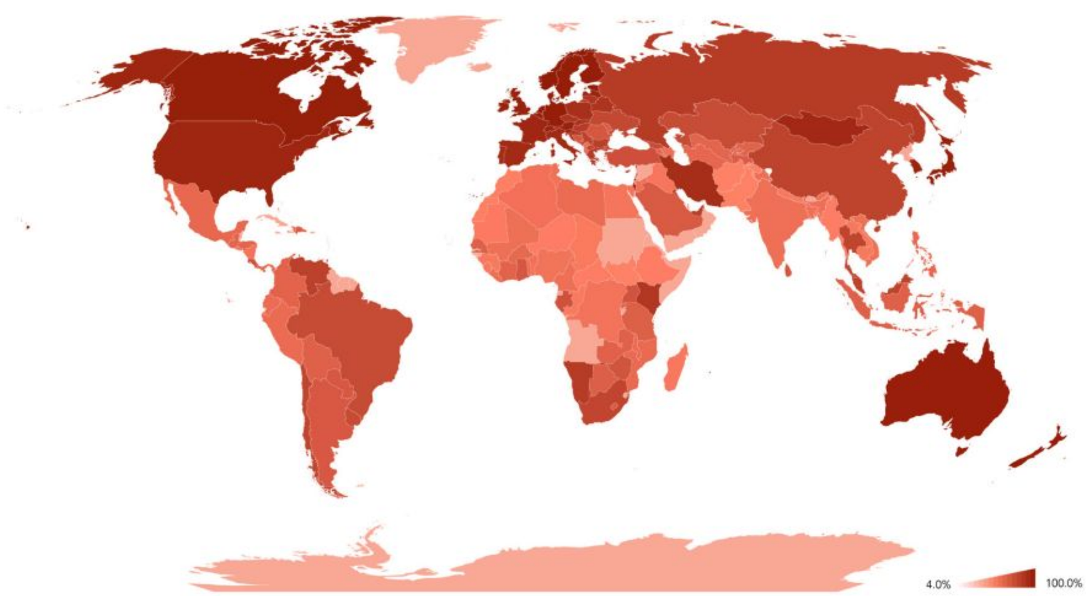
Digital payment transactions include online and mobile transactions, such as remittances and agriculture payments, as well as offline transactions, such as use of a debit or credit card. Figure 1.11 shows females lagging behind males in making or receiving digital payments in all regions except in Oceania — represented by two advanced economies, Australia and New Zealand. There are also differences within regions: in Africa, Kenya has over 75% female penetration; and in Asia, Iran and Mongolia both have higher than 85% female penetration rate, much higher than the rest of the region (Figure 1.12).

Figure 1.11
Percentage of females and males who made or received digital payments in 2017



Source: World Bank Global Findex Database 2017.

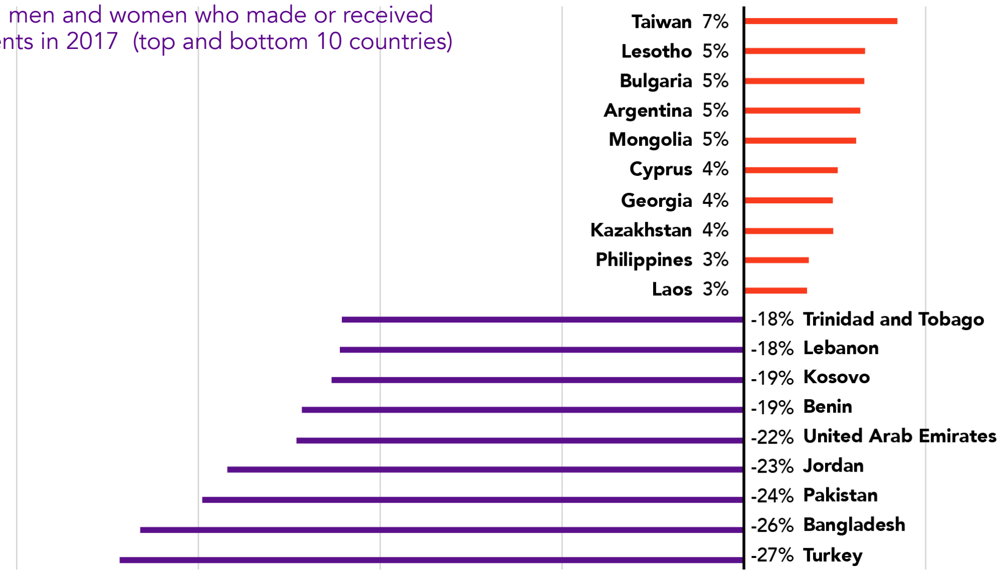
Figure 1.12
Percentage of females who made or received digital payments in 2017



Source: World Bank Global Findex Database 2017

While in general more men make digital transactions, three developing countries have more women than men who made or received digital payments in the past year: Lesotho, Argentina, and Mongolia (Figure 1.13).

Figure 1.13
Gap between men and women who made or received digital payments in 2017 (top and bottom 10 countries)

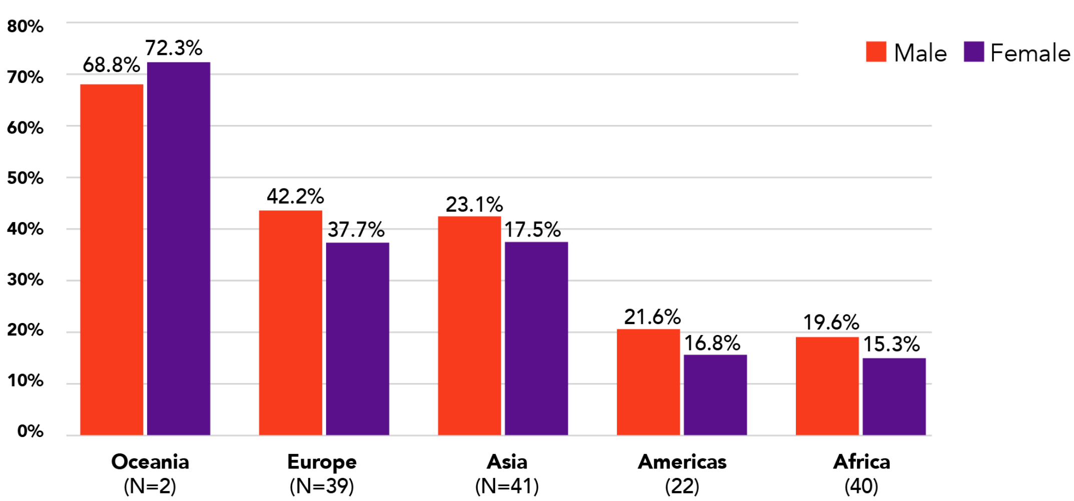


Source: World Bank Global Findex Database 2017

1.3.3 / ACCESSING AN ACCOUNT USING MOBILE PHONE OR THE INTERNET

While the use of mobile banking has been heralded in many developing countries for bringing the unbanked into the formal sector, with women as the targeted population in most cases, women still lag behind the use of mobile phone or internet to access a financial account. The exception is Oceania, represented by two developed countries, Australia and New Zealand, reporting higher use for females than males (Figure 1.14). The other regions show higher use for males; Africa, the Americas, and Asia show women's usage below 18%. There can, however, be significant variations within regions, as seen on the map of Figure 1.15. Notably, South Korea (in Asia) and Kenya (in Africa) show female usage rates higher than the regional average.

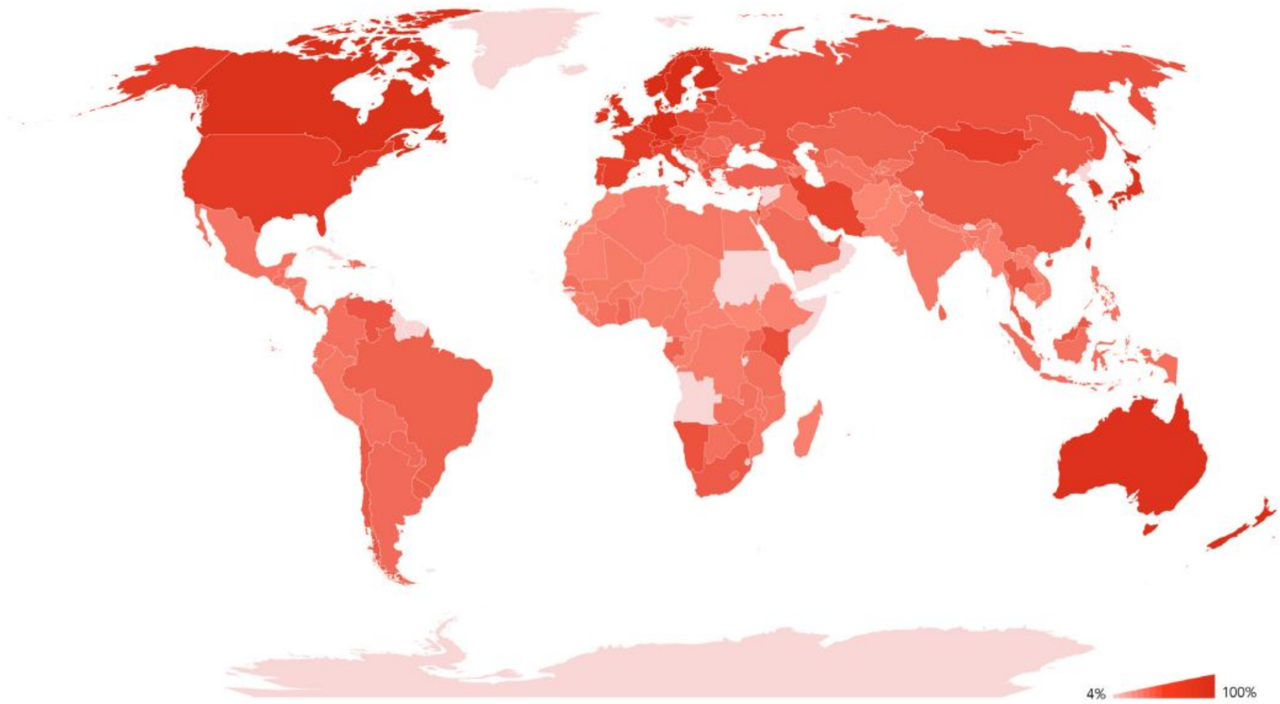
Figure 1.14
Percentage of male and female use of mobile phone / internet to access an account in 2017



Source: World Bank Global Findex Database 2017

Figure 1.15

Percentage of male and female use of mobile phone / internet to access an account in 2017

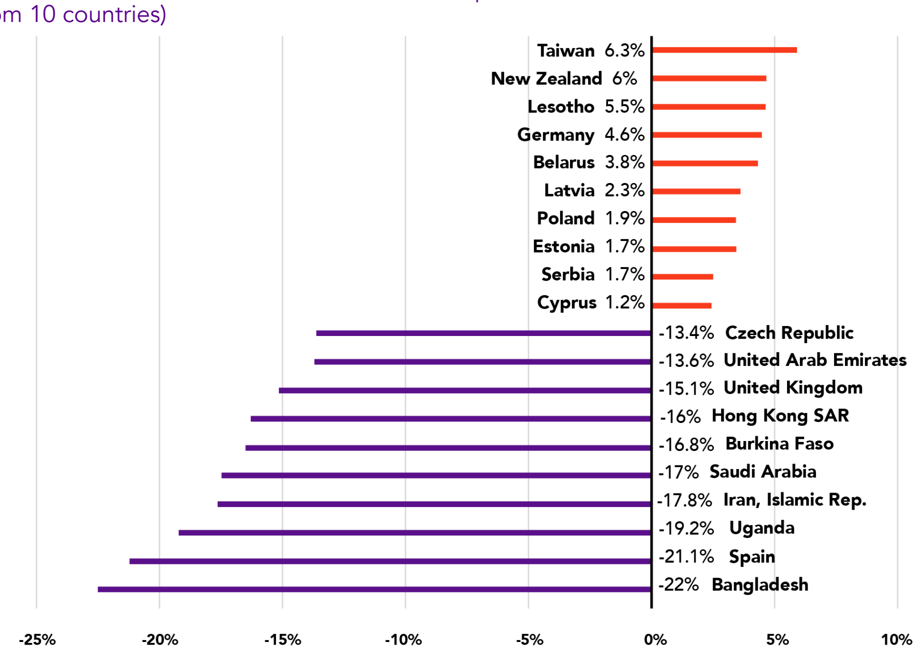


Source: World Bank Global Findex Database 2017

Figure 1.16 shows the gap between men and women (in percentage points) for the top 10 and bottom 10 countries in use of mobile phone or internet to access an account. Among the countries where the gap is in favour of women, we find a developing country, Lesotho; conversely, we find a highly developed market, the United Kingdom, among the bottom 10 of countries surveyed.

Figure 1.16

Gap between men and women who used a mobile phone or the internet to access an account in 2017 (top and bottom 10 countries)

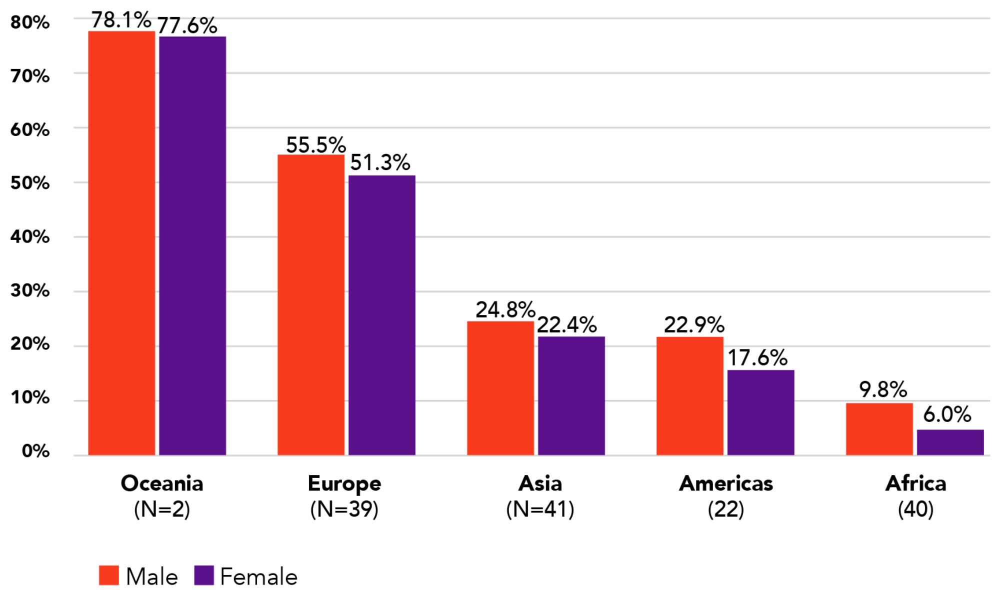


Source: World Bank Global Findex Database 2017

1.3.4 / USING THE INTERNET TO PAY BILLS OR MAKE PURCHASES ONLINE

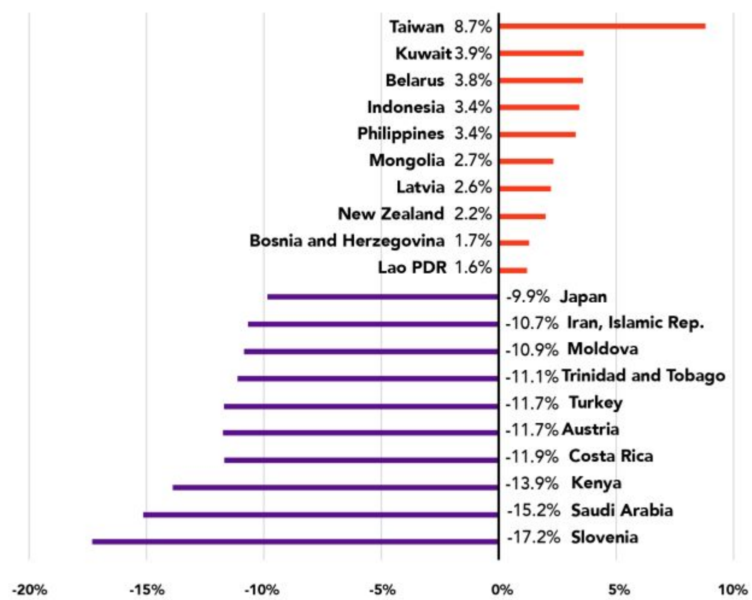
More male respondents reported having used the internet to pay bills or buy something online across all geographical regions (Figure 1.17). In Oceania and Europe, more than 50% of females reported having used the internet to make a purchase or pay their bills. Africa shows low internet use to pay bills or purchase online for both men and women. In Asia, developed countries such as South Korea and Japan report higher female usage rates (Figure 1.18).

Figure 1.17
Percentage of male and female use of the internet to pay bills or make purchases online in 2017



Source: World Bank Global Findex Database 2017.

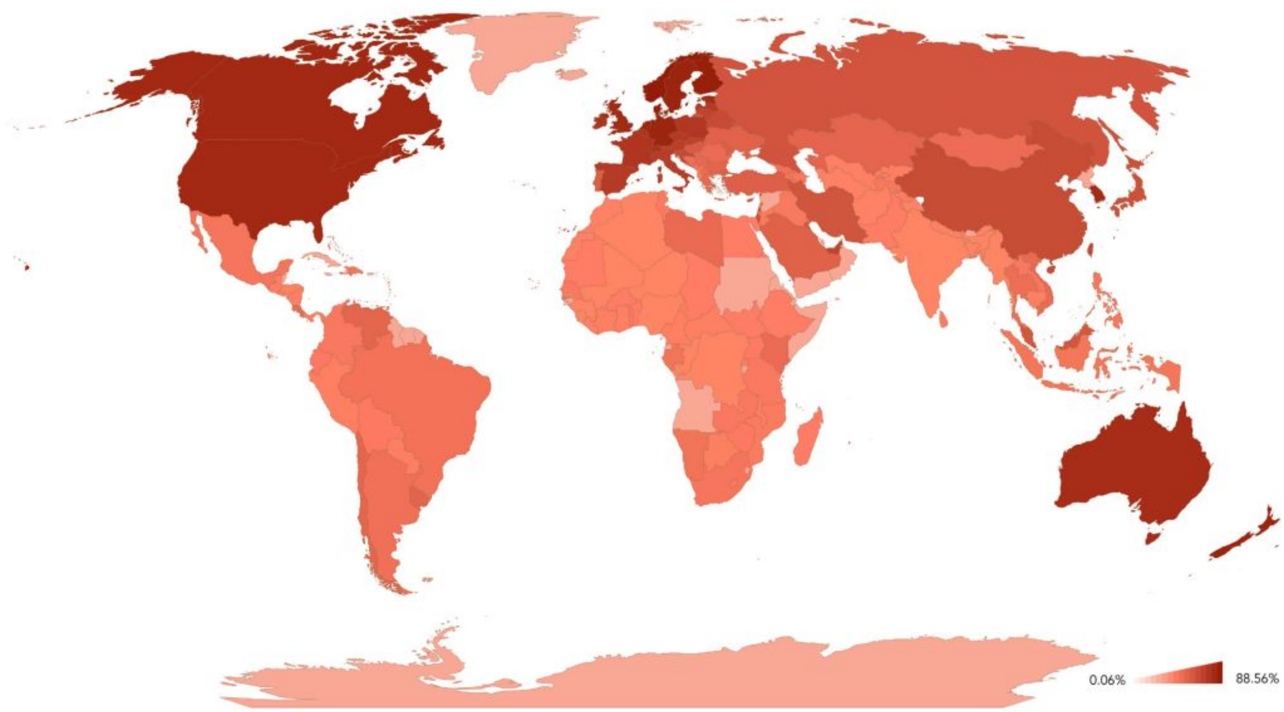
Figure 1.18
Percentage of females who used the internet to pay bills or make purchases online in 2017



Source: World Bank Global Findex Database 2017

Even for countries with high women's usage rates, women can still be at a disadvantage in relation to men, as in the case of Austria, Japan, and Slovenia (Figure 1.19). Those countries where more women than men use the internet to pay bills or make online purchases, such as the Philippines and Laos, in fact show low usage by both men and women.

Figure 1.19
Gap between men and women who used the internet to pay bills or make purchases online in 2017 (top and bottom 10 countries)

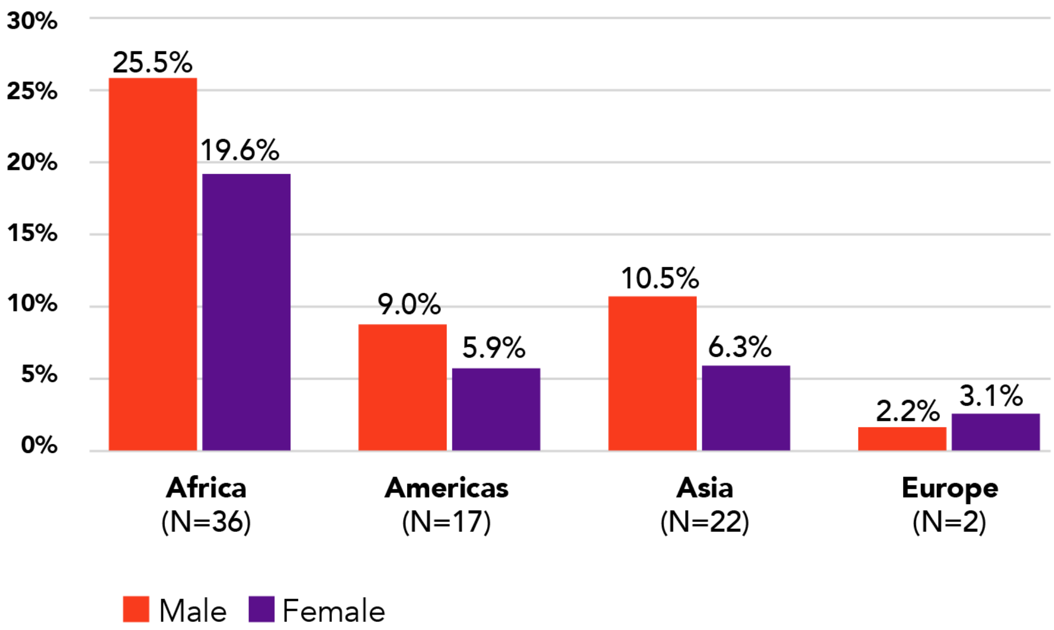


Source:World Bank Global Findex Database 2017

1.3.5 / MOBILE MONEY ACCOUNT

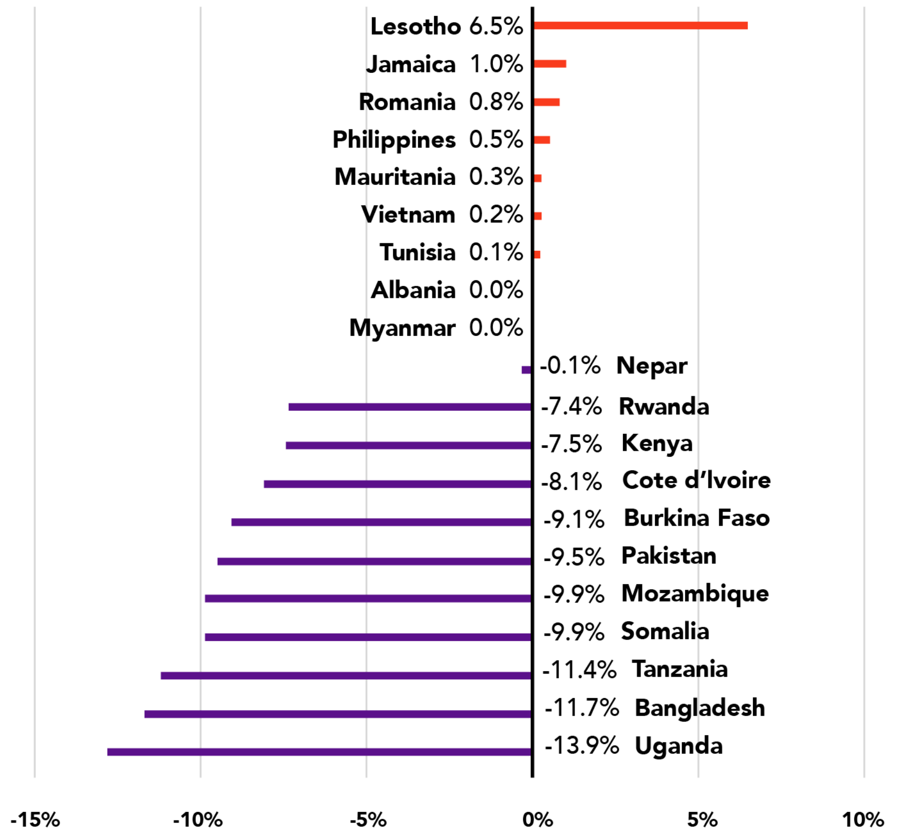
The survey on use of mobile money services excludes developed markets in the Americas (such as Canada and U.S.) and most of Europe (except Romania and Albania). We can still observe the same trend: women show less use of mobile money services than men, and their overall average across all regions is less than 20% (Figure 1.20). There are countries where women use these services more than men, as in Lesotho and Jamaica; however, these differences are relatively small compared to the bottom 10 countries, where the percentage difference between women and men can be greater than 10% (Tanzania, Bangladesh, and Uganda) (Figure 1.21).

Figure 1.20
Percentage of male and female use of mobile money services in 2017



Source: World Bank Global Findex Database 2017

Figure 1.21
Gap between men and women who used mobile money services in 2017 (top and bottom 10 countries)



Source: World Bank Global Findex Database 2017

1.4 / CONCLUSION

This chapter highlights the state of gender digital inequality across several dimensions of basic access and meaningful use. For basic access, available data suggest that gender gaps exist irrespective of the overall level of access. This is true across the four basic access indicators: computer use, mobile phone ownership, mobile phone use, and access to the internet. Beyond basic access, gender inequalities exist in terms of meaningful use, as represented here by data on use of digital financial services — perhaps the only area of meaningful use for which comparative data are available. Even for existing indicators, better data and wider country coverage are needed.

In general, the current state of gender inequality in basic access is well known. We are only beginning to understand the types and levels of inequality between men and women in their use of ICT services, once basic access issues are resolved. While significant progress has been made in establishing measurement standards and definitions to collect gender-disaggregated data on ICT access and use, more needs to be done to achieve global coverage.

REFERENCES

Broadband Commission. (2017). Working Group on Education: Digital skills for life and work. Retrieved from: http://unesdoc.unesco.org/images/0025/002590/259013e.pdf.

Decent Jobs for Youth. (2017). Digital skills: preparing young people for the future of work in the digital economy, thematic priority of the global initiative on decent jobs for youth. Retrieved from: https://www.decentjobsforyouth.org/wordpress/wp-content/uploads/2017/11/Thematic-Plan-1-Digital-Skills.pdf

Deen-Swarray, M., Gillwald, A., & Morrell, A. (2012). Lifting the veil on ICT gender indicators in Africa. Cape Town: Research ICT Africa and University of Cape Town. Helsper, E. J., & van Deursen, A. J. A. M. (2015). The Third-Level Digital Divide: Who Benefits Most from Being Online? In: Communication and Information Technologies Annual (Vol. 10, pp. 29–52). Emerald Group Publishing Limited. https://doi.org/10.1108/S2050-206020150000010002

Highet, C., Skelly H., Tyers, A. (2017). Gender and Information Communication Technology Survey Toolkit. Retrieved from: https://www.usaid.gov/sites/default/files/documents/15396/Gender_and_ICT_Toolkit.pdf

International Telecommunication Union. (2017). Measuring the Information Society Report 2017, Volume 1. Geneva: ITU. Retrieved from: https://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2017/MISR2017_Volume1.pdf
Lee, H., Park, N., Hwang, Y. (2015). A new dimension of the digital divide: Exploring the relationship between broadband connection, smartphone use and communication competence. Telematics and Informatics, 32(1), 45-56.

Rice, R., Katz, J. (2003). Comparing internet and mobile phone usage: Digital divides of usage, adoption, and dropouts. Telecommunications Policy 27 (2003), 597-623.

GSMA. (2018). Connected Women, The Mobile Gender Gap Report 2018. Retrieved from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/04/GSMA_The_Mobile_Gender_Gap_Report_2018_32pp_WEBv7.pdf

Scheerder, A., van Deursen, A., & van Dijk, J. (2017). Determinants of internet skills, uses and outcomes. A Systematic Review of the Second- and Third-level Digital Divide. Telematics and Informatics, 34(8), 1607–1624. https://doi.org/10.1016/j.tele.2017.07.007

Schradie, J. (2011). The digital production gap: The digital divide and Web 2.0 collide. Poetics, 39 (2011), 145-168.

Swedish International Development Cooperation Agency (SIDA). (2015). Gender and ICT. In: Gender Tool Box [Brief]. Retrieved from: https://www.sida.se/contentassets/3a820dbd152f4fca98bacde8a8101e15/gender-and-ict.pdf

Tsetsi, E., & Rains, S. A. (2017). Smartphone internet access and use: Extending the digital divide and usage gap. Mobile Media and Communication, 5(3), 239-255. DOI: 10.1177/2050157917708329

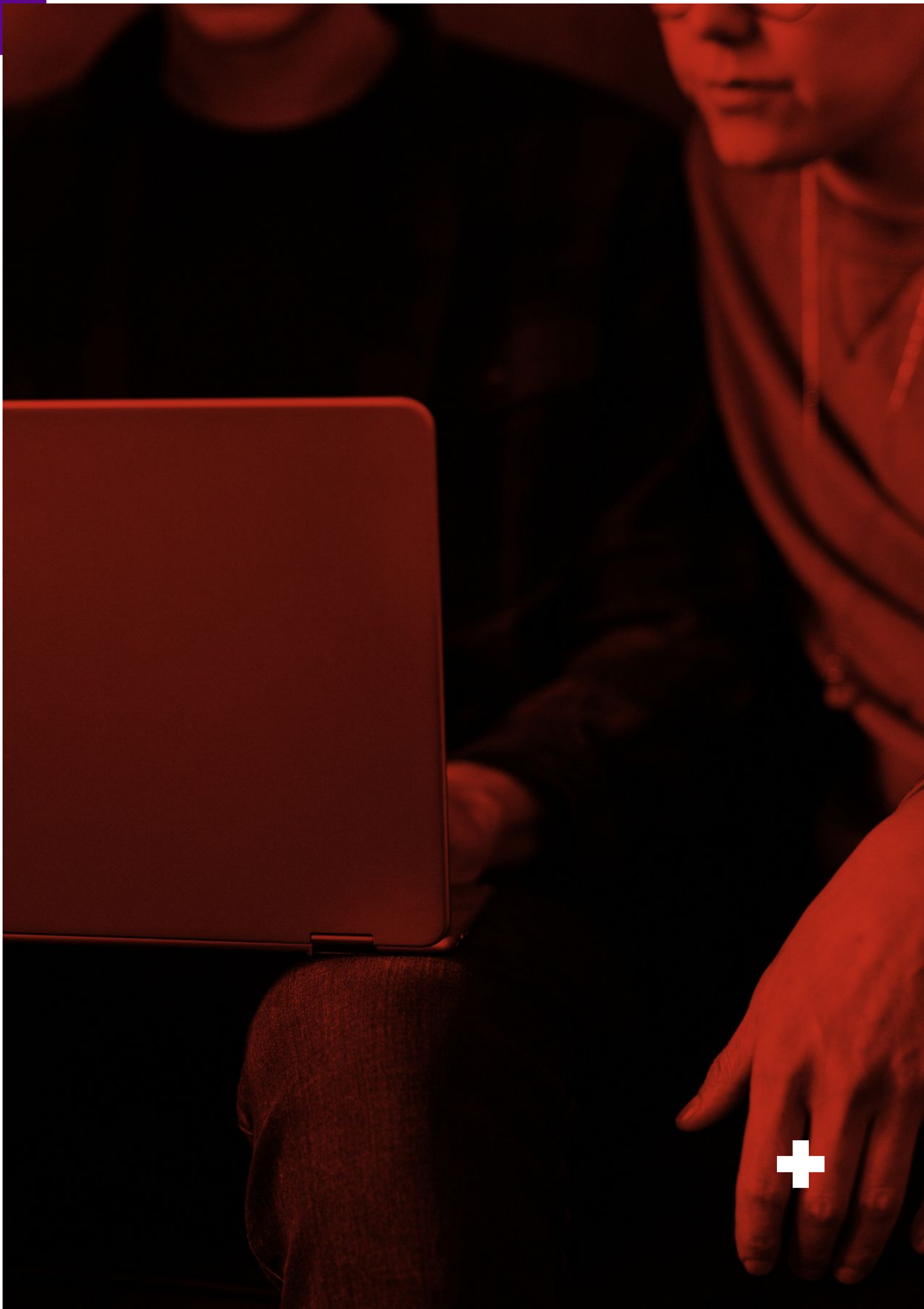
Van Deursen, A. JAM & Van Djik J. AGM. (2013). The digital divide shifts in differences in usage. New Media & Society, 16 (3), 507-526.

Van Djik, J.A.G.M. (2006). Digital divide research, achievements and shortcomings. Poetics, 34(4-5), 221-235.

Warschauer, M. (2003). Technology and social inclusion: Rethinking the digital divide. Cambridge, MA: MIT Press.

Databases consulted:

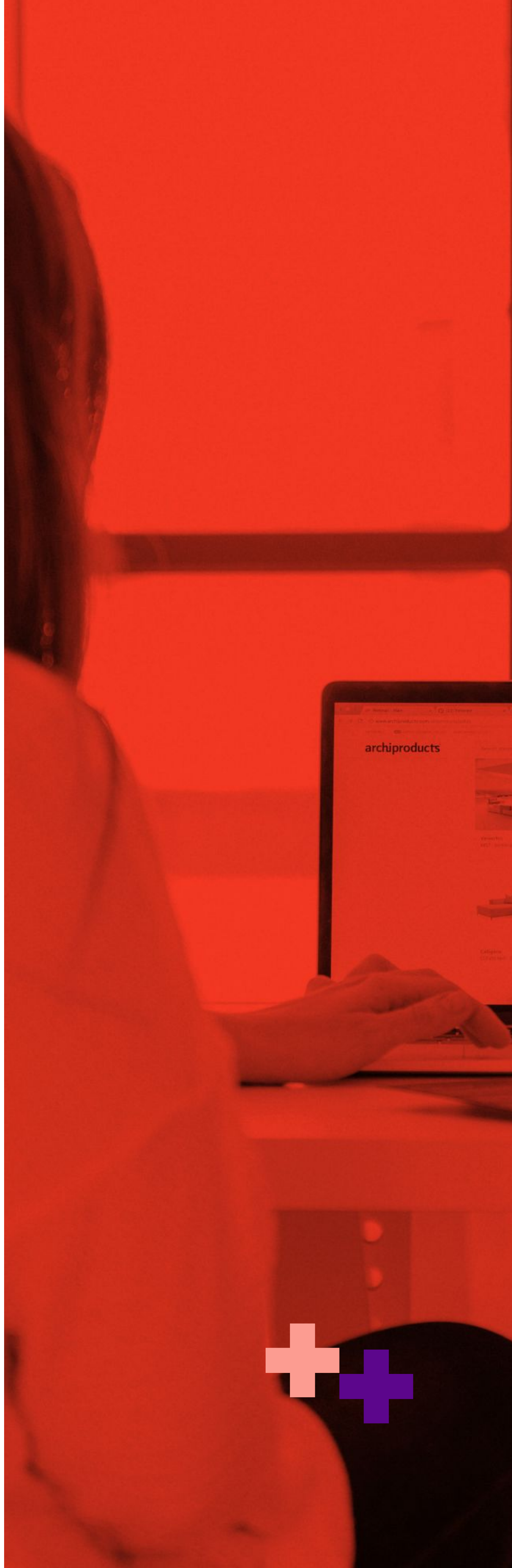
- ITU- World Telecommunications/ ICT Database
- UNCTAD Global Cyberlaw Tracker
- UN Stats- SDG Database
- World Bank- Findex Database
- World Bank Women Business, and the Law Report 2018



2

GENDER EQUALITY IN ICT SKILLS

AUTHOR:
JUHEE KANG AND
DON RODNEY JUNIO (UNU-CS)



KEY FINDINGS

- According to the available data, women are less likely than men to have advanced digital skills in the majority of reporting countries.
- While STEM education can provide the foundation for advanced digital skills and a career in the tech industry, girls in secondary education tend to have lower self-efficacy and interests in studying STEM subjects as well as lower aspirations for STEM careers.
- Only 35% of women major in STEM subjects at higher education; within STEM majors, they tend to study natural sciences more than applied sciences related to ICT.
- Multiple pathways have been developed to equip girls and women with advanced digital skills, such as coding schools, bootcamps, and makerspaces, but their effectiveness in enhancing gender equality in ICT skills has yet to be assessed.

2.1 / INTRODUCTION

As ICTs are increasingly ingrained in our everyday life, the ability to make use of digital technology has become an essential competency in modern societies. Despite their potential to empower women, ICTs are enmeshed with existing gender inequality, hindering women's participation in the production, management, and use of technology. As the previous chapter demonstrated, considerable gender gaps exist beyond basic access, extending to differential utilisation of ICTs by gender. More than ever, it becomes critical to ask whether men and women have different digital skills not only for accessing and using ICTs, but also for creating digital technologies, ICT services, and contents. Further, where gender gaps exist, it is important to examine whether women and girls have access to equitable education and relevant trainings to obtain adequate digital skills for thriving in the ICT-driven future on par with men. Such understanding will be valuable to achieve the UN's Sustainable Development Goals 4 and 5, which emphasise (among other goals) inclusive technical, vocational, and higher education for all, including women and the marginalised (Box 2.1). Examining the current contour of our knowledge on gender equality in digital skills, this chapter explores the question: *What is the current status of gender equality in digital skills beyond ICT literacy, and what are the opportunities for girls and women to participate in cultivating advanced digital skills?*

Box 2.1
Women's Digital Skills and the SDGs

Education and training are critical to cultivating digital skills for both men and women. The 2020 Agenda for Sustainable Development Goals underscores the inclusive and equitable education and lifelong learning (SDG 4) and gender equality and empowerment of girls and women (SDG 5). It sets specific targets including:

Target 4.3: ensure equal access for all women and men to affordable quality technical, vocational and tertiary education including university

Target 4.4: substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship

Target 4b: substantially expand the number of scholarships available to developing countries…for enrolment in higher education, including vocational training and ICT, technical, engineering and scientific programmes in developed and developing countries

2.1.1 / WHY IS IT IMPORTANT FOR WOMEN TO HAVE EQUAL DIGITAL SKILLS?

Gender gaps in digital skills can have significant ramifications for women's participation in the digital society, especially as we face the so-called 4th Industrial Revolution. Approaching the 2020s, we must expect seismic changes driven by emerging technologies such as artificial intelligence, robotics, internet of things, and biometrics, to mention a few. These new technologies will digitise, automate, and interconnect our everyday functioning across all sectors, in a way that changes how we live, work, and learn (Schwab, 2017). Like other technical revolutions, these changes will come with several challenges affecting the lives of both women and men, and in some regards it may strike women harder than men.

One foreseeable change is the reconfiguration of jobs. By 2020, it is expected that more than 7.1 million jobs will be displaced due to automation and disintermediation, according to a forecast by the World Economic Forum (WEF, 2016). Most of the estimated job loss (4.7 million) will come from office and administrative jobs, of which women perform a larger share, in most countries. The 4th Industrial Revolution will also create 2.1 million new jobs — mostly relating to computing, mathematics, architecture, and engineering (0.7 million). Yet the current participation of women in these booming fields, as discussed in detail in Chapter 3, is low and problematic.
Indeed, despite growing job demands for skilled ICT workers, there is a shortage of women equipped with advanced digital skills (Box 2.2). The gender gap in

digital skills is most notable in high-level digital skills, and in many countries it is widening due to persistently low numbers of young women studying ICT-related majors at tertiary-level and beyond. If this trend persists, we may continue living in a world driven by technologies that are mostly designed, produced, and managed by men.

Box 2.2
Women's ICT leadership and the SDGs

The job demand for skilled-ICT workers is expected to grow fast, as ICTs permeate all industry sectors including manufacturing, transport, healthcare, banking, retail, energy, military, farming, education, and so on. In Europe, it is forecasted that 9 out of 10 jobs will require some kinds of digital skills in the future (European Commission, 2017), while the shortage of skilled workers in the ICT sector will double — from 373,000 in 2015, to 756,000 by 2020 (European Parliament, 2017). In the U.S., it is projected that employment in computer-specific jobs will grow 13% by 2016, faster than all other occupations. Besides the growing quantity of demand, the quality and types of ICT skills required by industry are also changing (see Chapter 13). Certain skills are already in high demand, including expertise in software development, cloud computing, big data, and information security. Other high employment areas may include mobile app/web development, data science, cybersecurity, and emerging technologies, such as machine learning, artificial intelligence, and augmented reality. Despite the growing demand, however, the share of women equipped with such ICT skills is low. The data from OECD countries show that just 1.4% of female workers have jobs developing, maintaining, or operating ICT systems, compared to 5.5% of male workers (OECD, 2017). Moreover, the current gap is expected to get worse, with the stagnating female participation to STEM education in many developed countries.

2.1.2 / MEASURING GENDER EQUALITY IN DIGITAL SKILLS

Assessing the state of gender equality in digital skills begins with defining digital skills. Until recently, digital skills were understood as more or less equivalent to digital literacy or basic skills to access ICTs. International organisations such as the International Telecommunication Union (ITU) as well as many national governments usually measure digital skills by the range of activities one can perform on a PC or the internet. Although these data are increasingly sex-disaggregated, this techno-specific approach has drawbacks. It requires a constant update of its definition and measurement, in response to rapid technological change. Moreover, just as literacy only asks whether one can read rather than what one reads, this literacy-oriented approach fails to capture the breadth and depth of digital skills related to a variety of ICT activities.

Recognising these limits, researchers have made efforts to reconceptualise digital skills as a multifaceted concept (Box 2.3). Cutting across the various frameworks, digital skills are commonly classified into three types: basic skills to access ICTs; intermediate skills to use ICTs as effective digital citizens; and high-level skills to create ICTs and participate in the ICT industry. Yet, beyond the basic skills, these emerging frameworks have not yet been extensively discussed or agreed on at the international level. Globally comparable data are rare, as researchers are still developing new methodologies to measure the comprehensive dimensions of digital skills beyond ICT literacy. Furthermore, these frameworks are often designed for a general populace, without acknowledging the issues of global inequalities of income, race, and gender. Differential needs and contextual barriers associated with women and social minorities are not yet fully reflected in these early efforts. It is essential to begin a global dialogue on how digital skills can be reframed in consideration of women and social minorities, before these frameworks are fully established. To do so, we need more evidence-based research to understand the current gender gaps in digital skills and to what extent women and minorities are discouraged from acquiring and utilising more-than-literacy digital skills.

Box 2.3
Global efforts to redefine digital skills

Definitions of digital skills need to be constantly updated in response to rapid technological change. The type of skills required to participate meaningfully in today's digital economy are very different from a decade ago, and various organisations have adopted different ways of defining digital skills.
The United Nations (2017) refers to digital skills as "a range of different abilities, many of which are not only 'skills' per se, but a combination of behaviours, expertise, know-how, work habits, character traits, dispositions and critical understandings".
OECD (2016) categorises digital skills into three groups: 'ICT complementary skills' for everyday uses; 'ICT generic skills' for work; and 'ICT specialist skills' to develop technology.
The Broadband Commission (2017) defines digital skills as "a range of different abilities, many of which are not only 'skills' per se, but a combination of behaviours, expertise, know-how, work habits, character traits, dispositions and critical understandings". They also conceptualise digital skills as a "gradual continuum" from basic functional skills to high-level skills, with a range of intermediate skills existing in between.
The European Commission recently developed the "Digital Competence Framework for Citizens" which identifies and describes key areas of digital competence, providing a conceptual reference model for Europe. In the EC framework, digital skills comprise five core skills: (i) information and data literacy; (ii) communication and collaboration — interacting through digital technologies; (iii) digital content creation; (iv) safety; and (v) problem solving. Translating this concept into a measurable standard, Eurostat has developed a digital skills composite indicator, based on selected activities related to individuals' internet or software use in four specific areas (information, communication, problem solving, and software skills).
ITU (2018) also suggest five different skills for youth employment, including basic skills for using ICTs, advanced skills for developing ICTs, mid-level skills for producing content, soft skills for collaborating, and digital entrepreneurship skills for doing business. According to ITU, basic digital skills refer to effective use of technology including (for example) web search, online communication, use of professional platforms, and digital financial services. Intermediate skills refer to skills needed to perform work-related functions, such as graphic design and digital marketing; while advanced skills refer to skills that are necessary to create, manage, and test ICTs, including coding.
Another useful way of examining digital skills is to see it as part of a continuum across three levels: basic, intermediate, and advanced. The Decent Jobs for Youth Initiative, under the lead of the International Labour Organisation, adds to these three types of skills soft skills and digital entrepreneurship skills, as essential to succeed in the digital economy.

To facilitate our understanding of gender equality in digital skills, this chapter provides an analysis of available sex-disaggregated data on certain aspects of digital skills (Box 2.4)[1]. First we summarise existing data on basic digital skills and advanced ICT skills. We then take a closer look at women's current participation in ICT and science, technology, engineering, and mathematics (STEM) education, as a proxy for gender equality in the general pathways to high-level digital skills. Finally, we explore recent developments in creating alternative pathways to cultivate women's high-level skills, such as coding education, massive open online courses (MOOCs), and hackerspaces or makerspaces.

Box 2.4
Aspects of Gender Equality in Digital Skills

Current status of Gender Equality in Digital Skills
- Basic Digital Skills
- Intermediate Skills
- Advanced Skills: Programming Skills

Gender Gaps in Pathways to Develop Digital Skills: STEM Education
- Secondary Education
  a.Gender Gap in STEM participation and performance
  b.Gender Gap in STEM motivation, confidence and aspiration
- Higher Education
  a.STEM Participation
  b.Within STEM Gender Gap
  c. Global STEM and Gender Gap

Alternative Pathways to Develop Digital Skills
- Introductory Computing Education
- Coding Bootcamp
- MOOC
- Maker/Hackerspace

1 There are several different approaches to collect data on digital skills. First, standardised tests can provide the most accurate assessment of one's skills, but such measures are costly and difficult to expand in scale. Most available data on digital skills are collected via self-reported surveys which individuals assess one's level of knowledge in performing a range of ICT-based activities. For high-level digital skills, it is often estimated via proxies such as qualifications obtained from educational or training programs relevant to ICT specialisation, or in some cases, occupations or salaries to indicate the economic returns of having a certain level of digital skills. In many countries, the status of gender equality in high-level digital skills is often measured by comparing the number of female and male students who enrolled or graduated in STEM majors at tertiary-level education.

2.2 / BASIC DIGITAL SKILLS

Basic digital skills are the minimum foundational skills required to function effectively in the digital economy; they are an integral part of higher-level digital skills. Understanding the issue at this level could provide insights to shape policy proposals with a broader impact. It is also the area where initial work has been done to operationalise and measure the concept, and where gender disaggregated data are available. As part of the World IT Database, the ITU has collated nine indicators of digital skills (Figure 2.1).

Figure 2.1
Aspects of Gender Equality in Digital Skills

- Copying or moving a file or a folder
- Using copy and paste tools to duplicate or move information within a document
- Sending e-mails withattached files
- Using basic arithmetic formula in a spreadsheet
- Connecting and installing new devices
- Finding, downloading, installing, and configuring software
- Creating electronic presentations with presentation software
- Transferring files between a computer and other devices
- Writing a computer program using a specialised programming language

ITU's data on digital skills provide a starting point to assess the gender divide on basic digital skills. Of the nine available indicators, we select eight skills that can be classified as basic digital skills to examine the gender divide in these areas. Complete data are reproduced in Appendix C.

Table 2.1 provides a broad summary of data on the percentage of women with the relevant ICT skills clustered by region and skills type. We note that for countries in Africa and the Americas where data are available, the percentage for all eight skills categories falls below 50%. The types of skills with the highest reported percentage of women in those regions are copying or moving a file or folder (42.2%) and using copy and paste tools to duplicate or move information within a document (42.1%). The skill with the lowest percentage in those regions is creating an electronic presentation (0.1%), followed by using basic arithmetic formula in a spreadsheet (1.4%).

In Asia and Europe, there can be extreme variations within the region, even when on average more than 50% of women are reported able to perform a particular skill. In Asia, for example, 89% of women in Brunei are able to copy or move a file or folder, compared to only 3% in Pakistan. In Europe, while 68% of women in Netherlands can find, download, install, and configure software, only 2% of women from Russia are reportedly able to perform the same task.
Where data are available for the eight basic skill categories, in most countries men outperform women; in 35 countries there is no skill area where women outperform men (as illustrated below in Figure 2.8). In 14 countries, women outperform men in one or two skills; in two countries, women outperform men in three to four skills; and in two countries, women outperform men in five or more skills areas.

At the country level, more men than women reported having a specific digital skill in the majority of countries across Africa, Americas, Asia (Table 2.2), and Europe (Table 2.3). Tables 2.2 and 2.3 show that not all countries with a high percentage of men and women reporting ability for a specific skill would necessarily have a low difference in ability, as in Bahrain (see Appendix C). Statistics cannot tell a complete story: the issues underlying the disadvantages faced by women and girls may be very different in different countries. Furthermore, self-reported data may not be completely reliable, as multiple studies find that males tend to overestimate their digital skills while females do the opposite (see Section 2.5.1.2, Attitudes about STEM education).

The reported or perceived low ability of women in basic digital skills should be a cause for concern. If women and girls are disadvantaged at the level of basic skills, we can expect to see greater gender digital divides in higher ICT skills and ICT leadership.

Table 2.1
Percentage of women with ICT skills by region

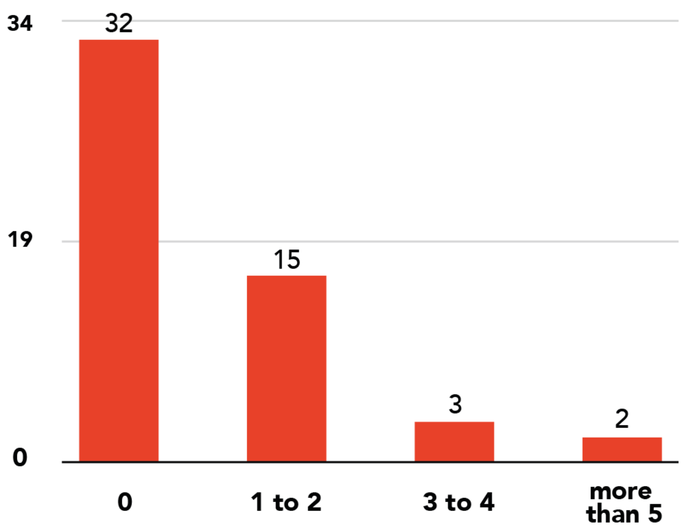
TYPE OF SKILL	DIMENSION	REGION			
		Africa	Americas	Asia	Europe
Copying or moving a file or folder	# of countries	**3**	**4**	**10**	**32**
	Lowest %	4	18	3	37
	Highest %	42	39	89	73
Using copy and paste tools to duplicate or move information within a document	# of countries	**3**	**3**	**8**	**21**
	Lowest %	3	18	2	20
	Highest %	42	37	68	82
Sending e-mails with attached files	# of countries	**3**	**4**	**9**	**1**
	Lowest %	3	20	2	
	Highest %	27	37	70	70
Using basic arithmetic formula in a spreadsheet	# of countries	**3**	**4**	**10**	**27**
	Lowest %	1	4	1	12
	Highest %	19	27	55	69
Connecting and installing new devices	# of countries	**3**	**4**	**9**	**4**
	Lowest %	1	7	4	6
	Highest %	24	30	47	65
Finding, downloading, installing and configuring software	# of countries	**3**	**3**	**10**	**26**
	Lowest %	1	8	2	2
	Highest %	29	15	57	68
Creating electronic presentations with presentation software	# of countries	**3**	**4**	**10**	**32**
	Lowest %	0	4	1	9
	Highest %	15	30	45	59
Transferring files between a computer and other devices	# of countries	**3**	**3**	**11**	**33**
	Lowest %	2	9	1	27
	Highest %	21	32	63	69

0 - 20% | 21 - 40% | 41 - 60% | 61 - 80% | 81 - 100%

Source: ITU WTI Database, 2017.

Note: Red –low percentage reporting ability to perform the specific skill (bottom quintile). Purple – high percentage reporting ability to perform the skill (top quintile). Color range: red, pink, gray, lavender, purple.

Figure 2.2
Number of countries with greater percentage of skilled women than men, per number of skills



Source: ITU WTI Database, 2017.

Table 2.2
Difference in percentages between males and females on different aspects of digital skills in Africa, the Americas and Asia

	Egypt	Morocco	Zimbabwe	Brazil	Colombia	Jamaica	Mexico	Bahrain	Brunei Darussalam	Cyprus	Georgia	Iran (I.R.)	Kazakhstan	Korea (Rep.)	Pakistan	Qatar	Singapore	Turkey
Copying or moving a file or folder	-3.9	-5.7	-2.6	-3.3	-1	1.8	-4.4	-19.3		-0.2	-1.1	-2	-2.9		-5.2	-9.6	-5.8	-16.8
Using copy and paste tools to duplicate or move information within a document	-2.8	-4.3	-1.8	-1.6	-0.6	2.8		-20.1			-0.5	0.1	-1.9		-3.8	1.1	-3.3	
Sending e-mails with attached files	-2	-3.3	-2	-1.8	-0.2	3.8	-3.3	-24.7			-1.8	-2.1	-1.3	-11.7	-3.5	-7.1	-2.4	
Using basic arithmetic formula in a spreadsheet	-0.6	-0.4	-0.9	-4.5	0.2	0.2	-4	-25		3.9	-0.3	-1.3	0	-11.1	-1.6	-9.6	-1.3	
Connecting and installing new devices	-0.4	-5.2	-1	-5.6	-1.3	0.5	-7.7	-10.3			-6	-2.3	-2.3	-15.7		4.1	-6.9	-15.1
Finding, downloading, installing and configuring software	-0.8	-5.2	-1.2	-7.5		-0.6	-6	-18.1		-6.2	-4.1	-3.8	-0.8	-13.6	-2.8	4.8	-7.9	
Creating electronic presentations with presentation software	-0.1	-1.8	-0.9	-1.1	-0.8	0.6	-3	-11.3		3.8	2.1	-1.6	0		-1.2	-1.1	-3.9	-11
Transferring files between a computer and other devices	-1.3	-5.3	-1.8	-4.9	-0.8	-0.1		-23.6		-1.8	-2.3	0.1	-3	-13.1	-2.1	-6.7	-8.3	-15.9

Note: Red – low percentage reporting ability to perform the specific skill (bottom quintile). Purple – high percentage reporting ability to perform the skill (top quintile). Color range: red, pink, gray, lavender, purple.

Table 2.3
Difference in percentages between males and females on different aspects of digital skills (Europe)

	Austria	Belgium	Bulgaria	Croatia	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Latvia	Lithuania
Copying or moving a file or folder	-11,4	-7	-0,7	-12	-5,4	-5	-1,9	-4,6	-2,6	-8,9	-3,1	-8,9	-6,1	-6,8	-7,5	-2,9	-0,2
Using copy and paste tools to duplicate or move information within a document		-5,4		-9,7	-2,1	-3,9		3,6	-0,2	-7,9	0	-3,4	4.4	-2,4	-5,3		
Sending e-mails with attached files																	
Using basic arithmetic formula in a spreadsheet		-8,4		-10,5	-3,5	-8,7		-8,1	-2,7	-11,9	-4,1	-2,9	0	-5,9	-8,9		-0,8
Connecting and installing new devices		-17,5											-25,7				
Finding, downloading, installing and configuring software				-12,8	-18	-7,9	-14,6	-12,2	-10,9	-14	-6,3	-15,2		-7,6	-11		-11,1
Creating electronic presentations with presentation software	-7,9	-6	0,9	-6,6	-5	-3,1	2,4	-2	-0,7	-7,2	-3,8	-3,8	2,2	-4,6	-5,2	5,7	-0,5
Transferring files between a computer and other devices	-12,3	-8,9	-1,2	-11,6	-8,9	-8,3	-8,2	-3,8	-3,6	-12,3	-5,1	-7,6	-8,8	-8,9	-9	-4,3	-3,7

	Luxembourg	Malta	Montenegro	Netherlands	Norway	Poland	Portugal	Romania	Russia	Serbia	Slovakia	Slovenia	Spain	Sweden	Switzerland	Macedonia	United Kingdom
Copying or moving a file or folder	-11,9	-5,4	-5,8	-7,8	-9,4	-4,5	-6,9	-5,2		-1,9	-4,6	0,3	-7,1	-8,8		-2,8	-7
Using copy and paste tools to duplicate or move information within a document				-5,1	-4,6		-5,8	-2,1			-1,8	1,5		-0,9		1	-3,5
Sending e-mails with attached files															-7,4		
Using basic arithmetic formula in a spreadsheet	-18,1	-5,5		-14	-11,9	-1,4	-6	-1,2		-1,8	-3	1		-9,4		-0,3	-2,9
Connecting and installing new devices	-15,1								-5,5								
Finding, downloading, installing and configuring software		-7,5	-10,5	-7,4	-3,7	-13,4	-10	-4,8	-2,6		-13,8	-10,4	-10,3	-5,5		-3,7	-6,3
Creating electronic presentations with presentation software		1,7	-5,2	-9,7	-4	-0,1	-0,1	-1,4	1,3	1,6	-0,5	2,2	-4,6	-0,3		0,9	0,2
Transferring files between a computer and other devices	-10,7	-5,8	-7,3	-6	-6,9	-7,3	-6,4	-4,2	-3,4	-2,8	-8,4	-1,6	-7,7	-7,9		-1,1	-5,9

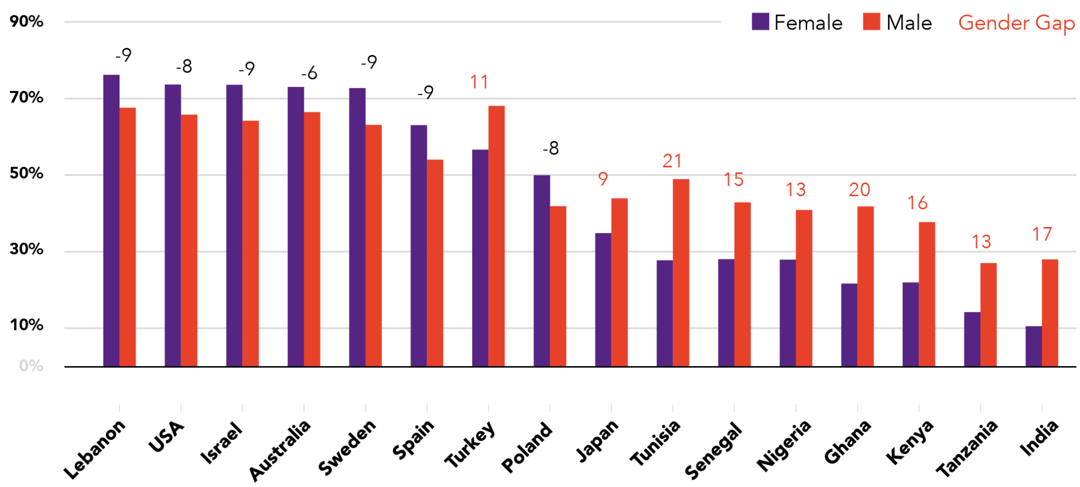
Note: Red – low percentage reporting ability to perform the specific skill (bottom quintile). Purple – high percentage reporting ability to perform the skill (top quintile). Color range: red, pink, gray, lavender, purple.

2.3/ INTERMEDIATE DIGITAL SKILLS

Beyond basic skills, there is currently no globally comparable data that, comprehensively measure the multiple dimensions of digital skills, due to the absence of internationally agreed definitions and methodologies. Some recent data may provide snapshots of the gender gap in intermediate digital skills.

Studies show that 90% of Wikipedia contributors and 69% of Wikipedia readers are male (Wikipedia Foundation, 2011; Glott, et. al, 2010; Economist, 2018). Although social media is more popular among women than men in most advanced countries, far fewer women in developing countries use it (Pew Research, 2018), possibly reflecting a lack of intermediate skills (such as downloading an app). The Pew survey of 39 countries found a large gender gap favouring men in social media use in Tunisia, Ghana, India, Kenya, and Senegal (Figure 2.3). Similarly, fewer women overall use mobile finance services than men (see Chapter 1). This evidence on differential use of ICTs by gender indicates a possible gender gap in intermediate skills in everyday ICT uses.

Figure 2.3
Gender divide in social media use



Source: Pew Research, 2018.
Note: Percentage of adults who use social networking sites

Assessing the gender gaps in intermediate digital skills is conceptually and methodologically challenging. With a vast range of everyday digital activities performed on multiple ICTs, it is difficult to measure overall skill gaps. Moreover, differential uses of ICTs by gender may reflect different levels of motivation, social influence, enabling contexts, or structural barriers. Finally, most of the data on online activities is held by private firms and rarely disclosed fully. Thus, it is difficult to assess how many women have the skills (or have already begun) to sell products on Amazon or Alibaba, view or post videos on YouTube, or install anti-virus software.

Beginning in 2014, the European Commission (EC) started to collect data from its 28 member-states on more comprehensive dimensions of digital skills. Reflecting the new framework for “Digital Competence Framework for Citizens”, it measures digital skills in four different categories: information, communication, problem-solving, and software skills (Table 2.4). Compared to the ITU data on basic skills, a greater variety of digital activities are included, such as seeking information, using social media, uploading contents, using online learning, selling online, and writing a code. (Note that each of these categories may include a range of skill levels, from basic to advanced; the EC survey relies on individuals’ self-reports).

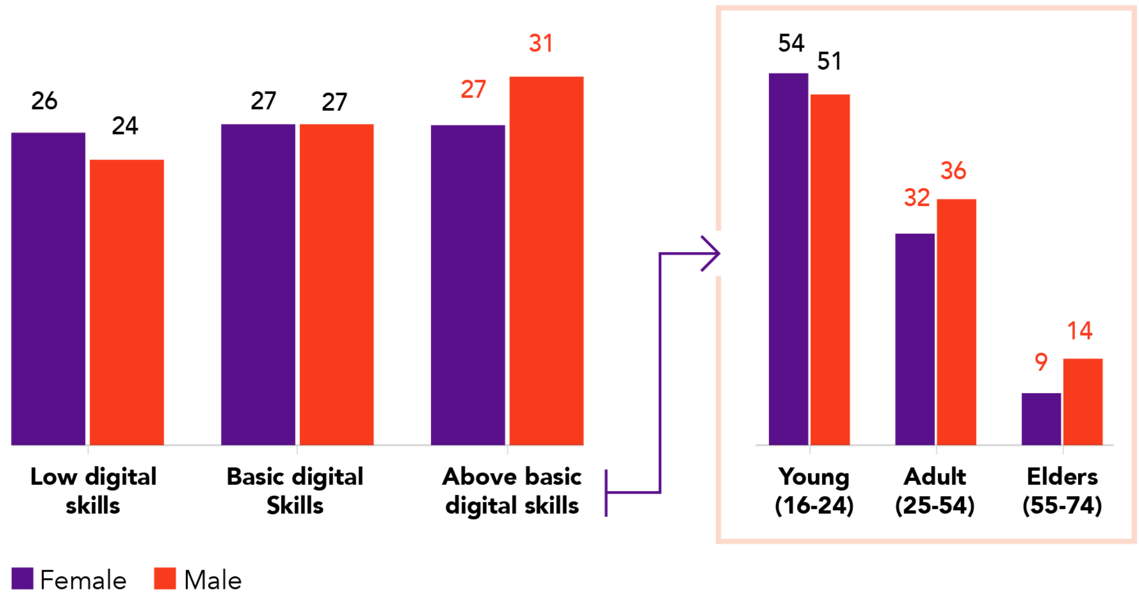
Table 2.4
European Commission comprehensive digital skills

Type	Activities used for measuring the skills
Information Skills	• Copied or moved files or folders; • Saved files on Internet storage space; • Obtained information from public authorities/services' websites; • Finding information about goods or services; • Seeking health-related information
Communication Skills	• Sending/receiving emails; • Participating in social networks; • Telephoning/video calls over the internet • Uploading self-created content to any website to be shared
Problem solving skills	• Transferring files between computers or other devices • Installing software and applications (apps) • Changing settings of any software, including operational system or security programs • Online purchases (in the last 12 months) • Selling online • Used online learning resources • Internet banking
Software skills	• Used word processing software • Used spreadsheet software • Used software to edit photos, video or audio files • Created presentation or document integrating text, pictures, tables or charts • Used advanced functions of spreadsheet to organise and analyse data (sorting, filtering, using formulas, creating charts) • Have written a code in a programming language

Source: European Commission, 2015.

In the EC findings, a sex-disaggregated analysis shows no gender gap in basic digital skills. However, slightly more men (31%) than women (27%) reported having "above basic" digital skills (Figure 2.4). Among those with "above basic skills", the gender gap increases with age. Except the young group (i.e., teens and young adults), moderate gender gaps exist disfavouring women: among the adult group, 4 percentage points, and among elders (over 55 years old), 5 percentage points.

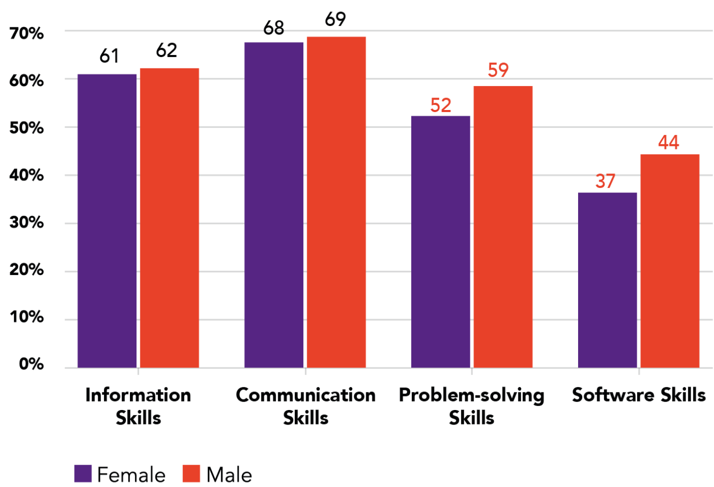
Figure 2.4
Gender difference in overall digital skills and by age



Source: Eurostat, 2017.

The group with "above basic" digital skills shows some variation by specific skill types. There are only minimum differences between men and women in information and communication skills. However, more men than women have higher skills in both problem-solving and software skills, by 7 percentage points (Figure 2.5). This finding indicates that European women are generally less skilled than men in handling computer or mobile applications, managing data, using the internet for business and learning, or creating software and digital content.

Figure 2.5
Gender difference among those with above digital skills by skill types (Europe

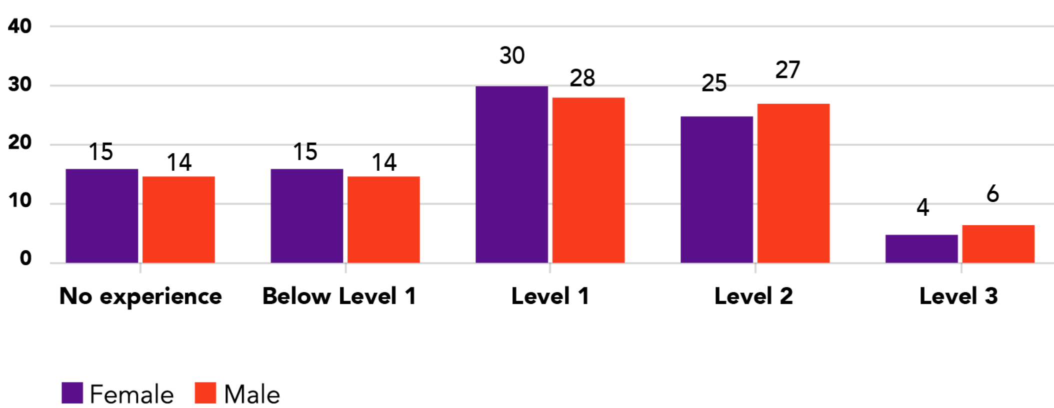


Source: Eurostat, 2017.

The OECD's Survey of Adult Skills (PIAAC) also provides sex-disaggregated data on applied ICT skills (OECD, 2016b). Along with literacy and numeracy, it assesses the ability to solve problems in technology-rich environments, which require integrated skill-sets of digital competency and cognitive abilities such as acquiring, evaluating, and organising information from ICTs. While the digital skills data from the EC and ITU are measured by self-reported surveys, the PIAAC uses a standardised test based on role-playing scenarios. "Acting" as a job seeker, the respondent is given multiple tasks such as: using a search engine to find a job agency, evaluating the information, registering, and bookmarking the page.

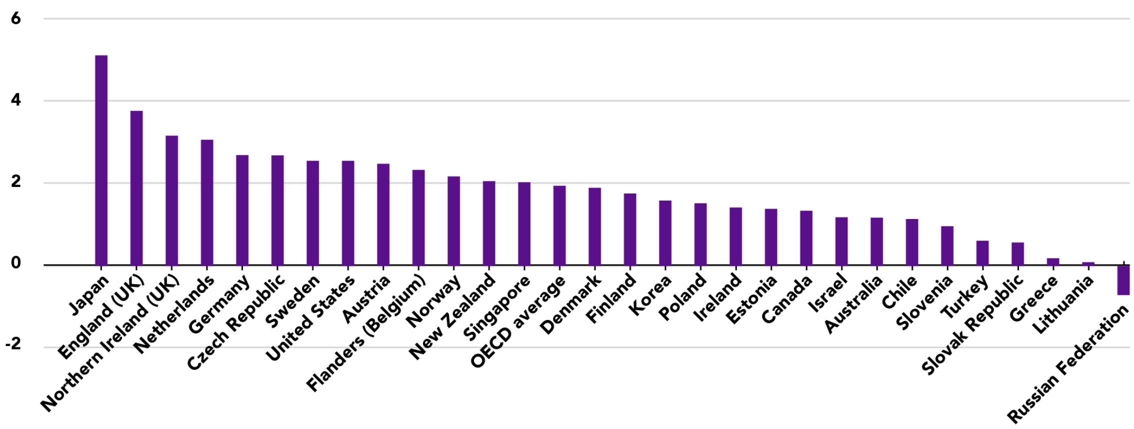
The OECD's sex-disaggregated data on problem-solving skills shows moderate gender differences overall (Figures 2.6). In the lower level groups (Level 1 and below), women predominate slightly, while in the higher score groups (Level 2 and 3) there are slightly more men. The country breakdown of the highest-level group shows a larger (but still moderate) gender gap among the countries with stronger economies, such as Japan (5.1 points), UK (3.7), Ireland (3.1), Netherlands (3.1), and Germany (2.7) (Figure 2.7).

Figure 2.6
Gender difference among those with above digital skills by skill types (Europe



Source: OECD, 2017

Figure 2.7
Gender gap in Level 3 ICT-based problem-solving skills (OECD countries)



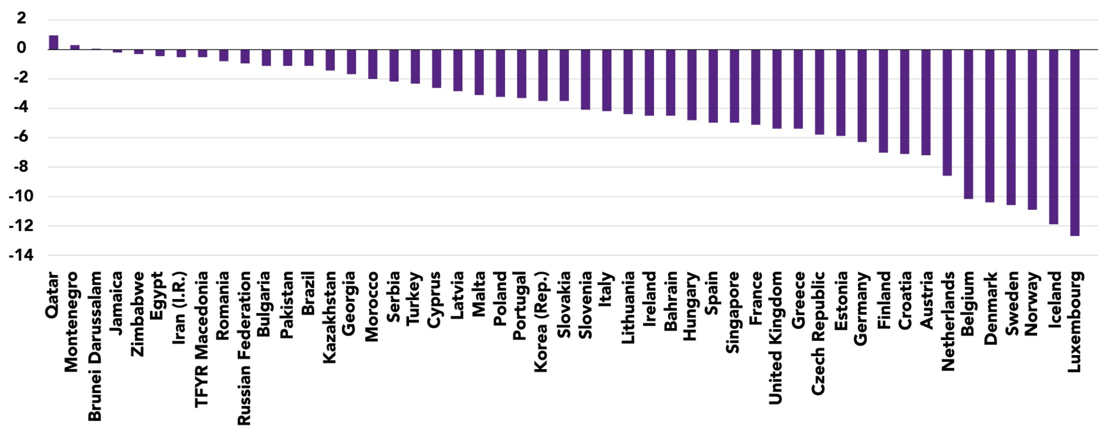
Source: OECD Survey of Adult Skills, 2016.

The data on the advanced economies of Europe and OECD countries suggest — in the absence of global data — that the gender gap becomes greater (in favour of men) in higher-level skills. In the following section, we examine the sex-disaggregated data on programming skills and data sciences, as two examples of high-level digital skills.

2.4 / ADVANCED SKILLS: PROGRAMMING

ITU's World ICT Development Indicator database includes one advanced digital skill — "write a computer program using a specialised programming language". The data covers 49 countries; it is based on self-reported surveys and is sex-disaggregated. On average, only 3.5% of women in the reporting countries can write a computer program, as compared to 7.8% of men. At the country level, the share of females who used programming skills in the last year was higher than average in Brunei Darussalam (17%), Iceland (12%), Bahrain (11%), Denmark (9%), and Greece (6%), but lower than the average in most reporting countries. Figure 2.8 presents the difference in programming skills between men and women by country. Interestingly, the percentage gap is wider among advanced economies in Scandinavia and Western Europe, such as Luxembourg (12.7), Iceland (11.9), Norway (10.9), Sweden (10.6), Denmark (10.4), and Belgium (10.2); it is much smaller in less advanced or developing countries such as Qatar (-1.0), Brunei Darussalam (0), Zimbabwe (0.3), Egypt (0,4), Iran (0.5), Romania (0.8), and Russia (0.9). Similar patterns will also be seen in the following section on STEM education, at the secondary and tertiary levels.

Figure 2.8
Gender gap in programming skills by country



Source: ITU WTID Database, 2017.

2.5 / PATHWAYS TO DEVELOP DIGITAL SKILLS: STEM EDUCATION

The gender gap in digital skills is more pronounced in the high-level skills required to create ICT software, hardware, and content — and this critical skills gap is closely related to gender imbalance in employment and leadership in the ICT and tech industry. Higher education in STEM and ICT is often seen as a pathway to acquiring the high-level digital skills required for ICT, science, and technology professions. (See Chapter 12 for discussion of the role of educational institutions.) For instance, most senior software developer positions require a college or graduate degree in computing disciplines, while system engineers or robotics designers would need at least some STEM education at the tertiary level. This pathway is more than a standard college education; described as a "STEM pipeline", it involves early education, secondary school specialisation, undergraduate major, and a master's or Ph.D. degree.

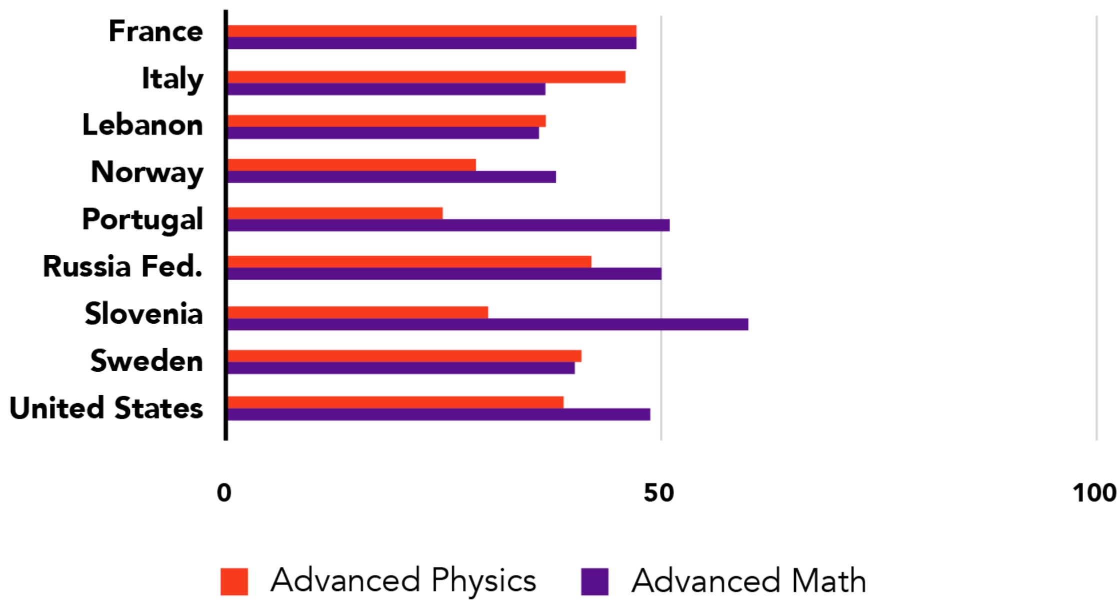
2.5.1 / SECONDARY EDUCATION

Girls' and women's participation in education has made significant progress in the last two decades. According to UNESCO's school enrolment data in 2015, global average figures show gender parity in both primary and secondary education, although the gender gap persists in some regions, including sub-Saharan Africa and Western Asia. The number of countries reporting gender parity in both primary and secondary education has almost doubled, from 36 in 2000 to 62 in 2015 (UNESCO, 2015). As illustrated in Figures 2.9 and 2.10, the available data shows that the learning gap between boys and girls is also closing in many countries (UNESCO, 2017). Still, considerable gender differences exist in students' level of interest in STEM subjects and motivation for STEM careers. However, caution is needed when interpreting global data due to the limited data availability, particularly from developing countries, and due to the complex variation that may exist within a region or country. Also, there is a lack of globally comparable data relating to the drivers and barriers of achievement, beyond school enrolment and test scores.

2.5.1.1 / Participation and achievement

Several studies suggest that early exposure to STEM subjects is critical in students' decision to specialise in higher education and future careers (Kermani & Aldemir, 2015; Lee, et al., 2011). In most countries, math and sciences are part of the core national curriculum for all primary and secondary students, so educational exposure to STEM subjects is more or less similar for boys and girls at the primary and lower-secondary level. The gender gap in STEM participation begins to be more noticeable in lower secondary education, when students start to make choices for subject specialisation (UNESCO, 2017; Spearman & Watt, 2013). A survey of young women in 12 European countries shows that girls become interested in STEM between the ages of 11 and 12 (Microsoft, 2017). With a lack of sex-disaggregated data on students' selection of specialisation courses, it is hard to confirm whether gender gaps exist at that stage. Among the very few available data, the Trends in International Mathematics and Science Study (TIMSS) Advanced 2015 shows that more boys than girls take advanced math or physics in Grade 12 (Figure 2.8); note that the data is limited to only nine countries (IEA, 2016; UNESCO, 2017).

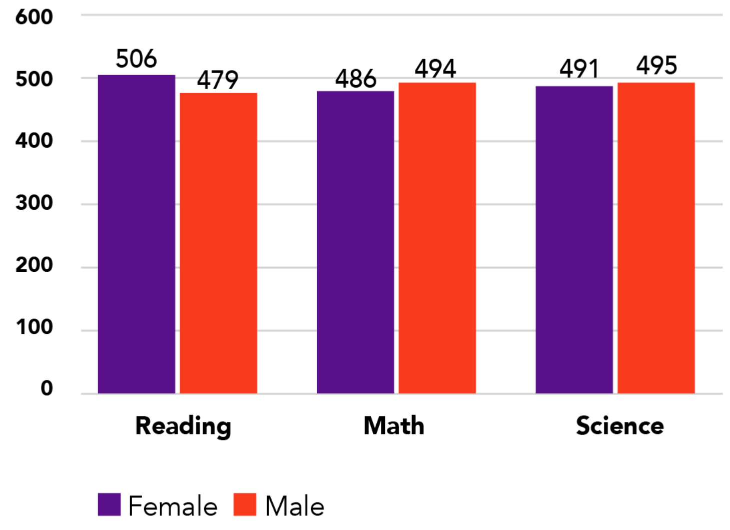
Figure 2.9
Percentage of grade 12 female students taking advanced math or physics courses



Source: TIMSS Advanced, 2015

Internationally standardised test scores show only marginal differences between girls and boys in lower secondary education. According to the Programme for International Student Assessment (PISA) data published in 2015, at age 15 girls outperform boys by almost 27 points in reading, but they slightly underperform in math and science, by 8 and 4 points (Figure 2.10). Similar patterns are found in TIMSS scores and other regional education data, according to a study by UNESCO (2017).

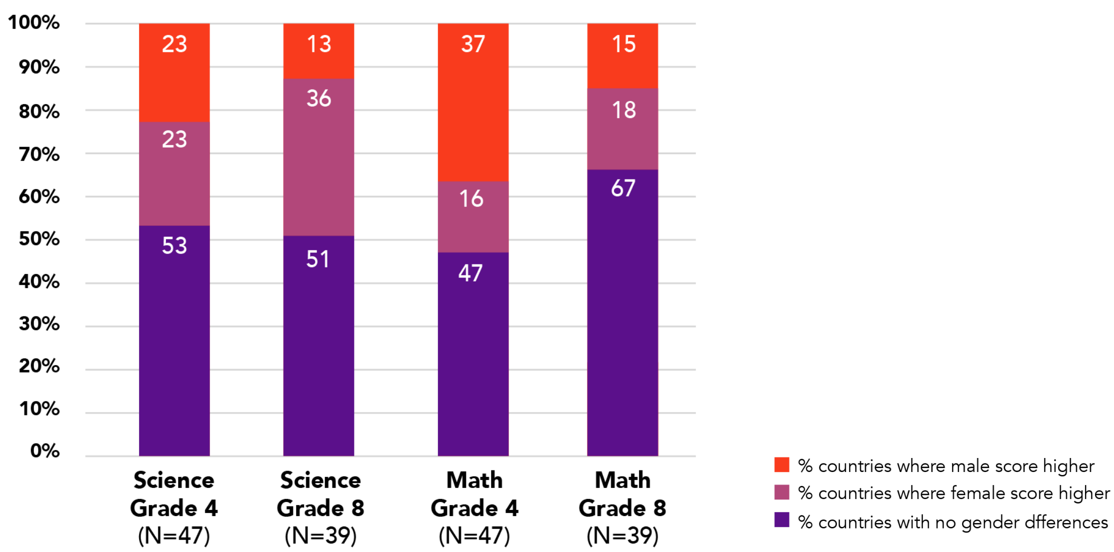
Figure 2.10
Gender difference in student performances at grade 8 (total scores)



Source: TIMSS Advanced, 2015

Figure 2.11 shows that close to or more than half of the countries studied in TIMSS 2015 showed no gender difference in math and science performance. For Grade 8 science, a substantially larger number of countries reported girls scoring higher than boys.

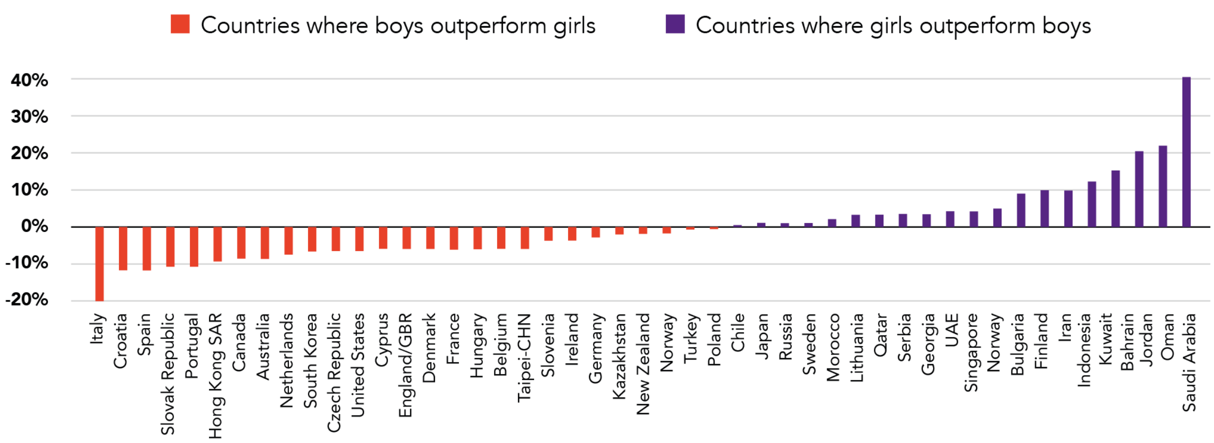
Figure 2.11
Number of countries with gender gaps in science and math scores in 2015)



*Source:*TIMMS, 2017.

Although the TIMSS 2015 data is based on less than 50 countries and covers only a few least developed countries, the participating countries are relatively diverse and regionally proportionate. It can provide a useful outline of gender gaps in student STEM performance in different social, economic, and political contexts. Math score differences by gender and country (Figure 2.12) show regional contrasts. Several European countries (Italy, Croatia, Spain, Slovakia, Portugal, Netherlands, and Denmark) showed a conventional gender gap, with boys scoring higher in math than girls. In contrast, countries in Western Asia (Saudi Arabia, Oman, Jordan, Bahrain, and Kuwait) show girls performing better than in math boys. This pattern of country variation will be re-visited in the following section on gender and STEM in higher education.

Figure 2.12
Gender differences by countries in math scores at grade 4



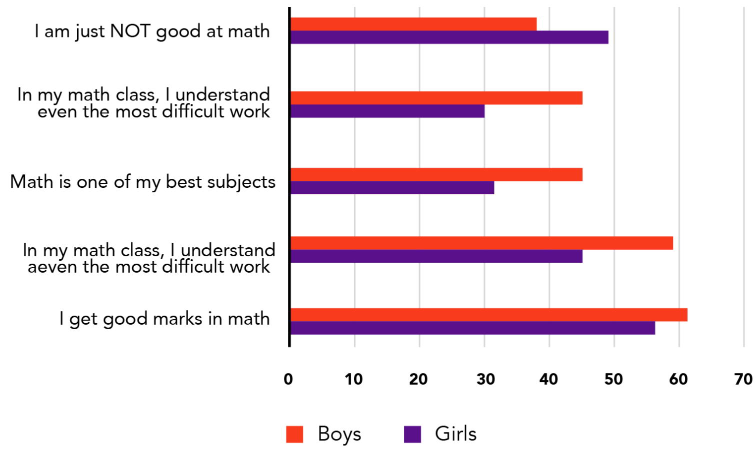
Source: TIMSS, 2015

2.5.1.2 / Attitudes about STEM education

Beyond the gender gaps in school enrolment or test results, several studies suggest that considerable gender differences exist in relation to students' attitudes and perceptions. Such attitudinal or psychological differences may include an internalised belief in their ability in STEM, their interest and motivation to study STEM subjects, and an aspiration to pursue a career in STEM. Given the lack of internationally comparable data measuring these psychological factors, we can only glimpse the picture by using psychometric indicators of the PISA data, coupled with a few small-scale surveys with limited geographic coverage.

Confidence. Significantly, girls tend to be less confident than boys about STEM subjects. Several studies have found that self-concept (a belief in one's abilities) and self-efficacy (a belief that one can do a certain task) affect successful learning and advancement (Pajares & Miller, 1994; Bandura, et al., 2001; MacPhee, et al., 2013). Notably, girls tend to have less self-confidence in math and sciences and feel more anxious than boys about their ability to solve problems in those subjects (OECD, 2015). Figure 2.13 shows that girls in OECD countries have much lower self-confidence in math and sciences than boys. Similarly, in a survey of 7,411 students in Vancouver, female students had lower self-perceived ability than males relating to STEM subjects including computer science, engineering and physics and gave lower estimates of their computer skills (Chan, et. al., 2001).

Figure 2.13
Gender difference in math self-concept

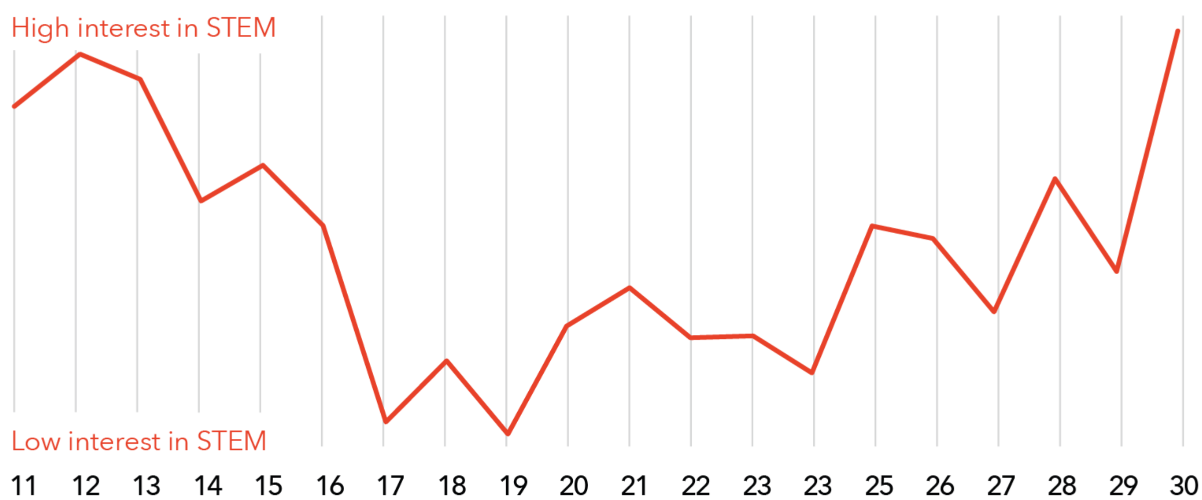


Source: OECD PISA, 2012.

Interest. Girls are reported to be less interested than boys in STEM subjects. Studies show that girls tend to lose interest in STEM earlier than boys do, often during their adolescence and before they choose a specialisation (UNESCO, 2017). A survey of 11,500 girls in 12 European countries shows differences by age[2]. As shown in Figure 2.14, girls' average interest in STEM peaked at 12 and continued to decrease until 17 and 19, when they would usually make decisions on majors in higher education (Microsoft, 2017).

A study in the UK found that boys and girls were almost equally interested in STEM at the age of 10 and 11 (75% of boys versus 73% of girls), but the gender gap became wider at the age of 18 (33% of boys versus 19% of girls) (Kearney, 2016).

Figure 2.14
Changing interest in STEM by age among young European females

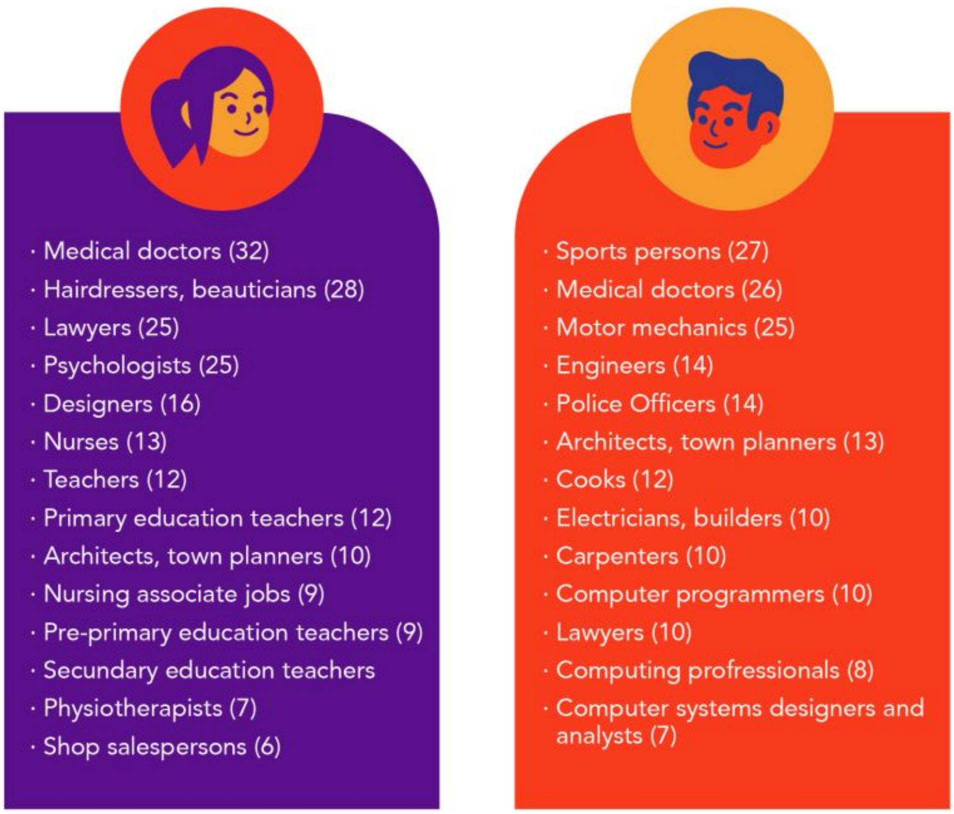


Source: Microsoft, 2017.

2 The 12 countries are Belgium, Czech Republic, Finland, France, Germany, Italy, Ireland, Netherlands, Poland, Russia, Slovakia, and the UK.

Aspiration. Girls tend to have less aspiration for STEM career. Studies based on the PISA data found that, while girls tend to be more ambitious than boys, only 5% of girls in OECD countries expected a career in computing and engineering when they grew up, compared to 18% of boys who wanted to work in these fields (Sikora & Pokropek, 2011). The list of popular career choices shows a clear difference between boys and girls: ICT-related occupations do not appear at all in the girls' list of dream careers, while boys highly rank engineers, computer programmers, and other ICT-related professions (Figure 2.15). There was no OECD country where more girls than boys were interested in entering computing and engineering careers.

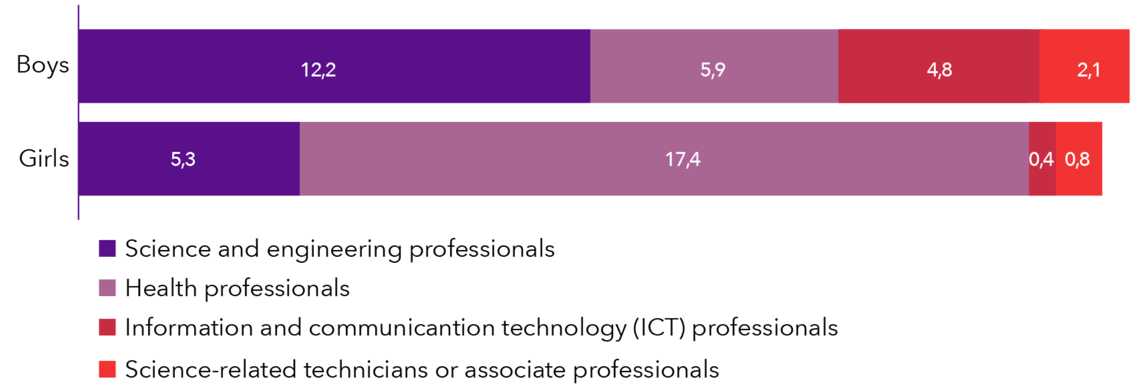
Figure 2.15
Popular career choices among OECD students



Source: OECD, PISA 2006 database; OECD, 2015

Despite the efforts by many governments to include more girls and women in STEM education, this gender gap in student's aspiration in STEM careers seems to have persisted over at least the past decade. Initially collected in 2006, the data has barely changed in the latest survey of OECD countries. According to PISA data from 2015, similar percentages of boys (25%) and girls (23.9%) are interested in pursuing some type of science-related career. Within the science field, however, girls are much more inclined to pursue health professions (doctors, nurses, and healthcare workers); only 0.4% of girls aspire to become ICT professionals, compared to 4.8% of boys (Figure 2.16).

Figure 2.16
Expectation of science careers at age 15, by gender



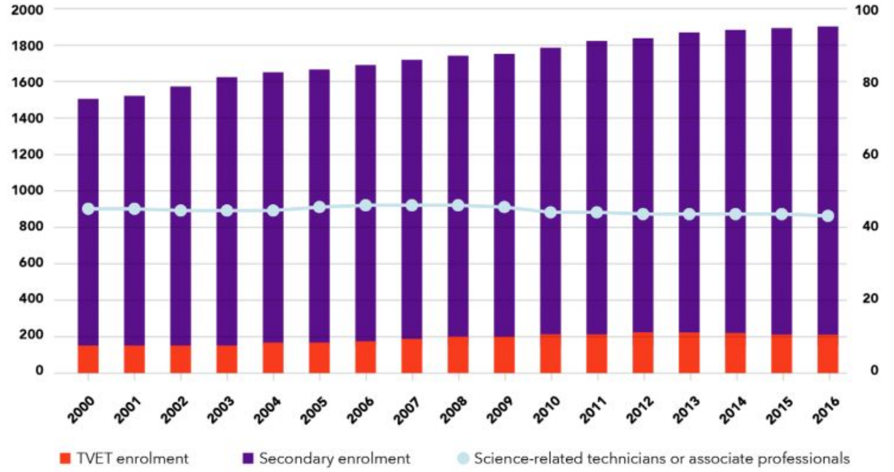
Source: OECD, 2016

These data indicate that girls at the secondary level tend to have lower self-efficacy and lower interest in STEM subjects, as well as lower aspiration for STEM careers, compared to boys. While STEM education at the secondary level creates a critical foundation for further developing their high-level digital skills, it seems that girls gradually move away from STEM studies regardless of their competence and potential. Apparently, these gender differences in attitude and motivation in STEM can affect their decision to choose a college major.

2.5.2 / TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING (TVET)

Instead of following conventional academic curricula, some secondary-level students pursue vocational training to prepare early careers. While the history of vocational education is long, the term TVET (technical and vocational education and training) was internationally recognised only in 1999. TVET has received relatively little attention due to underinvestment from governments, poor institutional capacity, and low social status of TVET graduates (UNESCO, 2015b). While TVET education can also be offered in post-secondary, tertiary, and adult life-long education, the most common approach is secondary-level training via public or private vocational schools. According to the UNESCO Institute of Statistics (UIS), globally around 10% of secondary-level students were enrolled in TVET schools in 2016, and the figure has remained almost steady since 2000. The share of female students in TVET education has hovered around 45% over the last 15 years (Figure 2.17). Regional differences exist: based on available data, participation in TVET is higher in Oceania (33.2%) and Europe (23.6%) as compared to Asia (9.3%) or Africa (5.6%).

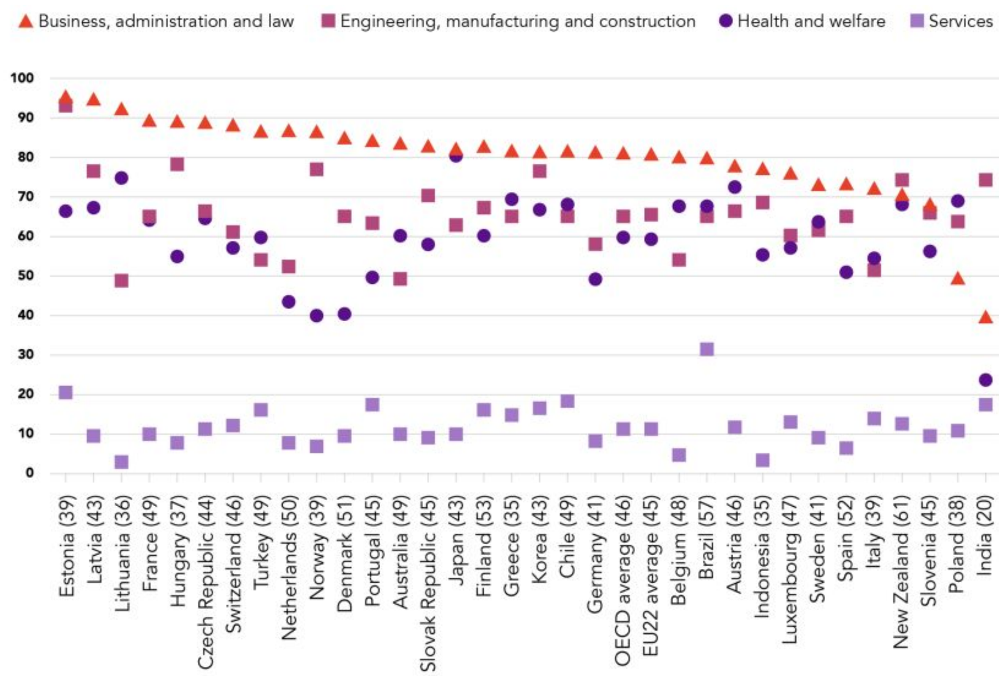
Figure 2.17
Enrolment in TVET and secondary education (in 1,000,000)



Source: UIS, 2017

The OECD data breaks out the gender gap in secondary vocational education by specialisation (OECD, 2017b). In OECD countries, most upper secondary vocational graduates earn a diploma with a specialisation in either engineering (33%) or business, administration, and law (19%). When the sex-disaggregated data is examined, however, it shows a considerable gender gap especially in engineering, manufacturing, and construction, where women represent only 11% of the graduates (Figure 2.18); with the exception of Brazil and Estonia, the OECD countries show fewer than 20% of female students graduating with a vocational diploma in that specialisation. By contrast, in the health and welfare specialisation, 80% of the graduates are women.

Figure 2.18
Share of females from upper secondary vocational programs in OECD countries, by field of education



Source: OECD, 2017.

Because ICT/computing has not been classified as a separate specialisation, we cannot say how many women specialise in ICT or high-level digital skills in their secondary vocational education. One notable case is Mirim Meister Women's High School in South Korea, offering training in digital creation skills such as programming, app development, User Interface (UI) design, and online content production skills, with 99% of graduates starting their careers in the ICT sector.

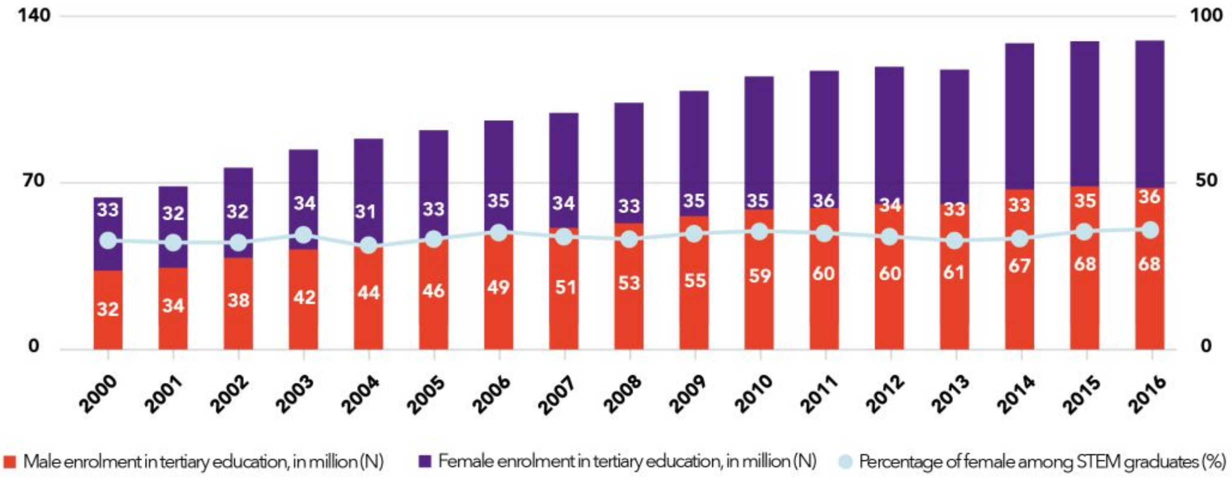
2.5.3 / HIGHER EDUCATION IN STEM

Looking at the data for the past 15 years, three major trends are identified. First, despite significant progress in women's participation in higher education, the percentage of women majoring in STEM studies has been remained low across the regions. Second, considerable gender-segregation exists even within STEM fields, as more women choose to study natural sciences rather than computer sciences and engineering. Third, notable country-level or regional differences exist: the gender gap in STEM tends to be larger in countries with higher levels of gender equality — a counter-intuitive trend referred to as the "gender & STEM paradox" (Stoet & Geary, 2018).

2.5.3.1 / More women in higher education — but few in STEM

According to the UIS data, the global enrolment of female students in higher education has almost doubled since 2000, and there are now more women than men pursuing either bachelor's degree (53%) or master's degree (54%). The growing female participation in tertiary education has become a common trend across all regions. Europe showed the highest share of female in higher education (53.8%) and Asia the lowest (49.8%), as of 2016. Nevertheless, as shown in Figure 2.19, the share of women in STEM majors has remained low, averaging less than 35% of total graduates in STEM in the past decade.

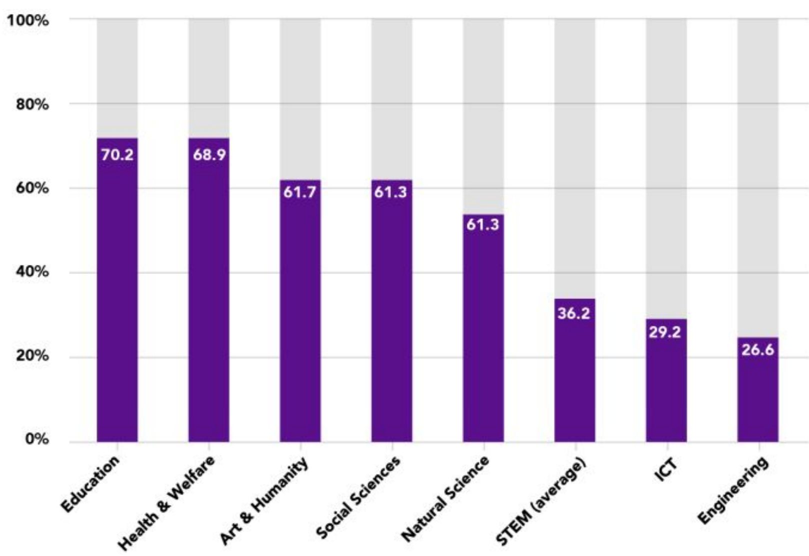
Figure 2.19
Female participation in higher education and STEM (2001–2017)



Source: UNESCO Institute of Statistics, 2017

Furthermore, regardless of majors, the percentage of women proceeding to pursue a doctoral degree (45%) is still lower than for men (55%). In low-income countries, women constituted only 27% of Ph.D. students in 2015, and this has marginally decreased over the past 15 years, according to the UIS data. As discussed in Chapter 3, this leak in the pipeline contributes to the low participation of women in research, accounting for only 29% of the world's researchers (UNESCO, 2017).

Figure 2.20
Percentage of female students among higher education students by field of study (2016)



Source: UIS, 2016.
Note: STEM data denote the number of graduates, not total enrolment.

2.5.3.2 / More women in higher education — but few in STEM

As shown in Figure 2.20, women represent the majority of students enrolled in education (70%), humanities and arts (62%), and social sciences (61%). In contrast, the share of women in STEM majors is significantly lower, at 36%. Among the STEM fields, the distribution of women's majors is heavily skewed towards natural or life sciences (54.8%) and much lower in either computer sciences (28.9%) or engineering (27.1%).

The underrepresentation of women in computing and engineering seems to be prevalent across the regions. In engineering and manufacturing, women are less than two-fifths of the total graduates in 103 out of 105 countries. At the national level, women represented only 18% of the graduates in computing in U.S. (National Center for Education Statistics, 2016); they were 26% of the graduates in math and computer or information sciences in Canada (Statistics Canada, 2017) and EU countries (Eurostat, 2016); 17% of the graduates in information technology and 15.6% of engineering majors in Australia (Australian Department of Education and Training, 2017); and just 14% of the engineering graduates in Japan (Ministry of Education of Japan, 2016).

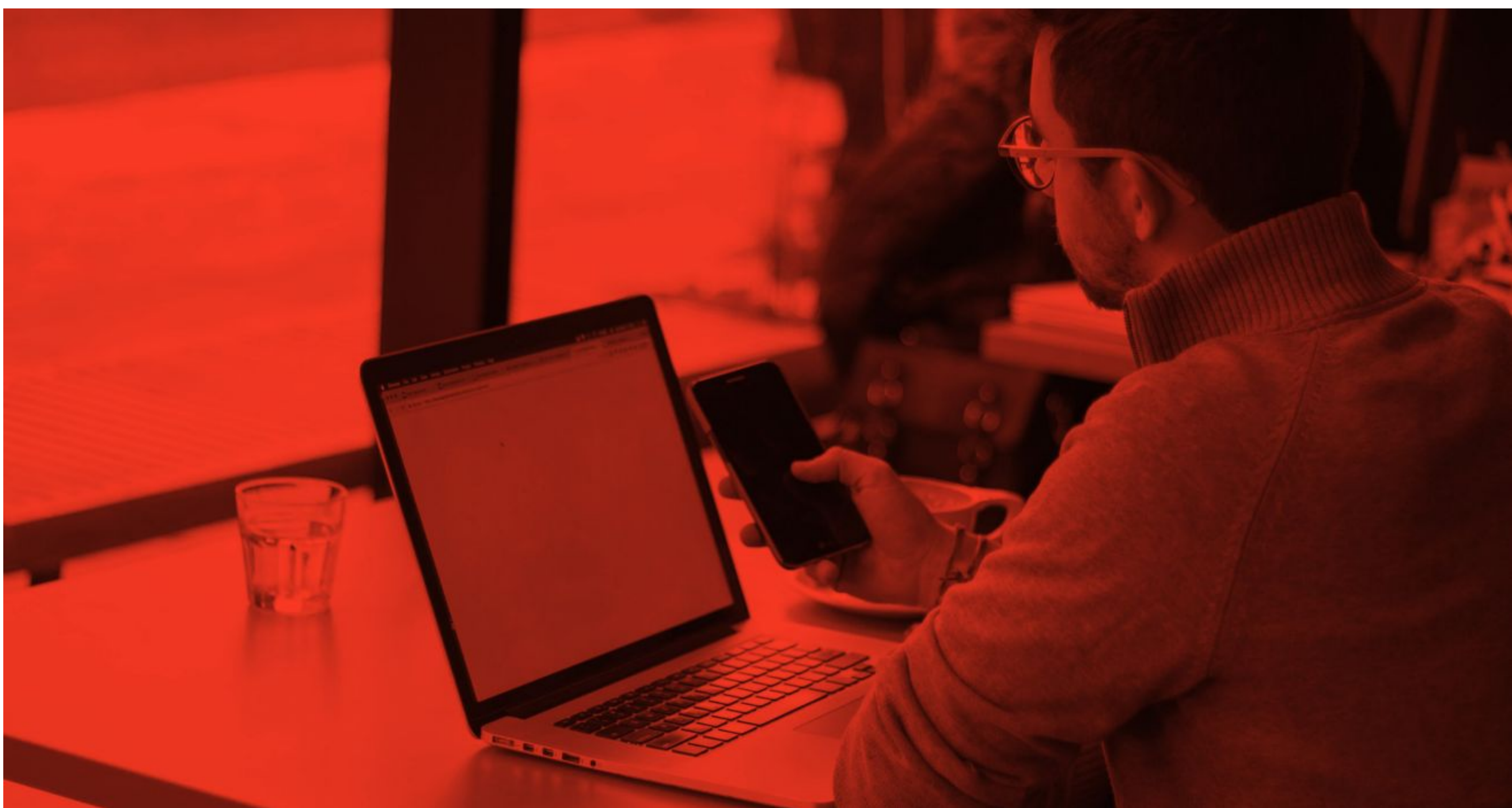
Similarly, fewer women than men graduate with computing and other ICT-related majors, in most countries. In Europe, 5.7 times more men than women graduated from ICT studies in 2015; only 1.2% of female graduates chose to major in ICT (European Commission, 2018b). The percentage of women majoring ICT is also low in OECD countries (19.8%), as well as in U.S. (18%), Canada (26%), and Australia (17%). The global trend has been downward over the past 15 years: the percentage of women enrolled in ICT majors dropped from 29.7% in 2000 to 20.2% in 2013, but began recovering in the past three years (UIS, 2017).

Inequality in education can be exacerbated by the intersectionality of factors such as ethnicity, income, and urban-rural location. However, such data are unavailable except for the U.S., where only small percentages of women of colour earned bachelor's degrees in any STEM field: black women at 2.9%, Latinas at 3.6%, and Asian women at 4.8% (National Centre for Education Statistics, 2016; Aspray, 2016).

Considerable regional and national variation exists in categorising the field of education. For instance, UIS uses 11 categories, including ICT as a separate field, while OECD has more than 20 sub-categories but does not list ICT as a separate field of study. Eurostat also has 11 categories, with computing as a distinct field. Individual countries also may have their own categorisations; many classify ICTs as part of information sciences, information technology, communications, or other science disciplines.

2.5.3.3 / The gender and STEM paradox: More gender equality, fewer women in STEM

Gender-segregation in fields of study varies between developed and developing countries. In fact, the gender gap is often larger in more economically developed countries (Charles & Bradley, 2009). Exceptions are noted in Malaysia, Pakistan, and India, where more women than men participate in STEM education (Mellström, 2009; Shabib-ul-Hasan & Mustafa, 2014; Gupta, 2012). More recently, researchers have argued that countries that rank higher on the Global Gender Gap Index (GGI, measured by the World Economic Forum) — that is, those making greater progress toward gender equality — tend to have fewer women graduated with STEM degrees (e.g., Stoet & Geary, 2018). This phenomenon has been referred to as the gender paradox in STEM education.



How should we understand this paradox? Researchers interpret that, in countries with higher gender inequality, high-paying and more stable STEM occupations can be attractive options for women, who experience fewer economic opportunities as well as higher gender barriers. For instance, studies found that computer-related jobs are perceived as women-friendly and better careers for women than men in Malaysia and India (Lagesen, 2008; Varma, 2010). But this does not explain the persisting small share of women studying STEM and ICT majors in more developed countries. Even in the wealthier countries of OECD, the economic benefits of a STEM career are clear: graduates in engineering tend to earn, on average, 10% or more than other college graduates, while those in education and teacher training earn 15% less (OECD, 2016c).

The gender imbalance in fields of study is closely related to an individual's future career and economic well-being as well as socio-political participation. Women's individual choices may be influenced by socio-cultural factors such as parents, peer-pressure, gender-stereotyping of STEM careers, and lack of role models and mentoring. As discussed in Chapter 5, many of these factors function as gendered barriers that discourage women from pursuing studies and careers in the STEM field and developing higher-level ICT skills to design and create technology.

2.5.4 / ALTERNATIVE PATHWAYS FOR HIGH-LEVEL DIGITAL SKILLS

As a metaphor to describe the educational requirements to incubate STEM and ICT professionals, many educators prefer the term "pathway" to "pipeline" (Aspray, 2016) — emphasising that there can be multiple pathways to train the necessary digital skills rather than a single pipeline. Indeed, there are many different occupations in the tech industry, with a wide spectrum of qualification and skills that can be obtained via various educational and training pathways.

With the increasing relevance of digital skills in today's world, we see more innovative approaches to provide STEM education, certainly in relation to computing skills. Traditionally, higher education in computer sciences or related STEM majors has been the conventional pathway to develop students' skills for careers in tech industries. Responding to the soaring demands for a skilled ICT workforce, however, new approaches advocate that computing education should be provided for all, including children and youth, rather than only in university classrooms. Further, experts argue it is necessary to equip all citizens with computational thinking and necessary computing skills, as coding skills become a new literacy of the 21st century (Rushkoff, 2011; European Schoolnet, 2015, 2017)

Innovative initiatives include: introductory computing education for national curricula; informal or private coding schools; bootcamps; MOOCs; hacker and makerspaces. These alternative pathways present new possibilities to bring ICT skills training to more girls and young women, though as yet there is no evidence-based research to assess their impact. (Chapter 14 also discusses the promise and pitfalls of skills development through on-the-job training at call centres.)

2.5.4.1 / Introductory computing education

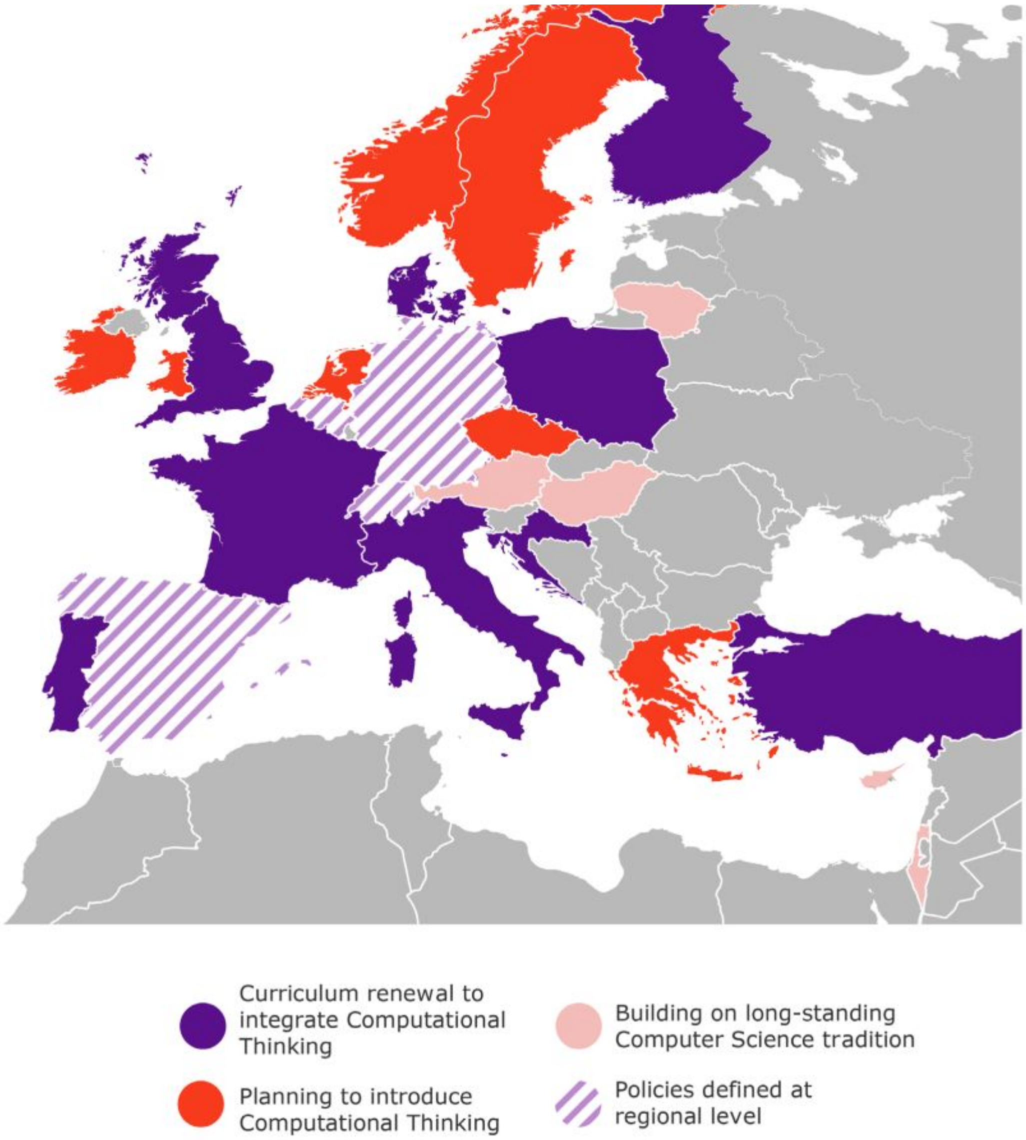
A growing consensus holds that computing education should be an essential part of national education. Advocates suggest that, just as schools teach children how electricity works or how body's digestive system works, today's children need to learn how computers, networks, and programming work, and what they mean to our society. Beyond this basic knowledge, "computational thinking" (CT) is also a critical competence to develop cognitive abilities (decomposition, recognition, abstraction, and algorithm) as well as integrated skills in problem-solving, collaboration, and creativity (Wing, 2006).

Many governments have implemented or plan to integrate computing education in their national curriculum; approaches vary from a mandatory national curriculum on computational thinking to optional basic coding courses. According to a study by European Schoolnet (2017), at least 20 European countries have integrated or are planning to adopt computing education in their curricula (Figure 2.23)[3]. Note that their policy documents use a variety of terms interchangeably, including coding, programming, computational thinking, problem-solving, and algorithmic thinking. The UK government replaced the existing ICT syllabus with computing education for students aged 5–16.

A survey by Google and Gallup (2016) reports that about 40% of U.S. school principals say their school offers computer classes in programming or coding; the non-profit College Board introduced a computer science exam to their roster of Advanced Placement tests. South Korea announced plans to teach programming and computational thinking through primary, secondary, and high schools beginning in 2018, while China has introductory computing courses at the high school level, with optional subjects such as algorithms, multimedia applications, network applications, data management, and artificial intelligence.

3These 20 countries include Austria, Belgium, Czech Republic, Switzerland, Germany, Estonia, Spain, Finland, France, Hungary, Croatia, Italy, Ireland, Lithuania, Malta, Poland, Portugal, Slovakia, UK England, and UK Scotland.

Figure 2.21
Status of computing education in Europe (2016)



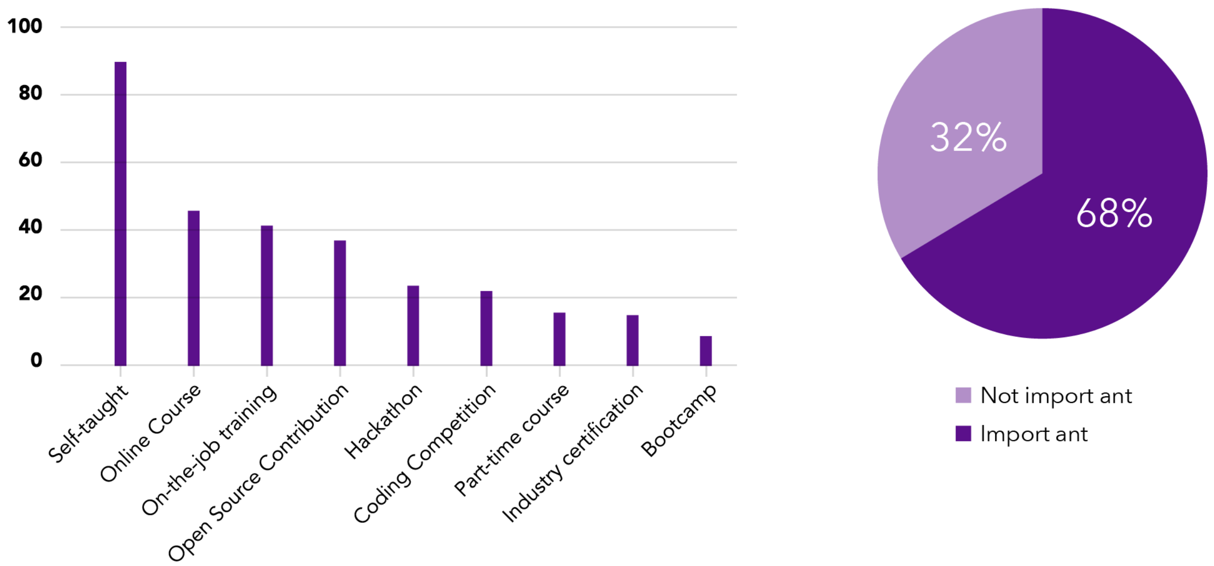
Source: UIS, 2017.

However, these movements are mostly very new, and there seems to be a lack of policy discussions or research on gender participation in introductory computing education. The gender barriers within current STEM education (Chapter 5) may persist despite the new initiatives. In the UK, an evaluation study of computing education shows that only 9% of girls-only schools offer computing at A-level, compared to 44% of boys-only schools and 25% of mixed-sex schools (Kemp, et al. 2016). Still needed are gender-sensitive computing curricula and institutional environments.

2.5.4.2 / Coding training

A growing number of initiatives aim to provide practical coding skills for youth and adults. Although they cannot offer the same depth of education as a conventional college education, such initiatives can be a cost-effective and efficient means of learning programming skills. A Stack Overflow survey of 64,000 global programmers shows that 76.5% of the respondents have a bachelor's degree or higher, and about the half (54%) of those with college education have studied computer science or software engineering. However, 32% of the respondents said that formal education was not very important or not important at all to their career success. Along with the formal education, many also have taken alternative pathways, such as online courses (45%), on-the-job training (41%), and Hackathon (24%) (Figure 2.24).

Figure 2.22
Importance of formal/alternative education for coding career



Source: Author's elaboration, using Stack OverFlow Survey data, 2017.

Coding bootcamp is an intensive training programme offering practical programming and career development skills. The coding bootcamp learning experience is project-based, using lectures, collaborative work, and online exercises. There are four models, ranging from early education to ready-to-work (Table 2.5). Bootcamp students are, on average, 29 years old, hold a university degree (71%), and are male (over 60%) (ITU, 2016). As women make up nearly 40 per cent of bootcamp participants, this option could contribute to narrowing not only the skills gap but also the employment gender gap in the technology industry.

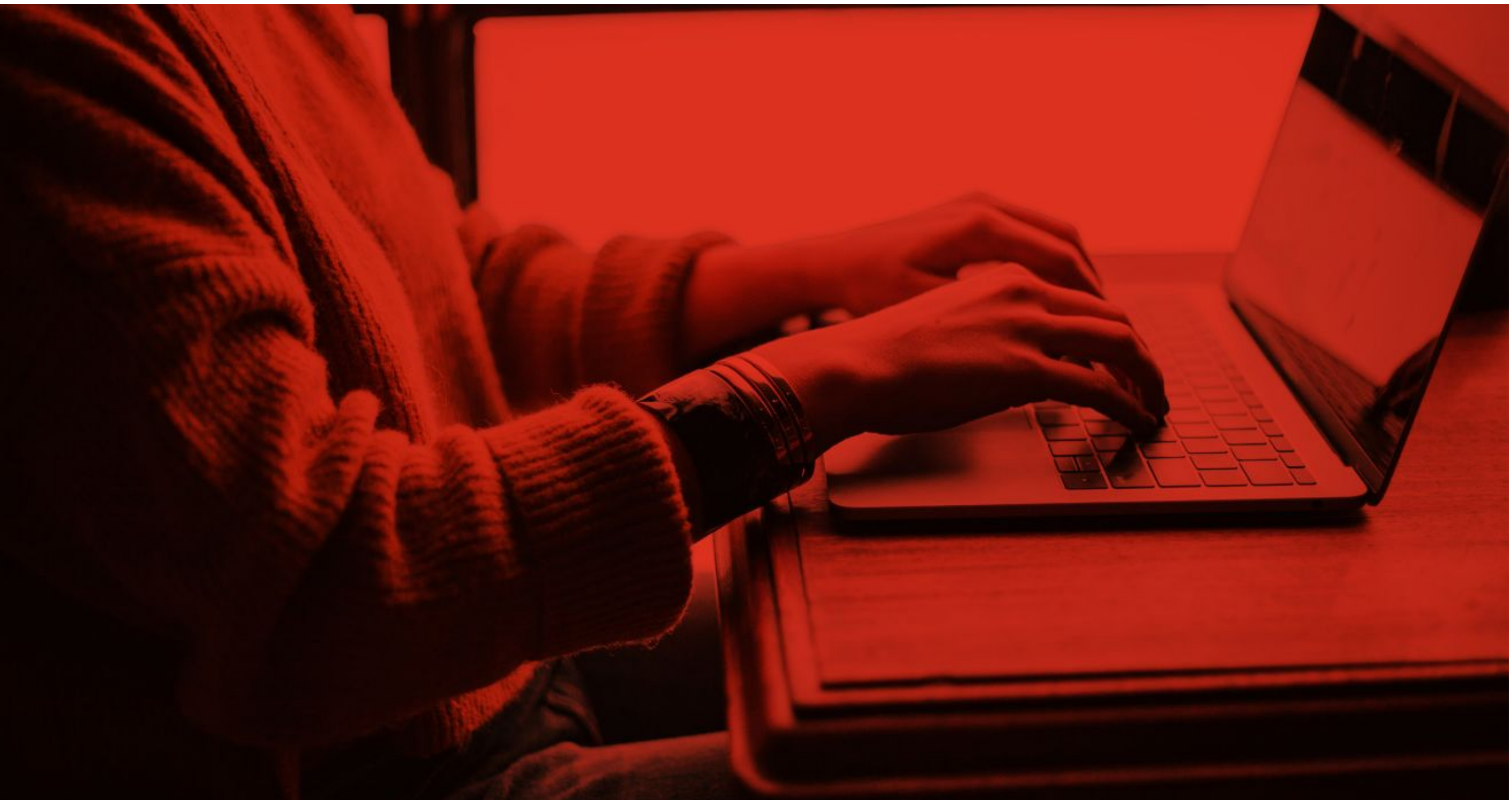


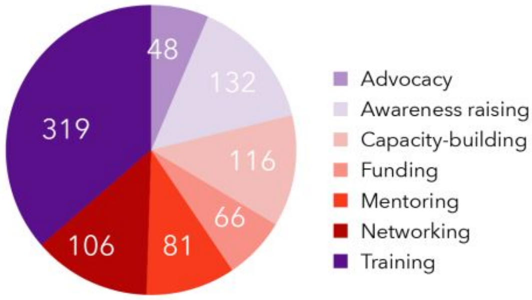
Table 2.5
Four models of coding bootcamp

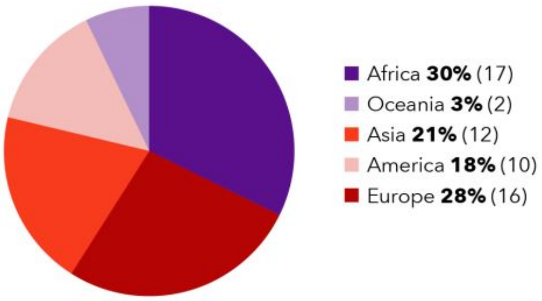
Ready-to-Work model	Traditional approach to coding bootcamps - intensive 12 to 24 weeks full or part-time rapid skills training programmes that prepare people to qualify for employment shortly after the training ends.
Bootcamp+ model	An extended training approach - longer training programmes (1 to 2 years) that equip students with a broader range of sustainable income-generation skills in addition to coding competencies. Found mainly in Africa, they tend to focus on adding entrepreneurship training
Mini Bootcamp model	Very short-term training programmes ranging in length from two days to one month. They are typically designed to spark interest in learning the basics of programming, to recruit or identify talent, for professionals to update their skills, and for outreach and community building.
Software skills	Efforts to trigger interest in programming at an early age. This model includes workshops, hackathons, and online platforms as well as more encompassing efforts such as schools integrating coding skills into their curriculum. Although not focused on employability in the short term, the early education model is an important trend to monitor.

Source: Author's elaboration, using Stack OverFlow Survey data, 2017.

Globally, a growing number of initiatives in coding education focus on girls and women. Several international organisations and national governments promote women's advanced digital skills and support grassroots efforts to provide coding education for girls and women, as in Case Study 2.1. The EQUALS Global Partnership conducted research in 2016 to identify initiatives to bridge the gender digital divide. The research found 857 gender tech projects (as of May 2018), including 143 projects from 70 organisations in 56 countries that provide coding education for girls and women. Another 319 projects provide training on digital skills, while others focus on awareness (132), capacity building in computing (116), networking among women developers (106), and mentoring current and future female developers (81) (Figure 2.25).

Figure 2.23
Digital Skills Initiatives for women, by project types and regions





Case Study 2.1

#eSkills4Girls – A global initiative to promote digital skills for women and girls

Author: Birgit Frank (BMZ) and Vanessa Dreier (GIZ)

In conjunction with Germany's G20 presidency 2017, the German Federal Ministry for Economic Cooperation and Development (BMZ) launched the initiative #eSkills4Girls to overcome the gender digital divide and promote education, skills, and employment for girls and women in a digital world, particularly in emerging and developing countries. The initiative found strong support among G20 member states as well as the private sector, civil society, and the general public. GIZ, as a federal enterprise, implements numerous activities under the initiative, to support the German Federal Government in achieving its goals in international cooperation, including collaboration between governments, private sector, academia and civil society organisations.

Project activities include:

Promoting role models of women and girls in tech.
Female role models with successful tech careers are acknowledged with a study and a video, providing an inspiration for young women and girls to discover STEM subjects and professions.

Creating networks to foster learning among grassroots programs.
In May 2017, BMZ brought together over 30 female tech leaders from all over Africa, at the #eSkills4Girls Africa Meetup, resulting in the #eSkills4Girls network to continue the dialogue.

Strategic partnerships with the private sector to promote local innovations.
Since 2015, BMZ is supporting Africa Code Week, initiated by the German software company SAP. This continent-wide digital literacy initiative involves hundreds of schools and teachers, along with governments, businesses, and non-profits. In 2018, coding workshops in 16 African countries shared a curriculum designed for girls and young women.

An online platform to allow knowledge exchange.
The #eSkills4Girls online platform showcases 32 flagship projects on digital skills, shares stories about female role models, and bundles information about studies, data, and events by G20 partners.

Implementation of #eSkills4Girls projects.
BMZ has expanded its portfolio with new projects and a special focus on #eSkills4Girls in Ghana, Rwanda, Cameroon, Mozambique and South Africa. In 2019, projects will focus on digital skills trainings for women and girls, the integration of digital technologies in vocational trainings and non-formal education settings, and raising awareness for tech careers.

The EQUALS partnership – Advancing gender equality in the digital age.
BMZ together with UNESCO spearheds the Skills Coalition of EQUALS, working on improving the data base on women's digital skills, developing principles for gender-inclusive digital trainings, and creating a digital skills fund for grassroots women leaders and activists to scale-up their digital skills projects.

2.5.4.3 / MOOCs and online learning

Massive Open Online Courses (MOOCs) are a form of e-learning, characterised by large enrolments and free or low-cost access. Unlike traditional e-learning courses offered by universities and businesses, students can select the courses that interest them and complete them at their own pace, driven by their interests, passions, and, in many cases, the desire to develop job skills or professional certifications (Glass et al., 2013; Ho et al., 2015). As early MOOC courses on Machine Learning and Artificial Intelligence drew over 150,000 students to a single course, the emergence of MOOCs in 2012 was heralded for their potential to "usher in an era of global access" for learners who were underserved by traditional educational pathways (EDUCAUSE, 2013; Brown & Adler, 2008).

However, in recent years, research has shown that, despite the potential for MOOCs to democratise access to education to anyone with an internet connection, there remain wide disparities in the types of learners who access and complete MOOCs. Early analyses suggested that the typical MOOC learner was a white, college-educated male, suggesting a potential rich-get-richer effect — that primarily learners with access to higher education were accessing online learning resources in the form of MOOCs (Ho et al., 2014). Due to the flexibility that MOOCs offer for learning across time, place, and context, much has been made of their promise in providing alternative pathways to education in low-resource areas, particularly for ICT domains lacking in local experts. Again, however, research has consistently found that learners from less developed parts of the world were less likely to enrol in and complete MOOCs (Ho et al., 2014; Kizelcec et al., 2015). Obstacles to greater MOOC uptake include access to a reliable internet connection and the digital literacy needed to access MOOCs (Christensen et al., 2013; Garrido et al., 2016), as well as differences in language and pedagogical style. Some research suggests that facilitating in-person groups of MOOC learners at telecentres might mitigate those challenges (Cutrell et al., 2015; Madaio et al., 2016; Liyanagunawardena et al., 2013).

If MOOCs represent a possible alternative pathway for women's computer science and STEM education, are there gaps in how women around the world participate in and complete MOOCs? Across multiple studies, male MOOC learners outnumber female learners by nearly 2 to 1, in contrast to traditional distance courses and online universities, where female learners outnumber males by a similar ratio (Christensen et al., 2013; Dillahunt et al., 2014; Ho et al., 2014; Kizilcec et al., 2013; Breslow et al., 2013). However, the gender gap in MOOC participation may reflect gender gaps in women's participation in STEM courses more broadly, as discussed earlier in this chapter. In a two-year retrospective of all MOOCs offered by Harvard and MIT on the MOOC platform edX, Ho et al. (2014) found that men outnumber women by five-to-one in CS courses and three-to-one in STEM courses, while women represented 40% of learners in the humanities and social science courses offered on edX (Ho et al., 2014). Once enrolled in MOOCs, however, multiple studies indicate that, across domains, female students complete courses at the same rate as male students (Ho et al. 2014; Breslow et al., 2013; Cisel, 2014). Two studies suggest that women in developing countries were more likely than men to complete a MOOC course (Jiang et al., 2016; Garrido et al., 2016).

With the high enrolment rates in MOOCs, there are equally high non-completion rates, with many learners signing up for free courses and never completing them (Ho et al., 2015). However, researchers have argued that these course completion rates may be misleading indicators of the potential impact of MOOCs. Some (Breslow et al., 2013) suggest that learners may stop participating at points that are appropriate for them individually; while others (Madaio et al., 2016) find that MOOC learners in developing countries may have different patterns of access than the course designers expected (such as downloading MOOC videos to be accessed in an offline repository), thus altering the definition of what completion looks like.

While much work has been done to develop empirical studies to understand who participates in MOOCs and how they learn, there remain gaps in obtaining comprehensive data that is broadly representative across regions and domain areas, as well as gaps in the research for understanding the factors that might influence learners' participation and success in learning with MOOCs. Moving forward, there is a need to collect more data to investigate MOOCs' potential to provide an alternative pathway for digital skill acquisition among women, particularly in developing countries contexts with limited access to high-quality formal ICT education.

2.5.4.4 / Hackerspaces and makerspaces

Hackerspaces are work spaces for people with similar interests (often in computers, machining, technology, and digital art), allowing them to collaborate and share knowledge to innovate. Hackerspaces are not rigidly defined in order to allow inclusivity, thus resulting in a variety of different hackerspaces and formats. Hackerspaces are alternatively referred as Hack Labs, Makerspaces, Fab Labs, Men's Sheds, DIY makers, and Repair Cafes. Currently 1,407 hackerspaces are reported to be in operation, while 2,269 hackerspaces are reported globally[4].

Research in 2011 showed that out of a total of 250 survey respondents, only 10% were women. Fully 85% of respondents were based in North America and Europe (Moilanen, 2012). Within the hackerspace, men generally engaged in software and hardware hacking, while women were most interested in software development. Some of the barriers to women's participation in hackspaces were lack of interest in STEM, finding the

4 *https://wiki.hackerspaces.org/List_of_Hacker_Spaces* hackerspaces male-dominated and thus intimidating or unpleasant, lack of clear outcome goals, and limited access to opportunities (Lewis, 2015). While men tend to dominate hacker culture, there are hackerspaces founded by women. Feminist Hackerspaces offer an environment where women are comfortable to learn, teach, work, and collaborate. These hackerspaces recognise the struggle of other minorities and are often trans- and queer-inclusive spaces.

As women increasingly participate in hackerspaces, a backlash has emerged; female hackers are groped, harassed, and discriminated against, especially at hacker conferences and hackerspaces. Beyond verbal abuse and misogynist behaviour, some feminist hackers have also received rape and death threats (Toupin, 2014). Hackerspaces and makerspaces might still be a versatile, informal means of improving gender balance in STEM as well as coding and digital skills, as part of a multipronged strategy for creating informal structures to integrate girls into coding and STEM. Empirical studies are needed to explore not only the potential of hackerspace, but also possible adverse consequences for women and potential solutions. Existing studies tend to be qualitative in nature, and focus on hackerspaces in the western hemisphere. More research may point to ways for more women to safely benefit from hackerspaces.

2.6 / CONCLUSION

This chapter examined the status of gender gaps in basic, intermediate and advanced digital skills by reviewing the available sex-disaggregated data on high-level digital skills, as well as women's participation in conventional and alternative STEM education. The industry demand for high-level ICT skills continues to increase, and many future jobs are expected in computing and engineering. However, from gender comparisons of the currently available data, women are far less equipped with programming and advanced digital skills. In developed countries, more men than women tend to have advanced skills to apply ICT skills for problem-solving or high-level tasks; globally, twice as many males as females can write a computer programme (8% vs. 4%).

To resolve these gender gaps, it is critical for more women to enter STEM education that provides a pathway to develop knowledge and skills to create and manage technologies, and to prepare for participating in the ICT industry. Nevertheless, the participation of girls and young women remains low, in STEM education and learning high-level digital skills. The analysis found only marginal gender differences in students' STEM performance but considerable gender gaps in motivation to study STEM, self-efficacy to do well in STEM studies, and aspiration to have a career in STEM. The percentage of women studying STEM subjects has remained low, hovering around 35% over the past 15 years. Moreover, most women in STEM chose to study natural sciences (56%) rather than applied sciences such as computer science (29%) or engineering (27%). Ironically, the share of women in STEM studies, including ICT majors, is lower in countries with higher gender equality: smaller percentages of women study ICTs in many European or North American countries than in Middle Eastern and Asian countries.

Alternative pathways are emerging to cultivate digital skills with more innovative pedagogic approaches: introductory computing is increasingly included in national educational curricula, and coding bootcamp, MOOCs, and makerspaces offer alternative digital skills training particularly in the area of coding skills. While these new movements seem promising, there is still a lack of data and evidence-based research on the effectiveness of these alternative pathways for closing the gender gap.

REFERENCES

A.T. Kearney. (2016). Tough choices: The real reasons A-level students are steering clear of science and maths. London: A.T. Kearney and the Your Life Campaign. Retrieved from: https://www.atkearney.com/documents/10192/7390617/Tough+Choices.pdf/a7408b93-248c-4b97-ac1e-b66db4645471

Aspray, W. (2016). Women and underrepresented minorities in computing: A historical and social study. Basel, Switzerland: Springer.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. Child development, 72(1), 187-206.

Bocconi, S., Chioccariello, A., Dettori, G., Ferrari, A.& Engelhardt, K. (2016). Developing computational thinking in compulsory education – Implications for policy and practice. EU Joint Research Council. Retrieved from: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC104188/jrc104188_computhinkreport.pdf

Breslow, L., Pritchard, D. E., DeBoer, J., Stump, G. S., Ho, A. D., & Seaton, D. T. (2013). Studying learning in the worldwide classroom: Research into edX's first MOOC. Research & Practice in Assessment, 8(1), 13–25.

Broadband Commission (2017). Working Group on Education: Digital skills for life and work. Retrieved from: http://unesdoc.unesco.org/images/0025/002590/259013e.pdf

Brown, J. S., & Adler, R. P. (2008). Minds on fire: Open education, the long tail, and learning 2.0. EDUCAUSE Review, 43(1), 16–32.

Chan, V., Stafford, K., Klawe, M., & Chen, G. (2001).

Gender differences in Vancouver secondary students. In: Balka E., Smith R. (eds.), Women, Work and Computerization. The International Federation for Information Processing (IFIP), Vol. 44. Boston, MA: Springer.

Charles, M., & Bradley, K. (2009). Indulging our gendered selves? Sex segregation by field of study in 44 countries. American journal of sociology, 114(4), 924-976. Retrieved from: https://www.jstor.org/stable/10.1086/595942

Christensen, G., Steinmetz, A., Alcorn, B., Bennett, A., Woods, D., & Emanuel, E. J. (2013). The MOOC phenomenon: Who takes massive open online courses and why? SSRN Electronic Journal. Retrieved from: https://doi.org/10.2139/ssrn.2350964

Cisel, M. (2014). Analysing completion rates in the first French xMOOC. EMOOCs 2014: Proceedings of the European MOOCs Stakeholders Summit, Research Track. 26-32.

Cutrell, E., O'Neill, J., Bala, S., Nitish, B., Cross, A., Gupta, N., … Thies, W. (2015). Blended learning in Indian colleges with massively empowered classroom. Proceedings of the Second (2015) ACM Conference on Learning @ Scale. L@S '15, 47–56. Retrieved from: https://doi.org/10.1145/2724660.2724666

Department of Education and Training, Australian Government (2017). Completion count by course level, by field of education, by gender, by year. Retrieved from: http://higherеducationstatistics.education.gov.au/

Dillahunt, T., Wang, Z., & Teasley, S. D. (2014). Democratizing higher education: Exploring MOOC use among those who cannot afford a formal education. International Review of Research in Open and Distance Learning, 15(5), 177–196. Retrieved from: https://doi.org/10.19173/irrodl.v15i5.1841

Economist (2018). Sweden tries to increase gender equality on the web. Retrieved from: https://www.economist.com/business/2018/03/08/sweden-tries-to-increase-gender-equality-on-the-web

Educause (2013). MOOCs II. 7 things you should know about MOOCs. Washington, DC: ELI.

European Commission (2015). Digital Skills Indicator – derived from Eurostat Survey on ICT usage by individuals: Methodology Note 201. Retrieved from: https://ec.europa.eu/digital-single-market/en/news/new-comprehensive-digital-skills-indicator

European Commission (2017). The digital skills gap in Europe: Factsheet. 19 October, 2017. Retrieved from: https://ec.europa.eu/digital-single-market/en/news/digital-skills-gap-europe

European Commission (2018). DigComp 2.0: The digital competence framework for citizens. EC Joint Research Center. Retrieved from: https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework

European Commission (2018b). Women in the digital age: Directorate-General of Communications Networks, Content & Technology. DOI: 10.2759/526938

European Parliament (2017) Digital skills in the EU labour market, January 2017. Retrieved from: http://www.europarl.europa.eu/RegData/etudes/IDAN/2017/595889/EPRS_IDA(2017)595889_EN.pdf

European Schoolnet (2015). Computing our future: Computer programming and coding, priorities, school curricula and initiatives across Europe. Retrieved from: http://fcl.eun.org/documents/10180/14689/Computing+our+future_final.pdf/746e36b1-e1a6-4bf1-8105-ea27c0d2bbe0

European Schoolnet (2017). European Schoolnet Perspective, Issue No. 3, July 2017. Retrieved from: http://www.eun.org/documents/411753/665824/Perspective_n3_24july2017_FINAL.pdf/66f14f1e-a825-4b38-9d75-7f57025432ba

Eurostat (2017). Tertiary education statistics, Data extracted in June 2017. Retrieved from: http://ec.europa.eu/eurostat/statistics-explained/index.php/Tertiary_education_statistics#Gender_distribution_of_participation

Garrido, M., Koepke, L., Andersen, S., Macapagal, M., & Dalvit, L. (2016). The advancing MOOCs for Development initiative: An examination of MOOC usage for professional workforce development outcomes in Colombia, the Philippines, & South Africa. Seattle: Technology & Social Change Group, University of Washington Information School., 7.

Glass, C. (2009). Who takes MOOCs? Practical Assessment, Research & Evaluation, 14(7), 1–11. https://doi.org/10.1002/ir

Glott, R., Schmidt, P. & Ghosh, R. (2010). Wikipedia survey – Overview of results. Maastricht, Netherlands: UNU-MERIT. Retrieved from: https://web.archive.org/web/20100414165445/http://wikipediasurvey.org/docs/Wikipedia_Overview_15March2010-FINAL.pdf

Google Inc. & Gallup Inc. (2016). Trends in the state of computer science in U.S. K-12 schools. Retrieved from: http://goo.gl/j291E0

Gupta, N. (2012). Women undergraduates in engineering education in India: A study of growing participation. Gender, Technology and Development, 16(2), 153-176.

Ho, A. D., Chuang, I., Reich, J., Coleman, C. A., Whitehill, J., Northcutt, C. G., … Petersen, R. (2015). HarvardX and MITx: Two years of open online courses Fall 2012-Summer 2014. SSRN Electronic Journal, (10), 1–37. Retrieved from: https://doi.org/10.2139/ssrn.2586847

IEA (2016). TIMSS advanced 2015 international results in advanced mathematics and physics. Retrieved from:

http://timss2015.org/wp-content/uploads/filebase/advanced/full%20pdfs/TA15-International-Results-in-Advanced-Mathematics-and-Physics.pdf

ITU (2016). Coding bootcamps: A strategy for youth employment. Retrieved from: https://www.itu.int/en/ITU-D/Digital-Inclusion/Youth-and-Children/Documents/CodingBootcamps_E.pdf

ITU (2018). Decent jobs for Youth: Digital skills – thematic priority of the global initiative on decent jobs for youth. Retrieved from: https://www.decentjobsforyouth.org/wordpress/wp-content/uploads/2017/11/Thematic-Plan-1-Digital-Skills.pdf

Jiang, S., Schenke, K., Xu, D., & Warschauer, M. (2015). Females' enrollment and completion in science, technology, engineering, and mathematics Massive Open Online Courses. Retrieved from: https://arxiv.org/abs/1608.05131

Jordan, K. (2014). Initial trends in enrolment and completion of massive open online courses. The International Review of Research in Open and Distributed Learning, 15(1). Retrieved from: https://doi.org/10.19173/irrodl.v15i1.1651

Kemp, P. E., Wong, B., & Berry, M. G. (2016). The Roehampton annual computing education report. London: University of Roehampton.

Kermani, H. & Aldemir, J. (2015). Preparing children for success: Integrating science, math, and technology in early childhood classroom. Journal Early Child Development and Care, 185(9). pp. 1504-1527. DOI: 10.1080/03004430.2015.1007371.

Kizilcec, R. F., Piech, C., & Schneider, E. (2013). Deconstructing disengagement: Analyzing learner subpopulations in Massive Open Online Courses. Lak '13, 10. https://doi.org/10.1145/2460296.2460330

Kizilcec, R. F., Davis, G. M., & Cohen, G. L. (2017). Towards equal opportunities in MOOCs: Affirmation reduces gender & social-class achievement gaps in China. Proceedings of the Fourth (2017) ACM Conference on Learning @ Scale. L@S 2017, 121–130. Retrieved from: https://doi.org/10.1145/3051457.3051460

Lagesen, V. A. (2008). A cyberfeminist utopia? Perceptions of gender and computer science among Malaysian women computer science students and faculty. Science, Technology, & Human Values, 33(1), 5-27.

Lee, J., Moon, S. & Hega, R. L. (2011). Mathematics skills in early childhood: Exploring gender and ethnic patterns. Child Indicators Research, 4(3), pp. 353-368. Retrieved from: DOI: 10.1007/s12187-010-9088-9.

Lewis, J. (2015). Barriers to women's involvement in hackspaces and makerspaces. Access as Spaces. Retrieved from: http://access-space.org/wp-content/uploads/2015/10/barriers-to-womens-involvement-in-hackspaces-and-makerspaces.pdf

Liyanagunawardena, T. R., Parslow, P., & Williams, S. A. (2014). Dropout: MOOC participants' perspective. Proceedings of the European MOOC Stakeholder Summit 2014, 95–100. Retrieved from: http://centaur.reading.ac.uk/36002/

MacPhee, D., Farro, S., & Canetto, S. S. (2013). Academic self-efficacy and performance of underrepresented STEM majors: Gender, ethnic, and social class patterns. Analyses of Social Issues and Public Policy, 13(1), 347-369.

Madaio, M. A., Grinter, R. E., Tech, G., Zegura, E. W., & Tech, G. (2016). Experiences with MOOCs in a West-African Technology Hub. Eighth International Conference.

Mellström, U. (2009). The intersection of gender, race and cultural boundaries, or why is computer science in Malaysia dominated by women? Social Studies of Science, 39(6), 885-907.

Microsoft (2017) Why Europe's girls aren't studying STEM. Microsoft Philanthropies Whitepaper. Retrieved from: https://onedrive.live.com/View.aspx?resid=89F9BC9CE672FF4!108&app=WordPdf&wdLOR=&authkey=!ANK-QohgdrHsqJg

Ministry of Education, Culture, Sports, Science and Technology of Japan (2016). Population of undergraduate students by Major: School Basic Survey 2016.

Moilanen, J. (2012). Emerging hackerspaces–peer-production generation. In IFIP International Conference on Open Source Systems (94–111). Springer.

National Center for Education Statistics (2016). Digest of Education Statistics. Retrieved from: https://nces.ed.gov/programs/digest/d16/

OECD (2015). The ABC of gender equality in education: Aptitude, Behaviour, Confidence. PISA, OECD Publishing. Retrieved from: http://dx.doi.org/10.1787/9789264229945-en

OECD (2016a). Skills for a digital world. OECD STI Committee on Digital Economy Policy. Retrieved from: http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/IIS(2015)10/FINAL&docLanguage=En

OECD (2016b). The survey of adult skills: Reader's companion (second edition). OECD Skills Studies. Paris: OECD Publishing. Retrieved from: http://dx.doi.org/10.1787/9789264258075-en

OECD (2016c). Education at a glance 2016: OECD Indicators. Paris: OECD Publishing. Retrieved from: http://dx.doi.org/10.187/eag-2016-en

OECD (2017). Digital Economy Outlook 2017: ICT specialists by gender. Retrieved from: http://www.oecd.org/internet/oecd-digital-economy-outlook-2017-9789264276284-en.htm

OECD (2017b). Education at a glance 2017: OECD Indicators. Paris: OECD Publishing. Retrieved from: https://doi.org/10.1787/eag-2017-en.

Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. Journal of Educational Psychology, 86(2), 193.

Pew Research (2018). Social media use continues to rise in developing countries, but plateaus across developed ones. Retrieved from: http://assets.pewresearch.org/wp-content/uploads/sites/2/2018/06/15135408/Pew-Research-Center_Global-Tech-Social-Media-Use_2018.06.19.pdf

Rushkoff, D. (2011). Program or be programmed: Ten commands for a digital age. New York, NY: Or Books.
Schwab, K. (2017). The Fourth Industrial Revolution. World Economic Forum. Retrieved from: https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab

Shabib-ul-Hasan, S., & Mustafa, S. (2014). Education to profession! Challenges of being women in Pakistan. AI & society, 29(1), 131-136.

Sikora, J. & A. Pokropek (2011), Gendered career expectations of students: Perspectives from PISA 2006. OECD Education Working Papers, No. 57, Paris: OECD Publishing. Retrieved from: https://doi.org/10.1787/5kghw6891gms-en.

Spearman, J. & Watt, H. M. G. (2013). Perception shapes experience: The influence of actual and perceived classroom environment dimensions on girls' motivations for science. Learning Environment Research, 16(217), 217-238.

Statistics Canada (2017). Postsecondary enrolments, by program type, credential type, Classification of Instructional Programs, Primary Grouping (CIP_PG), registration status and sex. Retrieved from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710001101

Stoet, G., & Geary, D. C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. Psychological science, 29(4), 581-593.

Toupin, S. (2014). Feminist hackerspaces: The synthesis of feminist and hacker cultures. Journal of Peer Production, 4.

UNESCO (2015). Education for All 2000–2015: Achievement and challenges. Paris: United Nations Educational, Scientific and Cultural Organization. Retrieved from: http://unesdoc.unesco.org/images/0023/002322/232205e.pdf

UNESCO (2015b). Unleashing the potential: Transforming technical and vocational education and training. Paris, UNESCO. Retrieved from: http://unesdoc.unesco.org/images/0023/002330/233030e.pdf

UNESCO (2017). Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM). Retrieved from: http://unesdoc.unesco.org/images/0025/002534/253479E.pdf

Varma, R. (2009). Why I chose computer science? Women in India. AMCIS 2009 Proceedings, 413.

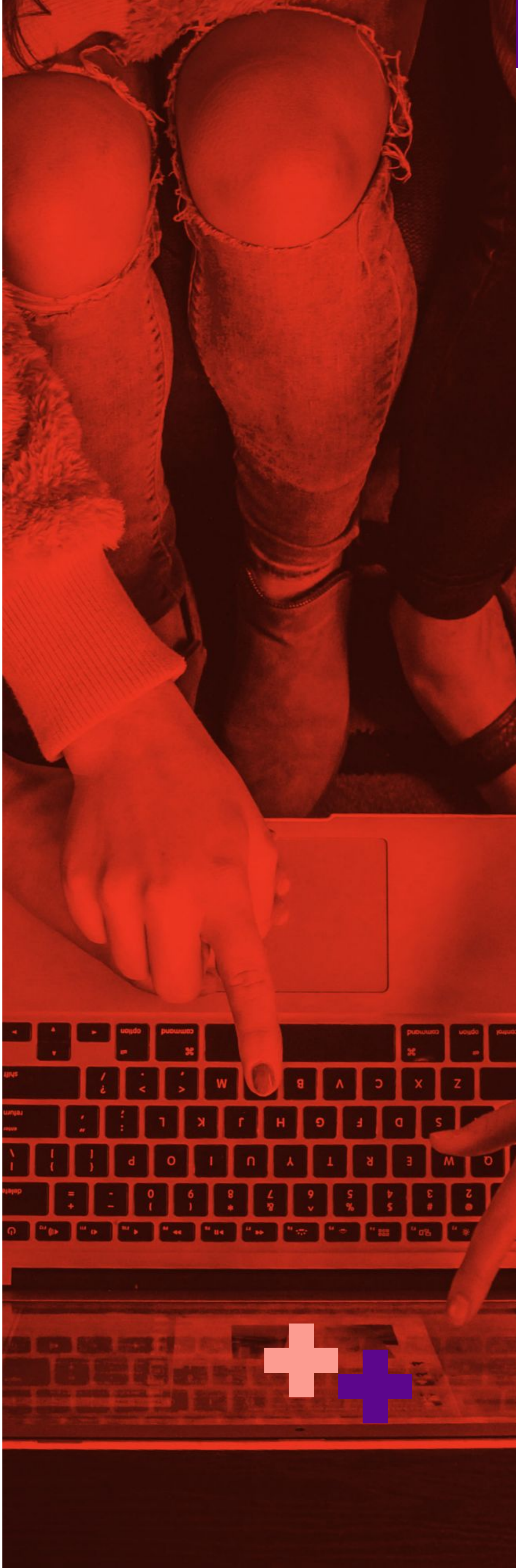
Wikipedia Foundation (2011). Wikipedia Editors Study: Results from the editor survey, April 2011. Retrieved from: https://upload.wikimedia.org/wikipedia/commons/7/76/Editor_Survey_Report_-_April_2011.pdf

Wing, J. (2006). Computational thinking. Communications of the ACM, 49(3) 33.
World Economic Forum (2016). The future of jobs: Employment, Skills and Workforce Strategy for the 4th Industrial Revolution. Retrieved from: http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf

3

GENDER EQUALITY IN ICT INDUSTRY LEADERSHIP

AUTHOR:
ARABA SEY (UNU-CS)



KEY FINDINGS

- Although gains have been made, women's representation remains low across different dimensions of ICT employment, entrepreneurship, and policymaking. On average, women constitute less than 35% of ICT and related professions. However, there is wide variation by country and by ICT sub-sector, ranging from as low as 2% to as high as 60%.
- Women in ICT tend to be in junior and support rather than managerial roles. Where women have made inroads into management, they are often in staff positions rather than the line positions that constitute the main pathway to executive roles.
- Evidence from North America and Europe indicates that women leave science and engineering jobs at higher rates than men. Their reasons for doing so are contested; some researchers cite family demands, while others point to workplace discrimination.
- Women are less likely than men to start enterprises in the ICT sector.
- Women have a very low rate of leadership in ICT policymaking. Worldwide, only 28 countries have a woman ICT minister, and only 25 have a woman heading the telecom regulator.

3.1 / INTRODUCTION

To what extent are women gaining employment in ICT and related industries, and what is their representation at senior management levels? Are women engaged in digital entrepreneurship, and how does their access to business capital compare to men's? This chapter draws on existing research and data to explore the question: What is the current status of women's participation in ICT industry leadership around the world? We review the literature on dimensions of gender equality in leadership within the ICT industry, presenting relevant data where available, and we discuss knowledge gaps and implications. Our starting premise is that women are capable of leadership in ICT fields, and that there is often a sizable pool of talented women for existing technology jobs.[5]

3.1.1 / WHY IS WOMEN'S EQUAL LEADERSHIP IN THE ICT INDUSTRY IMPORTANT?

The case for gender equality in technology leadership is usually presented as either an ethical argument or a business argument. From the ethical perspective, advocates note that in the digital age, technology jobs usually command more power, greater prestige, and higher pay. Those jobs are also more influential in driving economic development and producing the systems and tools that shape people's lives (Frehill, Abreu, & Zippel, 2015; Sassler, Michelmore, & Smith, 2017). Low proportions of women in leadership means that women's ability to have decision-making impact within the industry is limited. This argument aligns with the UN's Sustainable Development Goals, several of which advocate gender equality in the labour force (Box 3.1). Part Two of this report presents discussions on the importance of gender-diverse participation in designing information security technology (Chapter 13), technology innovation and transfer (Chapter 17), and artificial intelligence systems (Chapter 18), as well as reflections on the tendency to devalue women's work at all levels (Chapters 14 and 16).

Box 3.1
Women's ICT leadership and the SDGs

While none of the SDGs refer specifically to women in the technology industry, several targets are relevant to gender equality in tech. Progress on the related indicators would contribute to an enabling environment and signal progress in bringing more women into leadership in the technology industry.

Target 5.1: End all forms of discrimination against all women and girls everywhere.

Target 5.4: Recognise and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate.

Target 5.5: Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life.

Target 5.C: Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels.

Target 8.5: By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.

5 *See World Economic Forum(2017) analysis of LinkedIn members skill profiles.*

More recently, arguments have shifted to targeting organisations' self-interest by outlining business arguments for gender equality. Proponents, backed by research, argue that diversity leads to organisational benefits, such as improved financial health and returns on investment, higher staff productivity, a healthier workforce, and more creative problem-solving (Chanavat & Ramsden, 2013; Dawson, Kersley, & Natella, 2014; Gompers & Wang, 2017a; V. Hunt, Layton, & Prince, 2015; V. Hunt, Yee, Prince, & Dixon-Fyle, 2018; ILO, 2017a; Thomas, Dougherty, Strand, Nayar, & Janani, 2016; Vasilescu et al., 2015). For example, Thomas et al. (2016) found a correlation between diversity in tech company workforces and higher revenues, profits, and market value (in the U.S. and globally). They estimated that closing the global gender leadership gap could generate up to a 0.6% increase in global GDP. Companies in the U.S. and UK with the most gender diverse teams (especially at executive level) are 21% more likely to outperform other companies on profitability, according to (Hunt et al., 2018). More inclusiveness could also help to address industry skills shortages (e.g., Hewlett & Sherbin, 2014).

3.1.2 / MEASURING GENDER EQUALITY IN THE ICT INDUSTRY

Because technology now permeates every industry sector and an increasing number of job roles, the lines have blurred noticeably, making it more difficult to precisely quantify the tech workforce. (CompTIA, 2018, p. 11.)

There is no single high-tech industry; rather, new technology has transformed industries . . . and the functions of numerous occupations. . . . Occupations unknown a decade earlier have become common. . . . Classification schemes that rely on a single measure of technological expertise, as many do, may incorrectly rank industries and/or classify sectors. (U.S. Equal Employment Opportunity Commission, 2016, p. 4.)

Gaining an understanding of the true state of gender equality in the ICT industry presents several research and data collection challenges. First, there is lack of sufficiently fine-grained gender-disaggregated, consistently collected and comparable occupational data at the sector level for most countries (Data 2x, 2017; WIT Leadership Round Table Metrics Working Group, 2016). This limits researchers' ability to compile data at the global level and to do cross-country analyses. Most organisations do not collect and/or share diversity data, either because they are not required to do so by law or because they are reluctant to do so (Donnelly, 2017; Evans & Rangarajan, 2017).

Secondly, significant definitional issues affect this type of research. The continually evolving nature of technology developments gives rise to questions such as, what falls within the ICT industry, what constitutes an ICT or ICT-related occupation, and what does it mean to be a leader in this context. With the tentacles of digital technology reaching into diverse sectors, there are now at least three contexts in which a person could have an ICT-related occupation: 1) within the formal ICT industry; 2) within the informal ICT industry (e.g.; unregistered microenterprises, black market); and 3) within non-ICT sectors that make intensive use of technology (e.g., health sector). Different categorisations schemes — many of which collapse ICT sectors into general technology groupings — often make it necessary to use a technology as a proxy for ICT or to measure a narrow slice to represent the larger ICT category (Appendix D)[6]. This report is primarily concerned with gender equality in the ICT sector, particularly the formal ICT industry, where more adequate conceptualisation, research, and data collection exist. Future efforts should acknowledge and account for the informal[7] and non-ICT contexts as well.

The definition of a leadership position also impacts what situations are captured. Leadership can be found within the ranks of people working in technical roles, but also within the broad category of management, which includes people in non-technical roles. Indeed, technology company executives often come from non-technical positions (WIT Leadership Round Table Metrics Working Group, 2016).

The remainder of this chapter presents gender and ICT leadership in three areas – employment, entrepreneurship, and policymaking (Box 3.2). We also review research on the factors that constrain women's participation in the ICT industry and discuss potential remedies. Because much of the available data represent the broader science and technology industry, the analyses will often rely on technology industry data to signal the general status of women in the ICT industry.

For a comprehensive assessment of gender equality in the ICT industry, the WIT Leadership Round Table Metrics Working Group (2016, p. 3) recommends looking at both stationary metrics (e.g., female hires relative to all hires, or percentage of women at different organisational levels) and flow metrics (e.g., women promoted relative to all promotions, or attrition rates among women and men). This level of granularity — especially of flow data — is mostly unavailable through global public data sources, although individual organisations may have such data in their administrative records. We therefore focus on recruitment, retention, advancement, and work environment trends for industry in general, referring to specific data on the ICT industry where available.

6 *For example, Blau, Brummund, and Liu (2013) demonstrate how changes to occupational coding systems can affect research results. Also see UNCTAD (2015).*

7 *This particularly applies to low- and middle-income countries where a high proportion of the population are employed in the informal sector (ILO, 2018).*

Box 3.2
Aspects of gender & ICT leadership

Employment
working as an employee:
- Recruitment
- Retention
- Advancement

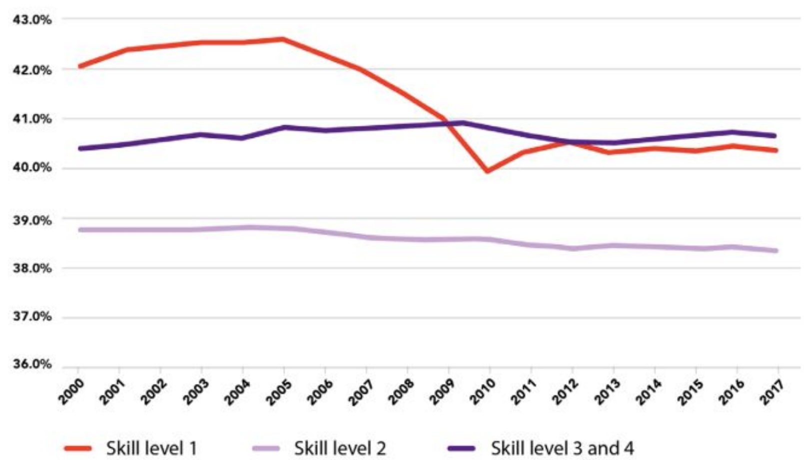
Entrepreneurship
establishing one's own enterprise in the industry (with or without employees):
- Participation
- Access to business training
- Access to business capital

Policymaking
working in an organisation that determines policy on technology and related issues:
- Recruitment

3.2 / EMPLOYMENT – RECRUITMENT

This section covers gender-relevant recruitment trends for selected occupational skill levels, technology-related industries, and technology-related occupations, supplemented with regional or country-specific data when possible.

Figure 3.1
Percentage of women employees at three occupation skill levels, global



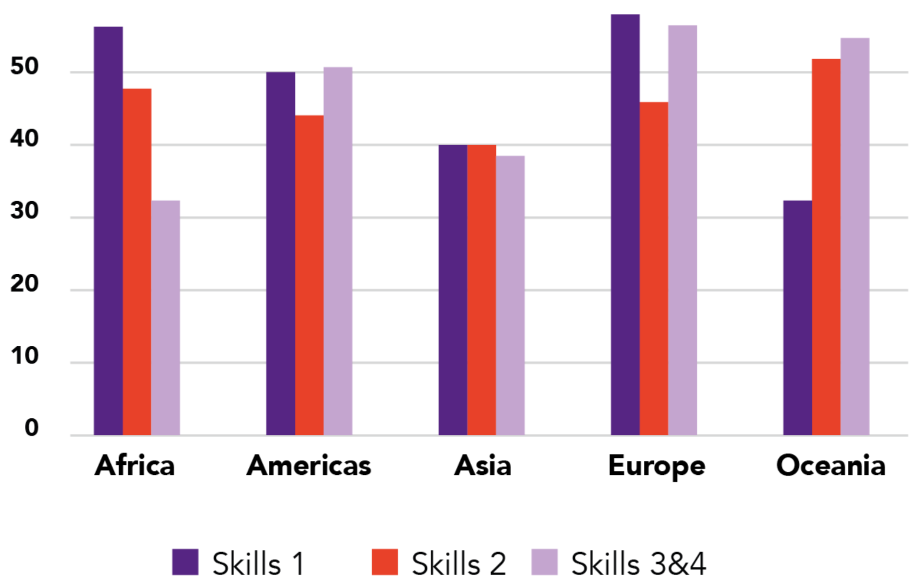
Source: ILOSTAT, ILO modelled estimates.
Notes: ILO defines skill levels as follows: Level 1 (low) = Elementary occupations; Level 2 (medium) = Clerical support workers, Service and sales workers, Skilled agricultural, forestry and fishery workers, Craft and related trades workers, Plant and machine operators, and assemblers; Levels 3 and 4 (high) = Managers, professionals, and technicians. See ILO indicator description: http://www.ilo.org/ilostat-files/Documents/description_OCU_EN.pdf
Robust data (Africa=53, Americas=33, Asia=51, Europe=40, Oceania=11) across all years and skill levels. Regional differences relatively stable from 2000-2017. Proportion of women is calculated by number of women workers/total number of workers per skill level.

3.2.1 / OCCUPATION SKILL LEVELS

Since leadership in the technology industry tends to require relatively high technical and/or managerial skills, it is instructive to first examine global data on women's employment at different skill levels. This data covers all industries and does not distinguish between ICT and non-ICT occupations. Globally, women's participation in jobs requiring high (level 3 and 4) skill levels has consistently been slightly above 40% since 2000 (Figure 3.1).

Although the data span both technology and non-technology industries, they do indicate fairly high levels of women employed in occupations that are associated with high skills, especially in Europe (51%), Oceania (50%), and the Americas (46%) (Figure 3.2). In Africa, however, progressively higher skill occupations are associated with lower proportions of women; the opposite applies in Oceania; and the numbers converge at around 35% for Asia. The picture is more mixed in Europe and the Americas, where the highest proportions of women are found at the extremes, in Level 1 and Level 3-4 jobs. Notably, there has been very little change in these trends over the last two decades, apart from a large drop in the proportion of women in low-skill (Level 1) occupations. The reasons for this drop are unclear, as it is not associated with a corresponding increase in employment at other skill levels. One possibility is that it could be an artifact of changes in data collection methods or the number of countries reporting.

Figure 3.2
Percentage of women by occupation skill level (2017)



Source: ILOSTAT, ILO modelled estimates.

3.2.2 / ICT INDUSTRIES AND RELATED FIELDS

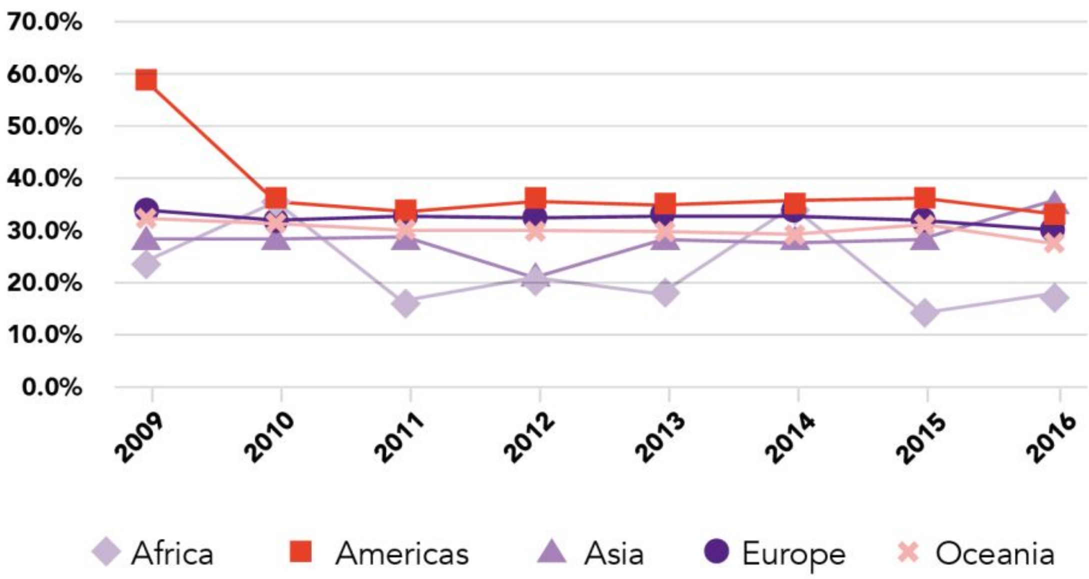
Most studies of gender diversity in the technology industry focus either on specific countries (usually the U.S.), geographic locations (e.g., Europe, Silicon Valley) or large global companies (e.g., Fortune 500, FTSE100, S&P100). While individual organisations show some variation[8], on average, levels of participation by women are low and the pace of change is slow. Thus, although (as the previous section notes) 40% of high-skill occupations are filled by women, it appears these jobs are mostly not in the ICT industry. The proportion of women in the U.S. technology industry, for example, remained at 22% between 2005 and 2015, according to the US Government Accountability Office (2017).

Even women technology workers were more likely to be employed outside the technology industry than within it. Similar findings were reported for Silicon Valley: women's employment was 30% in leading tech firms compared to 49% in non-tech firms (U.S. Equal Employment Opportunity Commission, 2016). In Europe, women comprised 21% of the workers in the digital work force (Quirós et al., 2018).

A global study of 54 telecommunications companies found that most (75%) had female employment between 10% and 40% of their workforce, and only one had more than 50% (Molina, Lin, & Wood, 2015). This finding is consistent with ILO data, which show levels between 18% (Africa) and 35% (Asia) in 2016 (Figure 3.3). The 2016 median for each region was between 28% and 34% (Table 3.1). However, Table 3.1 also shows that the averages mask wide variations between countries.

8 *For example, in 2016, both Pandora and Groupon had about 48% female employees (Information is Beautiful, 2018).*

Figure 3.3
Percentage of women telecommunications industry employees



Source: ILOSTAT, ISIC level 2.
Note: Includes self-employment. Thin data for most countries.

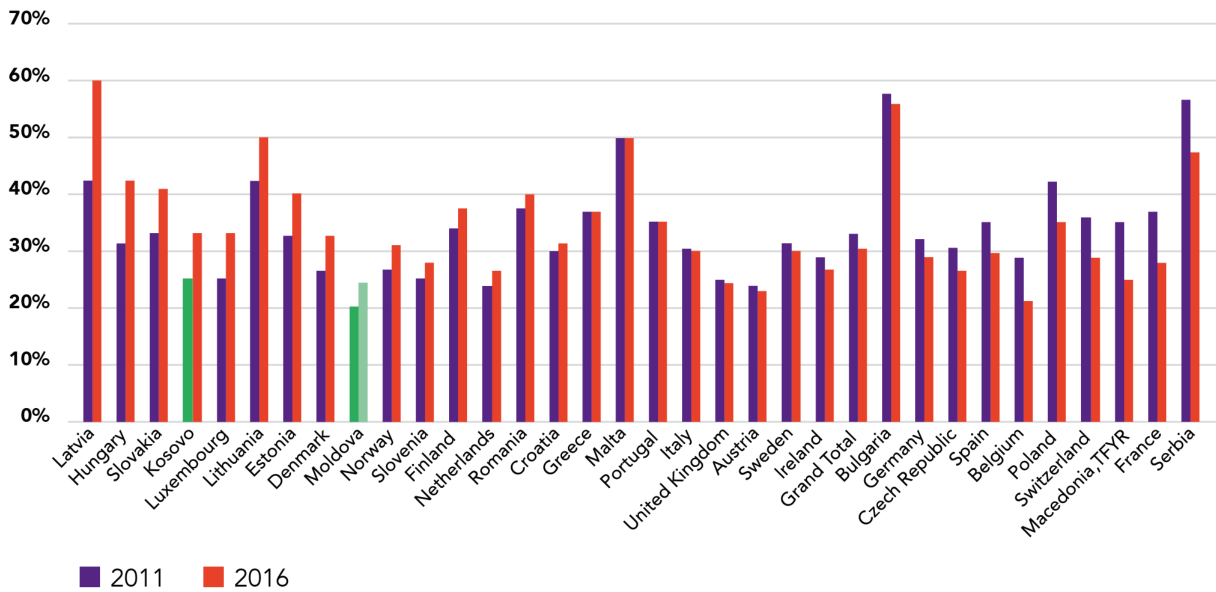
Table 3.1
Percentage of women employees in telecommunications industry, by region

REGION	2010	2016	MEDIAN 2016	LOWEST PERCENTAGE	HIGHEST PERCENTAGE	NUMBER OF REPORTING COUNTRIES
Africa	35,5	17,9	33,3	11 (Mali)	55 (Uganda)	13
Americas	35,8	33,2	33,3	21 (Guatemala)	51 (Ecuador)	11
Asia	28,1	35,3	34,4	5 (Pakistan)	50 (Mongolia)	18
Europe	32,4	30,5	32,3	17 (Bosnia/Herzegovina)	60 (Latvia)	36
Oceania	31,8	27,6	28,2	28 (Australia)	29 (New Zealand)	2

Source: ILOSTAT, ISIC level 2.
*Percent for last known year

Because of the limited number of reporting countries, however, the trends displayed in Figure 3.3 are only meaningful for Europe, where multiple countries have reported consistently over the years. By 2016, only three of Europe's 32 reporting countries had reached or exceeded parity (Figure 3.4). A closer look at changes between 2011 and 2016 shows a lot of variation at the country level: women's share increases in some countries (15 countries), remains essentially stagnant in a few (5 countries), and decreases in others (13 countries). Similar country variations can be seen in other world regions (Table 3.1). Regional analyses therefore need to be complemented with country-level breakdowns to get a true picture.

Figure 3.4
Percentage of women telecommunications industry employees, Europe



*Source:*LOSTAT.
Note: Kosovo uses 2014 data; Moldova uses 2014 and 2015 data.

3.2.3 / EMPLOYMENT IN ICT PROFESSIONS

Several studies confirm the existence of significant occupational segregation by gender (that is, gender concentration within specific fields), in both emerging and advanced economies, with women being most concentrated in education, health, and social work (e.g., Blau, Brummund, & Liu, 2013; ILO, 2017b). Furthermore, ILO reports that occupational segregation has "increased by one-third over the past two decades" (2017, p. 2). This tendency appears to be particularly pronounced in sectors related to ICTs. For example, women make up only 21.5% of the digital workforce in Europe (Quirós et al., 2018), 34% of the technology workforce in the U.S. (CompTIA, 2017), and 17% of IT specialists in the UK (BCS, 2017). After studying trends in computer and engineering education and employment in the U.S., Sassler et al. (2017, p. 19) conclude that "even though female employment throughout the life course has become increasingly normative in American society, and computer science jobs have proliferated and generally provide good wages, the occupation is not succeeding in drawing women. Instead, the evidence suggests that something about the field of computer science is repelling rather than attracting women." (See Chapter 5 for a discussion of reasons for women's low representation.) The Sassler study found that women with engineering and computer science degrees were 8% and 14% (respectively) less likely to work in STEM occupations than their men counterparts, suggesting that the engineering field is attracting more recent women graduates than the computer science field. The OECD Digital Economy Outlook placed the proportion of women workers who are ICT specialists at less than 2%, compared to over 5% for men (OECD, 2017).[9] In the cybersecurity field, a global study of 170 countries estimated that women constitute 11% of professionals (Frost & Sullivan, 2017). (For more detail on issues related to women's participation in the information security profession, see Part Two, Chapter 9 of this report.)

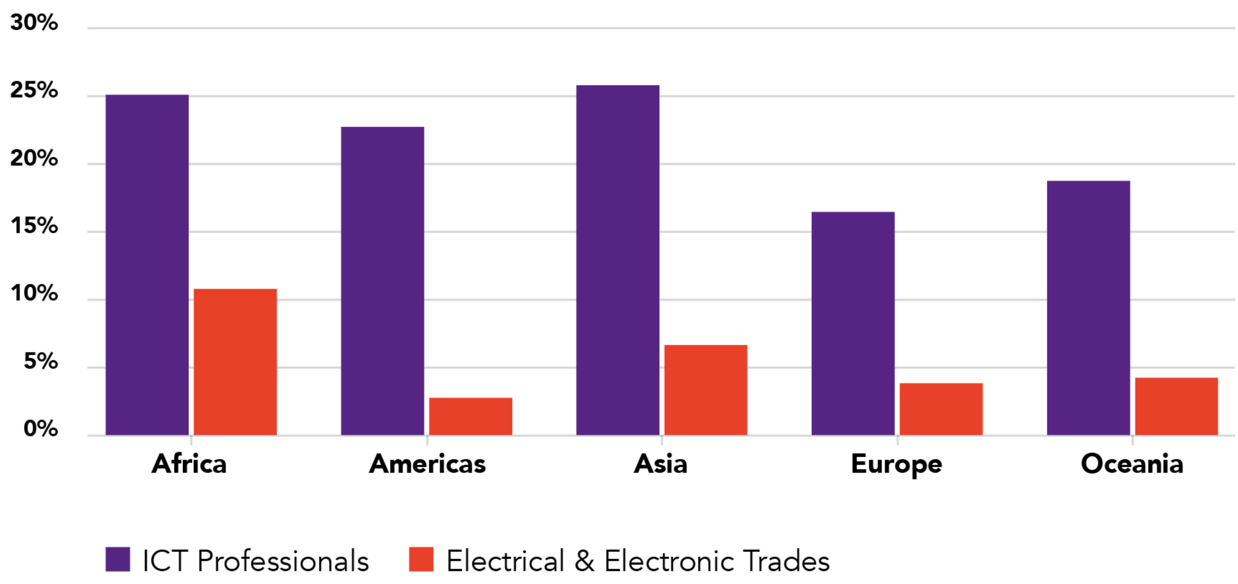
Other research, however, identifies contradictory trends, such as a decrease in occupational segregation among STEM graduates (Shauman, 2017). Furthermore, within the ICT industry, some sectors may be attracting higher proportions of women — for example, in the U.S., women's participation is only 27% in the Computer Systems Design sector, but almost 40% in Internet Publishing and Web Search Portals.

To explore this topic, we selected ICT-related professions for which some global data exists (using ILO occupational classification): ICT Professionals; Electrical and Electronic Trades Workers; and Science and Technology Researchers. Two other relevant professions, STEM Faculty and Software Developers, are also briefly discussed.

3.2.3.1 / ICT Professionals and Electrical and Electronic Trades

Overall, women represent less than 26% of ICT Professionals and Electrical and Electronic Trades employees (Figure 3.5). Europe, with the largest number of reporting countries, had roughly 15% to 17% women information and communication technology professionals between 2011 and 2016. The corresponding proportion of electrical and electronic trades workers in European countries was much lower — between 3% and 5% for the same period. Apart from a few spikes and drops that might be attributable to data gaps, regional trends have remained largely stable since 2011. At the country level, however, there are notable variations (Tables 3.2 and 3.3). For instance, women in Peru comprise 45% of ICT professionals and 60% of Electrical and Electronic Trades workers, compared to 14% and 2% in Mexico.

Figure 3.5
Percentage of female employees in ICT-related occupations, regional (2016)



Source: LOSTAT.

9 *ICT specialists are defined as people whose jobs include "tasks related to developing, maintaining and operating ICT systems and where ICTs are the main part of their job" (OECD, 2017, p. 183).*

Table 3.2
Percentage of female ICT professionals (%)

REGION	2010	2016	MEDIAN 2016	LOWEST PERCENTAGE	HIGHEST PERCENTAGE	NUMBER OF REPORTING COUNTRIES
Africa	29	25	33,3	19 (South Africa)	40 (Ethiopia)	5
Americas	22	22	25	14 (Mexico)	45 (Peru)	11
Asia	24	26	30,9	5 (Indonesia	34 (Thailand)	11
Europe	15	16	17,6	7 (Greece)	40 (Macedonia)	35
Oceania	16	19	19	19 (Australia)	-	1

Source: ILOSTAT (ISCO-08).
*Percent for last known year

Table 3.3
Percentage of female electrical and electronic trades workers

REGION	2010	2016	MEDIAN 2016	LOWEST PERCENTAGE	HIGHEST PERCENTAGE	NUMBER OF REPORTING COUNTRIES
Africa	8	11	8,6	2 (Algeria)	14 (South Africa)	4
Americas	8	2	4	2 (Mexico, Brazil, Ecuador)	60 (Peru)	9
Asia	29	7	3,7	>1 (Pakistan, Turkey)	24 (Philippines)	11
Europe	4	4	4	1 (several)	26 (Russia)	29
Oceania	5	4	35	2 (Australia)	67 (Fiji)	2

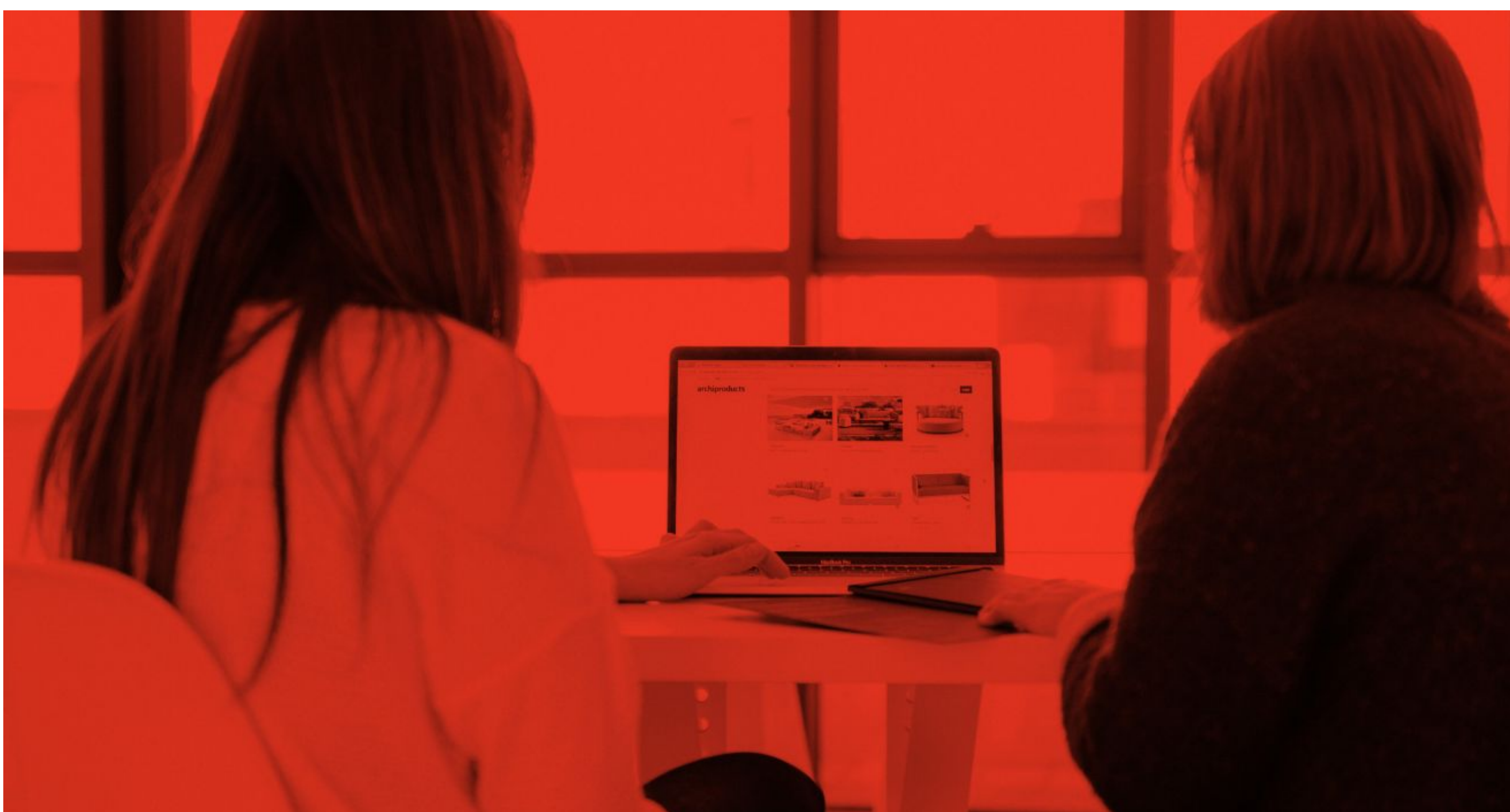
Source: ILOSTAT (ISCO-08).
*Percent for last known year.

3.2.3.2 / Software developers

At present, data on software developer employment is available mainly from individual countries or private surveys by the hosts of developer communities (such as Stack Overflow). OECD's intellectual property database also provides an avenue for investigating this topic, potentially covering a broader number of countries.

The software developer community appears particularly devoid of women, with potentially damaging consequences (Case Study 3.1). Analysis of a repository of intellectual property indicates that women comprise a very small proportion of R package developers (23%) and ICT patent holders (23%) in G20 countries (OECD STI, 2018). [10]

10 *R code is a free programming language and software environment for statistical computing (https://www.r-project.org/).*



Case Study 3.1

Women's participation in online software developer communities

Author: Michael Madaio & Araba Sey (UNU-CS)

Participation in online developer communities is becoming one of the primary ways for software developers to learn new programming languages, improve their skills, develop collaborative projects, and find new job opportunities (David & Shapiro, 2008; Ford et al., 2016; Vasilescu et al., 2015). These communities boast millions of users — over 29 million on GitHub (2018) and over one million on Stack Overflow (2018). GitHub users contribute code to about 60 million public "repositories" on the site, which are used by recruiters in hiring decisions. Professional software developers also hone their skills by asking and answering questions on coding Q&A sites like Stack Overflow. Stack Overflow developers also gain a public reputation from answering questions, further boosting their attractiveness to recruiters. Developers are also increasingly participating in coding challenges to hone their skills and signal their coding prowess to potential employers, through sites such as HackerRank, among others (Richard et al., 2015). However, despite the potential for these online developer communities to support software developers in their professional development, our analyses of open survey data (made available by GitHub, Stack Overflow, and HackerRank in 2017), indicate that gender gaps in participation may exacerbate the existing gender gaps in ICT, discussed throughout this report.

Who participates in online developer communities?
While women are estimated to comprise nearly 20% of the software development workforce (Wang et al., 2018), their participation in online developer communities is only a fraction of that. In a survey of approximately 100,000 software developers using Stack Overflow, only 4% of respondents identified as female. On GitHub's survey of 5,500 users, only 2% identified as female. HackerRank, the coding competition site, came closer to replicating the estimated gender gap in software development overall, with 16% of the 25,000 respondents identifying as female.

Among the users of Stack Overflow and HackerRank, men were nearly 15% more likely to be senior developers, nearly twice as likely to be in manager positions, and nearly four times as likely to be in executive roles. Male respondents on HackerRank were also nearly 15% more likely than women to be in hiring positions. However, women were more likely than men to be new graduates and junior developers, suggesting a newly burgeoning female software developer workforce. In addition, women on Stack Overflow were nearly twice as likely as men to fill technical roles like "data scientist" and "development operations engineer", which were listed as the top two best-paying jobs in 2018 (GlassDoor, 2018). Thus, while women in online developer communities still face gaps in traditional leadership roles, they may be emerging as leaders in new technical developer roles.

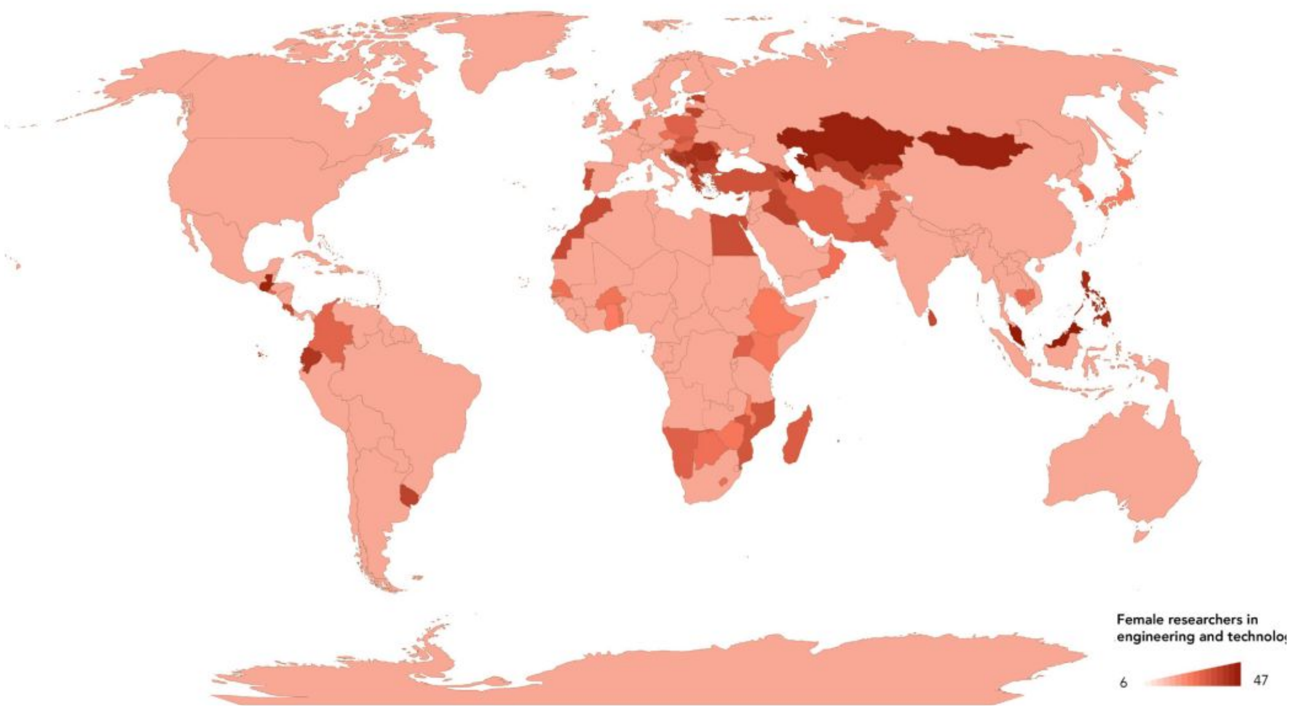
Do women and men participate differently?
On Stack Overflow, women were significantly less likely than men to have a registered account, and more likely to simply view Q&A on the site without responding or posting questions themselves. For GitHub, women were less likely than men to contribute code or "follow" other developers' repositories. These publicly visible acts of participation are precisely the types of "signaling incentives" that have been cited as a benefit of online developer communities for hiring decisions (e.g., Lakhani & Von Hippel, 2003; Vasilescu, 2014). In fact, when developers on GitHub were asked how interested they were in contributing to open-source projects in the future, there was no noticeable difference in male and female levels of interest; but when asked how likely they were to contribute in the future, female respondents reported feeling significantly less likely than male respondents to contribute code on GitHub in the future. While online developer communities can be valuable tools for skill development and recruitment, the lower rates of female participation suggest that women may not yet be reaping the benefits of these platforms. As a result, gender gaps in online developer communities may exacerbate existing gender gaps in ICT occupations.

3.2.3.3 / Faculty and researchers

There is surprisingly little publicly available and internationally comparable data on the proportions of women faculty employed in STEM or ICT-related academic programs. Possibly the most extensive source of substitutable data is the UNESCO Institute for Statistics' (UIS) data on female researchers, mostly in European countries.[11] The National Science Foundation (NSF) also collects detailed information on workforce participation of college graduates in the U.S. Statistics on other parts of the world are sparse and often dated, such as a 2015 USAID report presenting statistics on the leaky STEM academic pipeline in Africa dating back to 2008 (Cummings, 2015). This section presents UIS data on the proportion of female science and technology researchers as well as research on women faculty in STEM-related programs and business schools. Other potentially relevant data — such as women's share of research and development personnel and technicians — are unfortunately not systematically reported.

Researchers. As reported by the European Commission (2015), female researchers have been consistently underrepresented in Engineering and Technology, unlike other STEM fields such as the Medical Sciences. OECD (2017) research also finds that the proportion of women ICT specialists consistently lags behind the proportion of men, in all OECD communities. Figure 3.6 shows that the share of female researchers in the Engineering and Technology category ranges from 6% to 47%. While a few countries report that they are close to achieving equal participation of women (Malaysia, the Philippines, Kazakhstan, and Mongolia), most other countries are below 30%. Regional averages range from 22% to 29% for Engineering and Technology, as compared to between 34% and 50% for all other fields. At the country level, there is wide variation, from 30% to 55%. Trend data is uninformative, as the data available each year often represents different countries. [12]

Figure 3.6
Percentage of female researchers in engineering & technology (2010–15)



Source: UNESCO UIS

11 *UIS defines a researcher as a professional engaged in the conception or creation of new knowledge (UNESCO Institute for Statistics, 2017, p. 1).*

12 *For example, data is available for nine African countries in 2010 and a different set of three countries in 2015.*

STEM Faculty. Most of the studies carried out in North America and Europe show low proportions of women faculty in some STEM fields (often below 20%), particularly in fields related to engineering and computer science (e.g., Ling, 2017; Yoder, 2016). For example, workforce participation data from the 2013 National Science Foundation survey of doctorate recipients shows that, although women make up an equal proportion of United States graduates employed in science and engineering-related occupations in universities, they constitute only 34% of science and engineering occupations overall, and even fewer (17%) of computer and information scientists (https://www.nsf.gov/statistics/srvydoctoratework/).

Understanding the data from disparate research can be challenging; results may be contradictory or require nuanced interpretation. For example, Shauman (2017) found that women STEM graduates were more likely than men to enter tenure-track faculty positions within two years of degree completion, and equally likely to get such positions at research-intensive universities. However, while women were more likely than men to have jobs that require a doctorate, they were less likely to have research-oriented jobs. Furthermore, women graduates in engineering, mathematics, and computer science were less likely than other STEM graduates to work in business and industry. A controversial study by Ceci and Williams (2015) concluded that "women have substantial advantage in STEM faculty hiring, except when competing against more-accomplished men". Another study (Way, Larremore, & Clauset, 2016) found that hiring decisions in STEM departments were affected primarily by the productivity of candidates and the prestige of the candidates' academic institutions (although the authors also noted that subtle gender effects were probably at play).

A report by the Association of Academies and Societies of Sciences in Asia (AASSA, 2015) reviewed the state of women in science and technology in ten Asian countries, and found generally low representation of women in academic communities. In reference to Africa, Cummings (2015) laments the scarcity of robust data on women's representation in the STEM academic pipeline, noting that this hampers researchers' ability to provide a clear picture of the state of the academic pipeline in Africa:

The current inadequate data related to the underrepresentation of women faculty in STEAM careers undermines our capacity to provide adequate, scalable, replicable and sustainable solutions for gender inequalities. (Cummings, 2015, p. 3.)

Business School Faculty. Business schools represent an important context preparing individuals for leadership in both the corporate world and entrepreneurship. Analyses of the Global Salary Survey (a product of AACSB International, the Association to Advance Collegiate Schools of Business) indicate low proportions of women at leadership levels, shown in Table 3.4 (Brown, 2016). In 2017/18, 75% of deans and 66% of associate deans were men, and in 2015/16, just 20% of full professors were women (AACSB International, 2018).[13]

Table 3.4
Percentage of women faculty at business schools, by region

REGION	PROFESSORS	ASSOCIATE PROFESSORS	ASSISTANT PROFESSORS	INSTRUCTORS
Asia	13	27	38	50
Europe & near East	18	35	42	38
Middle East	13	21	25	47
Canada	23	34	41	39
US	28	31	29	42
Latin America and the Caribbean	20	33	37	40
All regions	20	33	38	40

Source: Adapted from Brown (2016).
Note: Based on 597 schools; no data for Africa and Oceania.

13 *Survey of 500 business school members of AACSB covering 25 countries, but primarily the U.S.*

3.3 / EMPLOYMENT–RETENTION AND ADVANCEMENT

Official statistics on retention rates are not collected at the global level. Evidence from North America and Europe indicates that women leave science and engineering jobs up to twice as frequently as men (Ashcraft, McLain, & Eger, 2016; Gumpertz, Durodoye, Griffith, & Wilson, 2017; J. Hunt, 2010). Most of this research, however, examines retention rates within the broad category of science and engineering, not the ICT industry specifically. Furthermore, much of the more recent literature on retention focuses on the reasons women leave the technology industry, rather than on their rate of leaving (e.g., Annabi & Lebovitz, 2018; Hunt, 2010; Servon & Visser, n.d.; Tapia & Kvasny, 2004). In Europe, Quirós et al. (2018, p.10) assert that attrition is especially high for women aged 30-40 years: "the prime working age and . . . the period when most Europeans have their first child and/or have to take care of their small children." Kahn and Ginther (2015) make a similar observation in their U.S. study. Research is needed to illuminate this topic, as much of what exists is limited in scale or scope and makes it difficult to compare churn rates for men and women technology workers, or across other types of industries. Reasons for attrition are contested; some researchers attribute it to family life demands, while others attribute it to workplace discrimination, including unequal pay, low access to advancement opportunities, dominant male culture, and unwelcoming environments. (This issue is further discussed in Chapter 4.)

According to the 2017 Global Gender Gap report (World Economic Forum, 2017), despite some gains since 2007, "every industry exhibits a leadership gender gap" and "the largest gaps are found in the STEM fields: Software and IT Services, Manufacturing and Energy and Mining" (p. 32).[14] In the absence of global data on women managers and executives in the ICT industry, this section examines three metrics on women female leaders more generally: employment in management positions; employment in senior and middle management positions; and employment as chief executives, senior officials and legislators. It also briefly covers women in academia leadership and ICT management, drawing on scholarly and other literature.

3.3.1 / GENERAL LEADERSHIP POSITIONS

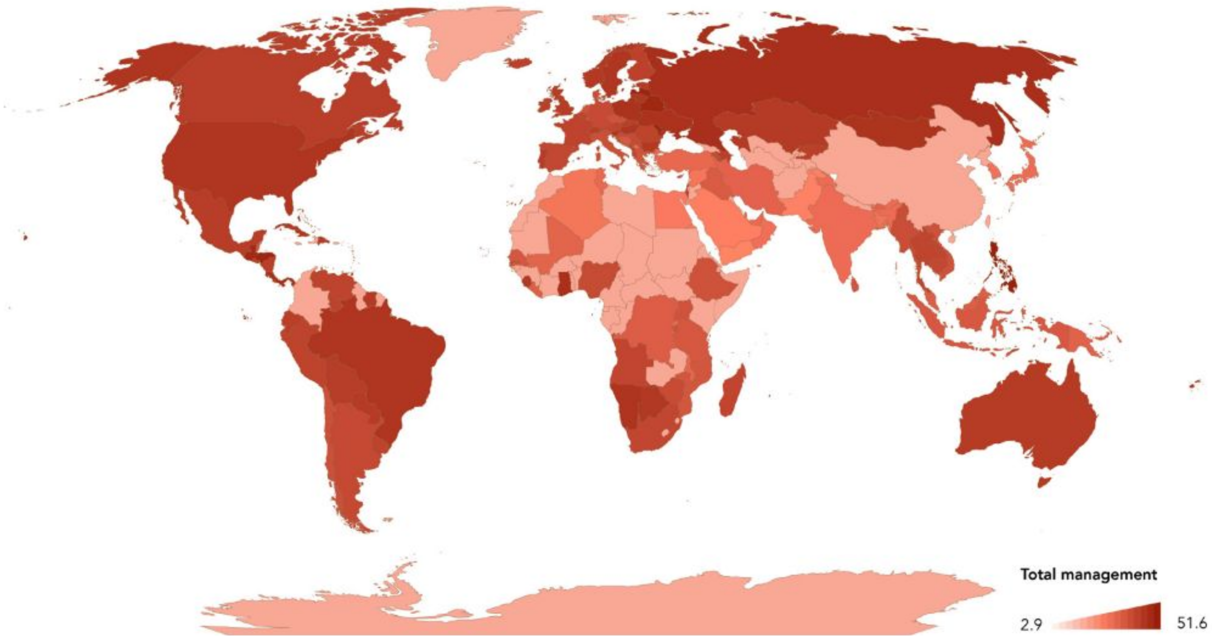
While regional trends suggest that women's employment in leadership positions is below 40% for all countries, a few countries nevertheless report close to or above parity (Figures 3.7–3.9). Regional trends appear essentially unchanged since 2009, despite some changes in several countries. Thus, as with the indicators in the previous sections, these metrics are best examined at the country level.

Exploring the data on senior and middle management positions for the last known year, we see wide variability in all regions (Figure 3.8). In Africa, the percentage of women managers ranges from 4% (Mali) to 44% (Seychelles), with 12 reporting countries. For the two countries with multiple year data (Mauritius and Seychelles), there is a rising trend between 2011 and 2015 of about 9% for Seychelles and 6% for Mauritius. Out of 13 countries reporting from the Americas, Uruguay has the lowest proportion of women senior and middle managers (33.7%), while the Dominican Republic has the highest (47%). Yearly data for the Americas (2011–2014) shows the proportion of women rising in two countries, remaining the same in two countries, and falling in three countries. Similar variability is seen in Asia (with 15 reporting countries), where women's employment as senior or middle managers ranges from 4% (Pakistan) to 37% (Mongolia); the proportion is increasing in three countries, decreasing in four, and remains the same in two. Likewise, in Europe, the proportion of women increases in nine countries, decreases in 21 countries, and is stagnant in two countries. The variation in Europe for the last known year ranges from 14% (Kosovo) to 48% (Russia). Finally, in Oceania, the figures range from 33% (Australia) to 42% (Samoa); the only country with yearly data (Australia) shows a slight increase from 30% in 2010.

14 *Based on an analysis of LinkedIn data.*

Figure 3.7

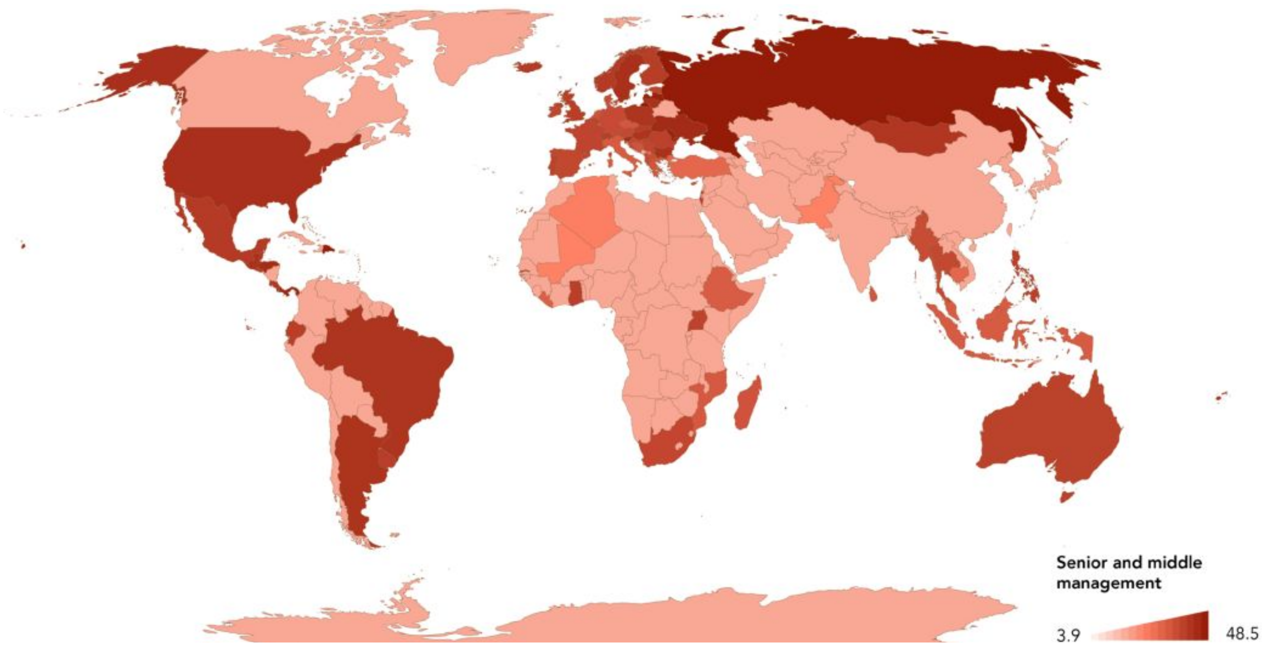
Female share of employment in managerial positions –
Total management



Source: ILOSTAT

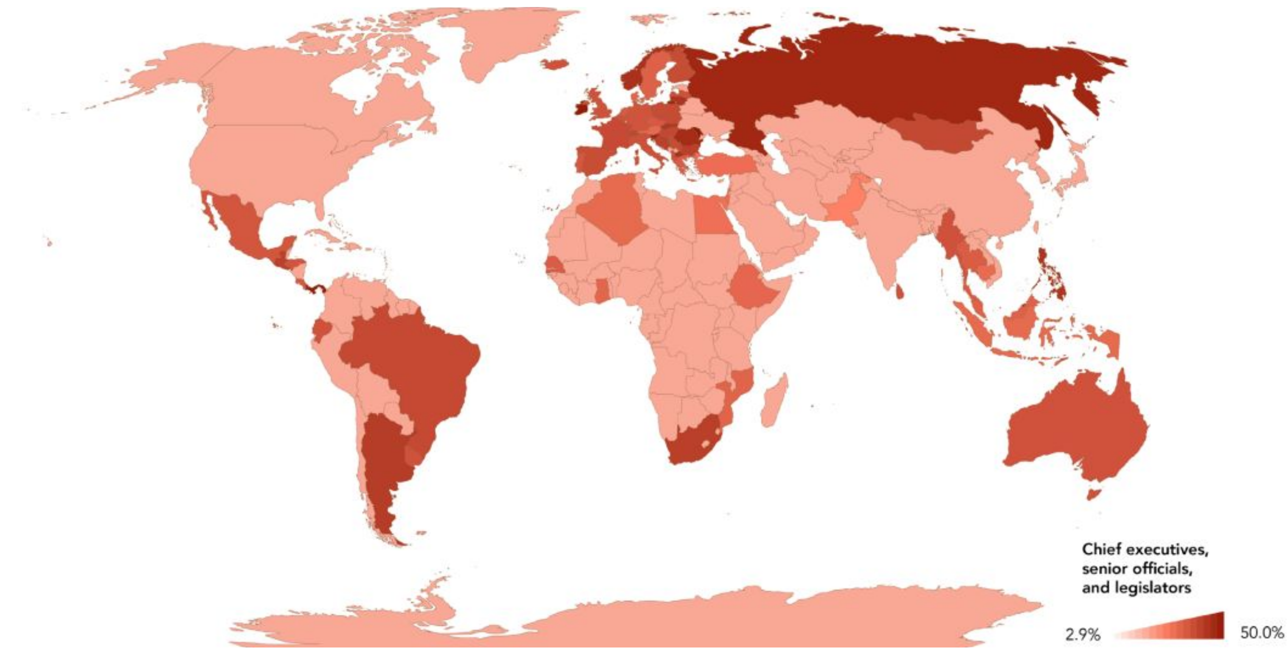
Figure 3.8

Female share of employment in managerial positions –
Senior & middle management



Source: ILOSTAT
Note: Limited data from most countries. For example, number of economies reporting for 2016: Africa 2; Americas 7; Asia 9; Europe 32; Oceania 2.

Figure 3.9
Female share of employment as chief executives, senior officials and legislators



Source: ILOSTAT

3.3.2 / LEADERSHIP POSITIONS IN THE ICT INDUSTRY

Data for the ICT industry is even less available than for general management trends. The most readily available data tends to come from a few national statistics departments. Other insights can be obtained from market research conducted by private organisations (which is often not freely available), and from academic research (addressing relatively narrow contexts). This section reviews examples of these studies covering three areas: the telecommunications industry, academies of science, and board membership. The variation in management levels, job titles, and business sectors sampled by various researchers limits the comparability of studies.

Telecommunications. A GSMA study of gender diversity in 54 telecom companies (Molina et al., 2015) showed that in all regions, women were employed in much larger proportions as entry-level staff rather than in middle and senior management positions. The largest gap was in Africa and the smallest in North America (Table 3.5). As with our observations on gender diversity in general management, the trends appear to be shifting, though from such a low level that the gap remains large. For example, the Global Telecoms Business lists the 100 most powerful people in the industry; it included 14 women in 2017 — up from only six in 2016, but still representing just 14%.

Table 3.5
Percentage of female telecom company employees

	ENTRY LEVEL	MIDDLE MANAGEMENT	SENIOR MANAGEMENT
Africa	35	21	9
Middle East	26	19	13
Asia-Pacific	28	19	15
Europe	43	30	20
North America	40	37	31

Source: Molina, Lin & Wood, 2015, p. 13.

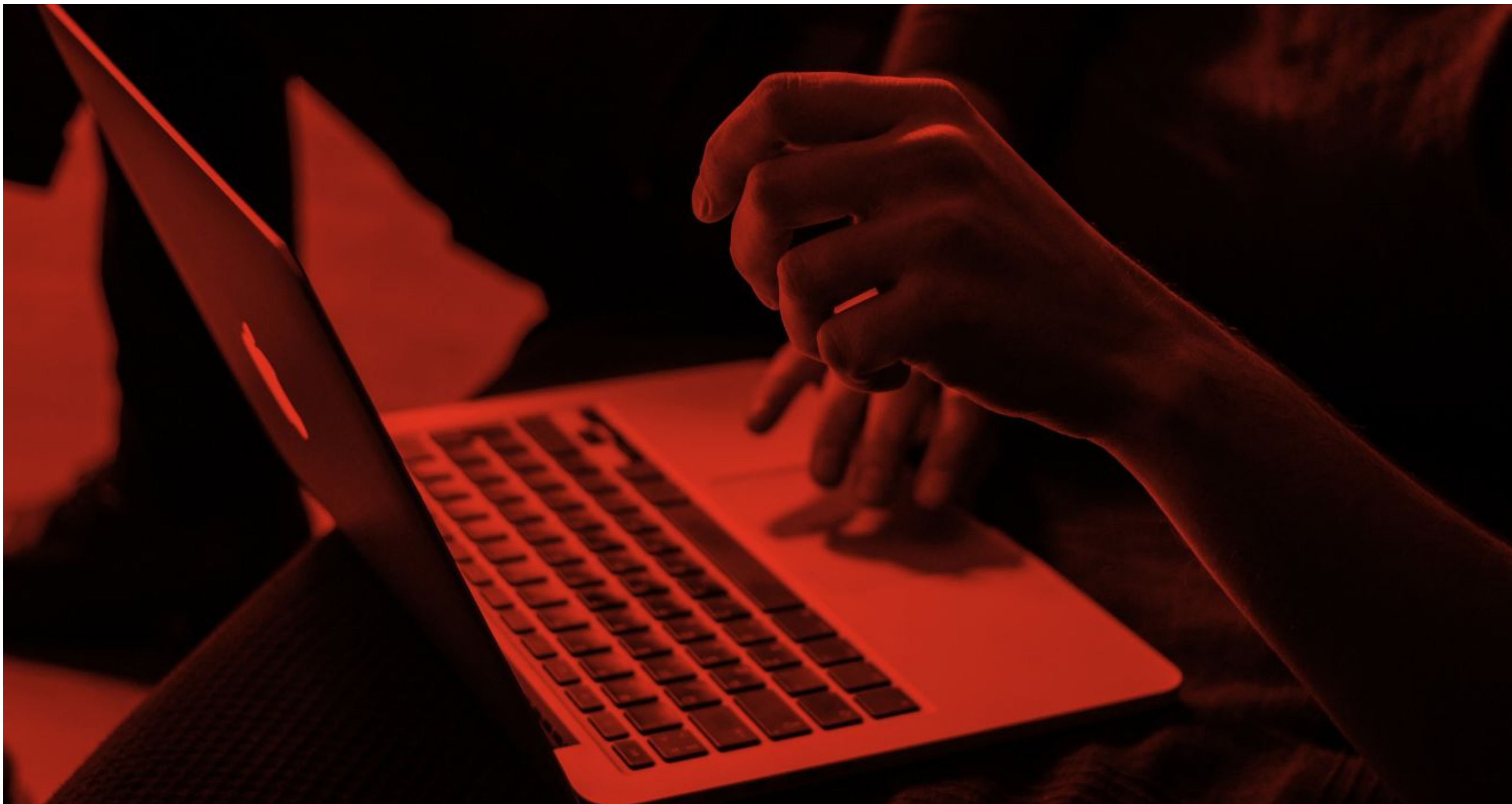
IT Sector. Examining the European landscape, Quiros et al. (2018, p. 13) report that in 2015 the IT sector was "the only sector without women occupying CEO positions in any of the corporations in STOXX 600." Women held 9.5% of CEO positions in the Telecom Services sector; only 25% of workers in the ICT sector had women bosses, compared to 48% in non-ICT sectors. In a global study, Dawson et al. (2014, p. 3) concluded that women were more represented in senior management of "new economy" companies, although overall women tended to be in less influential management roles. Table 3.6 shows that the proportion of women senior managers in several technology-related sectors exceeds the global average — except at CEO level.

Table 3.6
Women in senior management – Technology companies

	CEO	Operations	CFO/ Strategy	Shared Services*	Total
Tech – hardware	3,4	3,4	17,3	8,5	7,1
Telecoms	4,9	9,8	18,3	24,2	15,4
Tech – other	0	8,2	22,5	42,1	16,4
Tech – software	3,3	18,9	17	31,6	19,5
Global Average	3,9	8,6	17,5	18,9	12,9

Source: Dawson et al., 2014, p. 15.
Note: * HR, Legal, IT, External Relations

Data from the U.S. Bureau of Labor Statistics indicates that women currently make up about 29% of Computer and Information Systems managers. Similarly, the Equal Employment Opportunity Commission (2016) found that women comprised 20% of Executives, Senior Officials, and Managers in the high-tech industry in 2014. This percentage had not changed much by 2015; the U.S. Government Accountability Office (2017) reports that women occupied 19% of senior management positions in technology sector companies, and that this has essentially been unchanged since 2007. Bell and White (2014), on the other hand, conclude that progress has been made towards having more women in top positions over the past two decades, although they are still underrepresented. Overall, women tend to be in junior and support rather than managerial roles. Where women have made inroads into management, they are often in staff positions, rather than the line positions which constitute the main pathway to executive roles (Molina, Lin & Wood, 2015; United States Government Accountability Office, 2017; World Economic Forum, 2017). These trends appear to be repeated in the new industries developing around artificial intelligence (Case study 3.2; Parsheera, 2018).



Case Study 3.2

Where are the women? Gender disparities in AI research and development

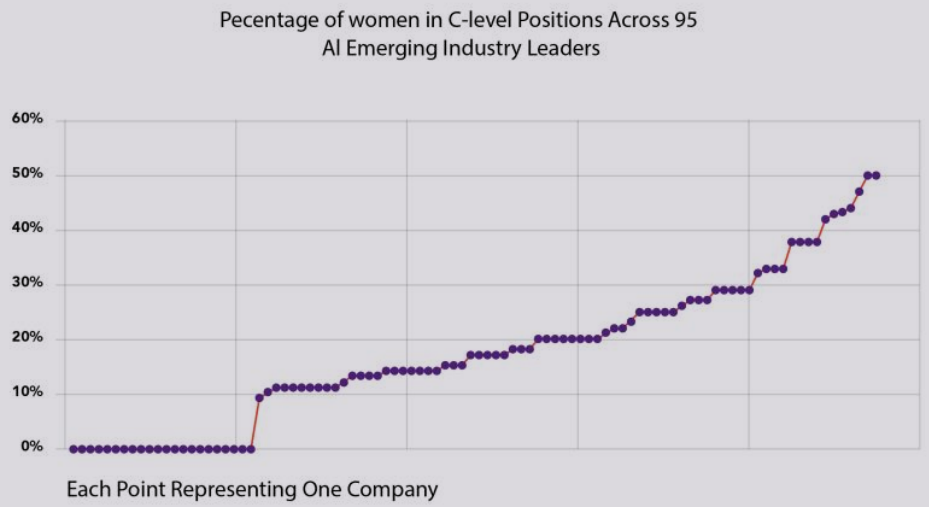
Author: Mike Best & Dhaval Modi (UNU-CS)

The artificial intelligence (AI) community has a diversity problem. Kate Crawford, a Microsoft researcher and NYU professor, asserts that AI has a "white guy problem" (Crawford, 2016). She explains why this matters: "Like all technologies before it, artificial intelligence will reflect the values of its creators. So inclusivity matters. . . . Otherwise, we risk constructing machine intelligence that mirrors a narrow and privileged vision of society, with its old, familiar biases and stereotypes."

The low level of female presence among AI researchers, developers, and thought leaders epitomises this diversity challenge. Hannah Wallach, a Microsoft-based AI researcher and founder of Women in Machine Learning (WiML), estimates that the entire field of machine learning is only 13.5% female (Weissman, 2016). To better amass evidence as to this gender disparity, we have accumulated data on women participation in leadership among top AI companies, as well as scholarly presence among the top U.S.-based university computer science faculty.

To calculate the percentage of women in executive management at leading AI startups, we began with CB Insights' 2018 "AI 100", their ranking of the top 100 promising start-ups in Artificial Intelligence (https://www.cbinsights.com/research/artificial-intelligence-top-startups/). CB Insights' 2018 "AI 100" list includes companies from the U.S., Canada, the UK, France, Spain, Japan, China, Taiwan, and Israel (https://www.cbinsights.com/research/artificial-intelligence-top-startups/). We were able to establish the gender balance among executive management for 95 of these companies. (One C-level manager is identified as non-binary and is not categorised here.) Only two companies have equal numbers of women and men in their C-level positions and none are majority female. Three in five have less than 20% women in their leadership team, and one in five have no females at all. Women overall made up 18% of these AI leaders.

Figure 3.10
Women in senior management – Technology companies



Source: Dawson et al., 2014, p. 15.
Note: * HR, Legal, IT, External Relations

We computed the percentage of female professors at top U.S.-based university AI programs, based on the top 20 programs listed in the US News & World Report 2018 ranking of best artificial intelligence graduate programs (https://www.usnews.com/best-graduate-schools/top-scienceschools/artificial-intelligence-rankings). We calculated the number of faculty members (including adjuncts) from each university's website and from laboratory staff listings (e.g., for Stanford University), as well as from research interests as stated on faculty websites (e.g., Carnegie Mellon).
We were able to obtain faculty gender information for all but two programs (UCLA and Cal Tech). The average percentage of female AI faculty was 22%, ranging from 8% (University of Pennsylvania) to 43% (Harvard). No university had achieved gender parity among its AI faculty.

3.3.3 / LEADERSHIP ON BOARDS

A similar trend of low representation of women is seen with board membership (Deloitte & Alliance for Board Diversity, 2016; Institutional Shareholder Services, Inc & Regulation, 2017; Quirós et al., 2018). However, it is unclear whether the situation is worse in the ICT industry than in other areas. Some data are difficult to interpret, due in part to varying definitions and the diversity of industry sectors. Adams and Kirchmaier (2016) studied data for listed firms in 20 countries and found that firms in STEM and Finance sectors had 1.8% fewer women on boards than firms in non-STEM sectors. In cybersecurity, men are four times more likely than women to hold executive-level positions, and nine times more likely to hold managerial positions (Frost & Sullivan, 2017). Women comprise 9% and 15% respectively of directors and executive officers in Canada's technology industry (MacDougall et al., 2017), while according to Bell (2016), Silicon Valley firms have relatively low proportions of women directors, at 14% (compared to 23% for large public companies).

Conversely, Chanavat and Ramsden (2013), evaluating multiple countries, found that technology companies had some of the most gender-diverse boards (around 20% women), but that telecommunication service companies had less diverse boards (around 15%). In Europe, however, the telecommunication service sector has the highest percentage of women on boards (at 27%) and "is also the only sector where all companies have at least one woman on their boards"(Quirós et al., 2018, p. 12). Quiros et al. (2018) also found significant improvement in the number of women board members in the IT industry — a 102% increase since 2011 — although the IT sector also had the highest percentage of all-men boards. A global study by Credit Suisse (Dawson et al., 2014) found that the telecom industry had one of the highest proportions of women on boards, while the technology industry had lower proportions (Table 3.7). Comparing women on boards in a variety of economic sectors, Deloitte (2017) found that, while in most regions the Technology, Media and Telecoms category was not among the top three performers, in Asia and the Middle East women constituted 8% and 12% (respectively) of boards in this category.

Table 3.7
Percentage of women on boards, by industry

	2010	2013	0	<10%	10% - 20%	20% - 30%	>30%
Technology	8,1	10,9	40,8	7,9	32,1	15,8	3,4
Telecoms	11,1	14,2	34,1	12,2	22	20,7	11
Total	9,6	12,7	33,7	11,1	31,4	16,9	6,9

Source: Dawson et al., 2014, p. 10.

These mixed findings complicate any analysis of gender equality in board membership of ICT companies. Furthermore, board size impacts diversity as well, as the boards of larger companies tend to be more gender diverse than those of smaller and younger companies (Bell, 2016; Brush, Greene, Balachandra, & Davis, 2014). This suggests that understanding and measuring board diversity may require more than simple headcounts.

3.3.4 / ACADEMIES OF SCIENCE

Analysis of data from the European Institute for Gender Equality (EIGE) shows that in the 28 EU member states, women comprise less than 22% of membership and less than 16% of presidents or chairs of the highest decision-making body in national academies of science (EIGE database, 2017)[15]. Only eight countries have women presidents or chairs. Similar trends likely pertain elsewhere; a survey by the Academy of Science of South Africa (2015) finds that, globally, women make up only about 12% of the membership of science academies. The highest proportion was at the Cuban Academy of Sciences (27%) and the lowest at the Polish and Tanzanian Academies of Sciences (4% each). Women constitute 12% of elected Fellows of The World Academy of Sciences (TWAS)[16] and 32% of its Young Affiliates programme (The World Academy of Sciences, 2018). As Table 3.8 shows, the distribution of women TWAS fellows across different disciplines mirrors the tendency for women science scholars to be concentrated in the medical and social sciences.

Table 3.8
The World Academy of Sciences Fellows

FIELD	NUMBER OF FEMALES	NUMBER OF MALES	PERCENTAGE OF FEMALES
Social & economic sciences	12	32	27%
Medical & health sciences including neurosciences	30	124	19%
Structural cell & molecular biology	21	116	15%
Agricultural sciences	18	85	17%
Biological systems & organisms	14	70	17%
Chemical sciences	16	142	10%
Astronomy, space and earth sciences	15	117	11%
Physics	14	167	8%
Mathematical sciences	7	106	6%
Engineering sciences	5	112	4%

Source: The World Academy of Sciences, https://twas.org/directory/overview

15 *Note: out of 58 positions. Most countries have just one leadership position per academy, but may have several academies.*

16 *A "global science academy dedicated to building science in the developing world" (TWAS website), with membership from 100 countries.*

3.4 / ENTREPRENEURSHIP

While some of the issues women face in the ICT employment realm may also apply to their participation in digital entrepreneurship, other issues are unique to women entrepreneurs. Access to venture capital is one that has received considerable attention in recent months, as data reveals how little such capital is available to women entrepreneurs. However, there is still limited data on this and other relevant issues (Kuschel & Lepeley, 2016). Thus, we use indicators relating to women entrepreneurship broadly, with a few additional sources about the ICT industry. The discussion below covers women's participation in ownership of businesses, access to business training, and access to business capital.

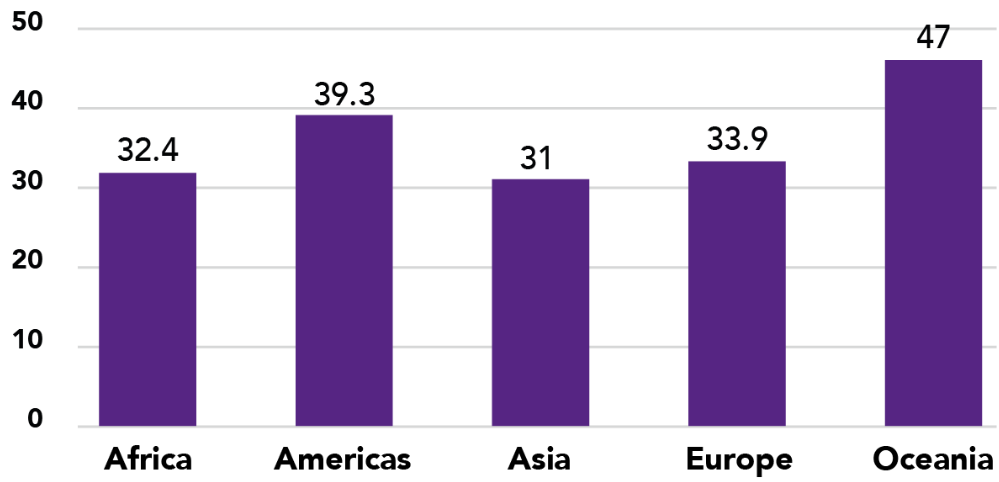
3.4.1 / FIRM OWNERSHIP

Globally, the gender gap in entrepreneurship has narrowed since 2014; however, women are less likely than men to start enterprises in the ICT sector (Kelley et al., 2017). Women constitute only 6% of information technology entrepreneurs in the U.S. (Gompers & Wang, 2017b); Europe has a higher proportion of women entrepreneurs in the ICT industry, at 23% (Quirós et al., 2018).

The data presented below relates to women's participation in ownership of firms in general, in the absence of global data on women's ownership of technology or ICT firms. (Note, however, that relatively few countries report even this data: 10% of countries in Oceania, 47% in Europe, 61% in Africa, 64% in Asia, and 65% in the Americas.) The available data shows that less than 50% of firms have at least one woman owner (Figure 3.11). Data collected by the Global Entrepreneurship Monitor (2015 dataset) shows a higher proportion of men entrepreneurs in most countries. That entrepreneurial gender gap ranges from 5% in the Philippines — where women are more likely than men to be engaged in entrepreneurial activity — to -11% in Lebanon, where men are more likely than women to be engaged in entrepreneurial activity. Women exhibit more entrepreneurial behaviour than men in six countries, of which five are in Asia.

At the country level, we see an entrepreneurship paradox similar to the education paradox mentioned in Chapter 2: the lower a country's level of socio-economic development, the smaller the gender gap in entrepreneurship seems to be.[17] However, women entrepreneurs in lower-income countries are more likely to be driven by necessity rather than opportunity motives (Kelley et al., 2017; OECD, 2012), and this can compromise the long-term sustainability and growth of their ventures. There is also insufficient data to determine whether women venture into digital entrepreneurship. Some evidence suggests that the digital economy has generated opportunities (such as airtime sales, phone repairs, data entry, community information services, and call centres) for women entrepreneurs in developing countries; see, for example, Heeks (2005) and UNCTAD (2014). However, more data is needed to determine the relative proportion of men to women in these enterprises, and whether there are differences in the conditions under which they work.

Figure 3.11
Percentage of firms with women participating in ownership



Source: World Bank.
Note: Variable data availability for different regions.

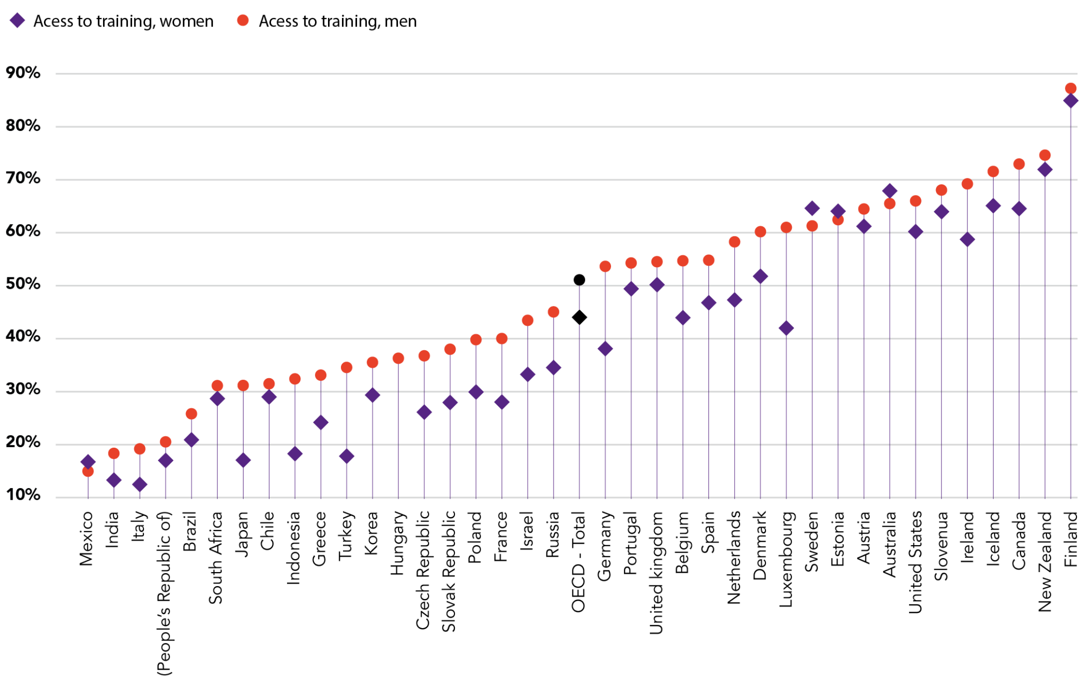
17 *The reasons for this are beyond the scope of this report, but some relevant factors may be found in the entrepreneurship literature.*

3.4.2 / ACCESS TO BUSINESS TRAINING

Most discussions of gender gaps in ICT entrepreneurship tend to approach the subject from the perspective of access to the appropriate technical training, with less attention being paid to obtaining the requisite business skills. Most ICT entrepreneurs require business knowledge to be successful in running the enterprise and, importantly, to raise business capital. Indeed, an interest in business —instead of an interest in technology — represents an alternative route to digital entrepreneurship.

OECD data indicates that women generally have less access than men to training on how to start a business (Figure 3.12). The tendency is the same in the six non-OECD economies included in the dataset. Only in four countries (Mexico, Estonia, Australia, and Sweden) are women equal to or slightly more advantaged than men with regard to such training. The gap is highest in Luxemburg (19% more men) and lowest in Sweden (3% more women).

Figure 3.12
Access to training to start a business



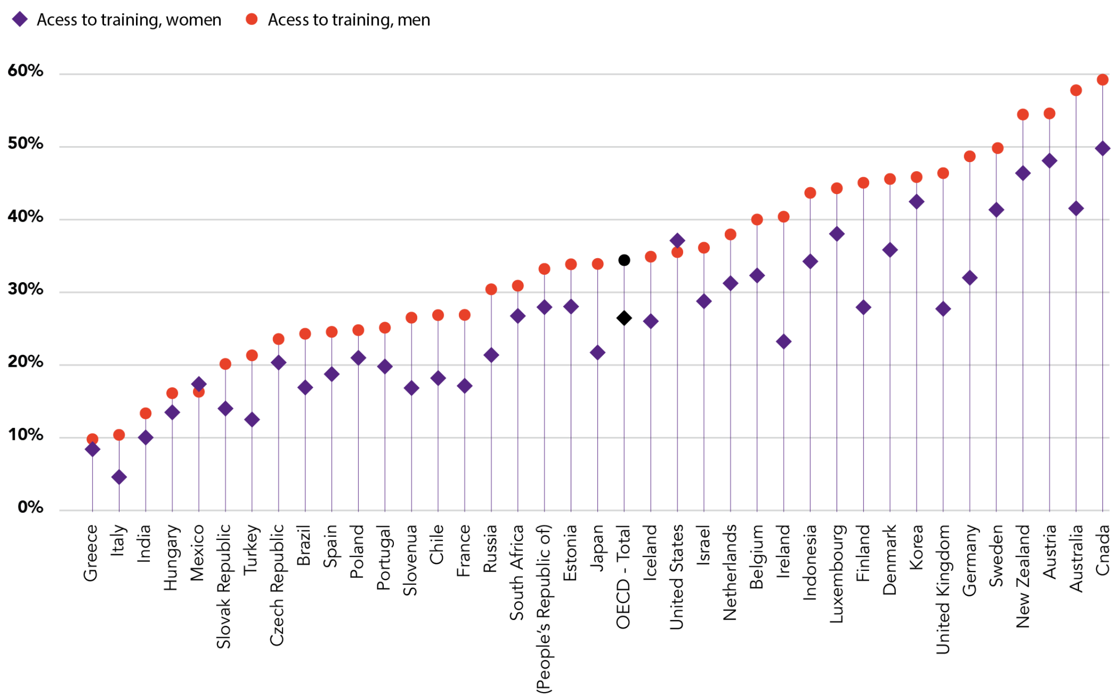
Source: OECD Social and Welfare Statistics, 2018 (database), http://dx.doi.org/10.1787/data-00723-en

3.4.3 / ACCESS TO BUSINESS CAPITAL

Access to capital is critical for entrepreneurs, regardless of business size. Some indication of ability to secure capital can be gleaned from data on the use of formal financial instruments by the general population. This section presents OECD data, on access to capital to start a business, as well as World Bank data, on ownership of a bank account, saving, and borrowing from a financial institution.

Overall, women are disadvantaged in access to financial services that could facilitate access to business capital. In most OECD countries, women are less likely to have access to capital to start a business compared to men (Figure 3.13).

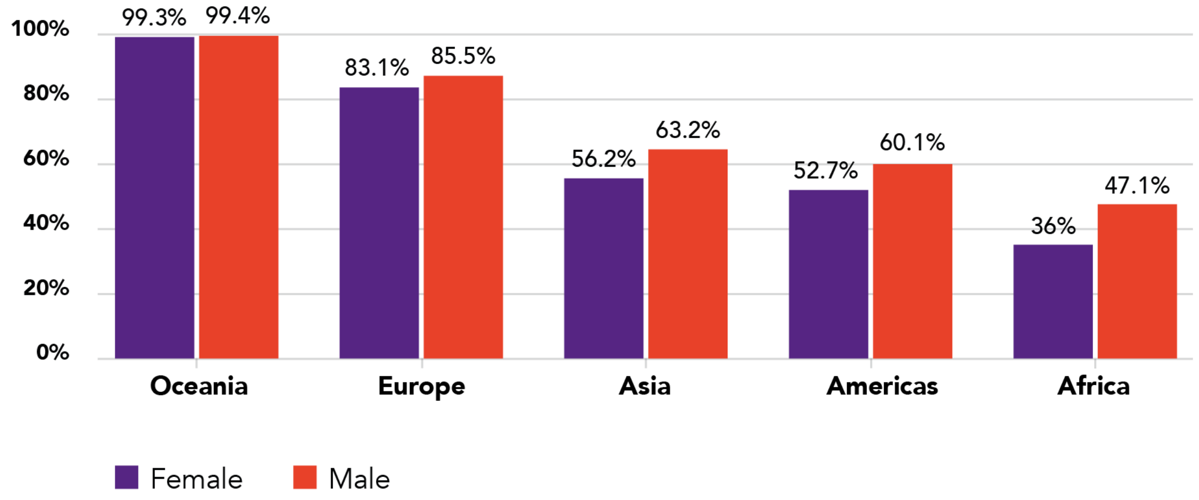
Figure 3.13
Access to finance to start a business



Source: OECD Social and Welfare Statistics, 2018 (database), http://dx.doi.org/10.1787/data-00723-en

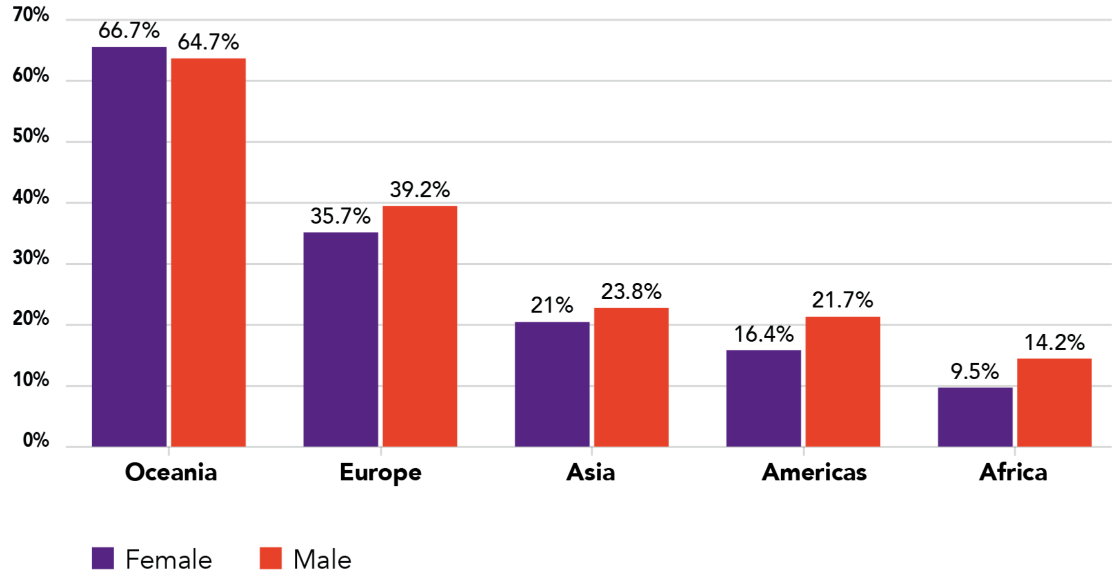
Levels of financial inclusion are low for both men and women in Asia, the Americas, and Africa. Even so, all regions except Oceania exhibit a gender gap in favour of men, though very narrow in some cases (Figures 3.14–3.16). The gap in account ownership ranges from 2% (Europe) to 11% (Africa). The gap in saving activity ranges from 3% (Asia) to 5% (Americas). And the gap in borrowing activity ranges from 2% (Africa) to 3% (Europe). In the two Oceania countries represented, women have equal access to bank accounts, they are more likely to save than men, and they are more likely to have borrowed from a financial institution. Globally, a pilot survey of 28 central banks and other regulators found that 40% of account holders and borrowers are women (IMF, 2018).

Figure 3.14
Percentage of adults (15+ years) with an account at a bank or other financial institution or with a mobile-money-service provider



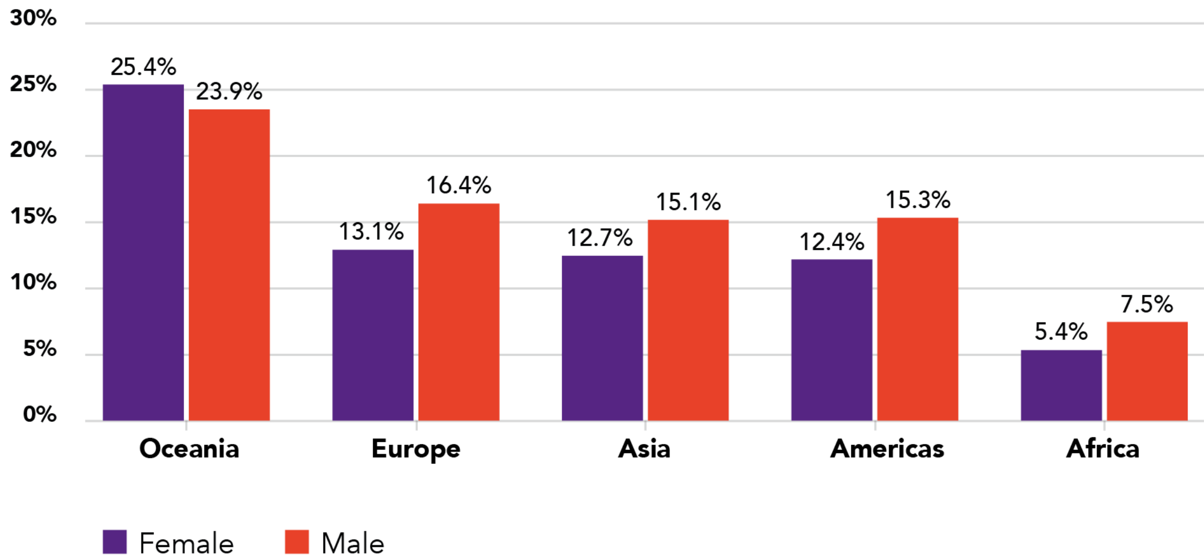
Note: Robust data – 144 countries represented; only 2 countries from Oceania.

Figure 3.15
Percentage of adults (15+ years) who have saved at a financial institution



Source: World Bank, Global Findex Database (http://www.worldbank.org/globalfindex).
Note: Robust data – 144 countries represented; only 2 countries from Oceania.

Figure 3.16
Percentage of adults (15+ years) who have borrowed from a financial institution



Source: World Bank, Global Findex Database (http://www.worldbank.org/globalfindex).
Note: Robust data – 144 countries represented; only 2 countries from Oceania.

3.4.4 / ACCESS TO VENTURE CAPITAL

The availability of venture capital (VC) investment provides a view on the experience of women trying to start ventures in the ICT industry, since a majority of venture capital goes into the ICT and related sectors (Ernst & Young, 2015). The U.S. (and especially the San Francisco Bay area) receives almost three-quarters of global venture capital (Ernst & Young, 2015), and a majority of this goes to the software (36%) and biotechnology (17%) sectors (NVCA, 2016).

Data on entrepreneurs' access to venture capital is only recently becoming public. It shows that investment in businesses with women partners has increased but still remains low, and women-run companies receive a dismal proportion of venture capital. Brush et al. (2014) examined a database of 6,793 VC recipients in the U.S. between 2011 and 2013 and found that over 15% of the companies had a woman on the executive team, up from less than 5% in 1999. Moreover, the companies with a woman on the team also received more funding than in previous years. However, only 2.7% of the companies had a woman CEO, and those companies only received 3% of total VC investments (see also: Bradley, Gicheva, Hassell, & Link, 2013; and Scott, Kapor Klein, McAlear, Martin, & Koshy, 2018). A study of 58 investment funds that ascribe to gender-lens investing found, on the positive side, that 59% of these funds had all-women partners (compared to the industry norm of 7%). However, they also noted "an inverse relationship between fund size and the proportion of women fund partners or investment committee members: the more women at the top, the less capital raised" (Biegel, Hunt, & Kuhlman, 2017, p. 6). Similarly, Quiros et al. (2018) observed that in Europe, wholly woman-owned startups received less than 5% of all VC deals in 2016 — an improvement over previous years — and that in the UK, for example, men entrepreneurs were 86% more likely to obtain VC funds than women (p. 12).

A lack of diversity can also be seen within venture capital firms, with very few woman venture capitalists. For example, a review of 160 venture capital firms in the UK found that only 13% of partners were women; 48% of investment teams had no women (Diversity VC, 2017). Likewise, Scott et al. (2018) report that women constitute just 11% of investment professionals in the U.S. This is important if, as some evidence suggests, VC firms with women partners are more likely to invest in businesses with women managers or CEOs, compared to VC firms with women in their management teams (Brush et al., 2014).

3.5 / POLICYMAKING

The dearth of gender perspectives in the technology industry could potentially be addressed by including more women in senior policymaking positions, not only in technology organisations but also in political institutions.

3.5.1 / PARTICIPATION IN NATIONAL GOVERNANCE

At the level of national governance, gender diversity is already low, as seen in the proportion of seats held by women in national parliaments (Table 3.9). All regions have less than 30% representation of women.

Table 3.9
Proportion of seats held by women in national parliaments

	SINGLE HOUSE OR LOWER HOUSE	UPPER HOUSE OR SENATE	BOTH HOUSES COMBINED
Americas	28,8	29,5	28,9
Europe	27,6	27	27,5
Sub-Saharan Africa	23,9	23,1	23,8
Asia	19,7	17,5	19,5
Arab States	18,5	12,6	17,7
Pacific	15,5	37,1	17,9

Source: Inter-Parliamentary Union, April 2018, http://archive.ipu.org/wmn-e/arc/world010418.htm

3.5.2 / PARTICIPATION IN ICT-RELATED POLICYMAKING AGENCIES

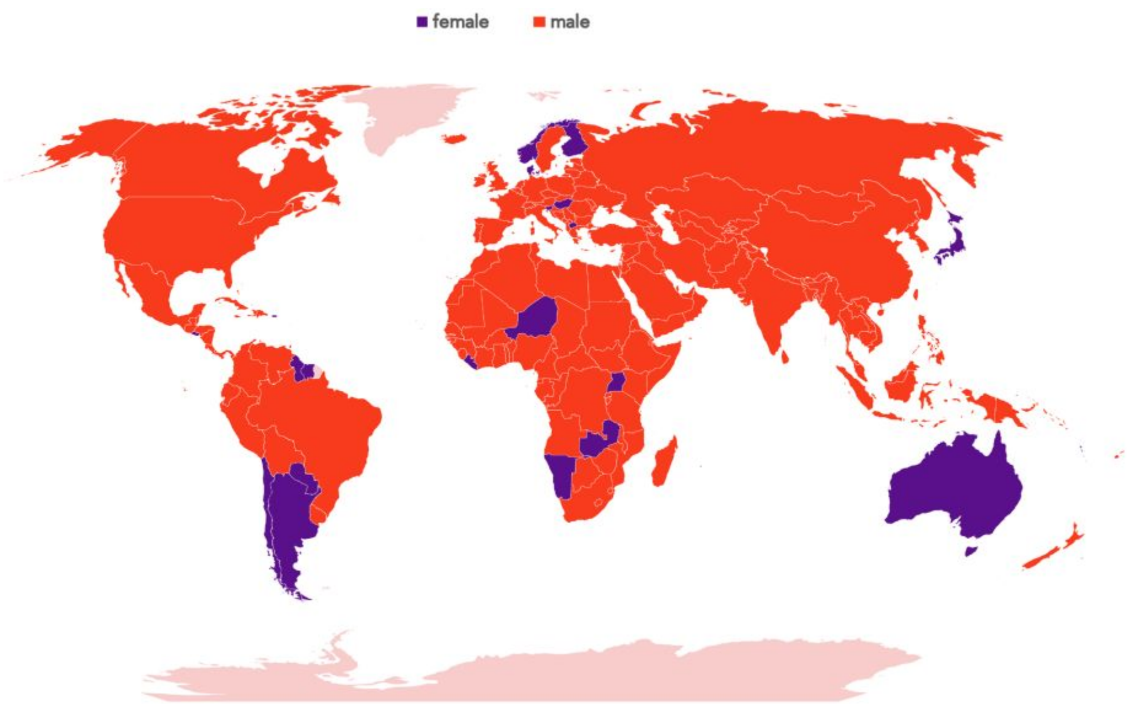
Public information is available relating to two key types of ICT-related government agencies — ICT ministries and telecommunications regulators. Worldwide, only 28 out of 203 countries have a woman in charge of the ICT ministry (Table 3.10). Nearly 88% of ICT ministers are men (Figure 3.17). Africa and the Americas have the highest percentage of ICT ministries led by a woman (17% and 23%, respectively).

Table 3.10
Proportion of female heads of policymaking agencies

	ICT MINISTRY	TELECOM REGULATOR
Americas	20%	23%
Africa	14%	9%
Europe	13%	13%
Oceania	7%	23%
Asia	2%	6%
TOTAL	12%	13%

Source: UNU-CS desk research, June 2018

Figure 3.17
Countries with a woman in charge of the ICT ministry



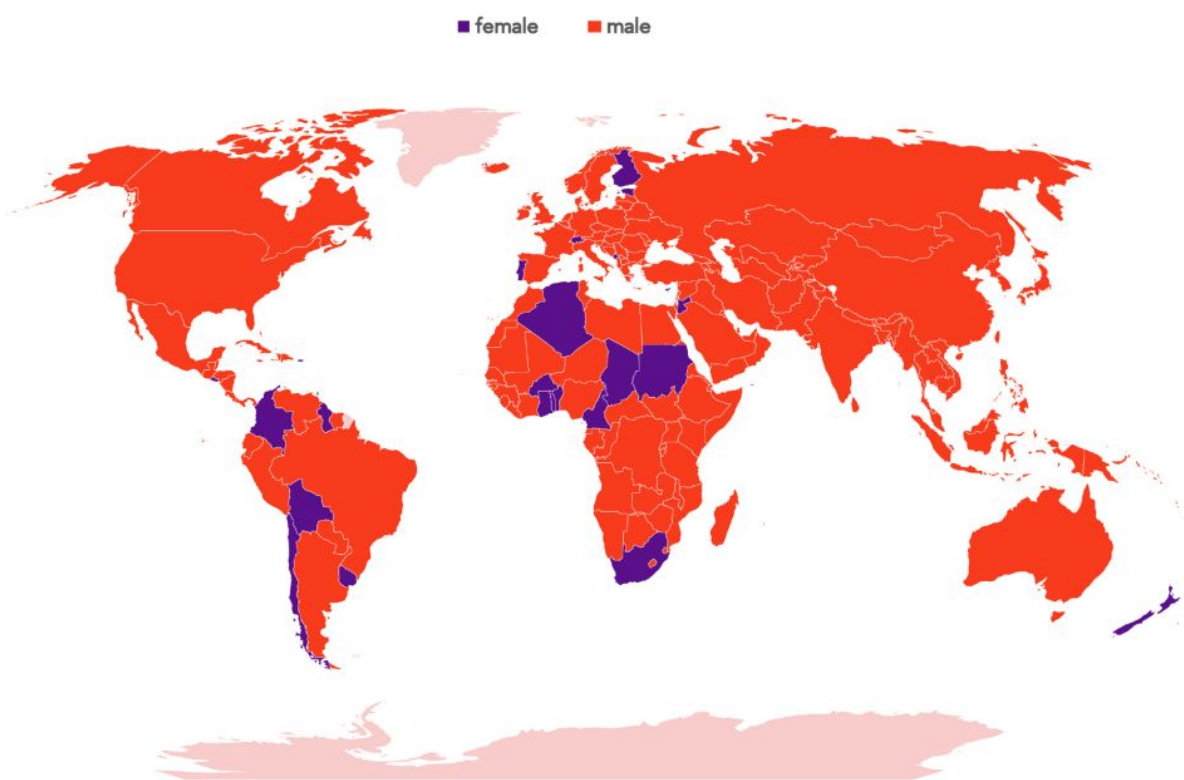
Source: UNU-CS desk research, June 2018

The 28 countries with a woman ICT minister in 2018 were: Algeria, Barbados, Benin, Bolivia, Burkina Faso, Cameroon, Chad, Chile, Colombia, Cyprus, El Salvador, Estonia, Finland, Ghana, Guyana, Jordan, Monaco, Montenegro, New Zealand, Portugal, Puerto Rico, Sint Maarten, South Africa, Sudan, Switzerland, Togo, Trinidad and Tobago, and Uruguay.

Similarly, in 2018, only 25 countries had a woman heading the telecommunications regulator (Figure 3.18). The Americas and Oceania have the highest percentage of woman telecommunication regulators (23% in each region). The 25 countries with a woman as head of the telecommunications regulator were: Argentina, Australia, Chile, Denmark, El Salvador[18], Finland, Guyana, Hong Kong, Hungary, Japan, Liberia, Macau, Macedonia, Namibia, Niger, Norway, Paraguay, Puerto Rico[19], Samoa, Sint Maarten, Slovenia, Suriname, Uganda, Vanuatu, and Zambia.

Figure 3.18

Countries with a woman in charge of the telecommunications regulator



Source: UNU-CS desk research, June 2018.

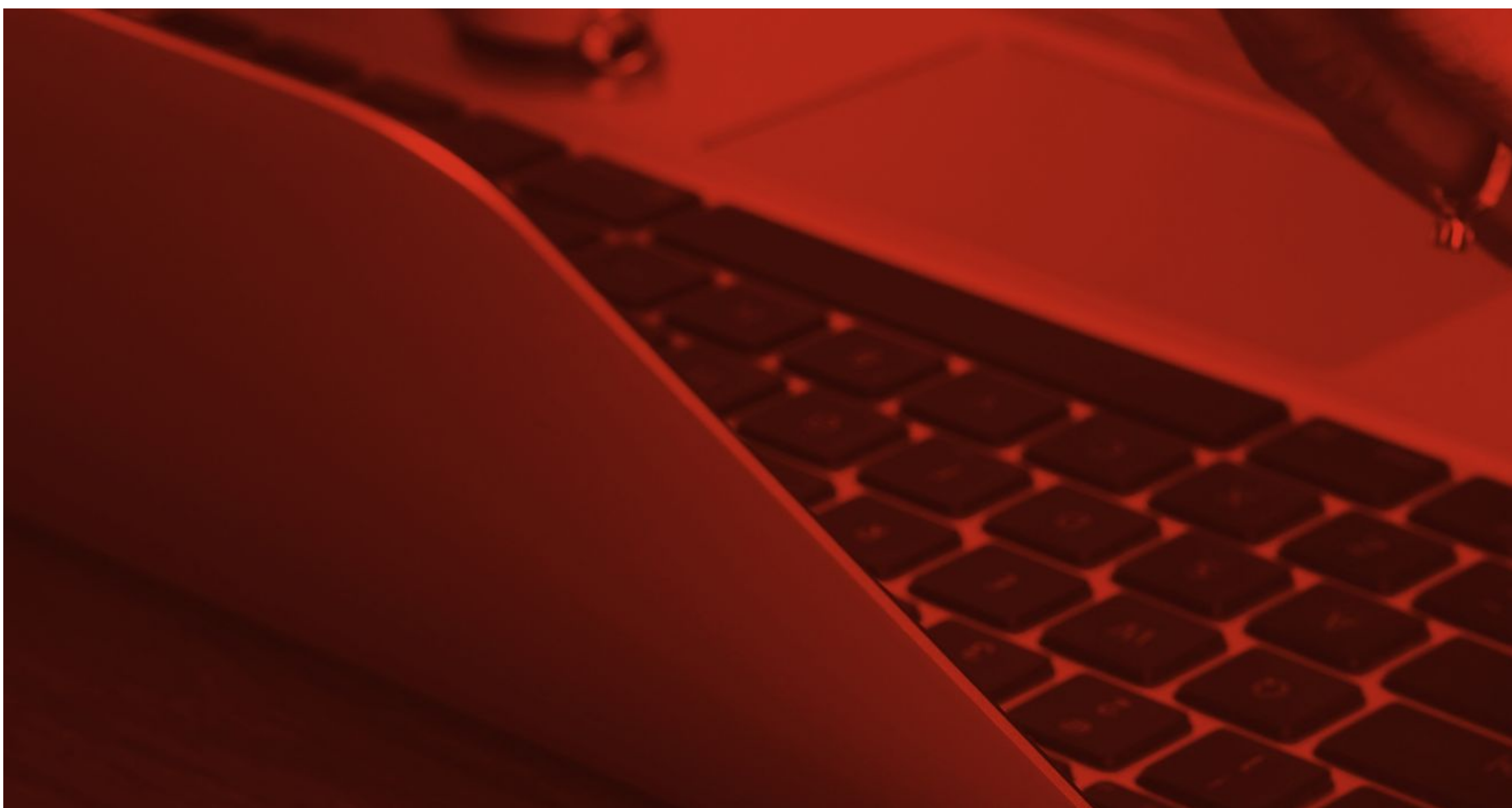
18 *The head of El Salvador's telecommunications regulator is also the Minister of Communications and Information Technology (ICT).*

19 *The head of Puerto Rico's telecommunications regulator is also the Minister of Communications and Information Technology (ICT).*

3.6 / CONCLUSION

This chapter reviewed data and research on women's employment in the ICT workforce, women's contribution to the industry as entrepreneurs, and women's inclusion in related policymaking. The results suggest that, although gains have been made over the years, women's representation is low across different dimensions. While more and more women are holding highly skilled jobs, few of them are in ICT-related fields; however, we see wide variation by country. Within ICT and STEM occupations, women are nearly absent from software development, in engineering and technology research, and in university teaching. There is a high rate of women leaving science and technology jobs, whether due to the lack of work-life balance frequently found in male-dominated fields or to a range of gendered obstacles to achieving their career goals. Few women are found at any level of technology leadership, and those tend to serve in subordinate roles with little chance for advancement. Women are also less likely to become ICT entrepreneurs; they generally lack training in business startups and have very little access to venture capital. Most seriously, they have a very low rate of representation in science and technology policy making.

However, the severe lack of relevant data makes it difficult to reach an accurate assessment of the global situation. European and North American countries tend to have the most ICT-specific data; and even there, the data is variable and often requires nuanced interpretation.



REFERENCES

AACSB International. (2018). Staff compensation and demographics report: 2017-18 executive summary. Association to Advance Collegiate Schools of Business. Retrieved from: https://www.aacsb.edu/-/media/aacsb/publications/data-reports/global-salary-survey/staff%20compensation%20and%20demographics%20report%202017-18%20executive%20summary.ashx?la=en

AASSA. (2015). Women in science and technology in Asia. The Association of Academies and Societies of Sciences in Asia. Retrieved from: www.interacademies.org/File.aspx?id=28016

Adams, R. B., & Kirchmaier, T. (2016). Women on Boards in Finance and STEM Industries. American Economic Review, 106(5), 277–281. Retrieved from: https://doi.org/10.1257/aer.p20161034

Annabi, H., & Lebovitz, S. (2018). Improving the retention of women in the IT workforce: An investigation of gender diversity interventions in the USA. Information Systems Journal, 0(0). Retrieved from: https://doi.org/10.1111/isj.12182

Ashcraft, C., McLain, B., & Eger, E. (2016). Women in tech: The facts (p. 76). National Center for Women & Technology (NCWIT).

BCS. (2017). Diversity in IT 2017. Swindon: BCS, The Chartered Institute for IT. Retrieved from: http://www.bcs.org/category/19217?src=hs4

Bell, D. (2016). Corporate Governance Practices and Trends: A Comparison of Large Public Companies and Silicon Valley Companies. Retrieved from: https://www.fenwick.com/FenwickDocuments/2016-Corporate-Governance.pdf

Bell, D., & White, S. S. (2014). Gender Diversity in Silicon Valley: A Comparison of Silicon Valley Public Companies and Large Public Companies. Retrieved from: https://www.fenwick.com/FenwickDocuments/Gender_Diversity_2014.pdf

Biegel, S., Hunt, S. M., & Kuhlman, S. (2017). TRACKING VENTURE CAPITAL WITH A GENDER LENS (p. 36). Retrieved from: https://socialimpact.wharton.upenn.edu/wp-content/uploads/2017/10/ProjectSage-Report_10.25.17.pdf

Blau, F. D., Brummund, P., & Liu, A. Y.-H. (2013). Trends in Occupational Segregation by Gender 1970-2009: Adjusting for the Impact of Changes in the Occupational Coding System. Demography, 50(2), 471–494.

Boddington, P. (2017). Towards a code of ethics for artificial intelligence. Springer International Publishing. Retrieved from: www.springer.com/gp/book/9783319606477

Bradley, S. R., Gicheva, D., Hassell, L., & Link, A. N. (2013). Gender differences in access to private investment funding to support the development of new technologies (UNCG Economics Working Papers No. 13–9). University of North Carolina at Greensboro, Department of Economics. Retrieved from: https://ideas.repec.org/p/ris/uncgec/2013_009.html

Brown, J. (2016, March 22). Women as full-time business school faculty – Does world region make a difference? Retrieved from: http://aacsbblogs.typepad.com/dataandresearch/2016/03/women-as-full-time-business-school-faculty-does-world-region-make-a-difference.html

Brush, C. G., Greene, P. G., Balachandra, L., & Davis, A. (2014). Diana Report: Women entrepreneurs 2014: Bridging the gender gap in venture capital. Retrieved from: http://www.babson.edu/Academics/centers/blank-center/global-research/diana/Documents/diana-project-executive-summary-2014.pdf

Chanavat, A., & Ramsden, K. (2013). Mining the metrics of board diversity. Retrieved from: https://www.thomsonreuters.com/en/press-releases/2013/average-stock-price-of-gender-diverse-corporate-boards-outperform-those-with-no-women.html

CompTIA. (2017). 2017 IT Industry job market & salary trends analysis. Cyberstates. Retrieved from: http://www.cyberstates.org/

CompTIA. (2018). 2018 IT (Information Technology) industry trends analysis. Retrieved from: https://www.comptia.org/resources/it-industry-trends-analysis

Crawford, K. (2018). Artificial Intelligence's white guy problem. The New York Times, January 20. Retrieved from: https://www.nytimes.com/2016/06/26/opinion/sunday/artificial-intelligences-white-guy-problem.html

Cummings, L. M. (2015). Gender Equality in science, technology, engineering, agricultural sciences and mathematics (STEAM) academic pipeline: Challenges transferring knowledge to practice. Retrieved from: https://www.usaid.gov/sites/default/files/USAID-Report-Sep-30-2015-Final.pdf

Data 2x. (2017). Ready to Measure: Phase II. Indicators available to monitor SDG gender targets, p. 21. Retrieved from: http://www.data2x.org/what-is-gender-data/ready-to-measure/

David, P. A., & Shapiro, J. S. (2008). Community-based production of open-source software: What do we know about the developers who participate? Information Economics and Policy, 20(4), 364–398. Retrieved from: https://doi.org/10.1016/j.infoecopol.2008.10.001

Dawson, J., Kersley, R., & Natella, S. (2014). The CS Gender 3000: Women in senior management. Credit Suisse. Retrieved from: https://publications.credit-suisse.com/tasks/render/file/index.cfm?fileid=-8128F3C0-99BC-22E6-838E2A5B1E4366DF

Deloitte. (2017). Women n the boardroom: A global perspective (5th edition). Retrieved from: https://www2.deloitte.com/za/en/pages/deloitte-africa/articles/women-in-the-boardroom.html

Deloitte, & Alliance for Board Diversity. (2016). Missing pieces report: The 2016 board diversity census of women and minorities on Fortune 500 Boards. Retrieved from: http://theabd.org/2016%20Board%20Diversity%20Census_Deloitte_ABD_Final.PDF

Donnelly, G. (2017). Only 3% of Fortune 500 companies share full diversity data. Fortune, June 7. Retrieved January 27, 2018, from: http://fortune.com/2017/06/07/fortune-500-diversity/

Ernst & Young. (2015). Venture capital insights – 4Q14: Global VC investment landscape. Ernst & Young. Retrieved from: http://www.ey.com/Publication/vwLUAssets/Venture_Capital_Insights_4Q14_-_January_2015/$FILE/ey-venture-capital-insights-4Q14.pdf

European Commission. (2015). She figures 2015: Gender in research and innovation, 2.

Evans Data Corporation. (2017). Global Developer Population and Demographic Study 2017 (1).

Evans, W., & Rangarajan, S. (2017,). Hidden figures: How Silicon Valley keeps diversity data secret. Reveal News, October 19. Retrieved from: https://www.revealnews.org/article/hidden-figures-how-silicon-valley-keeps-diversity-data-secret/

Ford, D., Smith, J., Guo, P. J., & Parnin, C. (2016). Paradise unplugged: Identifying barriers for female participation on stack overflow. Proceedings of the 2016 24th

ACM SIGSOFT International Symposium on Foundations of Software Engineering - FSE 2016, 846–857. Retrieved from: https://doi.org/10.1145/2950290.2950331

Frehill, L., Abreu, A., & Zippel, K. (2015). Gender, science, and occupational sex segregation. In W. Pearson, L. Frehill, & C. McNeely (Eds.), Advancing women in science: An international perspective (pp. 51–92). Switzerland: Springer. Retrieved from: http://www.springer.com/br/book/9783319086286

Frost & Sullivan. (2017). The 2017 Global Information Security Workforce Study: Women in cybersecurity. Retrieved from: https://iamcybersafe.org/wp-content/uploads/2017/03/WomensReport.pdf

GitHub. (2018). “User search”. Retrieved 2018-07-12 (showing 29,707,507 available users).

GlassDoor (2018). Best jobs in America. Retrieved 2018-06-25 from: https://www.glassdoor.com/List/Best-Jobs-in-America-LST_KQ0,20.htm

Gompers, P. A., & Wang, S. Q. (2017a). And the children shall lead: Gender diversity and performance in venture capital (Working Paper No. 23454). National Bureau of Economic Research. Retrieved from: https://doi.org/10.3386/w23454

Gompers, P. A., & Wang, S. Q. (2017b). Diversity in innovation (Working Paper No. 23082). National Bureau of Economic Research. Retrieved from: https://doi.org/10.3386/w23082

Gumpertz, M., Durodoye, R., Griffith, E., & Wilson, A. (2017). Retention and promotion of women and underrepresented minority faculty in science and engineering at four large land grant institutions. PLOS ONE, 12(11), e0187285. Retrieved from: https://doi.org/10.1371/journal.pone.0187285

HackerRank. (2018). 2018 Women in tech report. Retrieved May 29, 2018, from: https://research.hackerrank.com/women-in-tech/2018/

HackerRank (2018). HackerRank developer survey 2018. Retrieved June 6, 2018, from: https://www.kaggle.com/hackerrank/developer-survey-2018/home

Heeks, R. (2005). Developing women’s ICT-based enterprise: Summary of an international knowledge-sharing workshop (Workshop report). Retrieved from: https://assets.publishing.service.gov.uk/media/57a08c5ced915d622c0012c5/R8352-WorkshopKeralaReport.pdf

Hewlett, S. A., & Sherbin, L. (2014). Athena Factor 2.0: Accelerating female talent in science, engineering & technology. Retrieved from: http://www.talentinnovation.org/_private/assets/Athena-2-ExecSummFINAL-CTI.pdf

Hunt, J. (2010). Why do women leave science and engineering? (Working Paper No. 15853). National Bureau of Economic Research. Retrieved from: https://doi.org/10.3386/w15853

Hunt, V., Layton, D., & Prince, S. (2015). Diversity matters. Retrieved from: https://www.mckinsey.com/~/media/mckinsey/business%20functions/organization/our%20insights/why%20diversity%20matters/diversity%20matters.ashx

Hunt, V., Yee, L., Prince, S., & Dixon-Fyle, S. (2018). Delivering growth through diversity in the workplace. McKinsey & Company. Retrieved from: https://www.mckinsey.com/business-functions/organization/our-insights/delivering-through-diversity

ILO. (2017a). Economic impacts of reducing the gender gap. Research brief. Retrieved from: http://www.ilo.org/global/research/publications/what-works/WCMS_577685/lang--en/index.htm

ILO. (2017b). World Employment and Social Outlook: Trends for women 2017. Retrieved January 20, 2018, from: http://www.ilo.org/global/research/global-reports/weso/trends-for-women2017/lang--en/index.htm

ILO. (2018). Women and men in the informal economy: A statistical picture (3rd edition). Retrieved from: http://www.ilo.org/global/publications/books/

WCMS_626831/lang--en/index.htm
IMF. (2018). Financial Access Survey (FAS): Gender pilot outcomes.

Information is Beautiful. (2018). Diversity in Tech: Information is Beautiful. Infographics. Retrieved January 28, 2018, from: https://informationisbeautiful.net/visualizations/diversity-in-tech/

Institutional Shareholder Services, Inc, & Regulation, F. (2017, January 5). Gender parity on boards around the world. Retrieved March 5, 2018, from: https://corpgov.law.harvard.edu/2017/01/05/gender-parity-on-boards-around-the-world/

Kelley, D., Baumer, B. S., Brush, C. G., Greene, P. G., Mahnaz, M., Mahdi, M., … Dean, M. (2017). Global Entrepreneurship Monitor: Women's entrepreneurship 2016/2017 report. Retrieved from: https://www.babson.edu/Academics/centers/blank-center/global-research/gem/Documents/GEM%202016-2017%20Womens%20Report.pdf

Kuschell, K., & Lepeley, M.-T. (2016). Women start-ups in technology: Literature review and research agenda to improve participation. International Journal of Entrepreneurship and Small Business, 27(2/3), 333–346.

Lakhani, K. R., & Von Hippel, E. (2003). How open source software works: "Free" user-to-user assistance. Research Policy, 32(6), 923–943. Retrieved from: https://doi.org/10.1016/S0048-7333(02)00095-1

MacDougall, A., Valley, J., Adler, J., Bettel, C., Param, A., Schmidt, J., … Suppa, O. (2017). 2017 Diversity disclosure practices report: Women in leadership roles at TSX-listed companies. Retrieved from: http://www.osler.com/en/resources/governance/2017/2017-diversity-disclosure-practices-report-women

Molina, M., Lin, S., & Wood, C. (2015). Connected Women 2015: Accelerating the digital economy: Gender diversity in the telecommunications sector. A.T. Kearney & GSMA. Retrieved from: http://www.atkearney.tw/communications-media-technology/ideas-insights/connected-women-2015

NVCA. (2016, January 15). $58.8 Billion in venture capital invested across U.S. in 2015, according to the MoneyTree Report. Retrieved from: https://nvca.org/pressreleases/58-8-billion-in-venture-capital-invested-across-u-s-in-2015-according-to-the-moneytree-report-2/

OECD. (2017). OECD Digital Economy Outlook 2017. Paris: OECD Publishing. Retrieved from: https://www.oecd-ilibrary.org/science-and-technology/oecd-digital-economy-outlook-2017_9789264276284-en

OECD STI. (2018). Empowering women in the digital age. OECD Directorate for Science, Technology and Innovation. Retrieved from: https://www.oecd.org/social/empowering-women-in-the-digital-age-brochure.pdf

Parsheera, S. (2018). A gendered perspective on Artificial Intelligence. In ITU (Ed.), Machine learning for a 5G future (125–131). Santa Fe, Argentina: International Telecommunication Union. Retrieved from: https://www.itu.int/dms_pub/itu-t/opb/proc/T-PROC-KALEI-2018-PDF-E.pdf

Quirós, C. T., Morales, E. G., Pastor, R. R., Carmona, A. F., Ibáñez, M. S., & Herrera, U. M. (2018). Women in the digital age. European Commission. Retrieved from: https://ec.europa.eu/digital-single-market/en/news/increase-gender-gap-digital-sector-study-women-digital-age

Richard, G. T., Kafai, Y. B., Adleberg, B., & Telhan, O. (2015). StitchFest: Diversifying a college hackathon to broaden participation and perceptions in computing. SIGCSE '15: Proceedings of the 46th ACM Technical Symposium on Computer Science Education (March), 114–119. Retrieved from: https://doi.org/10.1145/2676723.2677310

Sassler, S., Michelmore, K., & Smith, K. (2017). A tale of two majors: Explaining the gender gap in STEM employment among computer science and engineering degree holders. Social Sciences, 6(3), 69. Retrieved from: https://doi.org/10.3390/socsci6030069

Servon, L. J., & Visser, M. A. (n.d.). Progress hindered: The retention and advancement of women in science, engineering and technology careers. Human Resource Management Journal, 21(3), 272–284. Retrieved from: https://doi.org/10.1111/j.1748-8583.2010.00152.x

Shauman, K. A. (2017). Gender differences in the early employment outcomes of STEM doctorates. Social Sciences, 6(1), 24. Retrieved from: https://doi.org/10.3390/socsci6010024

Stack Overflow. (2018). Stack Overflow Developer Survey 2018. Retrieved April 4, 2018, from: https://stackoverflow.com/insights/survey/2018/?utm_source=so-owned&utm_medium=social&utm_campaign=-dev-survey-2018&utm_content=social-share

Stack Overflow. (2018). "Users" Retrieved July 12, 2018 (showing 8,731,692 available users).

Tapia, A. H., & Kvasny, L. (2004). Recruitment is never enough: Retention of women and minorities in the IT workplace. In Proceedings of the 2004 SIGMIS Conference on Computer Personnel Research: Careers, Culture, and Ethics in a Networked Environment (84–91). New York, NY: ACM. Retrieved from: https://doi.org/10.1145/982372.982392

The World Academy of Sciences. (2018). TWAS Fellows. Retrieved June 5, 2018, from: https://twas.org/directory/overview

Thomas, A., Dougherty, J., Strand, S., Nayar, A., & Janani, M. (2016). Decoding diversity: The financial and economic returns to diversity in tech. Retrieved from: https://newsroom.intel.com/newsroom/wp-content/uploads/sites/11/2016/07/Diversity_report_7.7.16_web-1.pdf

UNCTAD. (2014). Empowering women entrepreneurs through information and communications technologies: A practical guide (UNCTAD Current Studies on Science Technology and Innovation, No. 9). Retrieved from: https://unctad.org/en/PublicationsLibrary/dtlstict2013d2_en.pdf

UNCTAD. (2015). Global assessment of sex-disaggregated ICT employment statistics: Data availability and challenges on measurement and compilation, 54.

UNESCO Institute for Statistics. (2017). Women in science (Fact Sheet No. 43; FS/2017/SCI/43). Retrieved from: http://uis.unesco.org/sites/default/files/documents/fs43-women-in-science-2017-en.pdf

U.S. Equal Employment Opportunity Commission. (2016). Diversity in high tech. Retrieved from: https://www.eeoc.gov/eeoc/statistics/reports/hightech/index.cfm#_ftnref16

US Government Accountability Office. (2017). Diversity in the technology sector. Retrieved from: https://www.gao.gov/assets/690/688460.pdf

Vasilescu, B. (2014). Human aspects, gamification, and social media in collaborative software engineering. Companion Proceedings of the 36th International Conference on Software Engineering. ICSE Companion 2014, 646–649. Retrieved from: https://doi.org/10.1145/2591062.2591091

Vasilescu, B., Filkov, V., & Serebrenik, A. (2015). Perceptions of diversity on GitHub: A user survey. Proceedings of the Eighth International Workshop on Cooperative and Human Aspects of Software Engineering, 50–56. Retrieved from: https://doi.org/10.1109/CHASE.2015.14

Vasilescu, B., Posnett, D., Ray, B., van den Brand, M. G. J., Serebrenik, A., Devanbu, P., & Filkov, V. (2015). Gender and tenure diversity in GitHub teams. In Crossings. Seoul, Korea. Retrieved from: http://delivery.acm.org.offcampus.lib.washington.edu/10.1145/2710000/2702549/p3789-vasilescu.pdf?ip=128.95.104.66&id=2702549&acc=ACTIVE%20SERVICE&key=B63ACEF81C6334F5%2EF43F328D6C8418D0%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&__acm__=1518685543_74e499233266245940ed485ccf165e04

Wang, Z., Wang, Y., & Redmiles, D. (2018, May). Competence-confidence Gap: A threat to female developers' contribution on GitHub. In: ICSE-SEIS'18, Proceedings of 40th International Conference on Software Engineering: Software Track (p. 10).

Weissman, C. G. (2016, August 18). The women changing the face of AI. Retrieved July 12, 2018, from: https://www.fastcompany.com/3062932/ai-is-a-male-dominated-field-but-an-important-group-of-women-is-changing-th

WIT Leadership Round Table Metrics Working Group. (2016). Diversity metrics for technology companies.

World Economic Forum. (2017). The global gender gap report 2017. Retrieved from: https://www.weforum.org/reports/the-global-gender-gap-report-2017/

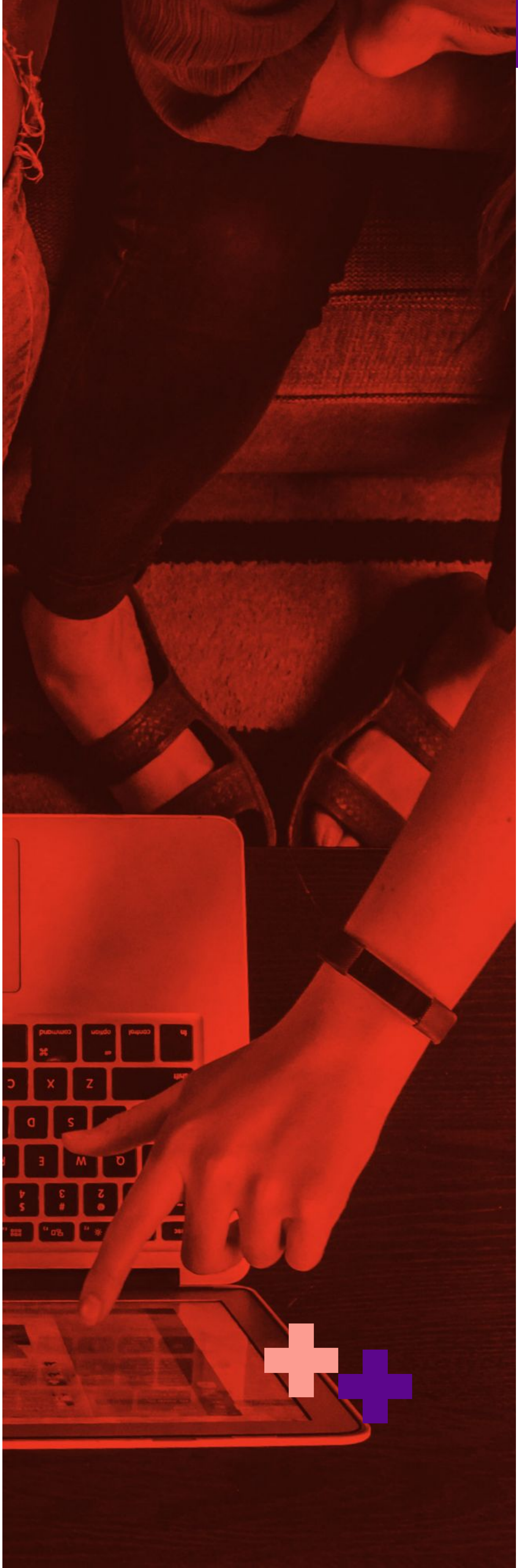
Yoder, B. (2016). Engineering by the numbers. American Society for Engineering Education. Retrieved from: https://www.asee.org/documents/papers-and-publications/publications/college-profiles/16Profile-Front-Section.pdf

Zlotnick, F., Smith, A., Linksvayer, M., & Filippova, A. (2018). The open source survey. Retrieved from: URL https://github. com/github/open-source-survey

4

THE DARK SIDE OF ICT ACCESS, SKILLS, AND LEADERSHIP

AUTHORS:
ARABA SEY AND
DON RODNEY JUNIO (UNU-CS)



KEY FINDINGS

- Greater female inclusion in ICT access, skills, and leadership could become associated with increased exposure to undesirable experiences, unless that inclusion is accompanied by corresponding changes in the social and institutional cultures that enable or tolerate negative behaviour.
- About 73% of women have already been exposed to or have experienced some form of cyber violence.
- Most countries have legislation against workplace-related sexual harassment. However, as of 2018, the majority (65%) of reporting countries have no sexual harassment legislation for schools and 83% have no legislation covering public spaces.
- Evidence on gender pay gaps within the technology industry is contextual and sometimes contradictory.
- A masculine-oriented work model pits work-devotion against family-devotion, and the associated tension can lead to overload among women in ICT professions.
- In theory, most countries have legal provisions to support working mothers; however, it is unclear the extent to which this legislation is helping attract and keep women in the ICT industry.

4.1 / INTRODUCTION

Promoting digital gender equality means more than women's capabilities to access, meaningfully use, and create ICTs. Neither does it mean merely opening doors to enable women to participate on an equal footing with men, as workers, employers, or decision-makers in the digital economy. For all its advantages, the digital age comes with gender-related risks and pitfalls; some are an extension of already existing dangers, while others are a direct response to women's increasing connectivity and visibility in male-dominated spaces. Greater female inclusion in the EQUALS Partnership action areas can become associated with increased exposure to undesirable experiences — unless that inclusion is accompanied by corresponding changes in the social and institutional cultures that currently enable or tolerate negative behaviour. Areas of concern include cyber violence against women and girls, sexual harassment in educational and employment settings, education- and work-related discrimination, and work and life balance. Other potentially relevant issues, such as internet addiction, risky online behaviours like sexting, or human exploitation, are not covered in this report. (See Unwin (2017) for a detailed discussion of the dark side of internet access.)

4.2 / CYBER VIOLENCE AGAINST WOMEN AND GIRLS

In 2015, the Broadband Commission sounded the alarm on the emerging threat of Cyber Violence Against Women and Girls (Cyber VAWG). At present, there is no globally agreed-on definition for cyber VAWG, as the issue is evolving together with its scope (Box 4.1). Accounting for instances of technology-enabled gender-based violence is complicated, and no single measure adequately captures its complexities. Hinson et al. (2017) note, that while existing tools such as the Cyber Psychological Abuse Scale and the Revised Cyber Bullying Inventory provide tangible methods, they are limited in that they measure specific cases of technology-enabled GBV and have been tested mostly in developed-country settings. However, different stakeholders have started laying the groundwork for developing valid and reliable measures. For example, the World Bank Group and the Sexual Violence Research Initiative have engaged the Centre for Research on Women to develop a way to measure technology-facilitated gender-based violence (GBV) on a global scale.

Box 4.1
Definitions of cyber VAWG

- TheBroadband Commission (2015) defines cyber VAWG as "any act of gender-based violence that results in, or is likely to result in, physical, sexual or psychological harm or suffering to women, including threats of such acts."
- The European Institute for Gender Equality (2017) includes the following acts as some forms of cyber VAWG: cyber stalking, non-consensual pornography (or "revenge porn"), gender-based slurs and harassment, "slut-shaming", unsolicited pornography, "sextortion", rape and death threats, "doxing", and electronically enabled trafficking.
- Women's Aid takes a broader view of the problem of cyber VAWG by looking at two broad categories of cyber VAWG: (1) online abuse — the use of the internet or other electronic means to direct abusive, unwanted, and offensive behaviour at an individual or group of individuals; (2) online harassment and stalking — the use of the internet or other electronic means to stalk or harass an individual, group of individuals, or organisation (Laxton, 2014). Online violence against women is also referred to as technology-facilitated gender-based violence (GBV).
- Other threats or acts that can fall under the scope of cyber VAWG include: hate speech (publishing a libel); hacking (intercepting private communications); identity theft; online stalking (criminal harassment); and uttering threats. It can also entail persuading a target to end their life (counselling suicide or advocating genocide).
- While the terms cyber-VAWG or technology-enabled GBV provide convenient anchor terms to frame online abuse and harassment faced by women and girls, these types of dangers are dissimilar in degree and scope. Each of these problems may require specifically tailored policy responses and policy actions.

4.2.1 / LEVELS OF CYBER VAWG

Tracking cyber VAWG is tricky because of the evolving nature of technology and the evolving kinds of cyber VAWG that can emerge. In the EU, it is estimated that one in ten women have already experienced a form of cyber violence since the age of 15 (EIGE, 2017). Global data is harder to come by, with no single international repository of data on cyber VAWG. Where data are available, the issue of under-estimation is also a concern, as cases of harassment and abuse tend to be under-reported because of the associated stigma and shame attached to being a victim, among other reasons. At present, evidence on the extent of cyber VAWG is mostly issue- and country-specific, and anecdotal rather than global in scope. (See Part II Chapter 3 for qualitative research results on online privacy and violence in Brazil, from a youth perspective.) High-profile cases of cyber VAWG, often in developed countries, have served to highlight the problem of cyber VAWG and help to galvanise deeper investigation and action on the topic (Box 4.2).

Box 4.2
Tracking cyber VAWG

In spite of the lack of global data on cyber VAWG, the following types of cyber VAWG have been documented.

Online harassment. Amnesty International notes that Twitter is a "toxic place for women", based on the survey conducted in the UK: 78% of women responded that women cannot share their opinions without receiving online vitriol, including death threats, rape threats, and racist threats. In the U.S., a survey found that 21% of women aged 18–29 have been sexually harassed online, double the share of men (9%) in the same age group, although overall, men (44%) are more likely to experience online harassment than women (37%)(Pew Research Center, 2017).

Nonconsensual pornography/ image-based abuse/ revenge porn. The widespread use of social media and image-capturing devices enable graphic forms of harassment. The first academic study of the subject, in Australia, revealed that one in five people are victims of revenge porn (Henry, et al., 2017). While women (22%) and men (23%) were equally likely to be victimised in general, women were more likely to be victimised by an intimate or ex-partner and were also more likely than men to have a stranger take a sexual image of them without permission. In South Korea, almost 5,200 sexual harassment cases involving spy-cam footage were reported in 2016; over 80% of the victims were women. In the UK, a Revenge Porn Hotline was launched in 2015 to respond to the severity of the issue. In most cases, the abuse aimed to control, intimidate, or gain monetary or sexual gratification from the victim.

Cyber bullying. Sex-disaggregated data on cyber bullying are sparse and limited in coverage. In the U.S., the Cyberbullying Research Center has been collecting data related to cyberbullying. A survey of a nationally-representative sample of 12-17-year-olds across the U.S. shows that 36.7% of females have been cyberbullied, higher than the rate for males (30.5%) (Hinduja & Patchin, 2016).

4.2.2 / PHYSICAL VIOLENCE AGAINST WOMEN

The closest indicators with global coverage that can give a sense of the issue of cyber violence are the indicators for physical violence against women — intimate-partner (IP) and other — that are tracked as part of the SDGs (Figure 4.1). The World Health Organisation (2013) estimates that one in three women throughout the world will experience physical and/or sexual violence by a partner or sexual violence by a non-partner in their lifetime. While offline and online violence are different, offline violence indicators can be used as a proxy indicator, as cyber VAWG forms part of the continuum of exploitation that women and girls encounter as a result of an unequal society. In fact, the Broadband Commission (2015) notes that cyber violence is as harmful as physical violence or sexual abuse.

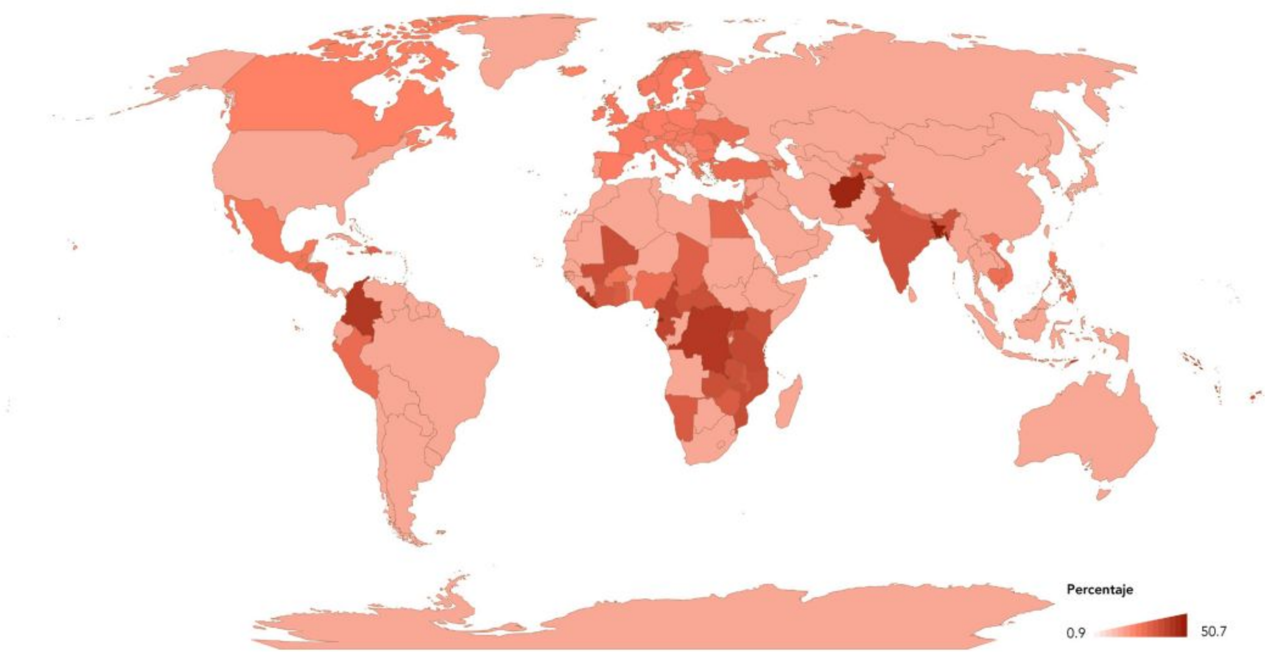
Figure 4.1
SDG Indicators related to Violence Against Women and Girls

Indicator 5.2.1
Proportion of ever-partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner in the previous 12 months, by form of violence and by age

Indicator 5.2.2
Proportion of women and girls aged 15 years and older subjected to sexual violence by persons other than an intimate partner in the previous 12 months, by age and place of occurrence

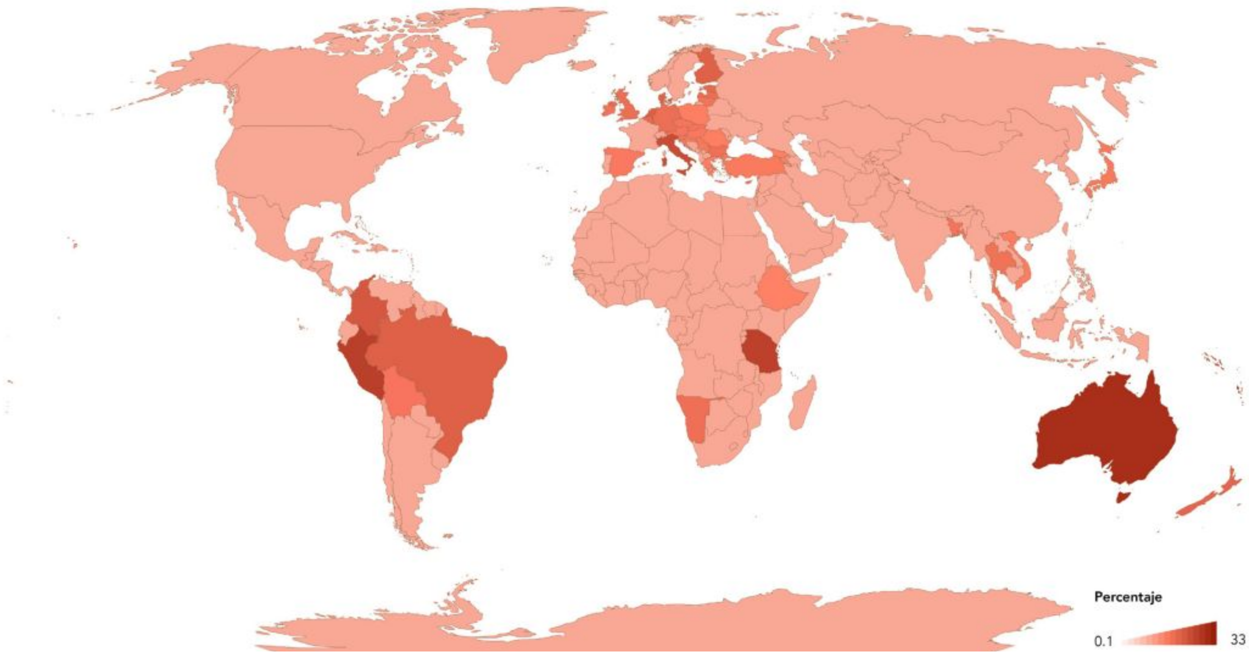
Even for physical VAWG, there is a lack of country coverage. Where data is available, the proportion of women and girls subjected to IP or non-IP physical, sexual, or psychological violence varies in range across different countries and regions (Figures 4.2 and 4.3).

Figure 4.2
Percentage of women subjected to physical and or sexual violence by a current or former intimate partner in the previous 12 months
(most recent year, 2005–2016)



Source: United Nations Statistics Division

Figure 4.3
Percentage of women and girls aged 15 years and older subjected to sexual violence by persons other than an intimate partner in the previous 12 months (most recent year, 2000–2014)



Source: United Nations Statistics Division

Beyond the UN data on intimate and non-intimate-partner violence, some other organisations collect data on cyber VAWG. The EU Agency for Fundamental Rights (European Union) deployed a survey in 2014 which included questions on cyber stalking and cyber harassment. In the U.S., the Pew Centre conducted a survey on online harassment in 2017. In developing countries, attempts to measure the problem are mostly spearheaded by NGOs and are donor-funded. For example, the Women's League Bureau (2015) through the Association for Progressive Communication has carried out research and country case studies on online gender-based harassment. In Pakistan, the Digital Rights Foundation's Hamara Internet project in 2017 included attempts to measure women's experiences of online violence. The study revealed that 40% of women in Pakistan had faced various forms of harassment on the internet, and most complaints related to harassment on Facebook. In all these studies, the figures reported are likely to be underestimates, due to the issue of under-reporting.

4.2.3 / RESPONDING TO CYBER-VAWG

While reliable data is lacking on the incidence of cyber violence against women, international organisations track legislation that can help address this problem. The UNCTAD Global Cyberlaw Tracker maps the status of cyberlaws in 194 UNCTAD member states, focusing on the state of e-commerce legislation in the fields of e-transactions, consumer protection, data protection or privacy, and cybercrime. As of May 2018, 140 countries or 72% of the 194 member states have enacted legislation related to cybercrime, and 112 countries — 58% of countries worldwide — have enacted laws related to data privacy and protection (Table 4.1).

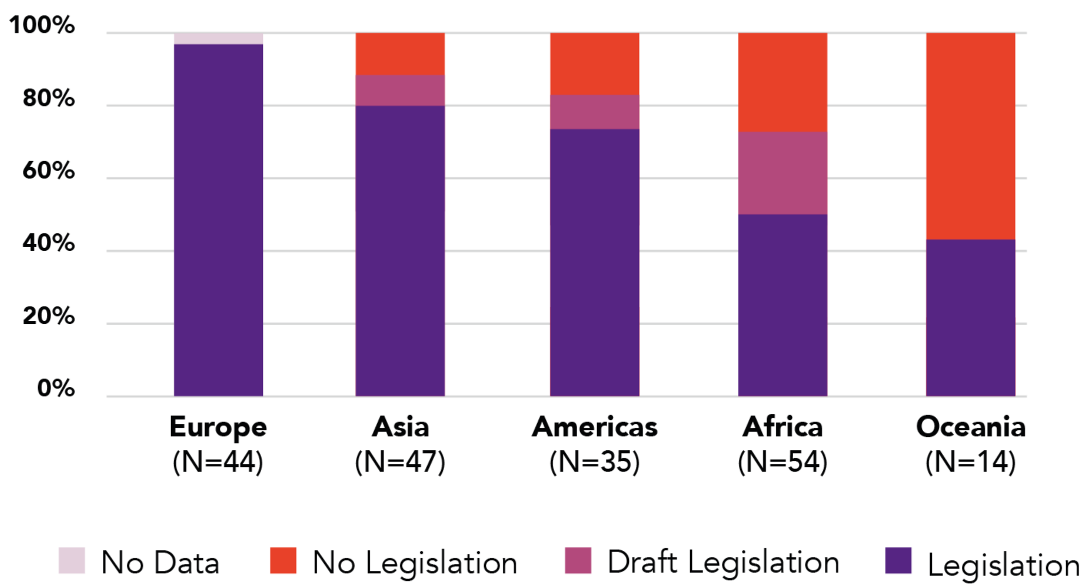
Table 4.1
Status of cybercrime and data privacy laws worldwide (May, 2018)

	ICT MINISTRY	DRAFT LEGISLATION	NO LEGISLATION	NO DATA
CYBERCRIME LEGISLATION	140 (72%)	18 (9%)	35 (18%)	1 (1%)
DATA PRIVACY AND PROTECTION	112 (58%)	19 (10%)	40 (21%)	23 (12%)

Source: UNCTAD Global Cyberlaw Tracker, 2018

Europe leads the other regions in terms of enacting cybercrime legislation, with 43 countries having passed a law related to cybercrime. Only the Vatican has no data reported. Out of the 35 countries with no cybercrime law, 15 are in Africa, 8 in Oceania, and 6 each in Asia and the Americas (Figure 4.4).

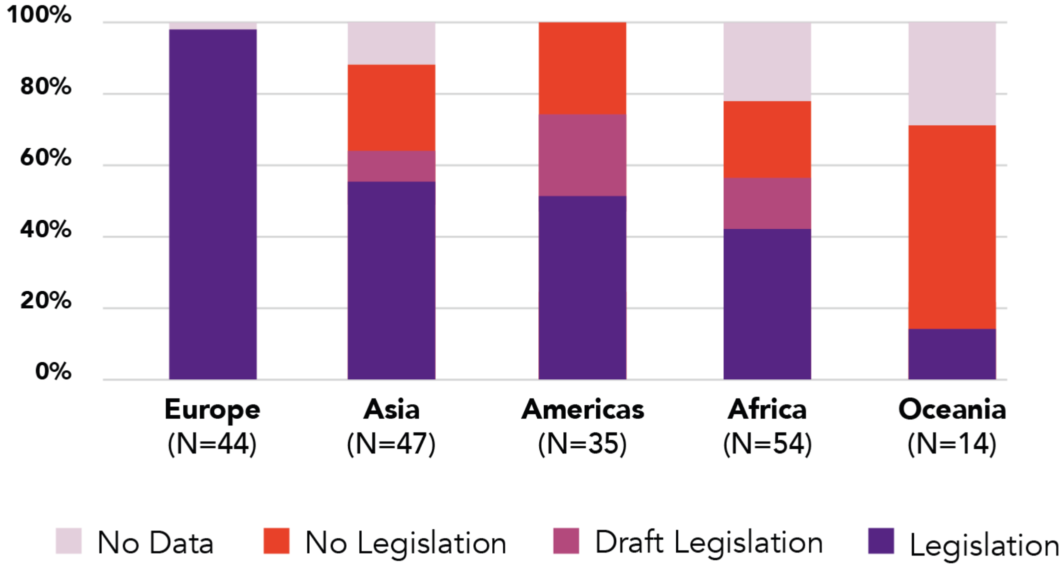
Figure 4.4
Status of cybercrime legislation by region (May, 2018)



Source: UNCTAD Global Cyberlaw Tracker, 2018

Apart from the Vatican, all countries in Europe have also adopted legislation to protect data. In other regions, several countries have no legislation related to data protection and privacy: in Asia (11), the Americas (9), Africa (12), and Oceania (8), as of May, 2018 (Figure 4.5).

Figure 4.5
Status of data protection and privacy legislation by region (2018)

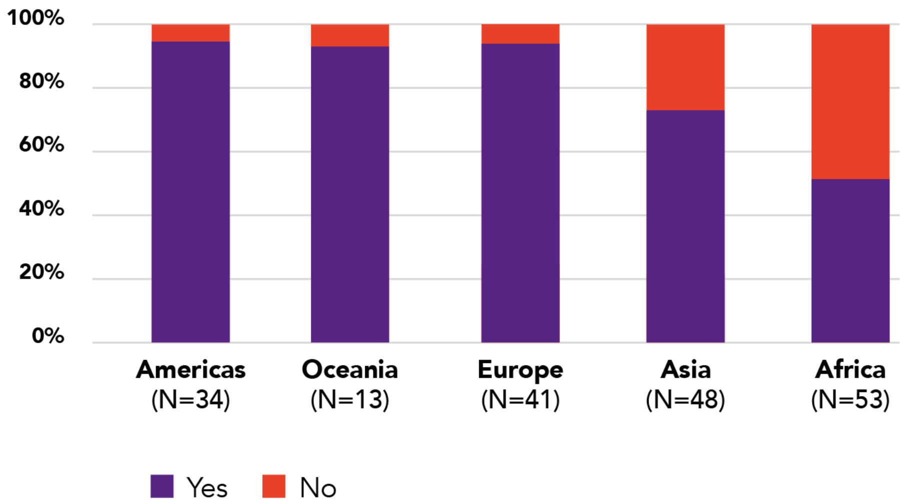


Source: UNCTAD Global Cyberlaw Tracker, 2018

Despite existing legal frameworks, reporting of cybercrime cases can be challenging for women, as social obstacles can prevent them from accessing the justice system. In Pakistan for example, reporting online harassment requires disclosing one's phone number and identity card, which can expose victims to further harassment. Moreover, leaving the house to visit the local police office would often require the accompaniment of a male guardian, which can be problematic if the perpetrator is a relative (Toppa, 2017).

In broader terms, we can also examine data on national legislation that addresses all types of violence against women and girls. The Women, Business and the Law Report (World Bank Group, 2018) collates data on various measures of gender discrimination that affect women's full participation in the economy, viewed from a legal perspective. More than 50% of countries globally have enacted legislation against domestic violence. More than half of the countries with no domestic violence legislation are located in Africa, where 26 countries have yet to pass such legislation (Figure 4.6).

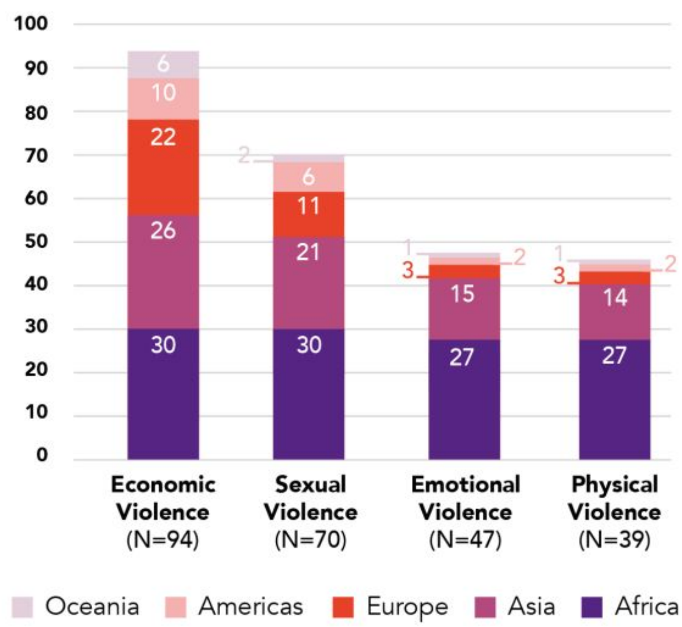
Figure 4.6
Domestic violence legislation by region (2018)



Source: World Bank, 2018.

Violence against women and girls comes in different forms — economic, sexual, emotional, and physical. Out of 189 countries surveyed in the World Bank report, the type of abuse with least legislation is economic violence, followed by sexual violence, emotional violence, and finally physical violence (Figure 4.7).

Figure 4.7
Countries with no coverage on the different domains of violence against women (2018)



Source: World Bank, 2018.

4.3 / SEXUAL HARASSMENT

In recent years, several gender-related scandals in the technology industry have dominated the news headlines, pointing to a culture of gender-based discrimination and harassment that discourages women from pursuing technology careers or that makes professional life challenging for those who stay. Although sexual harassment is often discussed in the context of the workplace, other areas such as public education and the public sphere are increasingly becoming recognised as sites of harassment (National Academies of Sciences, Engineering, and Medicine, 2018; World Bank, 2018).

Increased access to ICTs unfortunately means increased potential to experience sexual harassment, not only through cyber violence but also in offline spaces such as cybercafés. Likewise, increased access to educational and professional opportunities in male-dominated STEM and related areas also increases the possibility of encountering unwelcoming or hostile masculine environments. These environments act as barriers to entry or access for some females, and as physical and psychological burdens to those who choose or need to endure them. For example, one in ten female tech job leavers in the U.S. reported having experienced unwanted sexual attention in their last job (Tech Leavers Study, 2017). A similar problem affects men, as one in twelve men in the same study had also received unwanted sexual attention.

According to National Academies of Sciences, Engineering, and Medicine (2018, p. 52), academic environments (and especially science, engineering, and medicine education environments) present several of the features that create a high risk of sexual harassment (Box 4.3). Their study found that more than 50% of science, engineering, and medicine faculty and staff had encountered sexual harassment perpetrated by faculty, staff, and students.

Box 4.3
Conditions that foster sexual harassment in academic settings

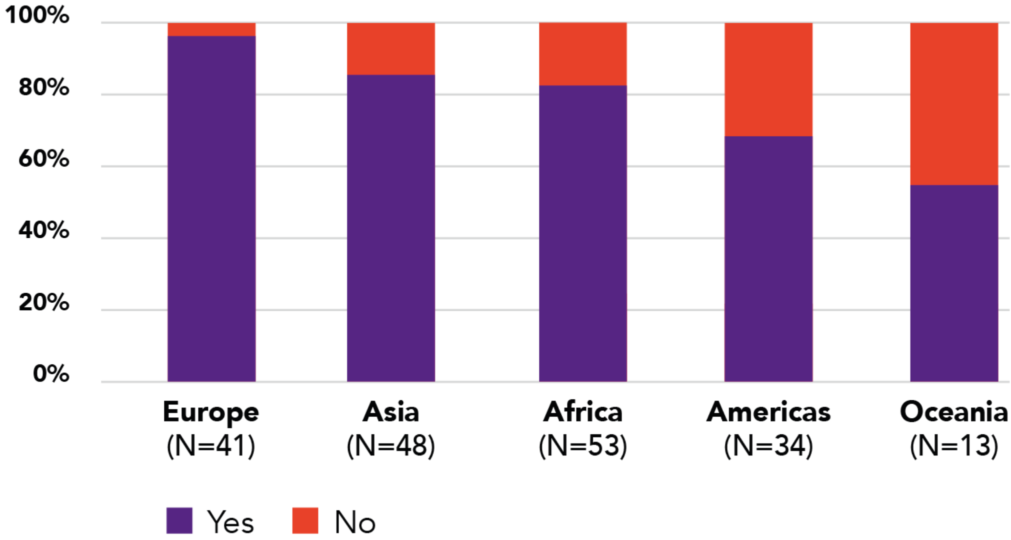
- Male-dominated environment, with men in positions of power and authority
- Organisational tolerance for sexually harassing behaviour (e.g., failing to take complaints seriously, failing to sanction perpetrators, or failing to protect complainants from retaliation)
- Hierarchical and dependent relationships between faculty and their trainees
- Isolating environments (e.g., labs and field sites) in which faculty and trainees spend considerable time

Source: National Academies of Sciences, Engineering, and Medicine, 2018, p. 172.

As women increasingly participate in online communities, the backlash against the changing status quo can include sexual harassment. A study by Toupin (2014) reports female hackers regularly experiencing groping, harassment, and discrimination, especially at hacker conferences and hackerspaces. Beyond verbal abuse and misogynist behaviours, some feminist hackers have also received rape and death threats.

The extent of sexual harassment experienced by women is difficult to estimate, as there is limited official data on this topic. We instead review data on the prevalence of legislation prohibiting sexual harassment. Globally, a majority of economies (more than half in each region) have enacted legislation on sexual harassment. As of 2018, only 35 out of 189 countries lack relevant legislation; the majority are in the Americas (11), followed by Africa (9), Asia (7), Oceania (6), and Europe (2) (Figure 4.8).

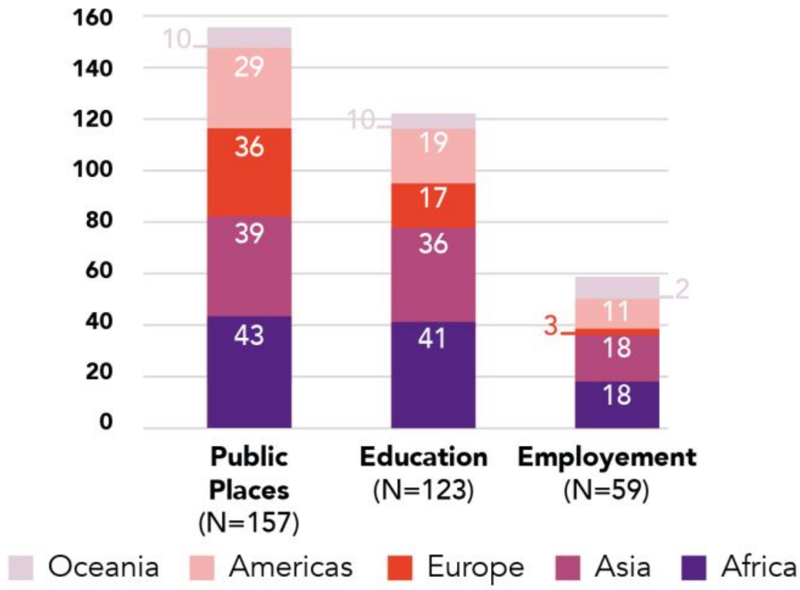
Figure 4.8
Percentage of countries by region with legislation dealing with sexual harassment (2018)



Source: World Bank, 2018.

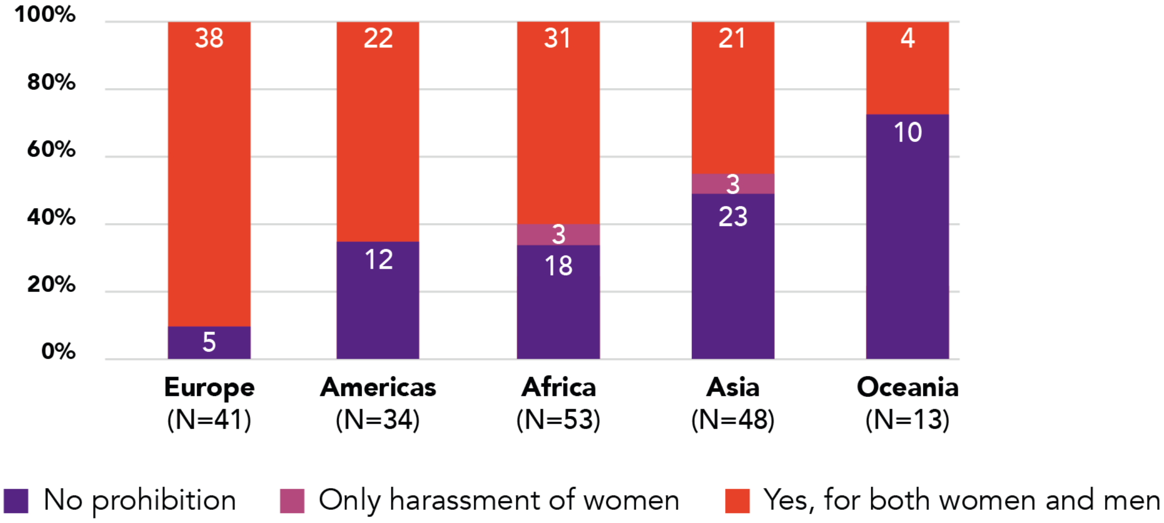
Regarding contexts of sexual harassment, there is widespread legislation on sexual harassment in the workplace. Out of the 189 countries surveyed by the World Bank, only 59 countries (31%) have yet to pass such legislation (Figure 4.9). In Europe, Africa, and the Americas, such legislation is often designed to protect both men and women (Figure 4.10). For other contexts, the vast majority of countries have no legislation dealing with sexual harassment in schools (65%, or 123 countries) or in public spaces (83%, or 157 countries).

Figure 4.9
Number of countries with no legislation on sexual harassment in the following areas (2018)



Source: World Bank, 2018.

Figure 4.10
Legislation explicitly prohibiting sexual harassment in the workplace (2016)



4.4 / DISCRIMINATION

Simply having more women students, employees, managers, or entrepreneurs in the ICT industry does not mean that gender disadvantage has been erased; the conditions under which women participate may also contribute to perpetuating inequality. Gender-based discrimination in occupational settings may be either overt or subtle, and it tends to affect women more than men. Types of gender-based discrimination include: unfairness in hiring, firing and promotions; unequal pay; unequal access to professional advancement opportunities; and unconscious biases. In this section we discuss two broad areas that affect genuine gender equality in ICT occupations: pay gaps and discriminatory work environments.

4.4.1 / GENDER PAY GAP

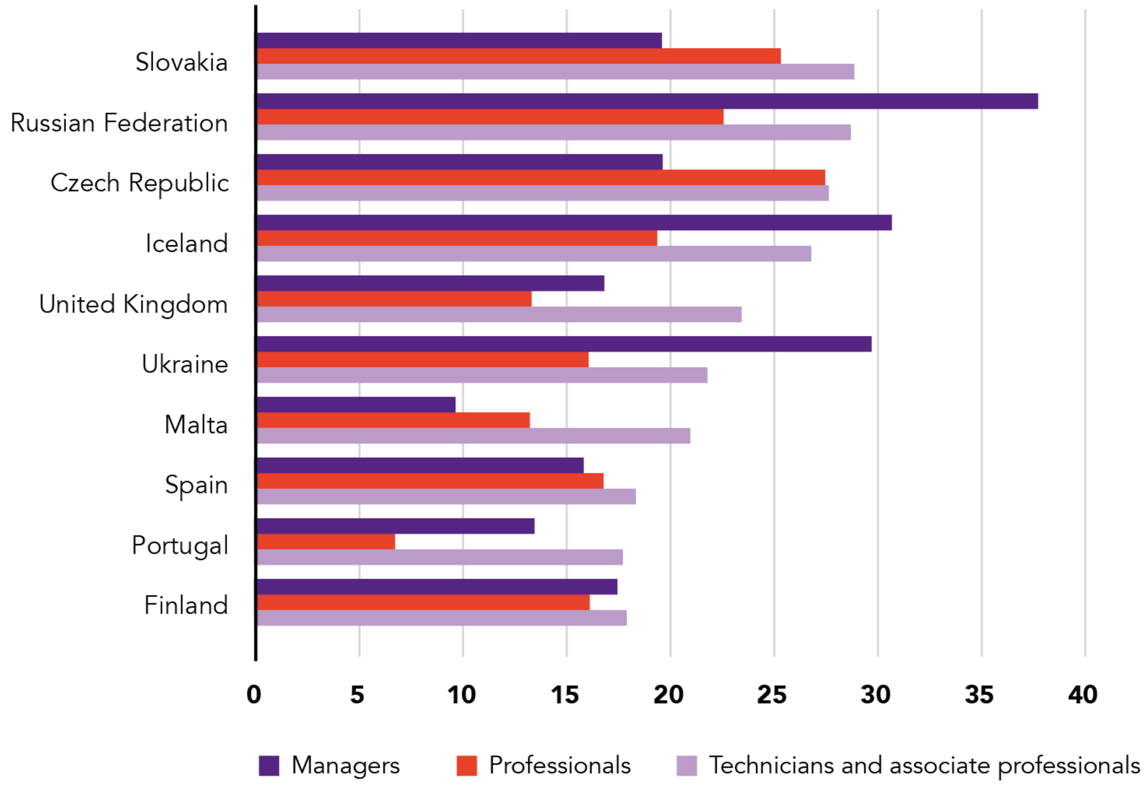
Unequal pay for the same work is one of the more enduring forms of gender-based discrimination in the workplace. At the global level, there has been a persistent unaccounted-for gender pay gap, although the gap is narrowing for certain professions (ILO, 2016). The Global Wage Report for 2016/17 assesses national-level gender pay gaps at between 0% and 45%, noting that the gap is almost 50% at higher levels of pay (ILO, 2016)[20]. Global data specific to the ICT industry are unavailable. However, ILO's research indicates that gender pay inequality is higher in enterprises and occupations with higher average pay. Since the ICT industry falls within the group of enterprises associated with higher levels of pay (ILO, 2018; US Government Accountability Office, 2017), it could be assumed that it would also exhibit higher gender pay gaps. However, the United States Department of Commerce (2017, p. 1) reports a smaller gender pay gap in STEM occupations than in non-STEM occupations.

We examined ILO data on occupational gender wage gaps, focusing on three categories: managers; professionals; and technicians and associate professionals. The raw data is difficult to interpret, as it shows contrasting patterns depending on the region or country (Figures 4.11–4.13). There is currently no data on gender pay gap by occupation for Africa and Oceania.

In Europe, where data is available for 10 economies, a pay gap exists in favour of male workers at all three professional levels, ranging from 6.6% to 38%. The Americas show a similar trend for the six reporting economies: mostly higher wages for men (by 2% to 25%), except for managers and technicians in Belize. The seven reporting economies in Asia show male workers earning more than female workers in most cases (from 2% to 33% more); however, in some cases women earn more than their male counterparts – e.g., professionals in Thailand, managers in Pakistan, and technicians or associate professionals in Brunei. Notwithstanding ILO's (2016) finding of higher gender pay gaps at higher levels of pay, the limited data for these three categories shows no clear hierarchy of gaps. The management category does not always have the largest pay gap; in Russia, Iceland, and Pakistan, the largest pay gap is among technicians or associate professionals.

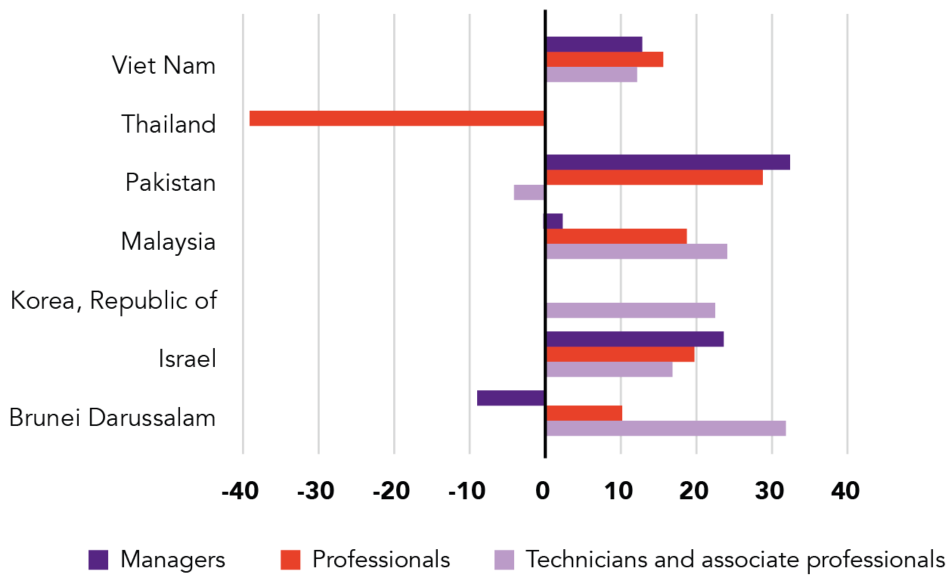
20 *Covering 46 countries, of which 22 are in Europe; data is for 2013 or earlier.*

Figure 4.11
Gender wage gap by occupation (%),
Europe (2014 –2016)



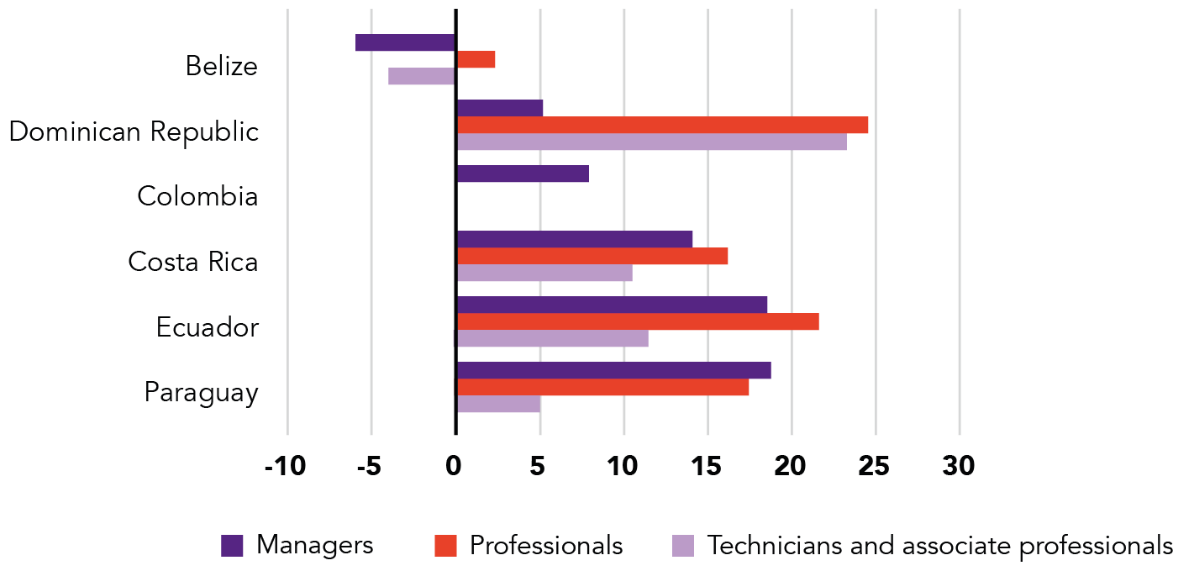
Source: ILOSTATS

Figure 4.12
Gender wage gap by occupation (%), Asia (2014 –2016)



Source: ILOSTATS

Figure 4.13
Gender wage gap by occupation (%),
Americas (2015–2016)



Source: ILOSTATS

There is insufficient longitudinal data to determine trends. For the few countries with data for both 2010/2011 and 2014, the picture is mixed: the gap widens, narrows, or stays the same for some occupations in some countries, with no clear pattern. For example, in Portugal the gap for managers increases by under 1%, while for professionals it decreases by 2%, and for technicians and associate professionals it increases by about 3%. Conversely, in Malaysia, the trend shows a 7% increase for managers, 0.6% decrease for professionals, and 0.1% decrease for technicians and associate professionals.

Reasons frequently cited for the gender pay gap include gendered differences in occupation, expertise, experience, and work patterns (Ardanaz-Badia & Rawlings, 2018; Cook, Diamond, Hall, List, & Oyer, 2018; ILO, 2018). Research has shown, however, that a gender pay gap remains after controlling for such factors. A UK study found that female IT professionals earned 11% less than male IT professionals, even after accounting for number of working hours (BCS, 2017). The career review platform Glassdoor conducted an analysis of 505,000 salaries, controlling for variables such as age, education, experience, occupation, industry, location, company, and job title (Zarya, 2016). The results showed that even when workers were almost identical in every way except gender, the gender pay gap for technology workers (at 28.3%) was several times higher than the gender pay gap for all workers (5.9%). ILO (2018, p. 95) recommend more attention to identifying the "'unexplained' part of the gender pay gap". (See also Part II Chapter 7 of this report, which examines differences in skill endowments and returns to skills between men and women in digital and less digital-intensive industries.)

4.4.2 / DISCRIMINATORY WORK ENVIRONMENTS

Quirós et al. (2018, p. 10) report that women in the European digital workforce experienced gender discrimination more than men, and they felt less able to enforce their ideas. Likewise, Hewlett & Sherbin (2014) found that over a quarter of female science, engineering, and technology workers in their study of three high ICT countries said they felt stalled in their careers: China (23%), U.S. (27%), Brazil (29%) and India (45%). Between 20% and 32% said they were likely to quit their jobs within a year (Hewlett & Sherbin, 2014). Over 50% of female cybersecurity professionals report having experienced discrimination in the workforce (Frost & Sullivan, 2017). Subtle forms of discrimination include heavier scrutiny accorded to female than male applicants (Blair-Loy et al., 2017). Furthermore, a culture of ostensible openness, technology neutrality, and meritocracy may perversely reinforce gender discrimination, as Nafus (2012) found within the Free Libre Open Source Software community.

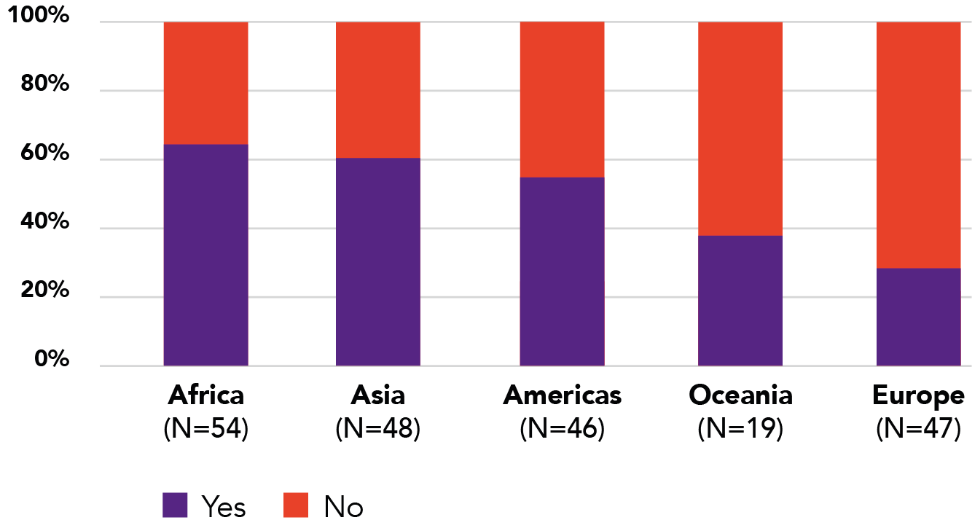
One of the few studies of why people leave technology jobs found that technical workers (at 40%) were more likely than non-technical workers (32%) to leave jobs in the U.S. technology industry due to unfairness (Scott, Kapor Klein, & Onovakpuri, 2017).[21] Perceptions of unfairness were higher in the tech industry (42% of leavers) than in the non-tech industry (32% of leavers) and was a major reason for both men and women to leave their tech jobs. Overall, employees within the technology industry report unwanted sexual attention at almost double the rates (10%) reported by tech employees in other industries (6%). These findings suggest that the technology industry has a particularly deep problem with unfairness and inappropriate sexual behaviour.

Female technology workers typically respond to discriminatory work environments either by changing jobs or developing strategies to avoid or rationalise their participation, such as downplaying their femininity, adopting male behaviours, enduring the organisational culture, or adopting the veneer of "professionalism" as a coping mechanism (Alfrey & Twine, 2017; Annabi & Lebovitz, 2018; Servon & Visser, n.d.). For instance, when online, some female developers masquerade as males to avoid discrimination (Vasilescu et al., 2015).

Various national policies address discriminatory work environments, including constitutional provisions on gender discrimination as well as implementing legislation related to professional advancement, training and pay. Overall, most economies have some legislation in place. Europe has the strongest record of legislation protecting against discrimination across the four areas shown in Figures 4.14 to 4.17, although only a few countries in Europe include any mention of gender in their constitutions' non-discrimination clauses (Figure 4.14). In all regions except Oceania, more than 51% of countries have legislated against each type of discrimination.

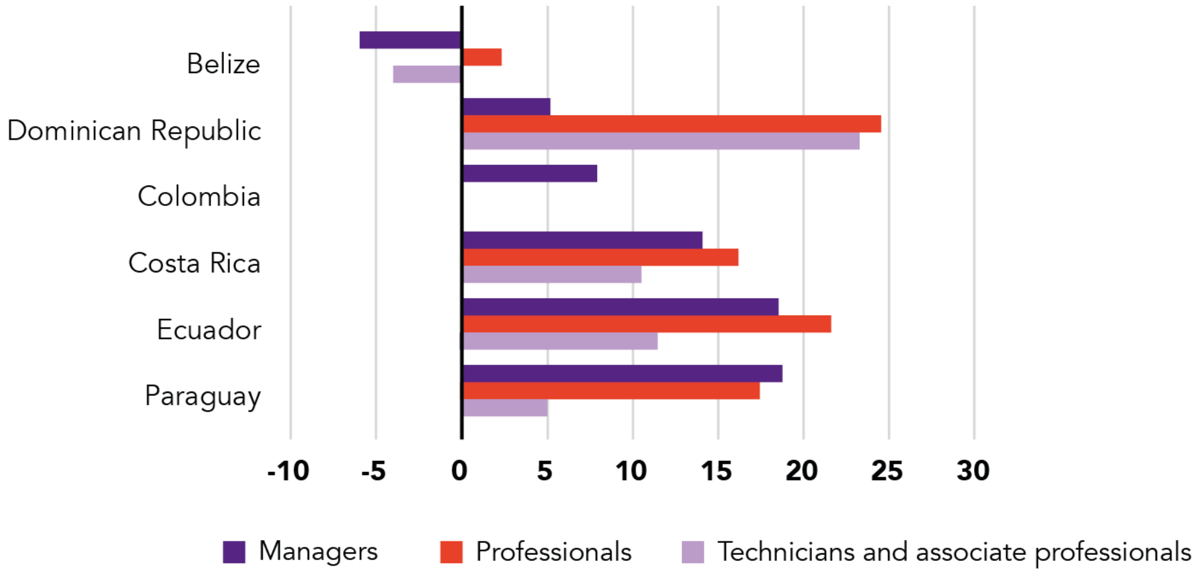
21 *Scott, Kapor Klein, & Onovakpuri (2017) is the report on a nationally-representative survey of U.S. adults who have left a job in a technology-related industry or function within the last three years.*

Figure 4.14
National constitution mentions gender in non-discrimination clause



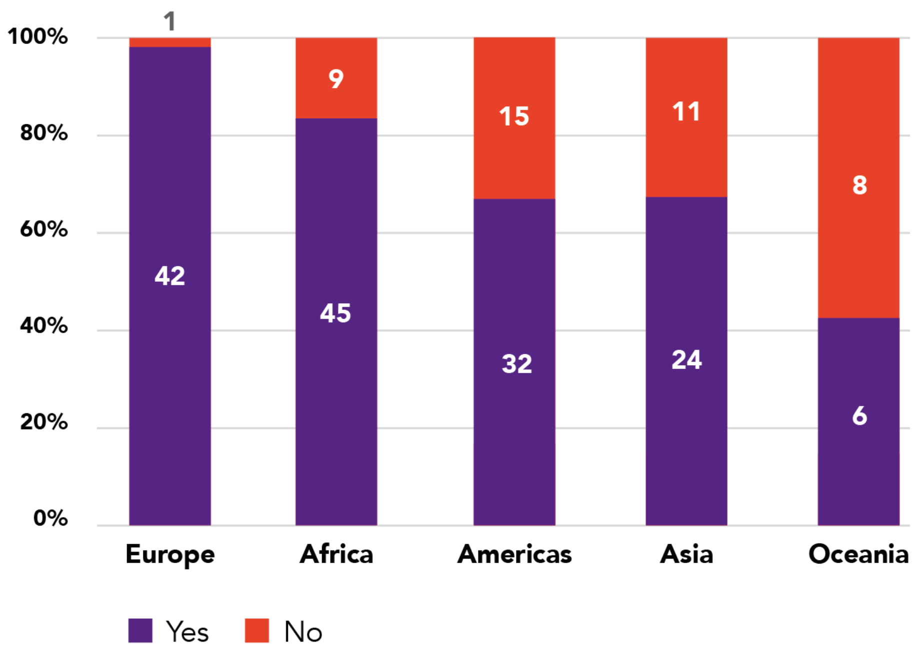
Source: World Bank
Note: West Bank and Gaza = Palestine. Kosovo data included in Europe.

Figure 4.15
National constitution mentions gender in non-Legislation protecting women from discrimination in promotion or demotion



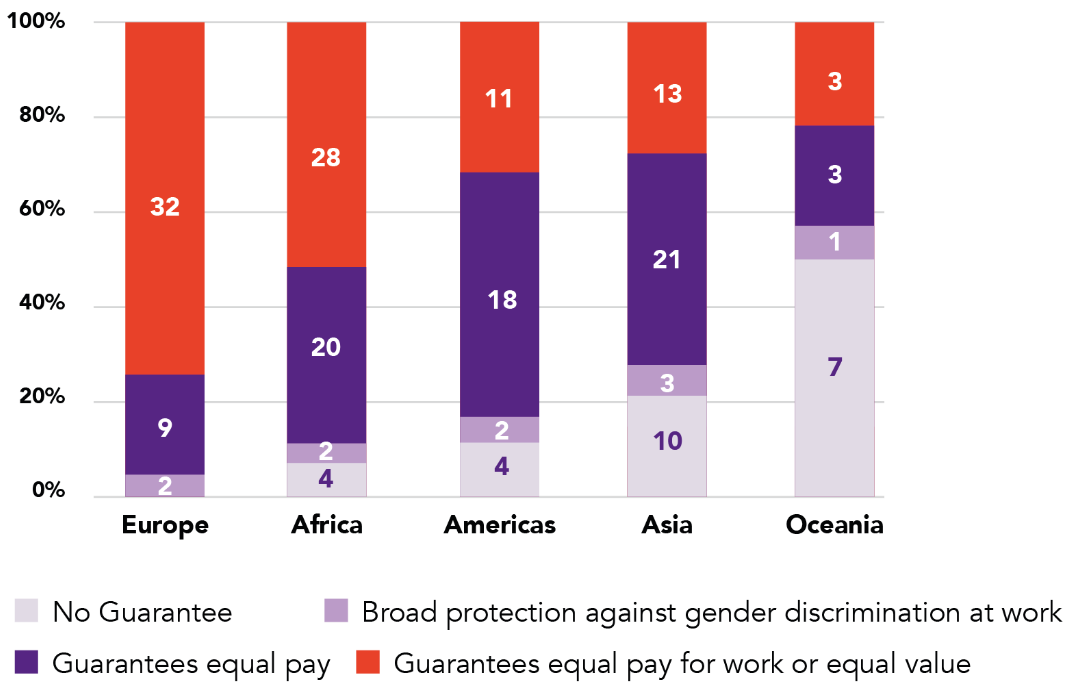
Source: World Policy Research Center, Discrimination at work database

Figure 4.16
Legislation protecting women from discrimination in access to vocational training



Source: World Policy Research Center, Discrimination at work database

Figure 4.17
Legislation guaranteeing equal pay



Source: World Policy Research Center, Discrimination at work database

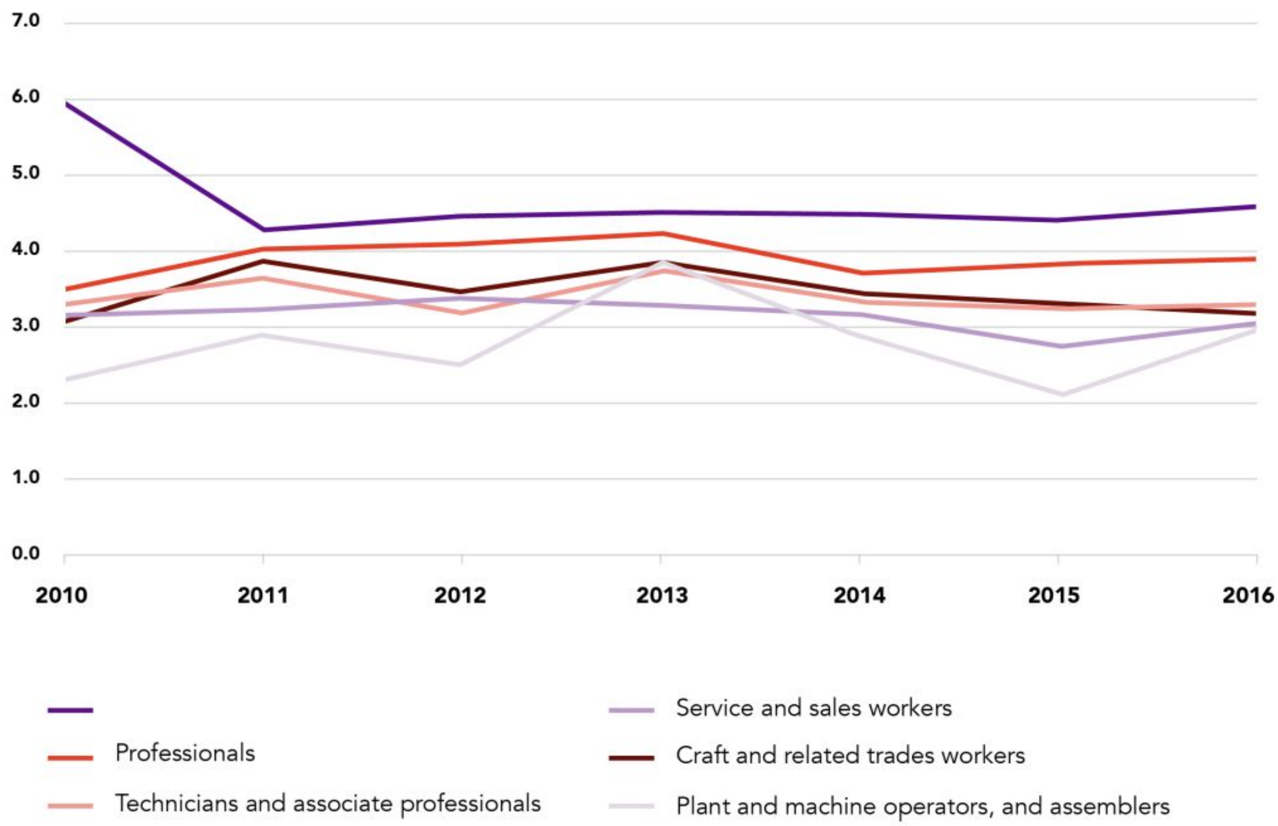
4.5 / WORK AND LIFE BALANCE

Several authors have argued that a masculine-oriented work model pits work-devotion against family-devotion, and the associated tension can lead to overload for women in technology professions (Blair-Loy & Cech, 2017; Bright Horizons, 2017; Weisgram & Diekman, 2015). The number of hours men and women work, and the prevalence and distribution of unpaid domestic and care work, serve as indicators of work and life balance.

4.5.1 / NUMBER OF HOURS OF WORK

The labour force data shows that women generally work fewer paid hours than men and spend a much larger proportion of their time than men on unpaid domestic and care work. In all six occupations represented in Figure 4.18, men consistently work more hours than women.discrimination, as Nafus (2012) found within the Free Libre Open Source Software community.

Figure 4.18
Global gender gap in mean weekly hours of work per employee, by sex and occupation



Source: Author's computation of ILO data.
Note: Computed by subtracting mean hours of work (men) from mean hours of work (women). Zero means no difference in mean hours of work. Above zero means men work more hours than women, below zero means women work more hours than men. Data might be skewed; for some job categories there is more data for men than women.

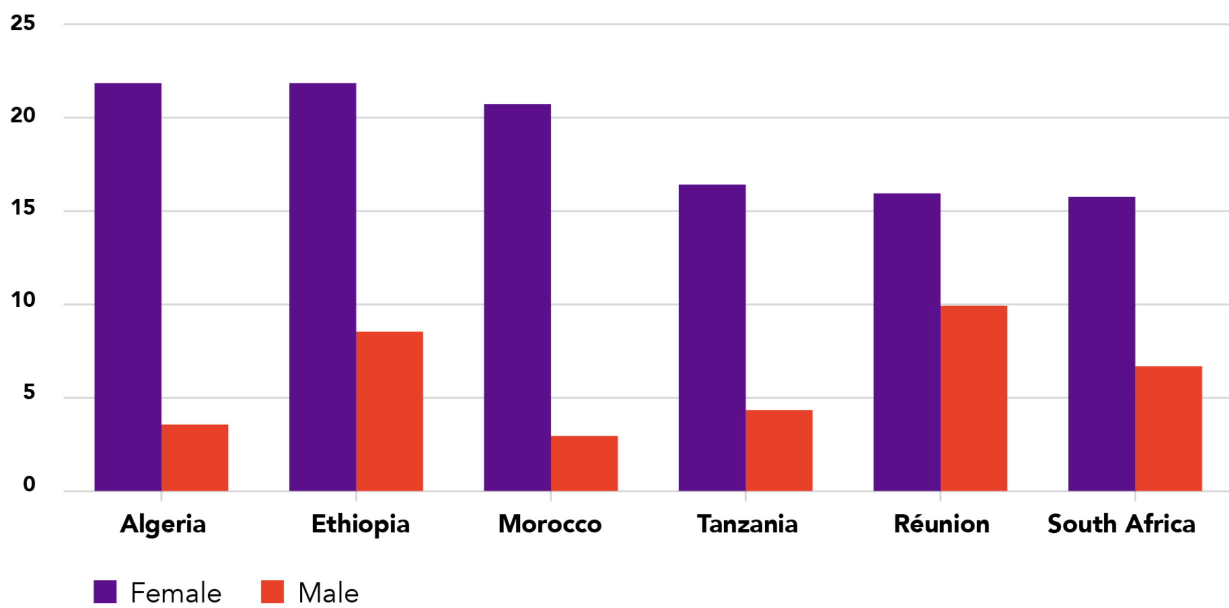
This tendency to work fewer hours could reflect women's personal choices, and a variety of considerations may factor into their choices, such as a desire for flexible work arrangements because of other social roles and personal values. Efforts to address gender inequality in employment that do not target these quality of life issues are unlikely to achieve maximal impact.

4.5.2 / UNPAID DOMESTIC AND CARE WORK

Data on this indicator is sparse for most regions, but it shows that compared to men, women spend a much larger proportion of their time on unpaid domestic and care work, at 10%–28% for women versus 3%–10% for men (Figures 4.19–4.22). Erosa, Fuster, Kambourov, & Rogerson (2017) provide some evidence of impact on labour force participation, arguing that an "asymmetry in household production" leads to women self-selecting out of occupations that reward long hours (p. 4). They conclude that a 10% reduction in women's discretionary time, due to their nonmarket activities, causes a 14% reduction in their labour market participation and an 11% increase in the gender wage gap. Others such as Xie (2006) assert that having children is the most important factor preventing women from pursuing careers in science and engineering.

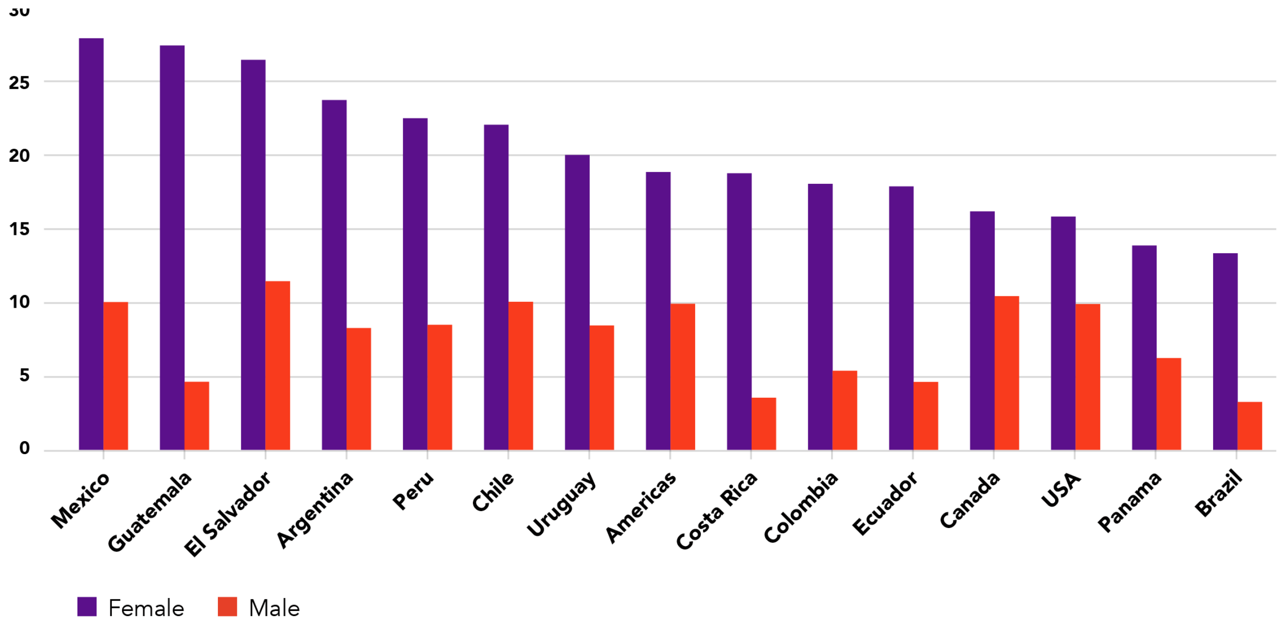
However, other scholars have argued that women's primary reason for leaving technology jobs is not family-related but rather due to obstacles to achieving company and career goals (Ashcraft, McLain, & Eger, 2016; Hunt, 2010; Meiksins, Beddoes, Masters, Micah, & Shah, 2016). Sassler, Glass, Levitte, and Michelmore (2017) found no difference in the tendency for career-minded versus family-oriented women to enter computer science professions in the U.S. They also observed that being married and having children equally affected men and women's propensity to work in computer science, leading to the conclusion that "is difficult to account for the factors associated with these employment disparities" (p. 19). Another issue is the potential quality-of-life compromises made by women in combining family and professional responsibilities. Some studies note the tension between work-devotion and family-devotion expectations, and the incidence of overload among women in technology professions (Blair-Loy & Cech, 2017; Bright Horizons, 2017; Weisgram & Diekman, 2015).

Figure 4.19
Proportion of time spent on unpaid domestic and care work, Africa (2010 –2014)



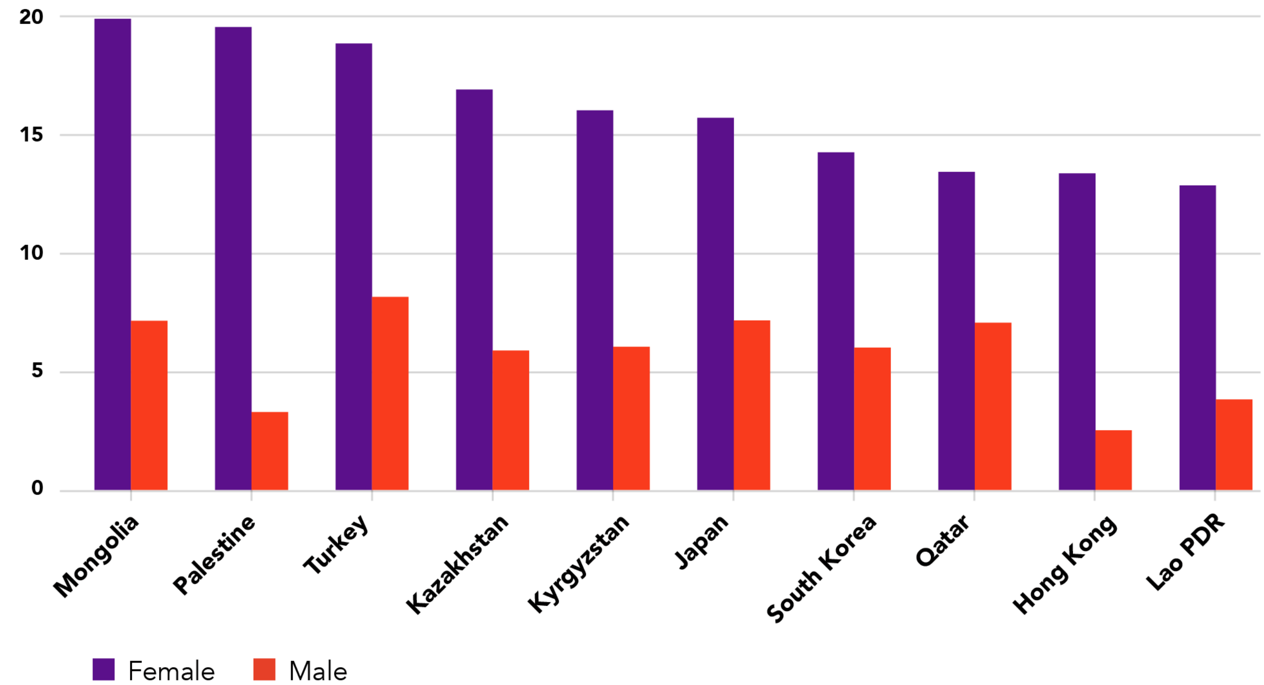
Source: ILO.

Figure 4.20
Proportion of time spent on unpaid domestic and care work, the Americas (2010–2015)



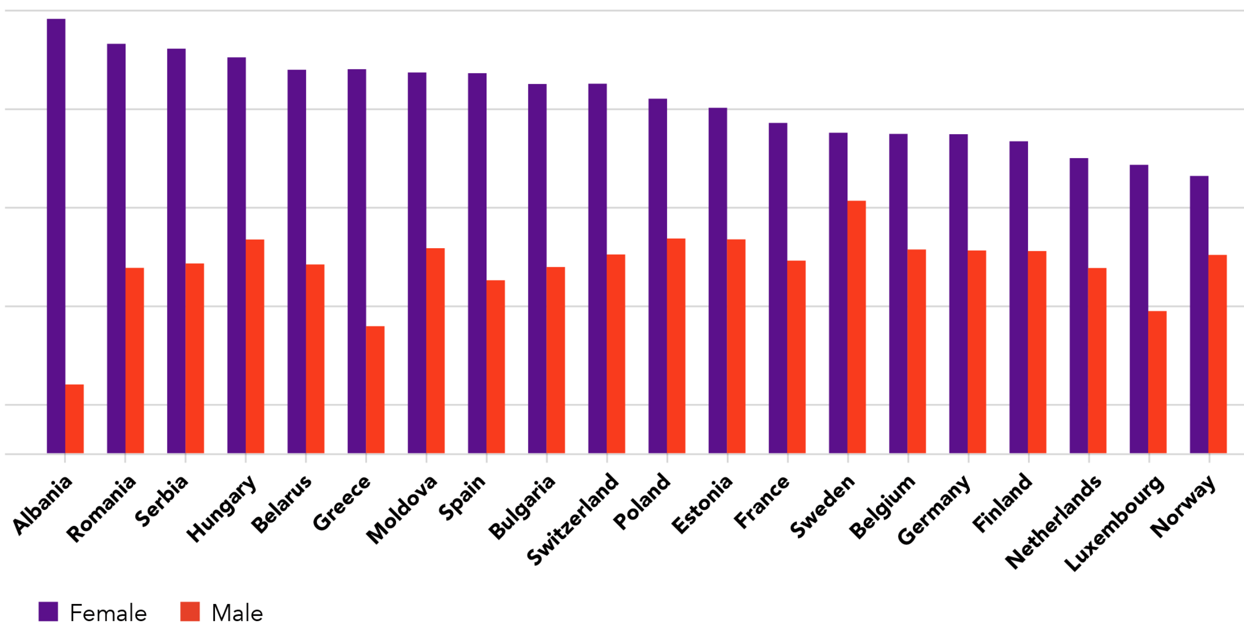
Source: ILO.

Figure 4.21
Proportion of time spent on unpaid domestic and care work, Asia (2011–2015)



Source: ILO.

Figure 4.22
Proportion of time spent on unpaid domestic and care work, Europe (2010–2015)



Source: ILO.

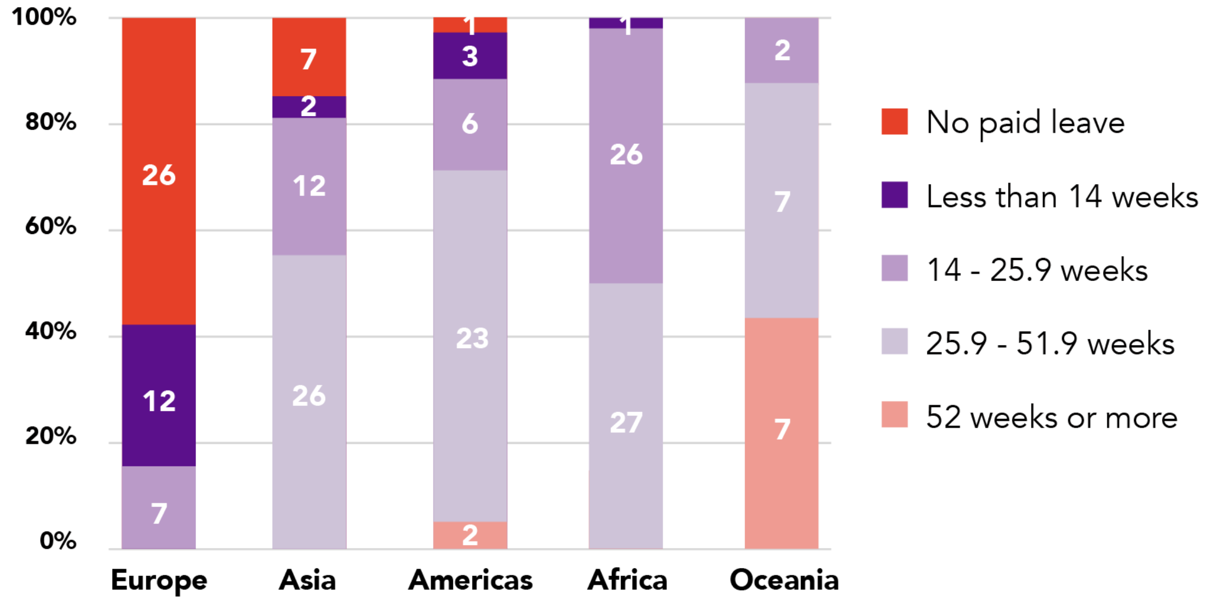
4.5.3 / PARENTAL LEAVE POLICIES

One major aspect of the unpaid care work that women often shoulder is child care. The extent to which organisations make it possible for women to combine motherhood with work can be a crucial factor affecting the size of the female work force. The World Policy Research Center tracks several gender policy indicators[22], four of which are relevant for this discussion. The data shows that, at the policy level, most countries have some provisions to support working mothers. European countries tend to have the most generous policies, while countries in Oceania tend to have the least generous allowances (Figures 4.23–4.26). The U.S. is one of just two countries in the Americas with no legislated parental leave.

Fifty-eight per cent of European countries provide 52 weeks (one year) or more paid leave; in contrast, in Oceania and the Americas, over 70% of countries provide either no leave or less than 14 weeks (Figure 4.23). Most countries in Africa and Asia provide between 14 and 52 weeks paid maternal leave. Paid maternal leave also covers above 60% of salary in most countries (Figure 4.24). European countries are also the most generous in offering breastfeeding options: about 80% of countries (37 out of 45) allow paid breastfeeding breaks at work for six months; only seven countries have no such provisions (Figure 4.25). With the exception of Oceania (at 38%), a majority of countries in the other regions (57%–74%) also support paid breastfeeding breaks. While 50% (103) of countries worldwide guarantee either paid maternal leave or breastfeeding breaks at work for at least six months, only 43 countries (mostly in Europe) guarantee both (Figure 4.26). Again, Europe fares the best in this regard, with only one country failing to provide any guarantees. Oceania and the Americas have the largest proportion of countries not guaranteeing either option (63% and 40% respectively).

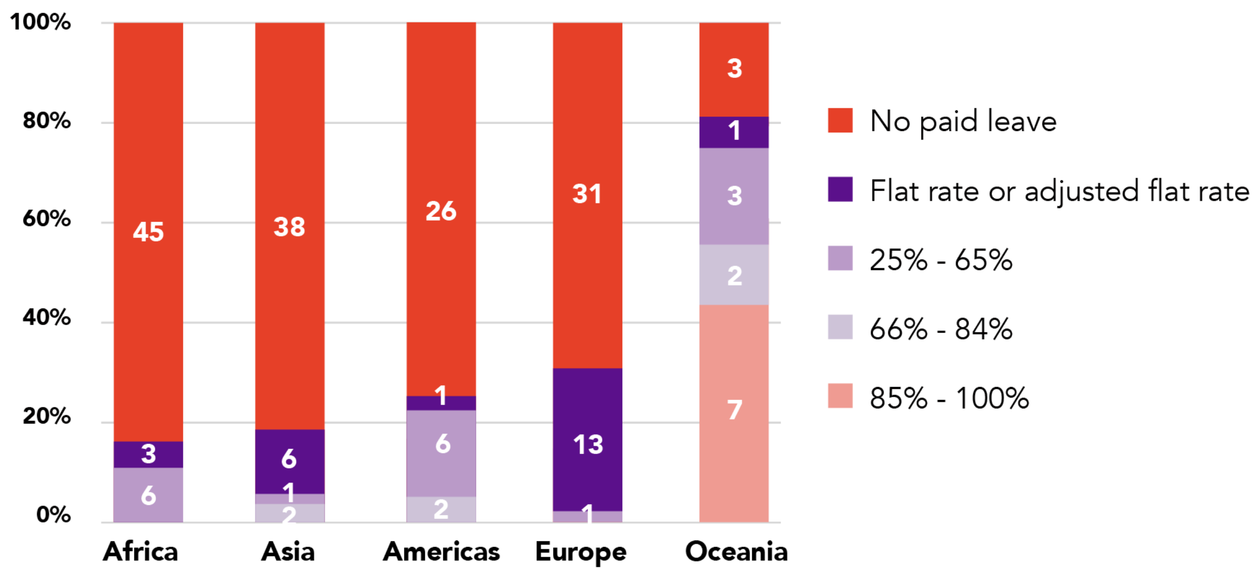
22 *Maternal and Child Health Equity (MACHEquity) research program.*

Figure 4.23
Paid leave available for mothers of infants (2013)



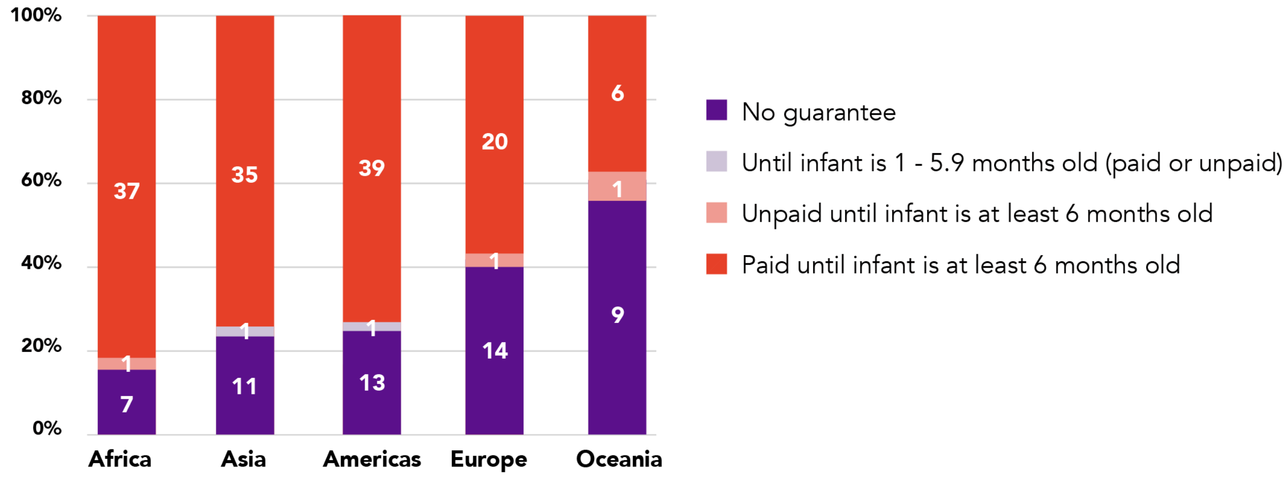
Source: World Policy Research Center, MACHEquity database.

Figure 4.24
Maximum wage replacement rate of paid leave for mothers of infants (2013)



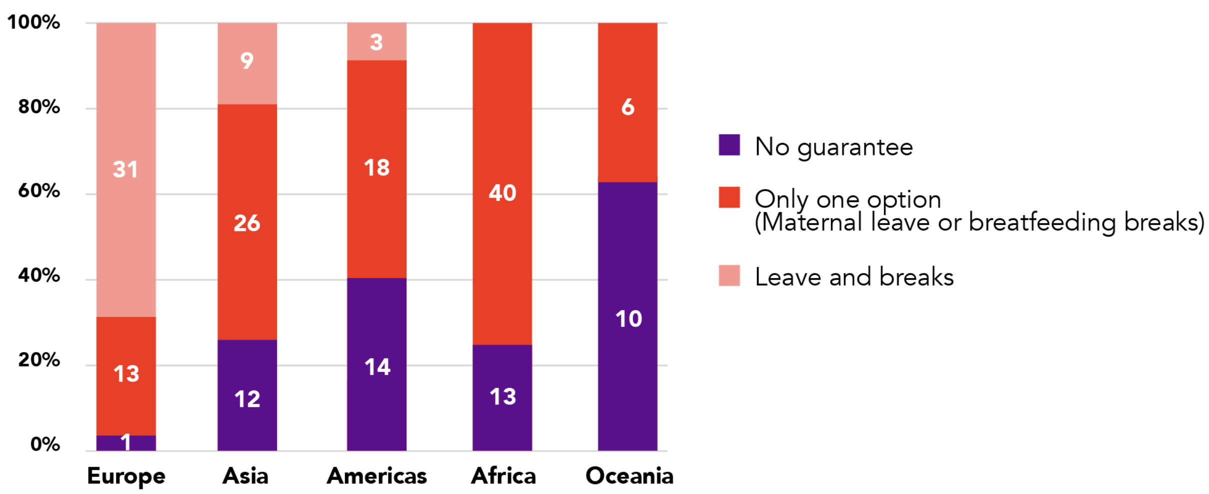
Source: World Policy Research Center, MACHEquity database.

Figure 4.25
Paid leave available for mothers of infants (2013)



Source: World Policy Research Center, MACHEquity database.

Figure 4.26
Working mothers guaranteed options to facilitate paid breastfeeding for at least six months (2013)



Source: World Policy Research Center, MACHEquity database.

4.6 / CONCLUSION

With violence against women widespread globally, access to ICTs increases the exposure of girls and women to cyberviolence. The response to this must include overall culture change in attitudes towards sexual harassment and all forms of gender-based violence. Similarly, as more women venture into STEM and related training and occupations, they risk exposure to sexual harassment and various forms of discrimination associated with the field. A dominant masculine-oriented work ethic also presents challenges for people interested in ICT careers but seeking greater work and life balance. However, from a gender perspective, our understanding of the dark side of ICT access, skills, and leadership is still very limited; much work needs to be done to collect relevant data and scope the issues. This is particularly challenging because of the complex issues involved and the evolving nature of ICTs and related landscapes.

REFERENCES

Alfrey, L., & Twine, F. W. (2017). Gender-fluid geek girls: Negotiating inequality regimes in the tech industry. Gender & Society, 31(1), 28–50. Retrieved from: https://doi.org/10.1177/0891243216680590

Annabi, H., & Lebovitz, S. (2018). Improving the retention of women in the IT workforce: An investigation of gender diversity interventions in the USA. Information Systems Journal (Special issue paper). Retrieved from: https://doi.org/10.1111/isj.12182

Ardanaz-Badia, A., & Rawlings, J. (2018). Understanding the gender pay gap in the UK. Office for National Statistics. Retrieved from: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/articles/understandingthegenderpaygapintheuk/2018-01-17

Ashcraft, C., McLain, B., & Eger, E. (2016). Women in tech: The facts. National Center for Women & Technology (NCWIT).

BCS. (2017). Diversity in IT 2017. Swindon: BCS, The Chartered Institute for IT. Retrieved from: http://www.bcs.org/category/19217?src=hs4

Broadband Commission. (2015a). Cyber violence against women and girls, a world-wide wake-up call: A report by the UN Broadband Commission for Digital Development Working Group on Broadband and Gender. Retrieved from: http://www.unwomen.org//~/media/headquarters/attachments/sections/library/publications/2015/cyber_violence_gender%20report.pdf?v=1&d=20150924T154259

Blair-Loy, M., & Cech, E. A. (2017). Demands and devotion: Cultural meanings of work and overload among women researchers and professionals in science and technology industries. Sociological Forum, 32(1), 5–27. Retrieved from: https://doi.org/10.1111/socf.12315

Blair-Loy, M., Rogers, L., Glaser, D., Wong, Y., Abraham, D., & Cosman, P. (2017). Gender in engineering departments: Are there gender differences in interruptions of academic job talks? Social Sciences, 6(1), 29. Retrieved from: https://doi.org/10.3390/socsci6010029

Bright Horizons. (2017). 2017 Modern Family Index. Retrieved from: https://solutionsatwork.brighthorizons.com/~/media/BH/SAW/PDFs/GeneralAndWellbeing/MFI_2017_Report_v4.ashx

Cook C., Diamond, R., Hall, J., List, J. A., & Oyer, P. (2018). The gender earnings gap in the gig economy: Evidence from: over a Million Rideshare Drivers. Retrieved from: https://web.stanford.edu/~diamondr/UberPayGap.pdf

Digital Rights Foundation. (2017). Measuring Pakistani women's experiences of online violence: A quantitative research study on online-gender based harassment in Pakistan. Retrieved from: https://digitalrightsfoundation.pk/wp-content/uploads/2017/05/Hamara-Internet-Online-Harassment-Report.pdf

Erosa, A., Fuster, L., Kambourov, G., & Rogerson, R. (2017). Hours, occupations, and gender differences in labor market outcomes (Working Paper 23636). National Bureau of Economic Research. https://doi.org/10.3386/w23636

European Institute for Gender Equality. (2017). Cyber violence against women and girls. Retrieved from: http://eige.europa.eu/sites/default/files/documents/cyber_violence_against_women_and_girls.pdf

European Agency for Fundamental Rights (2014). Violence against women: An EU-wide survey, main results. Luxembourg: Publications Office of the European Union. Retrieved from: http://fra.europa.eu/en/publication/2014/violence-against-women-eu-wide-survey-main-results-report

Frost & Sullivan. (2017). The 2017 Global Information Security Workforce Study: Women in Cybersecurity. Retrieved from: https://iamcybersafe.org/wp-content/uploads/2017/03/WomensReport.pdf

Henry, N., Powell, A., Flynn, A. (2017). Not just revenge porn: Australian's experiences of image-based abuse, a summary report. Melbourne: RMIT University. Retrieved from: https://www.rmit.edu.au/content/dam/rmit/documents/college-of-design-and-social-context/schools/global-urban-and-social-studies/revenge_porn_report_2017.pdf

Hewlett, S. A., & Sherbin, L. (2014). Athena Factor 2.0: Accelerating female talent in science, engineering & technology. Retrieved from: http://www.talentinnovation.org/_private/assets/Athena-2-ExecSummFINAL-CTI.pdf
Hinduja S., Patchin, J. (2016). 2016 cyberbullying data. Retrieved from: https://cyberbullying.org/2016-cyberbullying-data

Hinson, L., Mueller, J., O'Brien-Milne, L. (2017). Cyber violence: Disrupting the intersection of technology and gender-based violence. Retrieved from: http://blogs.

worldbank.org/voices/cyber-violence-disrupting-intersection-technology-and-gender-based-violence

Hunt, J. (2010). Why do women leave science and engineering? (Working Paper 15853). National Bureau of Economic Research. Retrieved from: https://doi.org/10.3386/w15853

ILO. (2016). Global Wage Report 2016/17. Retrieved from: http://www.ilo.org/global/research/global-reports/global-wage-report/2016/lang--en/index.htm

ILO (2018). Global Wage Report 2018/19: What lies behind gender pay gaps. Retrieved from: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_650553.pdf

Laxton, C. (2014). Virtual world, real fear: Women's Aid report into online abuse, harassment and stalking. Retrieved from: https://1q7dqy2unor827bqjls0c4rn-wpengine.netdna-ssl.com/wp-content/uploads/2015/11/Women_s_Aid_Virtual_World_Real_Fear_Feb_2014-3.pdf

Meiksins, P., Beddoes, K., Masters, S., Micah, R., & Shah, Y. (2016). Women in engineering: A review of the 2016 literature. Retrieved from: https://research.swe.org/wp-content/uploads/2018/03/SWE-Lit-Review-Compilation-2017.pdf

Nafus, D. (2012). 'Patches don't have gender': What is not open in open source software. New Media & Society, 14(4), 669–683. Retrieved from: https://doi.org/10.1177/1461444811422887

National Academies of Sciences, Engineering, and Medicine. (2018). Sexual harassment of women: Climate, culture, and consequences in academic sciences, engineering, and medicine. Washington, D.C.: National Academies Press. Retrieved from: https://doi.org/10.17226/24994

Pew Research (2017). Online Harassment 2017. Retrieved from: http://assets.pewresearch.org/wp-content/uploads/sites/14/2017/07/10151519/PI_2017.07.11_Online-Harassment_FINAL.pdf

Quirós, C. T., Morales, E. G., Pastor, R. R., Carmona, A. F., Ibáñez, M. S., & Herrera, U. M. (2018). Women in the digital age. European Commission. Retrieved from: https://ec.europa.eu/digital-single-market/en/news/increase-gender-gap-digital-sector-study-women-digital-age

Sassler, S., Glass, J., Levitte, Y., & Michelmore, K. M. (2017). The missing women in STEM? Assessing gender differentials in the factors associated with transition to first jobs. Social Science Research, 63, 192–208. Retrieved from: https://doi.org/10.1016/j.ssresearch.2016.09.014

Scott, A., Kapor Klein, F., & Onovakpuri, U. (2017). Tech leavers study. Kapor Center for Social Impact. Retrieved from: https://www.kaporcenter.org/wp-content/uploads/2017/08/TechLeavers2017.pdf

Servon, L. J., & Visser, M. A. (n.d.). Progress hindered: The retention and advancement of women in science, engineering and technology careers. Human Resource Management Journal, 21(3), 272–284. Retrieved from: https://doi.org/10.1111/j.1748-8583.2010.00152.x

Toppa, S. (2017, August 9). Abuse in Pakistan: 'I'm more scared of harassment online than offline'. The Guardian. Retrieved from: https://www.theguardian.com/global-development-professionals-network/2017/aug/09/abuse-in-pakistan-im-more-scared-of-harassment-online-than-offline

Toupin, S. (2014). Feminist hackerspaces: The synthesis of feminist and hacker cultures. Journal of Peer Production, 4.

United States Department of Commerce. (2017). Women in STEM: 2017 Update. Economics & Statistics Administration. Retrieved from: http://www.esa.doc.gov/reports/women-stem-2017-update

Unwin, T. (2017). Reclaiming information and communication technologies for development. Oxford University Press.

Vasilescu, B., Posnett, D., Ray, B., van den Brand, M. G. J., Serebrenik, A., Devanbu, P., & Filkov, V. (2015). Gender and tenure diversity in GitHub teams. In: Crossings. Seoul, Korea. Retrieved from: http://delivery.acm.org.offcampus.lib.washington.edu/10.1145/2710000/2702549/p3789-vasilescu.pdf?ip=128.95.104.66&id=2702549&acc=ACTIVE%20SERVICE&key=B63ACEF81C6334F5%2EF43F328D6C8418D0%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&__acm__=1518685543_74e499233266245940ed485ccf165e04

Women's Legal and Human Rights Bureau, Inc. (2015). End violence: Women's rights and safety online, from impunity to justice: Domestic legal remedies for cases of technology-related violence against women. Retrieved from: https://www.genderit.org/sites/default/upload/flow_domestic_legal_remedies.pdf

World Bank Group. (2018). Women, business and the law 2018. Washington, DC: World Bank. Retrieved from: https://openknowledge.worldbank.org/handle/10986/29498

World Policy Analysis Center (2017). Workplace discrimination database. Retrieved from: https://www.worldpolicycenter.org/maps-data/data-download/workplace-discrimination

Weisgram, E., & Diekman, A. (2015). Family friendly STEM: Perspectives on recruiting and retaining women in STEM fields. International Journal of Gender, Science and Technology, 8(1), 38–45.

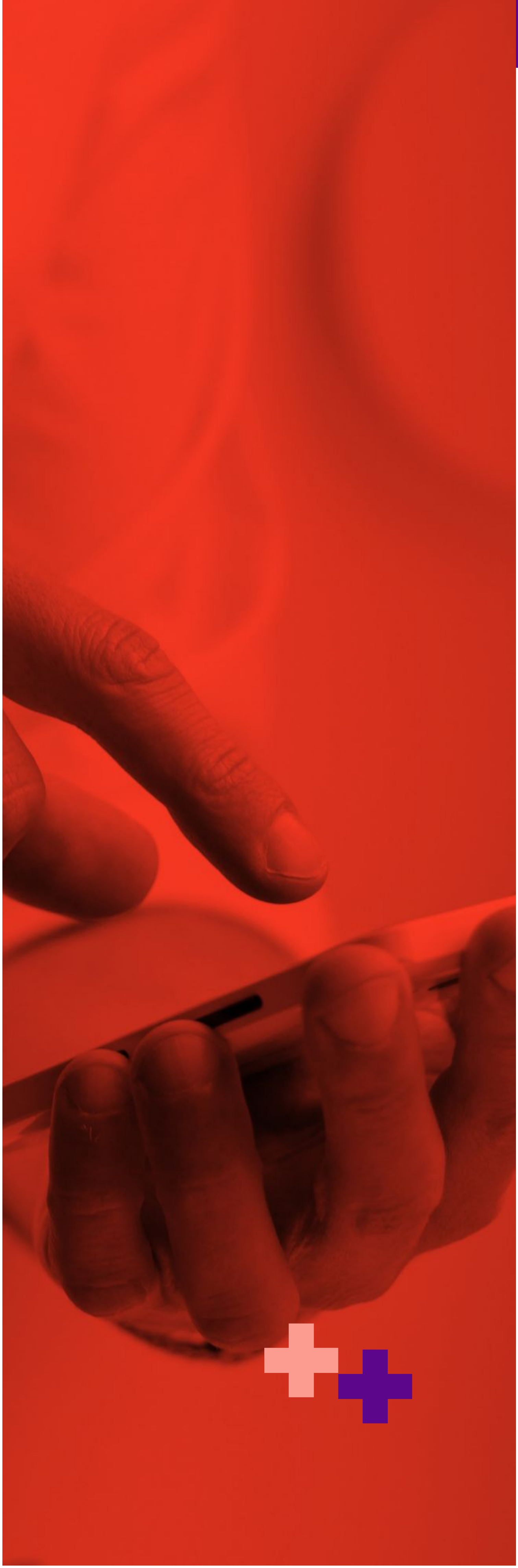
Xie, Y. (2006). Social influences on science and engineering career decisions. In National Academy of Sciences (Ed.), Biological, social, and organizational components of success for women in academic science and engineering: Workshop Report. Washington, DC: National Academies Press. Retrieved from: http://www.ncbi.nlm.nih.gov/books/NBK23778/

Zarya, V. (2016, November 16). Female programmers make nearly 30% less than their male counterparts. Retrieved from: http://fortune.com/2016/11/16/gender-pay-gap-programmers/

5

BARRIERS TO GENDER EQUALITY AND RECOMMENDATIONS

AUTHORS:
ARABA SEY, JUHEE KANG, AND
DON RODNEY JUNIO (UNU-CS)



KEY FINDINGS

- Barriers to gender digital equality are generally related to one or more of the following: 1) availability of infrastructure; 2) financial constraints; 3) ICT ability and aptitude; 4) interest and perceived relevance of ICTs; 5) safety and security; and 6) socio-cultural and institutional contexts. Most of these barriers cut across issues of access, skills, and leadership.
- There is no single strategy for eliminating gender digital inequalities. Recommendations generally call either for targeting specific symptoms (such as affordability or recruiting practices), or for reshaping deeply ingrained social norms and practices (such as gender stereotypes) that are at the root of gender inequalities.
- Strategies to increase gender equality in ICT access generally focus on: addressing accessibility and affordability barriers; providing relevant content; improving safety and security online and offline through public education, technical, and legal means; mainstreaming gender perspectives into policies and budgets; sharing good practices; investing in women's education and basic digital skills capacity-building.
- The main proposals for closing gender gaps in advanced digital skills and STEM education range from making training more accessible for women and underrepresented groups, to addressing gender stereotyping of STEM education and building girls' self-efficacy and confidence in STEM.
- Most proposed remedies for gender inequality in ICT leadership recommend one or several of the following: combating gender stereotypes and biases at individual, institutional, and societal levels; establishing programs and supportive structures to encourage female participation and advancement in ICT occupations; legislating diversity obligations; and diverting resources to institutions that are more gender-diverse.
- Reasons for and solutions to gender digital inequality remain contested, contextual, and nuanced. For example, some scholars assert that having children is the most important factor preventing women from pursuing careers in science and engineering, while others argue that women's primary reasons for leaving technology jobs are not family-related.

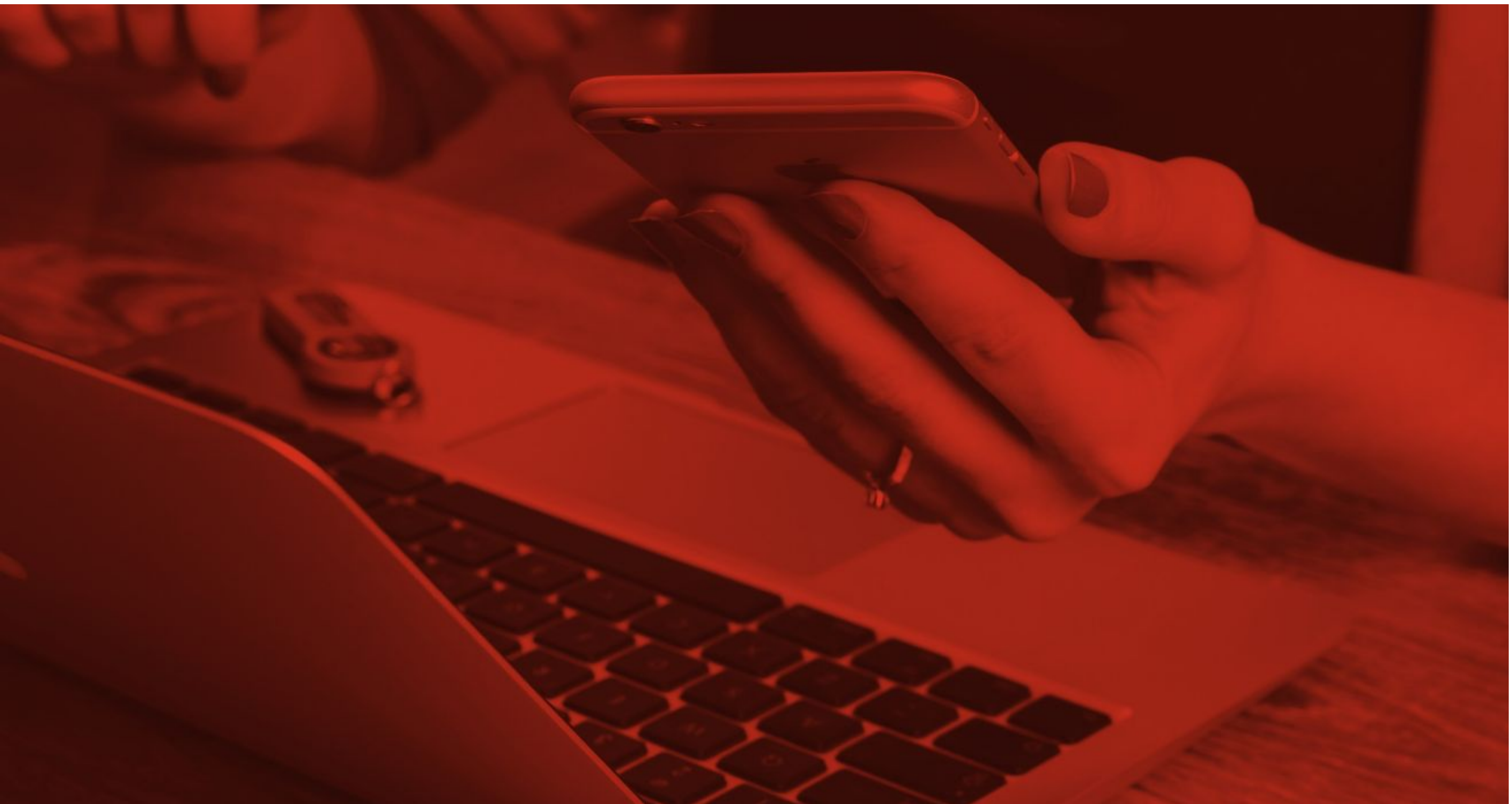
5.1 / INTRODUCTION

This chapter compiles literature and research that have identified barriers to gender digital equality and made recommendations for dealing with the barriers as they relate to ICT access, skills and leadership.

The barriers and disadvantages inhibiting gender digital equality are diverse, multifaceted, and often embedded in longstanding social structures that privilege men over women. Most of these barriers cut across access, skills, and leadership; they may manifest in slightly different ways (Table 5.1). The six broad types of barriers identified in Table 5.1 are discussed in more detail below.

Table 5.1
Sample manifestations of barriers

FIELD	NUMBER OF FEMALES	SKILLS	LEADERSHIP
Availability of infrastructure	· Urban versus rural broadband internet availability	-	-
Financial constraints	· Affordability of hardware and software	-	· Access to business capital
Ability and aptitude (real and perceived, by self or others)	· Lack of basic digital skills	· Perceived technical ability and aptitude · Perceived difficulty of STEM and advanced skills	· Perceived technical and managerial ability and aptitude
Interest and perceived relevance	· Lack of interest · Lack of relevant content	· Lack of interest and motivation · Lack of role models	· Lack of interest and motivation · Lack of role models
Safety and security	· Cyber violence · Public safety	· Discriminatory learning environments · Sexual harassment	· Discrimination, hostile work environments · Sexual harassment
Socio-cultural and institutional contexts	· Social norms, stereotypes, and cultural barriers	· Gender stereotyping of STEM · Lack of gender-sensitive curriculum and learning environments	· Biased recruiting practices due to gender stereotyping · Family demands and work-life balance issues · Policy and regulatory environments



5.2 / BARRIERS TO ICT ACCESS

5.2.1 / AVAILABILITY OF INFRASTRUCTURE

In resource-poor communities, access to ICTs is affected not just by economic conditions but also by the lack of technical infrastructure such as signal coverage. Although infrastructure availability affects all rural residents, the GSMA Gender Gap Report notes that, for both mobile ownership and mobile internet use, the gender gap is wider in rural areas than in urban areas; even where overall ownership levels are minimal, the percentage of rural women who own mobile phones is still far lower than men (GSMA, 2018). However, even in urban communities, some gender digital divides persist. For instance, the World Wide Web Foundation (2015) found that among the urban poor, women were nearly 50% less likely than men to access the internet. Van der Spuy and Aavriti (2015) have also identified infrastructure as one of the three key themes related to barriers to ICT access, in addition to cost/affordability issues and availability of relevant and appropriate content.

5.2.2 / FINANCIAL CONSTRAINTS

Studies on the gender digital divide point to affordability as one of the main (and in some cases the greatest) barriers to ICT adoption among women (Deen-Swarray et al., 2012; GSMA, 2018a; Hilbert, 2011; Milek et al., 2011). Of course, the prohibitive cost of access devices and of accessing the internet affects both men and women. Organisations such as the Alliance for Affordable Internet (A4AI, 2017) have noted that in some countries, access to the internet remains prohibitive: the cost of buying 1GB of data in Africa is equivalent to about 18% of monthly income, for example. However, when women are disadvantaged economically — as is the case if they are not gainfully employed or do not have control over their own finances — the issue of ICT affordability and ownership becomes more acute for them.

5.2.3 / ABILITY AND APTITUDE

This relates to women's educational background, aptitude, and skills to use ICTs. Even if costs of ICT devices and services go down, women would still be at a disadvantage if they are not equipped with the basic digital skills and literacy needed to operate in the digital economy. Education levels and functional literacy have been identified as significant barriers to accessing and using technology by women in both developed and developing countries (Antonio & Tuffley, 2014; GSMA, 2018a; Hilbert, 2011).

5.2.4 / INTEREST AND PERCEIVED RELEVANCE

Key findings of a four-country survey conducted by Intel (2012) showed that one of the main reasons why women did not access the internet is that they did not know what the internet is or how it might benefit them. The top three answers to questions about low usage levels were: (1) I'm not interested in it; (2) I'm not familiar or comfortable with the technology; and (3) I don't need to access the internet. Women's low interest in using ICTs could be linked to the (un)availability of content that is of relevance to their daily lives and aspirations, in accessible languages and formats (Chair, 2017; Ya'u & Aliyu, 2017). For example, Part II Chapter 2 notes that one reason why women in Africa are not online is the lack of relevant content in local languages. A possible lack of confidence in using the internet, compounded with negative perceptions of ICTs, may also be influencing how women utilise the internet. For instance, in a small case study of Turkish students, Varank (2010) showed that gender was a significant variable predicting computer attitudes.

5.2.5 / SAFETY AND SECURITY

Complacency and failure to address and solve cyber violence could significantly impede the uptake of broadband services by girls and women worldwide. (ITU Secretary-General Houlin Zhao, Combatting Online Violence Against Women & Girls: A Worldwide Wake-Up Call in 2015)

Safety issues are linked to the discussion of the dark side of ICT access; these include threats or experience of cyber VAWG, which some studies (e.g., GSMA, 2018) have shown affect women's interest in using ICTs. Once online, intimidation and harassment may inhibit women from fully engaging with the Internet. A report by Amnesty International (2018) on violence against women on Twitter stated that the abuse experienced on the platform leads women to "self-censor what they post, limit their interactions, and even drives women off Twitter completely." Focusing on developing countries, APC launched a report chronicling case summaries of women's experiences of technology-related violence against women in six countries (APC, 2015).

5.2.6 / SOCIO-CULTURAL AND INSTITUTIONAL CONTEXTS

Local cultural contexts may also limit women's access to and use of technology. These social norms, stereotypes, and cultural constraints are harder to measure than other types of barriers, especially since evidence on how they affect women is specific to particular countries and cases. For instance, in societies where cultural norms constrain women's ability to move around in public, female access to ICTs in some locations (such as community centres or internet cafes) is restricted (Alao et al., 2017). Likewise, where discrimination makes it difficult for women to acquire a good education and develop basic literacy, their ability to meaningfully use ICTs is also hampered (CITAD, 2017; Laizu et al., 2010). More often, these socio-cultural and institutional contexts interact with issues related to safety and security. Hassan, Unwin, and Gardezi (2017) examined the extent of mobile harassment in Pakistan, which has a complex institutional configuration that entwines patriarchy, religion, and culture. Among other things, their research shows that women are far more frequently blamed than men when they are sexually harassed; they trace this tendency to the "traditional patriarchal Islamic character of Pakistan's society, with its strong emphasis on family honor and shame."

5.3 / BARRIERS TO ICT SKILLS

5.3.1 / PERCEIVED ABILITY AND APTITUDE

Research indicates that girls tend to underestimate their digital abilities, and their self-assessment is often biased by several internalised perceptions. This is especially problematic for STEM and related training. For instance, an OECD (2012) report pointed out that when girls were told to "think like scientists", they performed much worse than boys. It suggested that the gender gap in academic performance in STEM originates more from girls' perceptions about themselves than from an actual ability gap. This tendency continues throughout the pipeline, as young women in STEM reportedly feel lower self-efficacy and higher self-doubt in their ability compared to men. In studies of U.S. computer science students, this lower self-perception has been associated with the sense of not belonging in the field (SWE 2016; Miller, 2016; Ro & Knight, 2016). The perception that girls don't have the aptitude for computing and related studies may also come from others, such as family, friends, and teachers, and can affect the guidance girls receive when making education choices. For example, a PISA study showed that teachers may harbour conscious or unconscious stereotyped notions about girls' and boys' strengths and weaknesses in school subjects (OECD, 2015). OECD (2012) also reported that parents are more likely to expect their teenage sons, rather than their daughters, to work in STEM occupations, despite their equal performance.

5.3.2 / PERCEIVED ABILITY AND APTITUDE

When girls make choices about secondary school specialisation or college majors, they often do not have adequate information about options related to STEM studies. In a survey of 4,500 girls and parents in the UK and Ireland, it was found that information on STEM subjects and career paths was perceived to be more fragmented and less obvious than other disciplines, making it difficult for students, parents, and teachers to evaluate options (Accenture, 2015, 2017). Girls listed parents as the biggest influence on their subject and career choice, but 51% of the parents felt that they were ill-informed on the benefits of STEM subjects, and only 14% said they were well aware of different career opportunities in STEM for their daughters.
Moreover, the existing underrepresentation of women can perpetuate future underrepresentation, as the lack of role models inhibits young women from imagining themselves as successful computer scientists or engineers (Dasgupta, 2011; Meltzoff, 2013; Murphy et al., 2007). Indeed, most parents (82%), teachers (89%), and young people (68%) agree that the STEM field lacks high-profile female role models (Accenture, 2015).

5.3.3 / SAFETY AND SECURITY

Anticipation of gender discrimination, such as harassment or promotion disadvantage, have been suggested as additional barriers dissuading girls and women from STEM study and career aspirations (Ceci et al., 2009; Moss-Racusin et al., 2012). Furthermore, as noted in Chapter 4, educational programs in science, engineering, and medicine tend to have environments that exacerbate vulnerabilities and foster gender discrimination and harassment.

5.3.4 / SOCIO-CULTURAL AND INSTITUTIONAL CONTEXTS

Criticisms have long been raised over the culture associated with STEM education — particularly the stereotyping of certain subfields as more suited to males than females, and the highly competitive environment ("swim or drown" culture) of introductory math and science courses. The result is to discourage both women and minority students (NAS, 2016). In fact, gender stereotypes about intellectual ability emerge as early as age six, when girls start to categorise more boys as "smart" and steer away from playing with the "smart" group (Bian et al., 2017). Gender career stereotyping is also strengthened by exposure to gendered toys and computer games marketed as objects for boys (Owen & Padron, 2016; Let Toys Be Toys UK, 2015). This notion persists through secondary education: for instance, nearly half of girls in the UK and Ireland believed that STEM subjects are for "male careers" and are a better fit for boys' brains (29%), personalities, and hobbies (27%) (Accenture, 2015). In addition, syllabus difficulty was the biggest reason behind not wanting to study STEM, with more than half of 12-year-old girls believing that STEM subjects are too difficult for them to learn.

Researchers also suggest that some STEM subfields have failed to present themselves as areas where women can pursue their values and goals. The lack of gender-sensitive curricula and gender-balanced learning environments in schools and colleges causes female students to avoid or drop out from engineering and technology studies. Some point to evidence that students perceive STEM fields as individual-centric and object-oriented, whereas women prefer more community-centric and people-oriented careers (Godwin et al., 2016; Stout et al., 2016; Wang & Degol, 2013). Others point to the masculine culture of engineering or geek culture in computer science, including "the stereotypes of socially awkward males who possess innate abilities that women allegedly lack" (SWE, 2016, p. 14; see also Cheryan et al., 2016). There is a general perception that STEM and ICT learning environments need to adapt to include participation of people with diverse values and career goals.

5.4 / BARRIERS TO ICT LEADERSHIP

Women's severe underrepresentation in science and engineering is an extremely complex social phenomenon that defies any attempt at simplistic explanations. (Xie, 2006, p. 167.)

5.4.1 / FINANCIAL CONSTRAINTS

As discussed in Chapter 3, on ICT leadership, women entrepreneurs tend to have less access to business capital than male entrepreneurs. There is insufficient research to determine the extent to which this inhibits women from pursuing ICT entrepreneurship, especially in the informal sector. Most of the existing evidence relates to venture capital and focuses on documenting the levels of funding that goes to female enterprises. In this area, researchers attribute the extreme skew in funding for female-managed businesses to biases in VC firms, driven in large part by homophily — "the tendency of individuals to associate with similar others" (Gompers & Wang, 2017b, p. 36), evidenced in low representation of women in VC firms. Brush et al. (2014) reported that, in 2013, only 6% of VC firms in the U.S. had women partners (a decline from 10% in 1999). Gompers & Wang (2017b) showed that over the almost three decades since 1990, women have consistently constituted less than 10% of the VC labour pool in the U.S., whereas other fields like medicine and law, starting at a similarly low level, have now reached parity. Furthermore, women venture capitalists in Information Technology stood at 5.5%, the lowest of all industries. Gompers, Mukharlyamov, Weisburst, and Xuan (2017) found that nearly 80% of VC firms had never hired a female investor. In Europe, studies estimate the percentage of female business angels between 10% and 30% (Quiros et al., 2018); a 2017 study found that women make up a minority (13%) of decision makers in U.K. venture capital firms (Diversity VC, 2017).

A few studies suggest that networking constraints limit women's ability to gain access to business opportunities, with men having better access to relevant networks in technology and finance sectors, as well as different modes of utilising them (Alakaleek & Cooper, 2017; BarNir, 2012; Kuschel & Lepeley, 2016). There are also indications that venture capitalist assess male-led firms differently from female-led firms. A study by Lee & Huang (2018) found that female-led ventures were evaluated more highly when their proposals were given a social impact framing, though that standard was not applied in assessing male-led ventures.

5.4.2 / PERCEIVED ABILITY AND APTITUDE

A lack of adequate technical, business, or entrepreneurship training continues to be cited as reasons why there are few women in ICT leadership positions (Brush, Greene, Balachandra, & Davis, 2014). This is countered by studies demonstrating that women are acquiring relevant degrees — in IT, computer science, engineering, business management, and investment banking — at much higher rates than their representation in the workforce for these fields (Brush, Greene, Balachandra, & Davis, 2014; Gompers & Wang, 2017). Despite this, the perception that women are less capable than men in computing professions continues to exert both endogenous and exogenous influence on women's professional choices — i.e., undervaluing by self and others. The result is evident in conscious and unconscious biases affecting hiring, performance evaluation, promotion policies, career development opportunities, and other workplace practices that shut women out or create work environments that are hostile or discouraging to women. Educational pathways to technology careers are also somewhat inflexible (Corbett & Hill, 2015), potentially ushering both males and females onto narrow career paths based on perceived technical versus non-technical capabilities.

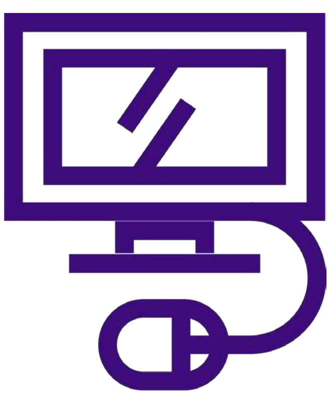
5.4.3 / INTEREST AND PERCEIVED RELEVANCE

Beliefs about gender difference can [thus] spawn powerful self-fulfilling prophesies. (Charles and Bradley, 2009, p. 929.)

Social attitudes about gender capabilities as well as the values associated with technology occupations may inhibit women from considering careers in some science and technology fields. Despite the expansion of job opportunities generated by the digital economy, both sectoral and occupational segregation by gender have increased over the last two decades. According to ILO (2017b, pp. 10–11), "to achieve matched allocation of men and women in every sector would require a shift of one in every five men or women to different sectors." Competing explanations for occupational segregation by gender cover a broad range: comparative advantages (based in biology); under-investment in women's education and training; preferences and prejudices; stereotypes; organisational barriers; and differential income roles (Bettio & Verashchagina, 2009; Wang, Degol, & Ye, 2015; Weisgram & Diekman, 2015).

5.4.4 / SAFETY AND SECURITY

As discussed in Chapter 4 on the Dark Side, technology firms are seen as perpetuating particularly hostile environments, characterised by a hypermasculine culture that is unwelcoming or even threatening to women (Hewlett & Sherbin, 2014) (Box 5.1). Expectations of harassment can deter women from pursuing computing careers.



Box 5.1
Unwelcoming environments discourage female software developers

Michael Madaio (UNU-CS)

Several of the most influential online software developer platforms (such as GitHub and Stack Overflow) are associated with a particular type of hacker culture characterised by highly critical, often-acrimonious language that is intolerant of novices in general, but particularly so for female novices (Ford et al., 2016; Nafus, 2012). Researchers attribute women's low participation in online software developer communities to this unwelcoming environment. In our analysis of datasets from large-scale surveys of GitHub and Stack Overflow users, we found that women were significantly more likely than men to say that a welcoming community and code of conduct were important to their participation in open-source software development. Female developers surveyed on those platforms were significantly less likely than men to consider themselves a member of those communities. On GitHub, the most widely used collaborative development platform — with over 29 million active users — men were more likely to feel that the community valued contributions from "people like them", while women were more likely to feel that they did not have the skills and knowledge valued by others on GitHub. This may be a result of how the rest of that community treated them when they did participate, though more data is needed to understand the particular ways in which the culture of online developer communities is hostile towards women in general and female novices in particular.

5.4.5 / SOCIO-CULTURAL AND INSTITUTIONAL CONTEXTS

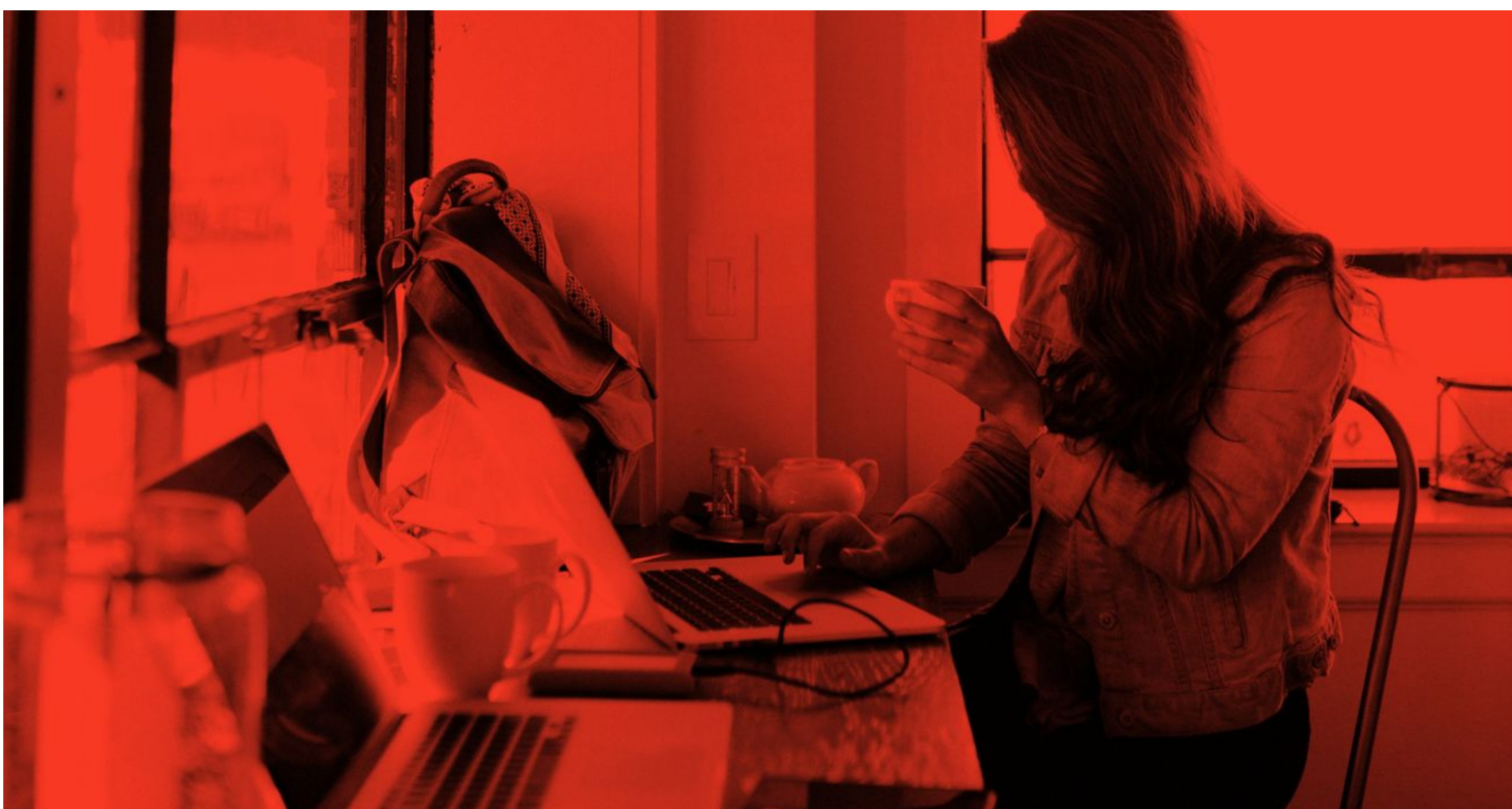
Starting at an early age, we acquire implicit biases simply by living in a society where different types of people fill different roles and jobs. . . . Passive exposure to widespread beliefs registers these beliefs in our minds without our even knowing it. (Corbett & Hill, 2015, p. 38.)

The traditional scientific or engineering career . . . is predicated on the assumption that the faculty member will have an unlimited commitment to his or her academic career throughout his or her working life. Attention to other serious obligations, such as family, is taken to imply lack of dedication to one's career. . . . The model . . . is increasingly unsuitable for both men and women who need or want to participate in other activities important to them and their communities. (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007, p. 160.) The overarching contexts of social structures (e.g., social norms and pressures regarding female roles) and policy environments (e.g., unsupportive business regulations) shape the extent to which various demand and supply issues can facilitate or inhibit women's equal participation (Box 5.2).

Box 5.2
Barriers to gender equality in ICT leadership

Barriers to gender equality in ICT leadership may be either supply- or demand-driven. Supply-side factors deal with the interest and willingness of women to participate in the ICT industry, while demand-side factors address the openness of the ICT industry to female participation. While some attribute gender inequalities to supply factors (Fernandez & Campero, 2017), others argue that demand factors play a stronger role. The truth is probably somewhere in between. Competing supply-side rationales for gender gaps include: the "critical filter hypothesis" (girls are handicapped because they are not good at mathematics); "pipeline problem" (women drop out of science training or careers); "productivity puzzle" (female scientists are less professionally productive than men); and "family life hypothesis" (women prioritise family life over careers in science (Xie, 2006). Demand-side rationales include: perceived or assumed lack of aptitude; biased recruiting and financing practices; gender-based discrimination; and unwelcoming professional environments (Meiksins, Layne, Beddoes, Masters, Roediger, & Shah, 2016).

Gender stereotyping of computing as a male domain acts as a deterrent to women's interest and motivation. These stereotypes pervade social consciousness, in sometimes subtle ways (Case Study 5.1).



Case Study 5.1

"Ok Google: Is AI Gendered?"

Author: Araba Sey and Lisandra Fesalbon (UNU-CS)

As artificial intelligence (AI) products such as Siri, Alexa, and Cortana become prominent fixtures in daily life, debates rage about their potential and dangers. There are high expectations that AI will engender diversity, social inclusion, fairness, and equality. However, evidence is already emerging that even AI is prone to reproducing social biases and stereotypes (Gustavsson & Czarniawska, 2004; Gustavsson, 2005). Against this backdrop, we explored some of the more overt ways in which AI might be mirroring societal biases regarding female roles. Specifically, we asked: Are AI products given gender identities — and, if yes, to what extent do these identities reinforce occupational gender stereotypes?

Methodology. We conducted internet searches using Google Play Store and Apple Store, as well as lists such as Imanuel (n.d), Pappas (2015), and Wycislik-Wilson and Ellis (2018). The search yielded 129 AI products, mostly cost-free, that are marketed on the internet:

- 98 virtual personal assistants: software and applications that respond to requests from users
- 31 text-to-speech services: software and applications that allow users to hear text read out loud

To determine gender identity, we classified the names, voices, and appearances of the AI product, based on information on product websites as well as product advertisements and demos. Names were classified based on the Worldwide Gender-Name Dictionary (Raffo, 2016). For products with a voice feature, gender of the voice was classified by downloading and listening to a demo and assigning female to higher-pitched voices and male to deeper-pitched voices. Appearance, for products with an embodied virtual agent, was determined by whether the agent resembled a female, a male, or looked neutral.

Findings. Virtual personal assistants had primarily female identities: 41% had a female name, 68% had a female voice, and 50% had a female appearance (Table 5.2). Male identities were less common. However, there was also a fair amount of neutral identities: 28% had a neutral name, 13% offered both male and female voices, and 29% were neutral in appearance.

Table 5.2
Gender identities of virtual personal assistants

	FEMALE	MALE	NEUTRAL	BOTH	UNSURE	TOTAL
NAME	40 (41%)	23 (23%)	27 (28%)	0	8 (8%)	98 (100%)
VOICE	48 (68%)	9 (13%)	0	9 (13%)	4 (6%)	70 (71%)
APPEARANCE	21 (50%)	8 (19%)	12 (29%)	1 (2%)	0	42 (43%)

Text-to-speech software and applications, on the other hand, were overwhelmingly neutral (Table 5.3). Practically all had generic names and non-gendered appearances. However, most (84%) offered the option to choose gendered names and accompanying voices within the software.

These findings suggest that AI products tend to be assigned gendered identities that to some degree replicate occupation stereotypes, especially regarding "pink-collar" jobs. Most virtual personal assistants are designed to carry out basic clerical tasks, such as answering e-mails, reading or sending messages, and planning calendar agendas. The fact that most of our sample of virtual personal assistants were female-gendered is consistent with the tendency for these types of frontline services to be associated with female workers in the offline world (Gustavsson, 2005; Piper,

Table 5.3
Gender identities of text-to-speech software and applications

	FEMALE	MALE	NEUTRAL	BOTH	UNSURE	TOTAL
NAME	1 (3%)	0	30 (97%)	0	0	31 (100%)
VOICE	5 (16%)	0	0	26 (84%)	0	31 (100%)
APPEARANCE	0	0	0	0	31 (100%)	31 (100%)

2016; Zdenek, 2007). Indeed, some researchers argue that both men and women prefer interacting with virtual females (LaFrance, 2016; Piper, 2016; Zdenek, 2007). However, the strong presence of products with neutral identities indicates that some developers are proactively eliminating overt gender stereotypes from their products. It is notable that the "older" product type, text-to-speech services, was the most likely to give users gender choices.

Recommendations. This is a relatively new area, with room for more exploration. Future research should expand the scope to include more AI products of varying types, life-stages, sectors, geographic origins, and languages. Demand-side analyses would shed light on consumer preferences as well. To mitigate widely held gender stereotypes that continue to shape people's career decisions, AI product developers could take a cue from text-to-speech products and assign their products neutral identities, or, at the very least, incorporate multiple options, allowing consumers to decide.

In addition, although the evidence is contradictory, it appears that, to a considerable extent, personal and societal expectations that a woman prioritise family over work hold some women back from pursuing academic and industry careers in ICT — or impose heavy professional and personal burdens. The "culture of overwork" (Corbett & Hill, 2015, p. 35) associated with technology firms exacerbates the situation for employees who shoulder domestic care and other such responsibilities.

Institutionalised discrimination also stunts involvement in computing careers. Unfortunately, a prevailing belief that technology firms are guided by meritocratic principles leads to women being unjustly excluded from candidate pools and advancement opportunities (Corbett & Hill, 2015; Dryden, 2013; Hewlett & Sherbin, 2014; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007; Sassler, Glass, Levitte, & Michelmore, 2017). For example, practices such as assessing candidates based on their activity on particular platforms (such as GitHub) stacks the deck against women, if these platforms are themselves inhospitable towards women.

In relation to entrepreneurship, although not specific to ICT entrepreneurship, some research suggests that limited policy support can inhibit female participation. The World Bank Group (2018) reports that fewer women work or own businesses in economies that have lower levels of gender legal equality[23]. Furthermore, data from the Internet Inclusiveness Index (Economist Intelligence Unit, 2018) shows that, globally, only 25 countries have a national "plan addressing female-driven innovation and women-owned businesses"; those countries are located in Africa (7), Asia and the Pacific (8), Europe (8), and the Americas (2). Research by Liberda and Zajkowska (2017) concludes that innovation policies in Europe fail to actively account for gender, leading to a focus on male-dominated sectors. In sum, barriers to gender digital equality can be grouped into six broad categories (Table 5.1).

Table 5.4
Summary of barriers to gender digital equality

BARRIER	NUMBER OF FEMALES	SKILLS	LEADERSHIP
Availability of infrastructure	√	-	-
Financial constraints	√	-	-
Ability and aptitude (real and perceived, by self or others)	√	-	√
Interest and perceived relevance	√	√	√
Safety and security	√	√	√
Socio-cultural and institutional contexts	√	√	√

23 *Note that this contrast somewhat with the conclusion of Kelley et al. (2017) conclusion (reported in Chapter 3) that there is more female entrepreneurship in countries with lower gender equality ratings.*

5.5 / RECOMMENDATIONS

Resolving digital gender inequalities will require addressing the different barriers that affect women's engagement with ICTs, including development of digital skills and career opportunities in the ICT industry. Table 5.2 summarises the range of recommendations identified in the literature, as they relate to the barriers discussed here. Some proposed remedies target specific manifestations or symptoms of gender digital inequality, such as affordability or recruiting practices: see Box 5.4 for UN Women's recommendations targeted at the business sector. Others recommend reshaping deeply ingrained social norms and practices that are at the root of gender inequality: see Case Study 5.2 for a life course perspective. Specific recommendations are discussed in more detail below.

Table 5.5
Recommendations for addressing barriers to gender equality in ICT access, skills, and leadership (collated from the literature)

BARRIERS	RECOMMENDATIONS
Availability of infrastructure	· Expand infrastructure to unserved/underserved communities · Support original research and the collection, tracking, analysis and sharing of sex-disaggregated data
Financial constraints	· Improve affordability · Remove gender-based barriers to acquiring business capital · Support original research and the collection, tracking, analysis and sharing of sex-disaggregated data
Ability and aptitude (perceived and real; endogenous and exogenous)	· Invest in digital literacy capacity-building · Address gender stereotyping of STEM · Invest in entrepreneurship capacity-building · Support original research and the collection, tracking, analysis and sharing of sex-disaggregated data
Interest and perceived relevance	· Provide relevant content and services · Increase awareness/demonstrate potential and relevance of ICTs and ICT careers · Address gender stereotyping of STEM · Support original research and the collection, tracking, analysis and sharing of sex-disaggregated data
Safety and security	· Develop social, technical and regulatory measures to eliminate safety and security threats in public, educational and workplace settings · Support original research and the collection, tracking, analysis and sharing of sex-disaggregated data
Socio-cultural and institutional contexts	· Combat stereotypes, biases and discriminatory norms at individual, institutional and societal levels (e.g. increase media awareness/sensitization, establish and enforce legislation, promote gender sensitive learning approaches and environments, spotlight role models, foster work/life balance, diversity policies & programs, gender lens investing) · Collaborate with stakeholders (e.g. consult and involve women and men, share good practices and lessons) · Support original research and the collection, tracking, analysis and sharing of sex-disaggregated data

Box 5.4

The Women's Empowerment Principles
Photo credit: UN Women/Ryan Brown

All businesses stand to benefit from gender equality. The Women's Empowerment Principles (WEPs) platform supports the private sector — regardless of size, sector or geography — to advance gender equality and women's empowerment in the workplace, marketplace, and community, and to contribute to achieving the Sustainable Development Goals. The WEPs provide a gender lens through which businesses can analyze their current initiatives, benchmarks, and reporting practices, and then tailor or establish policies and practices to realise gender equality and women's empowerment. Support for the seven Principles has gathered global momentum: more than 2,000 companies worldwide are now WEPs champions.

Women's Empowerment Principles

Principle 1: Establish high-level corporate leadership for gender equality.

Principle 2: Treat all women and men fairly at work – respect and support human rights and nondiscrimination.

Principle 3: Ensure the health, safety, and well-being of all women and men workers.

Principle 4: Promote education, training, and professional development for women.

Principle 5: Implement enterprise development, supply chain, and marketing practices that empower women.

Principle 6: Promote equality through community initiatives and advocacy.

Principle 7: Measure and publicly report on progress to achieve gender equality.

Case Study 5.2

Gender digital inequality from the Life Course perspective

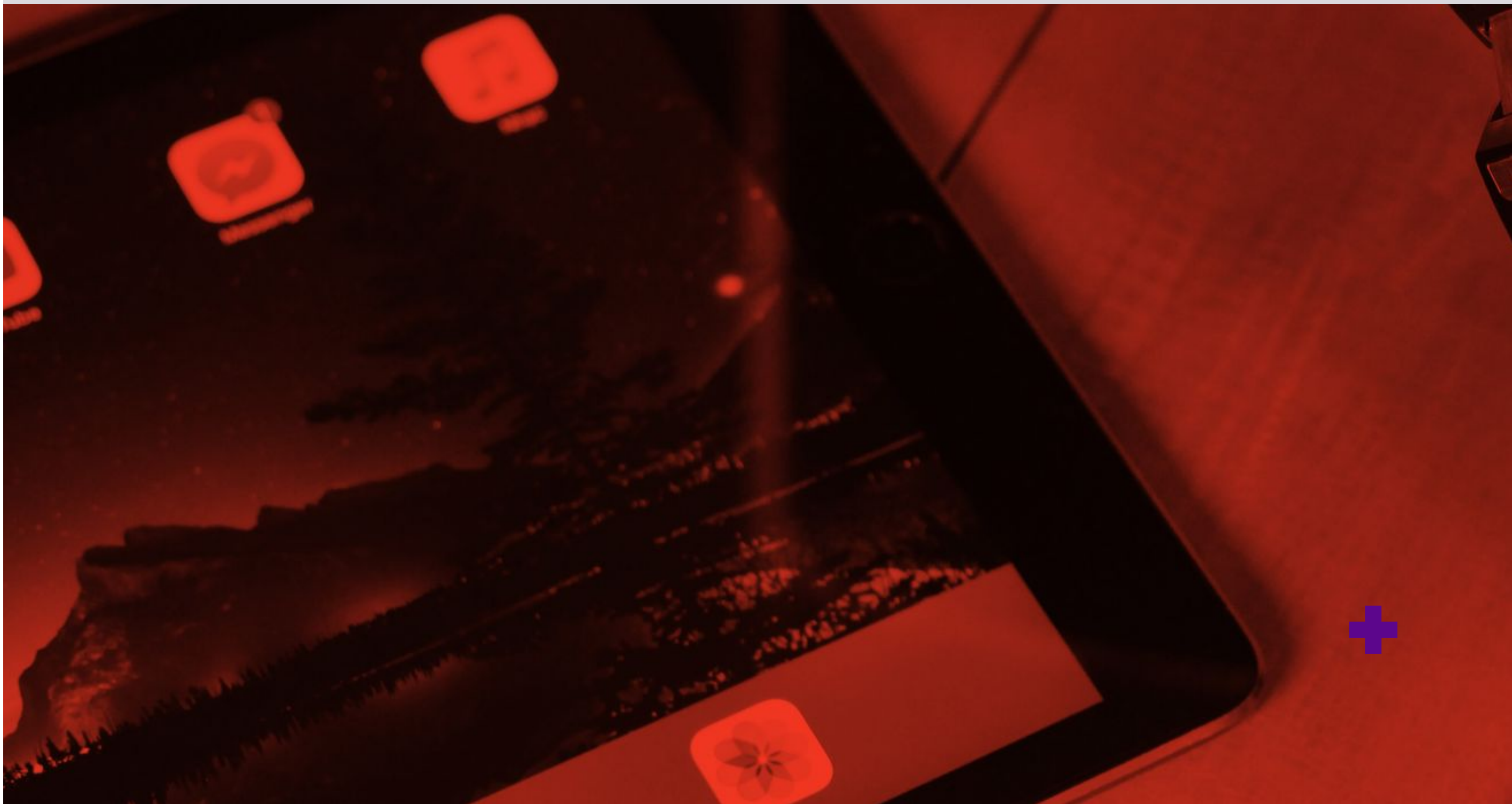
Author: Moon Choi (KAIST Graduate School of Science and Technology Policy)

The current state of gender digital inequality is the outcome of accumulated oppressions that women, who used to be girls, have faced throughout the course of their lives. For the last decade, research and discourse on gender digital inequality has advanced slowly but steadily; still, it lacks theoretical perspectives which could provide insight into the mechanisms of gender digital inequality as well as critical intervention points to reduce it. The concept of "life course" is one of the primary theoretical frameworks in the field of gerontology and human development — and it can be applied to enhance understanding gender digital inequality.

Individuals belong to a cohort based on their birth years, in historical context and time (Elder, 1998). The life course perspective emphasises the structural influences of cohort, history, culture, and location in relation to individuals' life experiences and pathwayswhile attempting to bridge sociological and psychological constructs (Hooyman & Kiyak, 2011; Settersten, 2006). For example, a girl born in a developing country during the twenty-first century has quite different gender norms, attitudes toward technology, and choices for her education, major, career etc., compared to a woman who was born in the same country during the early half of the twentieth century, or a girl born in the same year but in a developed country. Gender socialisation means "learning gender" (Moen, 2016); members of different cohorts and societies learn gender differently, which influences how they view their lives and make decisions about their future.

Early life experiences and decisions, often constructed by society, affect future life experiences; advantages and disadvantages tend to be accumulated over the life course and maximised in old age (Dannefer, 2003). The gender digital divide needs to be understood from this life course perspective. Women's decisions on education and career arise from early life experiences and social constructs by cohort. For example, strong gender identity and stereotypes have been reported to be associated with negative attitudes toward mathematics among female college students (Nosek, Banaji, & Greenwald, 2002), becoming a constraint on moving into careers in science and engineering (Moen, 2016). Also, after starting a family, woman often becomes the primary caregiver for children and other family members, responsibilities that may conflict with full-time employment in demanding positions, limiting career options and increasing women's vulnerability to poverty.

The life course perspective would suggest that enacting seemingly simple solutions, such as increasing access to the internet and digital devices among girls and women, cannot work effectively without fundamental changes in prevalent gender norms and culture. Current and future cohorts of both girls and boys should not learn gender, while both women and men need to unlearn gender, especially around the potential to succeed in math, science, and other technical subjects. Older women also suffer social exclusion related to digital literacy, in that accumulated disadvantages, including those related to gender norms, tend to be maximised in old age. Furthermore, older women often serve as caregivers of young children for dual-income couples. Considering that they are the agents transmitting values to the next generation and also the most vulnerable to digital exclusion, interventions targeted to grandparents and grandchildren might be effective in reducing gender digital inequality in both the short and long term.



5.5.1 / RECOMMENDATIONS FOR ICT ACCESS

Expand digital infrastructure.
This includes not only improving connectivity options through basic infrastructure (especially in rural areas), but also exploring models of service provision that are more attuned to the lifestyles and concerns of women (Alampay, 2006; Sambuli, Brandusescu, & Brudvig, 2018).

Improve affordability.
There is now greater understanding and visibility of ICT affordability issues in different parts of the world, because of improved data collection and measurement tools such as ITU's ICT Price Basket indicator. Much of A4AI's work is focused on how to drive down cost and expand access to the internet, with a goal of bringing down the cost of 1GB of mobile broadband to equal 2% or less of average monthly income. This increased attention to affordability issues over recent years has already galvanised action on the need to bring down the cost of ICTs as a strategy to widen ICT access.

Improve basic digital literacy.
There is a growing recognition that in increasingly "connected" world, digital skills matter (van Deursen and van Djik, 2010); Robinson et al., 2015). An ongoing conversation surrounds the questions of what exactly constitute digital skills, and what aspects of digital skills are particularly important to bring women online. Due to the speed of change in the technological landscape, the emergence of new ICTs continuously redefines the type of skills that are considered basic and relevant.

Promote education in general.
Closing the gender digital divide should not end at equipping women and girls with basic digital and literacy skills. Promoting education in general is advisable; research shows that access to higher education narrows the gender gap in internet access (World Wide Web Foundation, 2015).

Provide relevant content.
Insufficient attention has been paid to promoting the production and provision of digital content that is relevant to the lives of women (van der Spuy & Souter, 2018). This also encompasses presenting content in the (local) language that women understand (Dighe and Reddi, 2006).

Improve online safety and security.
To deal with cyber-VAWG, the Broadband Commission (2015) has recommended the following best practices:

a. **Sensitisation.** Prevent cyber VAWG through changes in social attitudes, by means of public education and training of enforcement agency staff on cyber VAWG.
b. **Safeguards.** Promote safeguards for online safety and equality on the internet for women and girls through the development of technical solutions and through promotion of due diligence and duty-to-report systems, with the industry maintaining responsible internet infrastructure and customer care practices.
c. **Sanctions.** Develop laws, regulations, and governance mechanisms; enforce compliance through effective punitive consequences for perpetrators; and consult on cyber civil rights agenda.

Improve offline safety and security.
As noted by Davaki, online violence against women and girls tends to reflect offline arrangements, including patriarchal forces which are uneasy about women's empowerment through ICT use and Internet access, repressive groups particularly targeting women, either through intimidation or negative campaigning, state authorities that might be retaining user data legally or illegally or aggressive and sexist hate speech feeding on traditional gender stereotypes. (Davaki, 2018, p. 22.)
Eliminating these offline threats will facilitate women's access to and use of digital technologies.

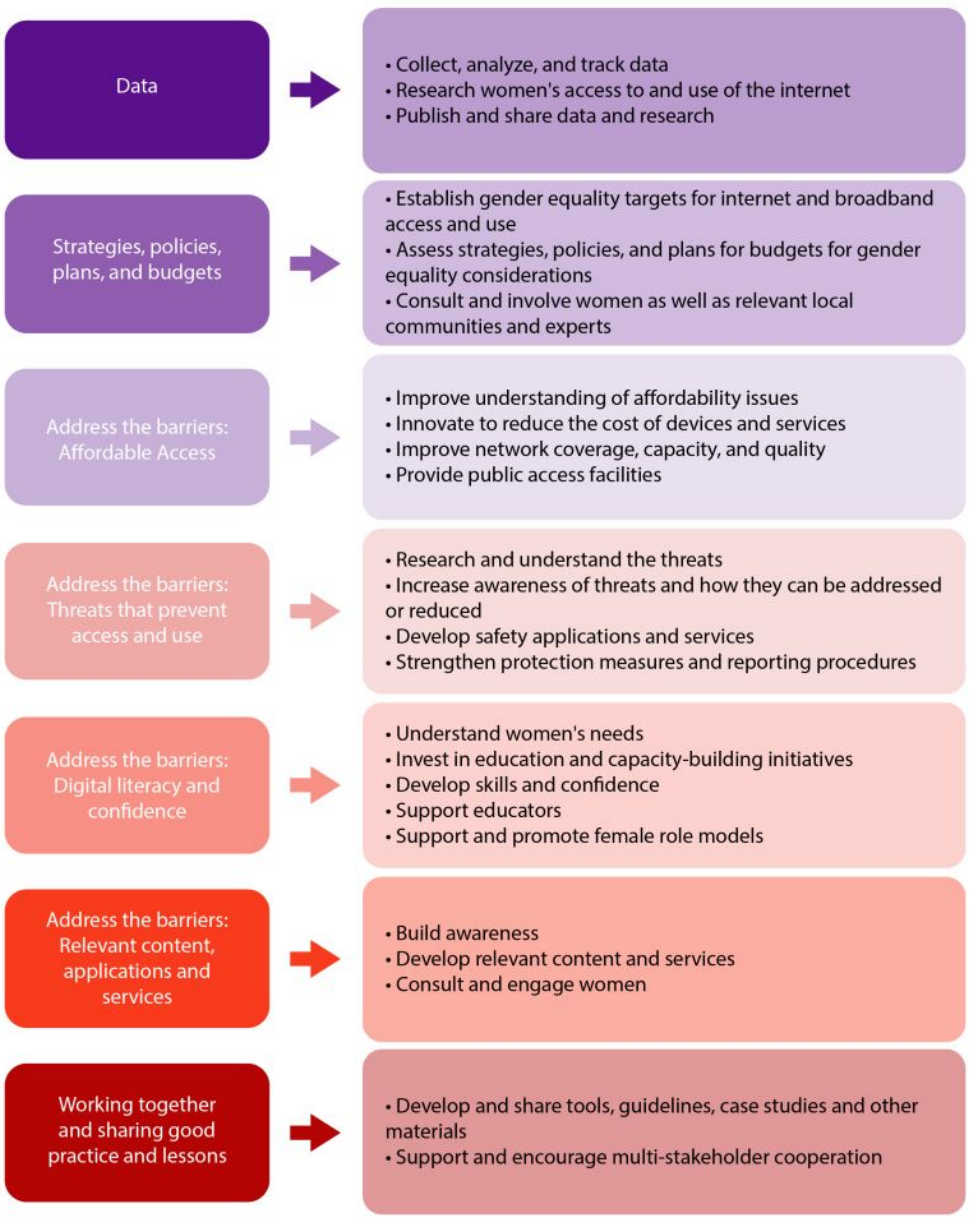
Combat social norms that disadvantage women.
A crucial dimension of narrowing the gender digital gap is to address the underlying economic, social, and cultural barriers that prevent women from accessing ICTs and meaningfully participating in the digital economy. The solutions to gender digital inequalities "cannot be concerned with digital policies alone"; it is also critical to attend to structural inequalities from a rights-based perspective (van der Spuy & Souter, 2018).

Collaborate with stakeholders.
There is a growing recognition that gender digital divides can only be closed with the concerted effort of all stakeholders, from academia to policy makers and the private sector and non-government organisations. Through the SDGs, the UN provides a rallying point for all stakeholders, with the inclusion of specific SDG targets that impact women's access to ICTs. The Broadband Commission (2013) has also helped raise the profile of the issue of gender digital divide by calling attention to this problem and calling for gender equality in access to broadband by 2020, as part of its broadband advocacy target.

A list of recommendations from the Broadband Commission's Working Group on the Digital Gender Divide (2017) usefully spells out a wide range of actions that stakeholders can take (Figure 5.1). Their four recommendation areas are: (1) support the collection, tracking, and analysis of sex-disaggregated data on internet access and use; (2) integrate gender perspectives into relevant strategies, policies, plans, and budgets; (3) address barriers related to affordability, skills, and safety; and (4) support stakeholders to collaborate more effectively.

Collect and share sex-disaggregated data. Central to most recommendations on closing gender digital divides is the need for gender-disaggregated data and better measurement tools, to accurately capture women's ICT access and use patterns (e.g., Davaki, 2018). Irregular data collection and inadequate country coverage persist, even for basic ICT access indicators. Partnerships are needed to strengthen gender-disaggregated data regimes in ICT access. These efforts need to go beyond the quantitative aspect of data collection; to meaningfully answer questions on key policy issues would require both quantitative metrics and qualitative assessments that are context-specific and sensitive to local conditions.

Figure 5.1
Summary of Broadband Commission Recommendations to Close the Gender Digital Divide



Source: Broadband Commission, 2017.

5.5.2 / RECOMMENDATIONS FOR ICT SKILLS

Provide equal opportunities to develop ability and aptitude.

In general, there is a need for more accessible digital skills and STEM learning opportunities targeting girls and women, both in and out of the classroom (Microsoft, 2017; UNESCO, 2017). Along with greater exposure to STEM education, teachers and parents can help girls to build their confidence by evaluating their actual abilities in STEM studies, helping them correct their biased self-perceptions, and encouraging their performance and achievement, as well as inspiring and envisioning what they can achieve through future careers in STEM (OECD, 2015). It is also important to ensure sufficient provision of incentives, such as scholarships or awards, in areas where girls are significantly underrepresented (UNESCO, 2017).

Train teachers in gender-responsive pedagogies.

Capacity building is needed to improve teachers' ability to implement gender-responsive STEM pedagogies (Accenture, 2017; OECD, 2015; UNESCO, 2017). Teachers with good knowledge and understanding in gender-sensitive pedagogy can play a critical role in encouraging more girls to pursue STEM careers, while deconstructing gender stereotypes in STEM education. In fact, studies have found that female students show less self-doubt in their STEM abilities when instructors employ specific gender-responsive pedagogical methods, such as student-centered teaching methods and female peer-group activities in classes (Ro & Knight, 2016).

Promote interest and perceived relevance.

It is widely suggested that early intervention is crucial in tackling gender imbalance in STEM education and in motivating more girls to be interested in learning STEM and advanced digital skills (Accenture, 2015; Microsoft, 2017; UNESCO, 2017). Approaches include: instituting computing education or computational thinking in primary or secondary education; and introducing innovative technologies, creativity, and hands-on experiences that speak to girls' interest (Accenture, 2015; Microsoft, 2017).

Together with the curricula to motivate more girls to study STEM subjects and learn digital skills, it is important for girls and underrepresented social groups to have role models and mentoring. UNESCO (2017) recommends that schools should facilitate frequent contact with female role models in the STEM and ICT industry and expand access to mentoring, career counseling, and apprenticeship or internship opportunities for STEM studies and careers. Along with role models in the industry and popular media, female teachers in STEM subjects can also be good role models. Studies found that girls who attended a high school with larger numbers of female math and science teachers were more likely to major in STEM fields (Stearns et al., 2016; Accenture, 2015).

Combat social and institutional norms that disadvantage women.

It is critical to change the institutional environment to become more gender-responsive so that women have equal opportunities, feel supported, and are able to pursue their goals and objectives in the learning environment (SWE, 2016). Suggested approaches include: hiring more well-trained female teachers (UNESCO, 2017); organised, well-funded efforts to change academic culture under strong leadership (Steward, Malley, & Herzog, 2016); and schools working to eliminate stereotypes and biases in their STEM curriculum or learning environment, while emphasising the importance of STEM to all students and highlighting women's achievement as STEM researchers and professionals (UNESCO, 2017). It is also recommended that schools expand education on media literacy, to cultivate critical thinking and gender-responsive knowledge that will help students recognise gender stereotypes in the media. For younger students, it is also recommended that parents are supported to educate themselves about STEM subjects and career perspectives, in order to counter common misconceptions about STEM (Accenture, 2017; UNESCO, 2017). Lastly, educational institutions should try to ensure a safe and inclusive STEM learning environment that is free from discriminatory social and cultural norms and harassment (UNESCO, 2017).

Develop gender-responsive national policy on digital skills.

As education is central to any nation's social policy, it is important to mainstream gender equality not only in STEM education policy but also across sectors such as education, social welfare, and labour (UNESCO, 2017). Governments should prioritise public investment in fostering gender-responsive STEM and digital skills education, while incentivising the private sector to support gender equality — particularly promoting women's participation in STEM studies and careers (Broadband Commission, 2017).

Collaborate with stakeholders.

No single entity can resolve gender digital inequality. At national level, it is recommended to create collaborative efforts involving educational systems, industry, and government, to deliver a consistent message in a sustained way across the country (Accenture, 2017; UNESCO, 2017). At the global level, it is necessary to enable global dialogue as well as a knowledge-sharing platform, to discuss and disseminate good practices and lessons learned.

Collect and share research and sex-disaggregated data.
The gender equality in digital skills can only be fully understood through internationally comparable, sex-disaggregated data that capture not only such quantifiable factors as educational enrolment and performance grades, but also more qualitative and psychological issues such as self-belief and sociocultural barriers. When such data are collected and shared globally, it will facilitate much-needed research and knowledge. For example, more research is needed to identify how girls' self-beliefs are formed, and what interpersonal and intrapersonal factors affect their self-concepts (Moeller & Marsh, 2013; OECD, 2015).

5.5.3 / RECOMMENDATIONS FOR ICT LEADERSHIP

Address social norms, stereotypes, and socio-economic constraints that hold women back and discourage girls from considering STEM careers.
Equip young girls with the skills and motivation to make informed choices about work in STEM careers; promote alternative pathways to STEM careers; change the image of computing and engineering in the media; and address the unevenness of historical transformations in gender roles, by promoting male participation in female-dominated occupations (AAUW, 2017; Ashcraft, McLain, & Eger, 2016; Banchefsky & Park, 2018; Blau, Brummund, & Liu, 2013; Brush, Greene, Balachandra, & Davis, 2014; Corbett & Hill, 2015; Erosa, Fuster, Kambourov, & Rogerson, 2017; ILO, 2017a; Miller, Nolla, Eagly, & Uttal, 2018; Molina, Lin, & Wood, 2015). In the process, it is important to act in an inclusive manner so as not to alienate the male population or exacerbate backlash. For example, Lean In (2018) reports that, in the wake of the Me Too movement, male managers may increasingly be pulling away from engaging with female colleagues (mentoring, working, or socialising).

Improve recruitment and advancement practices to remove conscious and unconscious bias.
Promote more creative job design, expand candidate evaluation criteria, and develop external partnerships to generate a more diverse talent pipeline (Ashcraft et al., 2016; Corbett & Hill, 2015; Dryden, 2013; MacDougall et al., 2017; Molina et al., 2015; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007; State Street Global Advisors, 2018; Thomas, Doughertty, Strand, Nayar, & Janani, 2016; WISE, n.d.).

Promote change in organisational culture to be more inclusive and less discriminatory.
Recommended actions include: removing systemic barriers, increasing transparency of administrative processes, addressing discrimination and harassment, and forming diversity and inclusion committees. Measures might reach as far as establishing limits on CEO pay to narrow the gender pay gap at executive levels (Acker, 2016; Cardador & Hill, 2018; Davis-Ali, 2017; Hunt, Layton, & Prince, 2015; ILO, 2016; MacDougall et al., 2017; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007; WISE, n.d.).

Establish professional development initiatives targeting women and other marginalised groups.
Provide training, mentorship, and networking programs (Davis-Ali, 2017; Hewlett & Sherbin, 2014; Hunt et al., 2015; MacDougall et al., 2017; Molina et al., 2015; WISE, n.d.).

Foster greater work/life balance for all employees.
Promote less masculine-oriented definitions of the ideal worker; enable flexible work arrangements for workers with domestic care obligations, as well as better childcare benefits and family leave options (Ecklund & Lincoln, 2016; MacDougall et al., 2017; Molina et al., 2015; WISE, n.d.).

Ensure accountability.
Take measures to collect, monitor, and openly share gender-disaggregated data on recruitment and other trends; establish diversity goals; assign managerial responsibility; and share lessons and good practices (Davis-Ali, 2017; Kalev, Dobin, & Kelly, 2006; MacDougall et al., 2017; Molina et al., 2015; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007; State Street Global Advisors, 2018; Thomas et al., 2016; WISE, n.d.).

Introduce regulatory measures to enforce diversity.
Strategies include mandatory quotas, "comply or explain" policies, and extending diversity requirements to contractors (Chanavat & Ramsden, 2013; Institutional Shareholder Services, Inc. & Regulation, 2017; MacDougall et al., 2017; US Government Accountability Office, 2017). At the macro level, some have suggested that governments establish labour market, wage, and fiscal policies that promote decent work and protect vulnerable groups, such as correcting the tendency for low wages to be associated with female-dominated occupations (ILO, 2016).

Leverage the power of shareholders and investors to compel corporations to improve their gender diversity status.
Exercise shareholder voting power, as has been done by State Street Global Advisors (2018). Develop gender lens investment products, such as the SSGA Gender Diversity Index, Thomson Reuters Diversity & Inclusion Index, EDGE Certification, Equileap Global Gender Equality 100 Leaders Net Total Return Index, Lyxor Gender Equality ETF, and Evolve Gender Diversity Index.

Foster women ICT entrepreneurs.

Four broad recommendations relate specifically to women in ICT entrepreneurship:

1. Address social, cultural and regulatory barriers to economic opportunity for women (Ritter-Hayashi, Vermeulen & Knoben, 2016).
2. Promote information about entrepreneurship as a career choice (Gompers & Wang, 2017). This could also directly improve gender diversity in the ICT workforce: a study by Steiner (2017) concluded that, compared to firms without a female founder, firms with at least one female founder had double the levels of female employees, female executives, and females on engineering teams.
3. Address gender biases in venture capital decision-making processes. Improving gender inequality in ICT entrepreneurship involves increasing female numbers not only in ICT and entrepreneur ranks, but also in investment capital circles. Brush, Greene, Balachandra, & Davis (2014) report that VC firms with women on their teams are twice as likely to fund businesses with female partners. Research by Gompers, Huang, & Wang (2017) found that gender homophily was evident among female MBA students; that is, women were more likely to pair up with other women. However, they also found that, in the technology and finance fields, men were more likely to associate with people with similar educational backgrounds and industry experience, rather than people of the same gender. More research is needed on how people form business and investment partnerships in the real world.
4. Recognise the diversity of entrepreneurial activity; look beyond the current focus on venture capital-funded businesses and masculine models of entrepreneurship (Kelley et al., 2017).

Collect and share research and sex-disaggregated data.

Research is needed beyond the collection of basic national gender-disaggregated data: revisit the definitions of STEM and STEM occupations in the digital age; examine the contexts in which career choices are made and the forces driving people's decisions (AAUW, 2017; Gorbacheva, Beekhuyzen, vom Brocke, & Becker, 2018). Research should be: multi-gender (including both female and male researchers); multidisciplinary (e.g., including social science, psychology, management, economics, engineering, computing and feminist studies); and based on diverse theories and methodologies, as well as leveraging big data (AAUW, 2017; Meiksins, Layne, Beddoes, Acton, & Lewis, 2018). Of crucial importance is sharing data and research results to promote knowledge and evidence-based action.

Four caveats

Past studies have suggested that for progress to occur, women need to be proactive in obtaining more equity financing. Recommendations included learning the language of finance, becoming more financially savvy, having "big dreams," or starting businesses in high-technology sectors. Other prescriptions include expanding networks and learning to pitch more like men. Based on our research, it is increasingly apparent that many women entrepreneurs have followed these prescriptions, yet they have not been able to achieve proportionate increases in early-stage growth capital. (Brush et al., 2014, p. 15.)

1. Desired outcomes are not guaranteed.

The above observation by Brush et al. (2014) is an important caveat to all recommendations regarding gender equality in ICT leadership. Positive outcomes are not guaranteed, and actions often bring unintended consequences (positive and negative). For example, while diversity training and evaluation activities may be relatively easy to implement, some researchers have suggested that they are less effective than other measures, such as assigning organisational responsibility for diversity or establishing networking programs (Kalev, Dobin, & Kelly, 2006; Thomas et al., 2016). Diversity initiatives are often employed as window dressing rather than being based in evidence (Kalev et al., 2006, p. 610), which can compromise their outcomes.

2. A good practice applied to the wrong problem will not have the desired results.

For example, Hunt (2010, p. 2) observes, in relation to the issue of overwork culture: "Long work hours may indeed disproportionately lead women rather than men to leave science and engineering, but long work hours may also disproportionately lead skilled women to leave other fields. . . . Thus, while it may be worthwhile for science and engineering employers to implement Hewlett et al. (2008)'s prescription of more flexible working time, if other employers implement and benefit from similar policies, any science and engineering-specific disadvantage in retaining women will persist." In other words, if organisations in other industries also implement flexible working hours, then it may not be any easier for the science and engineering field to attract women based on offering flexible work arrangements.

3. The evidence for some solutions is currently contradictory.

For example:

- Some research indicates that local government regulation is more effective than voluntary efforts in engendering diversity (Chanavat & Ramsden, 2013; MacDougall et al., 2017). However, other research shows that diversity can be achieved in the absence of strict regulatory regimes, as in Finland and Sweden (Institutional Shareholder Services, Inc & Regulation, 2017).
- A report by UNCTAD (2017) cautions that policies to reduce occupational segregation by gender could in fact be counterproductive, depending on the economic context.
- Some argue that a social impact framing would make technology careers more attractive to females (Boucher, Fuesting, Diekman, & Murphy, 2017; Su & Rounds, 2015; Wang, Degol, & Ye,

2015). This may backfire, however, if women have already been socialised to believe that altruism is not consistent with the culture of the profession (Cheryan, Ziegler, Montoya, & Jiang, 2017; Smith-Doerr, Vardi, & Croissant, 2016).

- Blau and Kahn (2013, abstract) argue that family-friendly workplace policies such as paid leave and part-time employment options "appear to encourage part-time work and employment in lower level positions" — which could compromise women's leadership opportunities.

4. **Stakeholders should avoid the temptation to adopt simplistic, one-size-fits-all solutions.**
Addressing gender equality in any context requires a multi-faceted approach and adaptation to local contexts (Cummings, 2015; Davis-Ali, 2017; Institutional Shareholder Services, Inc & Regulation, 2017; Perales & Vidal, 2015; Sassler, Michelmore, & Smith, 2017; Thomas et al., 2016; Xie, 2006).

5.6 / CONCLUSION

The factors that contribute to gender digital inequalities usually fall into the following six categories: infrastructure availability; financial constraints; ability and aptitude; interest and perceived relevance; safety and security; and socio-cultural and institutional constraints. While the reasons for gaps in access and basic skills are relatively well-established, scholars and policymakers have not reached a consensus on how and why there is a gender gap in advanced computing skills and ICT industry leadership. This is largely because the problem is complex: women's underrepresentation is often shaped by intersections of multiple gendered barriers (personal, social, cultural, and organisational) that can be challenging to observe or capture.

Complicating things further, there are no comprehensive official statistics examining these barriers at the international or regional level. As such, while numerous reasons have been proffered for the low presence of women in technology and engineering fields, few are backed by strong empirical evidence; most of our knowledge exists as a quilt of national or small-scale surveys and case studies.

Nevertheless, there is growing acknowledgment that these barriers can only be eliminated through concerted efforts involving multiple stakeholders, including academia, policy makers, the private sector, non-government organisations, and civil society. Additionally, the barriers identified in this report often interact with and influence each other. Impact will therefore be greater if stakeholders address these issues holistically rather than taking a siloed approach.

Proposed solutions include some that target symptoms of gender equality, and others that target underlying socio-cultural environments. Scholars increasingly caution against one-size-fits-all solutions. Furthermore, it is important to act in an inclusive manner so as not to alienate the male population, overlook other disadvantaged populations, or exacerbate backlash. In light of the sometimes contradictory evidence for different solutions, data collection and monitoring are essential components to determine what solutions may be effective, and why.

REFERENCES

AAUW. (2017). A research agenda on gender in engineering and computing. American Association of University Women. Retrieved from: https://www.aauw.org/aauw_check/pdf_download/show_pdf.php?file=Research-Agenda-Gender-Engineering-Computing

Acker, J. (1990). Hierarchies, jobs, bodies: A theory of gendered organizations. Gender & Society, 4(2), 139-158. Retrieved from: https://doi.org/10.1177/089124390004002002

Alampay, E. (2006). Analysing socio-demographic differences in the access & use of ICTs in the Philippines using the capability approach. The Electronic Journal of Information Systems in Developing Countries, 27(1), 1–39. Retrieved from: https://doi.org/10.1002/j.1681-4835.2006.tb00182.x

Alao A., Lwoga T.E., & Chigona W. (2017). Telecentres use in rural communities and women empowerment: Case of Western Cape. In: Choudrie J., Islam M., Wahid F., Bass J., Priyatma J. (Eds.), Information and communication technologies for development. ICT4D 2017. IFIP Advances in Information and Communication Technology, vol. 504. Springer.

Alliance for Affordable Internet (2017). 2017 Affordability report. Retrieved from: http://1e8q3q16vyc81g8l3h3md6q5f5e.wpengine.netdna-cdn.com/wp-content/uploads/2017/02/A4AI-2017-Affordability-Report.pdf

Alakaleek, W. & Cooper, S. Y. (2018). The female entrepreneur's financial networks: Accessing finance for the emergence of technology-based firms in Jordan. Venture Capital, 2(2), 137-157, DOI: 10.1080/13691066.2017.1345120

Ashcraft, C., McLain, B., & Eger, E. (2016). Women in tech: The facts. National Center for Women & Technology (NCWIT). Retrieved from: https://www.ncwit.org/sites/default/files/resources/ncwit_women-in-it_2016-full-report_final-web06012016.pdf

Banchefsky, S., & Park, B. (2018). Negative gender ideologies and gender-science stereotypes are more pervasive in male-dominated academic disciplines. Social Sciences, 7(2), 27. Retrieved from: https://doi.org/10.3390/socsci7020027

BarNir, A. (2012). Starting technologically innovative ventures: Reasons, human capital, and gender. Management Decision, 50(3), 399-419. Retrieved from: https://doi org.offcampus.lib.washington.edu/10.1108/00251741211216205

Bettio, F., & Verashchagina, A. (2009). Gender segregation in the labour market: Root causes, implications and policy responses in the EU. Luxembourg: Publ. Office of the European Union. Retrieved from: ec.europa.eu/social/BlobServlet?docId=4028

Blau, F. D., Brummund, P., & Liu, A. Y.-H. (2013). Trends in occupational segregation by gender 1970-2009: Adjusting for the impact of changes in the occupational coding system. Demography, 50(2), 471–494. Retrieved from: http://dx.doi.org/10.1007/s13524-012-0151-7

Blau, F., & Kahn, L. (2013). Female labor supply: Why is the US falling behind? Working Paper No. w18702. Cambridge, MA: National Bureau of Economic Research. Retrieved from: https://doi.org/10.3386/w18702

Boucher, K. L., Fuesting, M. A., Diekman, A. B., & Murphy, M. C. (2017). Can I work with and help others in this field? How communal goals influence interest and participation in STEM fields. Frontiers in Psychology, 8. Retrieved from: https://doi.org/10.3389/fpsyg.2017.00901

Bradley, S. R., Gicheva, D., Hassell, L., & Link, A. N. (2013). Gender differences in access to private investment funding to support the development of new technologies. UNCG Economics Working Papers No. 13–9. University of North Carolina at Greensboro, Department of Economics. Retrieved from: https://ideas.repec.org/p/ris/uncgec/2013_009.html

Broadband Commission. (2013). Doubling digital opportunities: Enhancing the inclusion of women and girls in the information society. Broadband Commission Working Group on Broadband and Gender. Retrieved from: http://www.broadbandcommission.org/Documents/publications/bb-doubling-digital-2013.pdf

Broadband Commission. (2015). Combatting online violence against women and girls: A worldwide wake-up call (highlights). Discussion paper from the Broadband Commission Working Group on Gender. Retrieved from: http://www.broadbandcommission.org/Documents/publications/bb-wg-gender-report2015-highlights.pdf

Broadband Commission. (2017b). Recommendations for action: Bridging the gender gap in Internet and broadband access and use. Working Group on the Digital Gender Divide. Retrieved from: http://www.broadbandcommission.org/Documents/publications/WorkingGroupDigitalGenderDivide-report2017.pdf

Brush, C. G., Greene, P. G., Balachandra, L., & Davis, A. (2014). Diana Report: Women entrepreneurs 2014: Bridging the gender gap in venture capital. Retrieved from: http://www.babson.edu/Academics/centers/blank-center/global-research/diana/Documents/diana-project-executive-summary-2014.pdf

Cardador, M. T., & Hill, P. L. (2018). Career paths in engineering firms: Gendered patterns and implications. Journal of Career Assessment, 26(1), 95–110. Retrieved from: https://doi.org/10.1177/1069072716679987

Chanavat, A., & Ramsden, K. (2013). Mining the metrics of board diversity. New York, NY: Thomson Reuters. Retrieved from: https://www.thomsonreuters.com/en/press-releases/2013/average-stock-price-of-gender-diverse-corporate-boards-outperform-those-with-no-women.html

Charles, M., & Bradley, K. (2009). Indulging our gendered selves? Sex segregation by field of study in 44 countries. American Journal of Sociology, 114(4), 924–976. Retrieved from: https://doi.org/10.1086/595942

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? Psychological Bulletin, 143(1), 1–35. Retrieved from: https://doi.org/10.1037/bul0000052

Corbett, C., & Hill, C. (2015). Solving the equation: The variables for women's success in engineering and computing. Washington DC: American Association of University Women. Retrieved from: https://www.aauw.org/research/solving-the-equation/

Cummings, L. M. (2015). Gender equality in science, technology, engineering, agricultural sciences and mathematics (STEAM) academic pipeline: Challenges transferring knowledge to practice. Washington, DC: USAID. Retrieved from: https://www.usaid.gov/sites/default/files/USAID-Report-Sep-30-2015-Final.pdf

Davaki, K. (2018). The underlying causes of the digital gender gap and possible solutions for enhanced digital inclusion of women and girls. Brussels: Policy Department for Citizens' Rights And Constitutional Affairs. Retrieved from: http://www.europarl.europa.eu/RegData/etudes/STUD/2018/604940/IPOL_STU(2018)604940_EN.pdf

Davis-Ali, S. (2017). Advancing women technologists leaders: Strategies for cultivating confident women leaders. Anita Borg Institute. Retrieved from: http://anitab.org/wp-content/uploads/2017/04/advancing-women-technologists-leaders.pdf

Deen-Swarray, M., Gillwald, A., & Morrell, A. (2012). Lifting the veil on ICT gender indicators in Africa. Cape Town: Research ICT Africa and University of Cape Town.

Dighe, A. and Reddi, U. (2006). Women's literacy and information and communication technologies: Lessons that experience has taught us. Burnaby, Canada: Commonwealth of Learning.

Diversity VC. (2017). Women in U.K. venture capital 2017. Retrieved from: http://www.diversity.vc/women-in-uk-vc/

Dryden, A. (2013). The ethics of unpaid labor and the OSS community. November 13. Retrieved from: https://www.ashedryden.com/blog/the-ethics-of-unpaid-labor-and-the-oss-community

Economist Intelligence Unit. (2018). The Inclusive Internet Index: Bridging digital divides. Retrieved from:

https://theinclusiveinternet.eiu.com/summary

Erosa, A., Fuster, L., Kambourov, G., & Rogerson, R. (2017). Hours, occupations, and gender differences in labor market outcomes (Working Paper No. 23636). National Bureau of Economic Research. Retrieved from: https://doi.org/10.3386/w23636

Ford, D., Smith, J., Guo, P. J., & Parnin, C. (2016). Paradise unplugged: Identifying barriers for female participation on Stack Overflow. Proceedings of the 2016 24th ACM SIGSOFT International Symposium on Foundations of Software Engineering (FSE 2016), 846–857. Retrieved from: https://doi.org/10.1145/2950290.2950331

Gompers, P. A., Huang, K., & Wang, S. Q. (2017). Homophily in entrepreneurial team formation (Working Paper No. 23459). National Bureau of Economic Research. Retrieved from: https://doi.org/10.3386/w23459

Gompers, P. A., & Wang, S. Q. (2017). Diversity in innovation (Working Paper No. 23082). National Bureau of Economic Research. Retrieved from: https://doi.org/10.3386/w23082

Gorbacheva, E., Beekhuyzen, J., vom Brocke, J. & Becker, J. (2018). Directions for research on gender imbalance in the IT profession. European Journal of Information Systems, DOI: 10.1080/0960085X.2018.1495893

GSMA. (2018). Connected women: The mobile gender gap report 2018. Retrieved from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/04/GSMA_The_Mobile_Gender_Gap_Report_2018_32pp_WEBv7.pdf

Hewlett, S. A., & Sherbin, L. (2014). Athena Factor 2.0: Accelerating female talent in science, engineering & technology. Retrieved from: http://www.talentinnovation.org/_private/assets/Athena-2-ExecSummFINAL-CTI.pdf

Hilbert, M. (2011). Digital gender divide or technologically empowered women in developing countries? A typical case of lies, damned lies, and statistics. Women's Studies International Forum, 34(6), 479–489. Retrieved from: https://doi.org/10.1016/j.wsif.2011.07.001

Hunt, V., Layton, D., & Prince, S. (2015). Diversity matters. McKinsey & Co. Retrieved from: https://www.mckinsey.com/~/media/mckinsey/business%20functions/organization/our%20insights/why%20diversity%20matters/diversity%20matters.ashx

ILO. (2016). Global wage report 2016/17. Retrieved from: http://www.ilo.org/global/research/global-reports/global-wage-report/2016/lang--en/index.htm

ILO. (2017a). Economic impacts of reducing the gender gap (Research brief). Retrieved from: http://www.ilo.org/global/research/publications/what-works/WCMS_577685/lang--en/index.htm

ILO. (2017b). World employment and social outlook: Trends for women 2017. Retrieved from: http://www.ilo.org/global/research/global-reports/weso/trends-for-women2017/lang--en/index.htm

Institutional Shareholder Services, Inc. (2017). Gender parity on boards around the world. Retrieved from: https://corpgov.law.harvard.edu/2017/01/05/gender-parity-on-boards-around-the-world/

Kalev, A., Dobin, F., & Kelly, E. (2006). Best practices or best guesses? Assessing the efficacy of corporate affirmative action and diversity policies. American Sociological Review, 71, 589–617.

Kelley, D., Baumer, B. S., Brush, C. G., Greene, P. G., Mahnaz, M., Mahdi, M., … Dean, M. (2017). Global Entrepreneurship Monitor: Womens entrepreneurship 2016/2017 report. Retrieved from: https://www.babson.edu/Academics/centers/blank-center/global-research/gem/Documents/GEM%202016-2017%20Womens%20Report.pdf

Kuschel, K. & Lepeley, M-T. (2016). Women start-ups in technology: Literature review and research agenda to improve participation. International Journal of Entrepreneurship and Small Business, 27(2/3), pp.333–346. Retrieved from: https://www.researchgate.net/publication/288992443_Women_start-ups_in_technology_Literature_review_and_research_agenda_to_improve_participation

Lean In. (2018). How women & men are feeling after #MeToo. Retrieved from: https://leanin.org/sexual-harassment-backlash-survey-results/

Lee, M., & Huang, L. (2018). Gender bias, social impact framing, and evaluation of entrepreneurial ventures. Organization Science, 29(1), 1–16. Retrieved from: https://doi.org/10.1287/orsc.2017.1172

Let Toys Be Toys (2015). Who gets to play? What do toy ads on UK TV tell children about boys' and girls' play? Retrieved from: lettoysbetoys.org.uk

Liberda, B., & Zajkowska, O. (2017). Innovation and entrepreneurship policies and gender equity. International Journal of Contemporary Management, 16(1), 37–59. Retrieved from: https://doi.org/10.4467/24498939IJCM.17.002.7046

MacDougall, A., Valley, J., Adler, J., Bettel, C., Param, A., Schmidt, J., … Suppa, O. (2017). 2017 Diversity disclosure practices report: Women in leadership roles at TSX-listed companies. Osler. Retrieved from: http://www.osler.com/en/resources/governance/2017/2017-diversity-disclosure-practices-report-women

Meisksins, P., Layne, P., Beddoes, K., Masters, S., Roediger, M., & Shah, Y. (2016). Women in engineering: A review of the 2016 Literature. Society of Women Engineers. Retrieved from: https://research.swe.org/wp-content/uploads/2018/03/SWE-Lit-Review-Compilation-2017.pdf

Meiksins, P., Layne, P., Beddoes, K., Acton, B., & Lewis, M. (2018). Women in Engineering: A Review of the 2017 Literature. Retrieved from: https://research.swe.org/

literature-reviews/

Milek, A., Stork, C., Gillwald, A. (2011). Engendering communication: a perspective on ICT access and usage in Africa. info, 13(3), 125-141. Retrieved from: https://doi.org/10.1108/14636691111131493

Miller David I., Nolla Kyle M., Eagly Alice H., & Uttal David H. (2018). The development of children's gender-science stereotypes: A meta-analysis of 5 decades of U.S. draw-a-scientist studies. Child Development, 89(6), 1943-1955. Retrieved from: https://doi.org/10.1111/cdev.13039

Molina, M., Lin, S., & Wood, C. (2015). Connected Women 2015: Accelerating the digital economy: Gender diversity in the telecommunications sector. A.T. Kearney. Retrieved from: https://www.atkearney.com/documents/10192/5580445/Connected+Women+2015-WDReport.pdf/d3c08b0a-fab6-431c-80c0-0d332b9e882d

Nafus, D. (2012). "Patches don't have gender": What is not open in open source software. New Media and Society, 14(4), 669–683. Retrieved from: https://doi.org/10.1177/1461444811422887

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2007). Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering. Executive Summary. Washington, DC: The National Academies Press. Retrieved from: https://www.nap.edu/resource/11741/bias_and_barriers_summary.pdf

Owen, P. & Padron, M. (2016). The language of toys: Gendered language in toy advertisements. Journal of Research on Women and Gender, 6, 67-80

Perales, F., & Vidal, S. (2015). Looking inwards: Towards a geographically sensitive approach to occupational sex segregation. Regional Studies, 49(4), 582–598. Retrieved from: https://doi.org/10.1080/00343404.2013.786828

Ritter-Hayashi, D., Vermeulen, P., & Knoben, J. (2016). Gender diversity and innovation: The role of women's economic opportunity in developing countries. Tilburg, Neth.: Tilburg University. Retrieved from: https://pure.uvt.nl/ws/portalfiles/portal/15156406/Policy_B

Robinson, L., Cotten, S.R., Ono, H., Quan-Haase, A., Mesch, G., Chen, W., Schulz, J., Hale T.M., & Stern, M.J. (2015). Digital inequalities and why they matter. Information, Communication & Society, 18(5), 569-582. DOI: 10.1080/1369118X.2015.1012532

Sambuli, N., Brandusescu, A., & Brudvig, I. (2018). Advancing womens rights online: Gaps and opportunities in policy and research. Washington, DC: The Web Foundation. Retrieved from: http://webfoundation.org/docs/2018/08/Advancing-Womens-Rights-Online_Gaps-and-Opportunities-in-Policy-and-Research.pdf

Sassler, S., Glass, J., Levitte, Y., & Michelmore, K. M. (2017). The missing women in STEM? Assessing gender differentials in the factors associated with transition to first jobs. Social Science Research, 63, 192–208. Retrieved from: https://doi.org/10.1016/j.ssresearch.2016.09.014

Sassler, S., Michelmore, K., & Smith, K. (2017). A tale of two majors: Explaining the gender gap in STEM employment among computer science and engineering degree holders. Social Sciences, 6(3), 69-94. Retrieved from: https://doi.org/10.3390/socsci6030069

Smith-Doerr, L., Vardi, I., & Croissant, J. (2016). Doing gender and responsibility: Scientists and engineers talk about their work. Journal of Women and Minorities in Science and Engineering, 22(1), 49–68. Retrieved from: https://doi.org/10.1615/JWomenMinorScienEng.2016011513

State Street Global Advisors. (2018). Guidance on enhancing gender diversity on boards. Retrieved from: https://www.ssga.com/investment-goals/environmental-social-governance-esg/enhancing-gender-diversity-on-boards.html

Steiner, C. (2017, June 14). The 2017 US startup team gender diversity study. Retrieved from: https://fundersclub.com/blog/2017/06/14/2017-us-startup-team-gender-diversity-study/

Su, R., & Rounds, J. (2015). All STEM fields are not created equal: People and things interests explain gender disparities across STEM fields. Frontiers in Psychology, 6. Retrieved from: https://doi.org/10.3389/fpsyg.2015.00189

Thomas, A., Dougherty, J., Strand, S., Nayar, A., & Janani, M. (2016). Decoding diversity: The financial and economic returns to diversity in tech. Intel. Retrieved from: https://newsroom.intel.com/newsroom/wp-content/uploads/sites/11/2016/07/Diversity_report_7.7.16_web-1.pdf

UNCTAD. (2017). The gender dynamics of inclusion and exclusion: A macro perspective on employment. In: United Nations Conference on Trade and Development, Trade and development report 2017 (67–92). Retrieved from: https://doi.org/10.18356/1cef4f1d-en

US Government Accountability Office. (2017). Diversity in the technology sector. Retrieved from: https://www.gao.gov/assets/690/688460.pdf

Van der Spuy, A. and Aavriti, N. (2018). Mapping research in gender and digital technology. Association for Progressive Communications. Retrieved from: https://www.apc.org/sites/default/files/IDRC_Mapping_0323_0.pdf

Van der Spuy, A., & Souter, D. (2018). Women's digital inclusion. Association for Progressive Communications. Retrieved from: https://www.apc.org/sites/default/files/WomensDigitalInclusion_BackgroundPaper.pdf

Wang, M.-T., Degol, J., & Ye, F. (2015). Math achievement is important, but task values are critical, too: Examining the intellectual and motivational factors leading to gender disparities in STEM careers. Frontiers in Psychology, 6. Retrieved from: https://doi.org/10.3389/

fpsyg.2015.00036

World Wide Web Foundation. (2015). Women's rights online, translating access into empowerment. Retrieved from: http://webfoundation.org/docs/2015/10/womens-rights-online21102015.pdf

Weisgram, E., & Diekman, A. (2015). Family friendly STEM: Perspectives on recruiting and retaining women in STEM fields. International Journal of Gender, Science and Technology, 8(1), 38–45

WISE. (n.d.). The Ten Steps. Retrieved from: https://www.wisecampaign.org.uk/consultancy/industry-led-ten-steps/10-steps

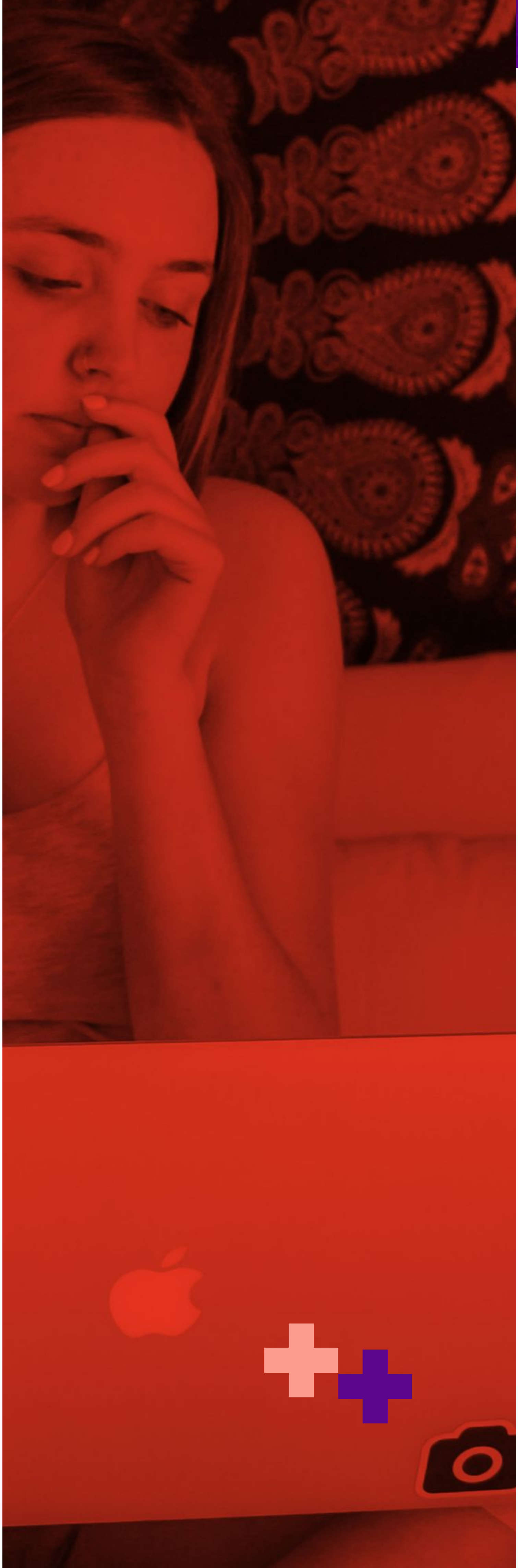
World Bank Group. (2018). Women, business and the law 2018 (Advance Edition). Washington, DC: World Bank. Retrieved from: https://openknowledge.worldbank.org/bitstream/handle/10986/29498/9781464812521.pdf

Xie, Y. (2006). Social influences on science and engineering career decisions. In: National Academy of Sciences (Ed.), Biological, social, and organizational components of success for women in academic science and engineering: Workshop report. Washington, DC: National Academies Press. Retrieved from: http://www.ncbi.nlm.nih.gov/books/NBK23778/

6

THE STATE OF SEX-DISAGGREGATED DATA

AUTHORS:
ARABA SEY, DON RODNEY JUNIO & JUHEE KANG (UNU-CS)



KEY FINDINGS

- There is a severe lack of official sex-disaggregated data on most ICT-related topics
- Most indicators are conceptually unclear, lack an agreed methodology, and are not regularly collected by most countries in any region or development category (less than 50% of countries, for most indicators).
- Africa, Asia and Oceania have the lowest availability of sex-disaggregated ICT data.
- Barriers to collection of sex-disaggregated data include: low data collection and analysis capacity of national statistics offices; diversity of potential issues and indicators; and lack of conceptual and definitional clarity.

6.1 / INTRODUCTION

There is a severe lack of official sex-disaggregated and gender data on most ICT-related topics, even though such data is essential for gender researchers to capture and analyse societal differences between men and women (G20, 2018; UNECE, 2010, p. 1). Considering the centrality of ICTs in modern society, sex-disaggregated data is critical for meaningful dialogue and policymaking on gender equality. Within the United Nations and other global organisations, this challenge is receiving heightened attention, and some initiatives have been generated to address it. Examples of these are the UN's Evidence and Data for Gender Equality (EDGE) project (launched in 2013), the World Bank's Gender Data Portal (re-launched in 2016), GSMA's (2018b) toolkit researching women's internet access and use, and USAID's Gender and ICT Survey Toolkit (Highet et al., 2018). The first two target gender indicators in general, while the latter two focus on ICT data.

Over the years, advances have been made in promoting collection of sex-disaggregated data on basic ICT access. The UN has developed four ICT access measures — proportion of adults with an account at a bank or other financial institution or with a mobile-money service provider; proportion of individuals using the internet; proportion of individuals who own a mobile telephone; proportion of households with access to mass media — which are included in its Minimum Set of Gender Indicators (UNSD, 2018). The Minimum Set of Gender Indicators categorise the prescribed indicators into three tiers, based on three criteria: conceptual clarity, established methodology, and regularity of data collection (Figure 6.1). This chapter assesses the ICT access, skills, and leadership indicators covered in this report in light of these UN criteria, summarising the extent of data collection in different world regions. Appendix A presents three detailed country profiles, based on the indicators covered in this report.

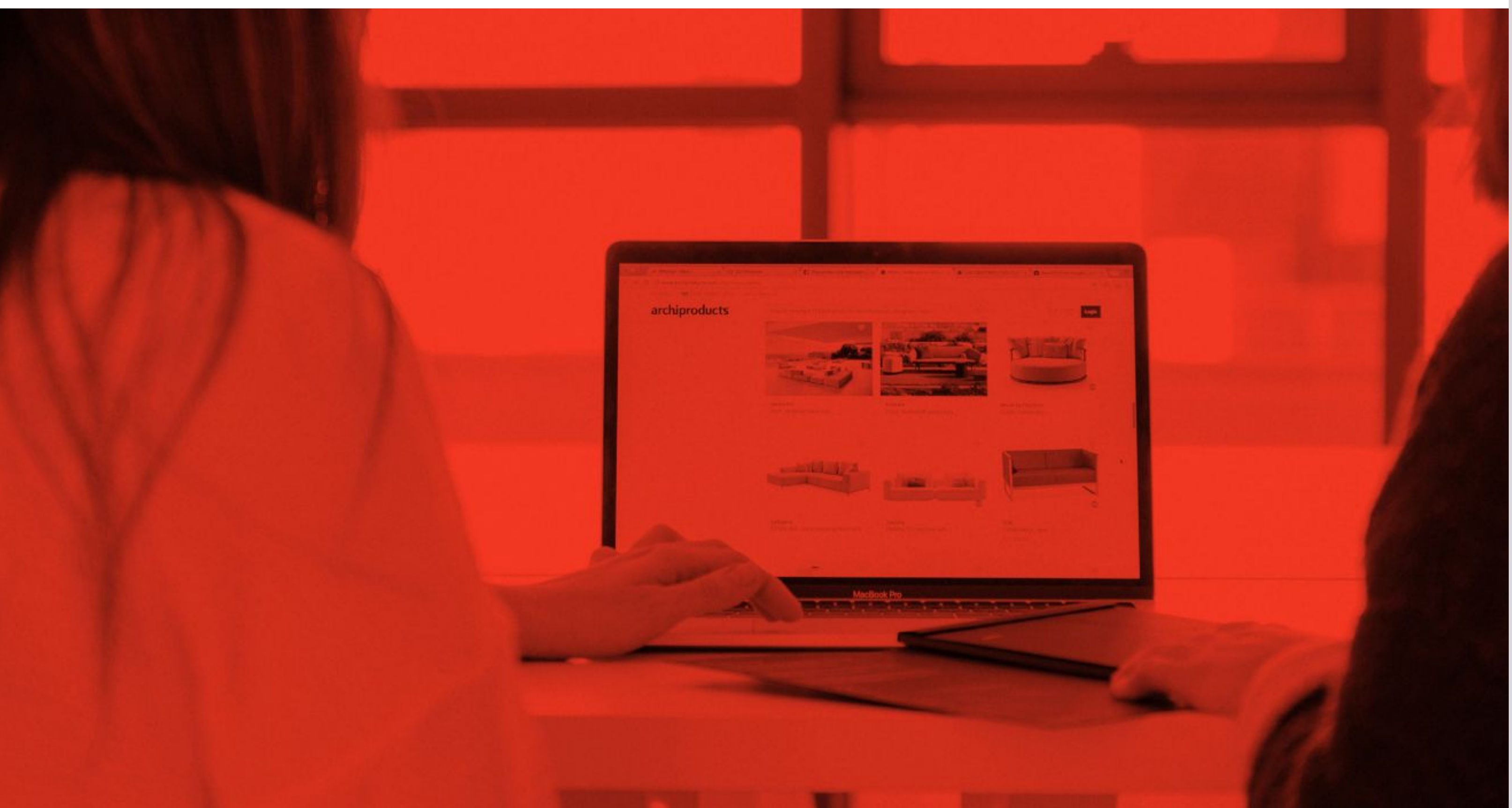
Figure 6.1
UN Minimum Set of Gender Indicators – tier definitions

Source: UN Statistics Division, 2017.

Based on the UN data tiers and the availability of academic studies, most of the indicators relevant to gender digital equality fall into Tier 2 or 3 (Table 6.1). Notably, even some of the indicators classified by the UN as Tier 1 might be better classified as Tier 2 since, as demonstrated below, few countries are reporting those indicators. Data on African countries is particularly lacking (Case Study 6.1). Research knowledge is mostly fair or poor, as much of the existing scholarly work takes the form of narrowly-scoped research concentrated in a few North American and European countries. The rest of this chapter focuses on the availability of official statistics.

Table 6.1
State of data and knowledge on gender digital inequality

	Access	Skills	Leadership	Dark side	Barriers & Recommendations
OFFICIAL STATISTICS	Tier 1/2	Tier 2/3	Tier 3	Tier 3	Tier 3
RESEARCH KNOWLEDGE	Good/Fair	Fair/Poor	Fair/Poor	Fair/Poor	Fair/Poor



Case Study 6.1
ICT, Gender and Data in Africa

Author: Gloria Muhoro
(African Development Bank)

Several studies in Africa identify lack of access to Information and Communication Technology (ICT) as a key element in women's marginalisation (Africa Development Bank, 2015; World Wide Web Foundation, 2016; Intel, 2018). The International Telecommunications Union reports that the gender digital divide in Africa stood at 23% in 2016, meaning that women were 23% less likely than men to be online. The benefits of ICTs have thus been unevenly distributed, and women have been locked out of opportunities for jobs, growth, education, financial inclusion, and citizen advocacy, among others. Despite the potential of ICTs to catalyse women's empowerment, as recognised in the UN Sustainable Development Goals (specifically goal 5B), the scarcity of gender data on this topic makes it difficult to fully justify the inclusion of gender issues in ICT policies, strategies, and initiatives, particularly in developing countries. This global problem is even more pronounced in Africa, where we have very little information about the situation of women and ICTs: their mobile phone and internet access and use, ICT employment, decision making, entrepreneurship, and ICT skills, and ICT policies. Sex-disaggregated data and gender indicators on ICTs are unavailable and unexplored.

Many African National Statistical Offices do not collect national ICT statistics with consistency and regularity, and rarely is the data disaggregated by sex. Telecommunication companies and national regulators provide most data on ICTs in these countries (not sex-disaggregated), mainly on connectivity. Development partners, private sector, and NGOs also provide some limited data. Data is unavailable on such gender digital divide indicators as content, education, entrepreneurship, employment, decision-making, skills, and policy.

The UN World Summit on the Information Society has affirmed the need for such data, prompting some initiatives. In Kenya, the Kenya National Bureau of Statistics publishes some key indicators measuring gender equality in ICTs: mobile phone, mobile money, and internet penetration rates. Still missing are data in other areas such as ICT employment, entrepreneurship, policy, leadership, and education.

Relevant data is often not disaggregated by sex. In Rwanda, the Ministry of Information Technology & Communications annual ICT sector profile lacks data on women and girls' access and use of technology. This points to the need for gender sensitisation training beyond the national statistics offices to other government agencies and all institutions that provide and manage national data. Development partners and multilateral partnerships can assist in this area; civil society organisations, particularly gender equality advocates, can pressure policy makers and national statistical offices to produce and publish accurate, relevant, and accessible sex-disaggregated data. Key areas include: access and usage, content, employment, ICT occupations, entrepreneurship, education, consideration of gender issues in national ICT policy, representation in decision-making, and the relative impact of ICT on women and men.

Realistically, it might take some time before sufficient progress is seen in this area. A first step would be collecting all available national ICT data in the context of citizen-generated data (despite its insufficiency or heterogeneity), as a basis for ongoing policy discussions initiated between civil society organisations and national statistical offices. In the medium-term, individual-level ICT questions (gender-identified) can be incorporated as a module into already existing national data collection mechanisms, such as census or labour force surveys.

Reliable, transparent and comprehensive data on how women and men engage with ICT is crucial for a better understanding of the digital divide and for governments and development partners to design and implement policies for inclusive ICT for development. Sweeping generalisations based on observation and anecdotal evidence are of limited value. "Without data, there is no visibility; without visibility, there is no priority." Bridging the data gap on gender and ICTs is essential to bring the full benefits of the information society to both men and women, critical for the socio-economic development of Africa.

6.2 / AVAILABILITY OF SEX-DISAGGREGATED DATA ON ICT ACCESS

6.2.1 / OVERVIEW

Based on the ITU World Telecommunication and ICT Indicators database, most countries currently do not collect or share sex-disaggregated data on ICT access and basic digital skills. The proportion of countries with data on basic access ranges from 17% (mobile phones) to 46% (internet access). For the eight digital literacy-related skills, the highest number of countries reporting any of the skills is 50 (i.e., 26% of countries worldwide); for certain skills, the number is as low as 17 countries. Data on financial inclusion are more readily available: the World Bank's Global Findex contains data on between 142 and 144 countries for most indicators. Overall, European countries have the best data availability and African countries the least. Table 6.2 summarises the state of sex-disaggregated data on ICT access. (See Chapter 1 for a discussion of gender equality in ICT access.)

Table 6.2
Status of conceptualisation and collection of sex-disaggregated data on ICT access

FIELD	Source	Tier 1	Tier 2	Tier 3	Number of reporting countries	Notes on tier classification
Used a mobile phone or the internet to access a financial account	World Bank Findex	√	-	-	144 (74%)	Classified by UN
Used the internet to pay bills or buy something online	World Bank Findex	-	√	-	144 (74%)	Classified by author. Indicator produced from World Bank demand-side surveys. Consistently collected in last two rounds of FINDEX (2014 / 2017)
Made or received digital payments in the past year	World Bank Findex	-	√	-	144 (74%)	Classified by author. Indicator produced from World Bank demand-side surveys. Consistently collected on the last two rounds of FINDEX (2014 / 2017)
Individuals using the internet	ITU	√	-	-	90 (46%)	Classified by UN
Individuals using a computer	ITU	√	-	-	78 (40%)	Classified by UN
Used a mobile money service in the past year	ITU	-	√	-	77 (39%)	Classified by UN
Individuals owning a mobile phone	ITU	√	-	-	40 (21%)	Classified by UN
Individuals using a mobile phone	ITU	√	-	-	34 (17%)	Classified by UN

6.2.2 / REGIONAL SUMMARY

6.2.2.1 / Basic access

Over the years, advances have been made in defining relevant indicators to measure basic ICT access. The UN Inter-Agency and Expert Group on Gender Statistics has included internet and mobile phone use as part of the UN Minimum Set of Gender Indicators (Figure 6.2).

The inclusion of these indicators provides an impetus for UN member countries to systematically and regularly collect this data. However, although both indicators are classified as Tier 1, the 2017 edition of the ITU World Telecommunication/ICT Indicators database shows that several member countries do not collect this data (Table 6.3). Even for countries where data is available, the absence of longitudinal data inhibits identification of trends. Moreover, different organisations use different methodologies to collect data (or calculate estimates in the absence of official data). As a result, different organisations show inconsistent estimates of the gender digital divide, which may impact the way policy targets are framed (A4AI, 2018).

Figure 6.2
UN Minimum Set of Gender Indicators: Internet and mobile phone use

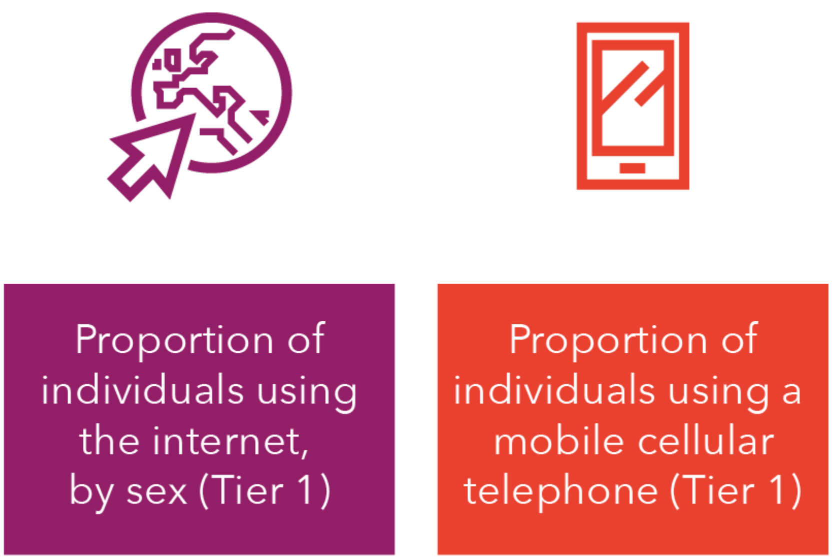


Table 6.3
Number of countries sharing sex-disaggregated data on selected basic access indicators

	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
Individuals using the internet	9	16	27	37	1	90
Individuals using a computer	6	13	25	34	0	78
Individuals owning a mobile phone	6	7	19	8	0	40
Individuals using a mobile cellular telephone	4	11	15	4	0	34

Source: ITU WTI Database, 2017.

Beyond ITU, no other organisations regularly collate sex-disaggregated data on basic ICT access at a global scale. However, other organisations attempt to fill the data gap by collecting data at a smaller scale. For example, data in the Mobile Gender Gap Report 2018 came from the GSMA Intelligence Consumer Survey 2017, a nationally representative survey of 23 low- and middle- income countries that covers over 73% of the adult population in those countries. This is one of the more visible demand-side data collection and aggregation efforts in recent years; however, access to that data is currently limited to what is presented in the report. Other sources of data include EUROSTAT, OECD, GSMA, and the World Values Survey.

Research institutions such as LIRNEAsia, Research ICT Africa (RIA), and Dialogo Regional sobre Sociedad de la Informacion (DIRSI) have also pioneered data collection on basic access and other aspects of ICT use in developing countries, using demand-side, nationally representative samples. (See Part II Chapter 2 for a discussion of the gender digital gap in the Global South). These initiatives, however, are limited in scale and geographical focus. More recently, researchers are exploring innovative ways to address data gaps, such as collecting data from non-traditional sources (Case Study 6.2)

Case Study 6.2
Measuring Gender Digital Inequality with Web Data

Author: Ridhi Kashyap (University of Oxford) and Ingmar Weber (Qatar Computing Research Institute)

Reducing gender inequalities in internet access and mobile phone ownership, along with improving digital literacy, have been recognised as important development targets within the UN Sustainable Development Goals (SDGs) framework. Tracking progress on gender digital inequalities is challenging, however, due to limited gender-disaggregated data, especially in less-developed country contexts. With support from Data2X (an initiative of the United Nations Foundation), and as a part of Data2X's "Big Data for Gender Challenge", we have been exploring the use of data obtained from social media advertising application programming interfaces (APIs) to generate real-time measures of gender digital inequality (http://data2x.org/big-data-challenge-awards/#digital).

As outlined in a recently published study in *World Development*, we leveraged Facebook's advertisement audience estimates (available from the platform's marketing API) to generate measures of gender gaps in internet and mobile phone access in a global perspective (Fatehkia, Kashyap, & Weber, 2018). These Facebook advertising audience estimates are publicly-accessible, allowing advertisers, or any user with a Facebook account, to query aggregate numbers of Facebook users by various geographic and demographic attributes such as age, gender, and device type. By providing aggregate data across different attributes for the platform's over 2 billion users, the data serve as a kind of digital census of Facebook users that can be valuably repurposed for social research.

We used the Facebook data to generate a "Facebook Gender Gap Index", an indicator of the ratio of female to male Facebook users in a given country. While the Facebook Gender Gap Index does not represent internet access per se, we found it to be highly correlated with official statistics on internet gender gaps (from the International Telecommunications Union or ITU) and mobile phone gender gaps (from the GSMA), for countries where data are available. The Facebook Gender Gap Index captured gender inequalities in internet access in less developed countries, where access to the internet is most unequal by gender.

We used these Facebook indicators to predict internet and mobile gender gaps found in official statistics, and then compared the performance of models using the Facebook indicators with two other types of models: 1) models using offline variables linked to a country's development (e.g., GDP per capita) or to the broader gender divide (e.g., gender gaps in literacy); and 2) models combining online Facebook variables with offline ones. For internet gender gaps, we found that models using Facebook data did better than those using offline indicators alone. As shown in Figure 6.3 panel (b), using Facebook data, we were able to significantly expand geographical coverage to of internet and mobile gender gap indicators compared to available statistics in the ITU database (as shown in Figure 1 panel (a), with the biggest gains for less developed countries. Higher values in the figure show greater levels of gender equality, with 1 indicating complete parity.

With help from our Data2X grant, our team has developed an online platform (www.digitalgendergaps.org) where we will release regularly updated measures of gender gaps in internet and mobile phone access across the world based on the approach described above. Ad audience estimates, like the ones we have described above, are available from most large web and social media platforms (e.g. Twitter, Google), and in ongoing work we are exploring the potential of applying our general approach to capture other forms of gender inequality, such as in education, digital literacy, and occupations.

Figure 6.3

The internet gender gap index: proportion of female population with internet access divided by proportion of male population with internet access

Figure 6.3a

Modeled using ITU ground truth data

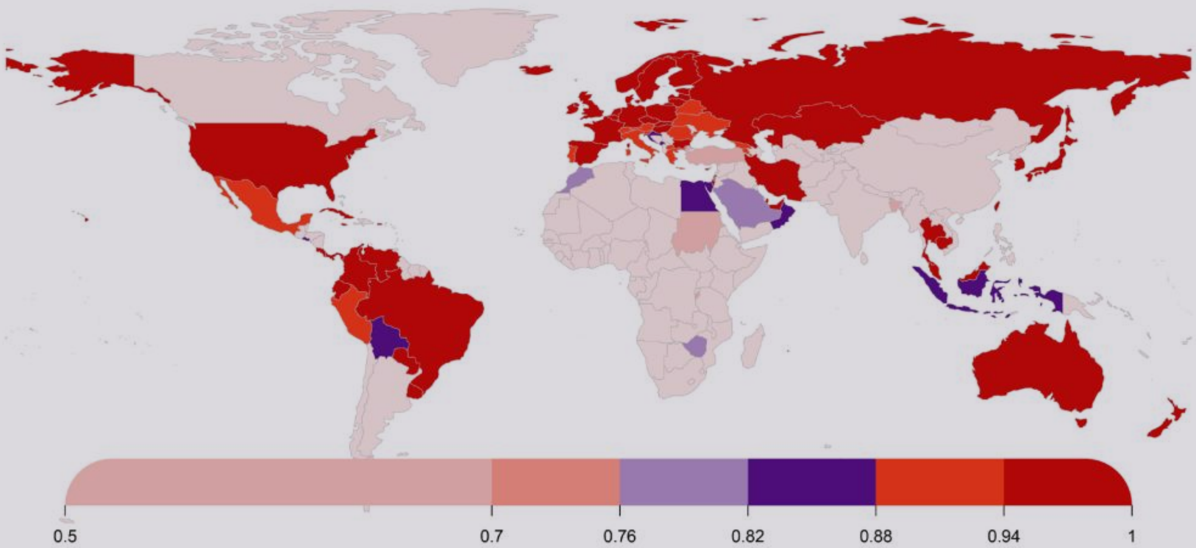
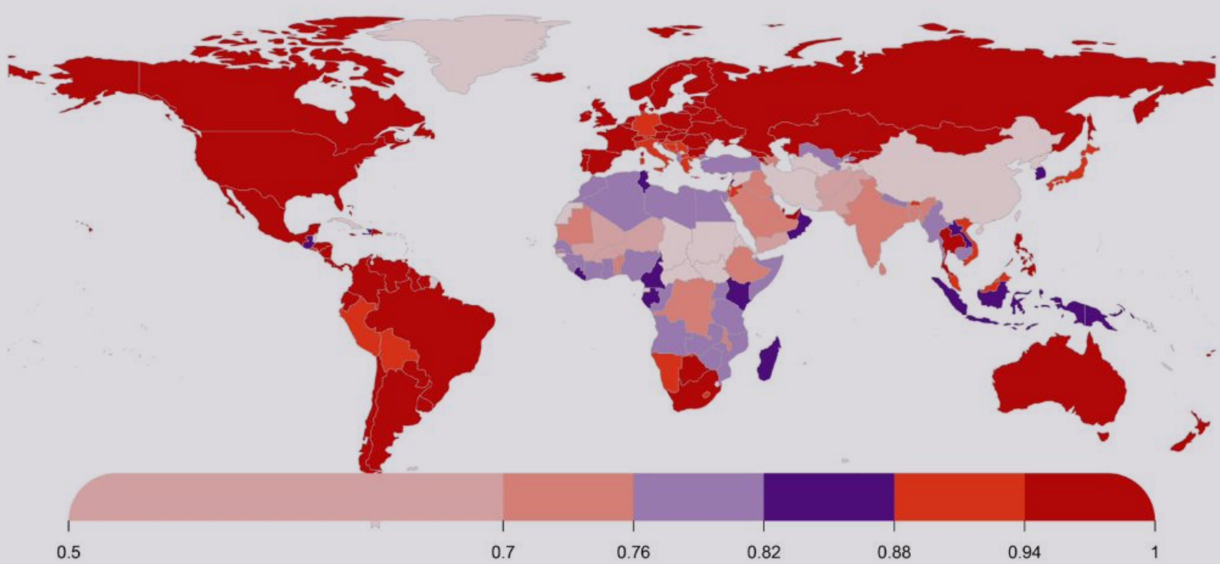


Figure 6.3b

Modeled using Facebook gender gap index



Source: Fatehkia, Kashyap and Weber (2018).
Note: Results were computed by (a) using ITU ground truth data, and (b) using Facebook18+ user gender gap index. Higher values indicate greater gender equality.

6.2.2.2 / Use of digital financial services

The World Bank's Global Findex covers a number of digital financial inclusion indicators across all world regions (Table 6.4). The only exception is use of mobile money; that data is mostly limited to developing countries, where mobile money is more widely used.

Table 6.4
Number of countries covered in Global Findex indicators

		AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
Used a mobile phone or the internet to access an account	2014	-	-	-	-	-	-
	2017	40	22	41	39	2	144
Used the internet to pay bills or buy something online	2014	37	23	41	39	2	142
	2017	40	22	41	39	2	144
Made or received digital payments in the past year	2014	37	23	41	39	2	142
	2017	40	22	41	39	2	144
Used a mobile money service in the past year	2014	34	17	22	1	-	74
	2017	36	17	22	2	-	77

Source: World Bank Global Findex Database, 2017.

6.3 / AVAILABILITY OF SEX-DISAGGREGATED DATA ON ICT SKILLS

6.3.1 / OVERVIEW

As with basic digital literacy, there is a lack of internationally comparable data that comprehensively measures advanced digital skills. ITU's indicator on the proportion of a population that can write a computer programme has data for only 49 countries. OECD's Survey on Adult Skills includes a test-based measure of ICT skills for problem-solving, but the data is limited to 36 (mostly European) OECD countries. In general, high-level digital skills are estimated via a proxy of qualifications indicating formal education or training in ICT or STEM specialisations, mainly from the UNESCO Institute of Statistics (UIS). Data is particularly lacking on alternative pathways to advanced digital skills. Following the trend for data on ICT access, Europe has the most data coverage, followed by Asia; data from Africa is sparse. Table 6.5 summarises the state of data on ICT skills. (See Chapter 2 for discussion of gender equality in ICT skills.)

Table 6.5

Status of conceptualisation and collection of sex-disaggregated data on ICT skills

INDICATOR	Source	Tier 1	Tier 2	Tier 3	Number of reporting countries	Note on tier classification
Primary education enrolment, Female	-	√	-	-	167 (86%)	Classified by UN
Secondary education enrolment, Female	-	√	-	-	149 (76%)	Classified by UN.
TVET education enrolment, Female	-	√	-	-	125 (64%)	Classified by author. Similar to others defined by UN.
Tertiary education enrolment, Female	-	√	-	-	123 (63%)	Classified by author. Similar to others defined by UN.
Female graduates from STEM programmes in tertiary education	-	√	-	-	97 (50%)	Classified by author. Similar to others defined by UN.
Female graduates from ICT programmes in tertiary education	-	√	-	-	96 (49%)	Classified by author. Similar to others defined by UN.
Student performance in STEM (PISA 2015)	-	-	-	√	72 (37%)	Classified by author. Limited to participating countries.
Student self-concept in STEM (PISA 2012)	-	-	-	√	65 (33%)	Classified by author. Not regularly collected
Student performance in Math and Science by gender (TIMSS 2015)	-	-	-	√	57 (29%)	Classified by author. Limited to participating countries, Collected every four years.
Literacy: Transferring files between a computer and other devices	ITU	-	√	-	50 (26%)	Classified by UN
ITU ICT skills on programming	ITU	-	√	-	49 (25%)	Classified by UN.
Literacy: Copying or moving a file or folder	ITU	-	√	-	49 (25%)	Classified by UN
Literacy: Creating electronic presentations with presentation software	ITU	-	√	-	49 (25%)	Classified by UN
Literacy: Writing a computer program using a specialised programming language	ITU	-	√	√	49 (25%)	Classified by UN
Adults with vocational education (OECD)	OECD	-	-	-	44 (22%)	Classified by author. Data for OECD countries only.
Literacy: Using basic arithmetic formula in a spreadsheet	ITU	-	√	-	43 (22%)	Classified by UN
Literacy: Finding, downloading, installing and configuring software	ITU	-	√	√	42 (22%)	Classified by UN
OECD Survey on Adult Skills (ICT-based problem-solving)	OECD	-	-	-	36 (18%)	Classified by author. Data for OECD countries only.
Literacy: Using copy and paste tools to duplicate or move information within a document	ITU	-	√	-	35 (18%)	Classified by UN
EU comprehensive digital skills indicators	-	-	-	√	28 (14%)	Classified by author. Data for EU countries only.
Literacy: Connecting and installing new devices	ITU	-	√	-	20 (10%)	Classified by UN
Literacy: Sending e-mails with attached files	ITU	-	√	-	17 (9%)	Classified by UN
Alternative training avenues (e.g. MOOCs, bootcamps, makerspaces)	N/A	-	-	√	N/A	Classified by author. No known global data repository.

Source: World Bank Global Findex Database, 2017.

6.3.2 / REGIONAL SUMMARY

6.3.2.1 / Basic digital literacy

Over the years, advances have been made in defining Despite being the main data repository for ICT data, including basic digital skills, ITU's indicators measuring basic digital literacy suffer from lack of coverage. As seen in Table 6.6, few countries (especially in Africa and Asia) shared relevant data for the period 2014–2016.

Even among the countries that have shared data on basic ICT skills, only nine have data for all the skills ITU monitors (Table 6.7). Furthermore, the data should be interpreted with care, since data collection methodologies are unclear and the reliability of the data is therefore not certain.

Table 6.6
Number of countries covered in ITU sex-disaggregated data on basic digital skills

	AFRICA	AMERICAS	ASIA	EUROPE	TOTAL
Copying or moving a file or folder	3	4	10	32	49
Using copy and paste tools to duplicate or move information within a document	3	3	8	21	35
Sending e-mails with attached files	3	4	9	1	17
Using basic arithmetic formula in a spreadsheet	2	4	10	27	44
Connecting and installing new devices	3	4	9	4	20
Finding, downloading, installing and configuring software	3	3	10	26	42
Creating electronic presentations with presentation software	3	4	10	32	49
Transferring files between a computer and other devices	3	3	11	33	50

Source: ITU WITD Database, 2017.

Table 6.7
Countries with sex-disaggregated data on all eight ITU digital skills

Countries with sex-disaggregated data on all eight ITU digital skills		
Africa	Egypt	2015
	Morocco	2016
	Zimbabwe	2014
Americas	Brazil	2016
	Jamaica	2015
Asia	Bahrain	2016
	Brunei	2016
	Georgia	2016
	Iran	2015
	Singapore	2017
	Kazakhstan	2016
	Qatar	2015

Source: ITU WITD Database, 2017.

6.3.2.2 / Advanced skills

As discussed in Chapter 2, digital skills are often measured by self-reported surveys on the range of ICT activities performed by users. Beyond basic skills, there is a lack of internationally comparable data measuring a comprehensive set of advanced digital skills — especially for Africa, the Americas and Oceania. For example, of the 49 countries reporting the number of people who can write a computer program, only three are in Africa, two are in Latin America, and none are in the Oceania region (Table 6.8).

Table 6.8
Number of countries covered in ITU and OECD data on advanced ICT skills

	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
ITU ICT skills on programming	3	2	11	33	0	49
OECD Survey on Adult Skills (ICT-based problem-solving)	0	6	7	21	2	36

6.3.2.3 / STEM Education

The UNESCO Institute of Statistics (UIS) produces annual globally-comparable data on education, collected from national ministries of education. UIS emphasises the importance of gender equality in education and STEM education, as evidenced in its recent programme on STEM and Gender Advancement (SAGA, https://en.unesco.org/saga). Most UIS data on enrolments and graduates are broken down by gender as well as field of study, including some specific STEM or ICT-related majors.

While the coverage of UIS sex-disaggregated data on school enrolment is relatively comprehensive, the number of reporting countries gradually decreases; most report on primary education (167) and least on tertiary education (123). The data coverage is even less complete for female students' majors in higher education. Combining both 2015 and 2016 data, only 96 out of 195 countries reported the female share of students graduating with an ICT specialisation (Table 6.9). Furthermore, it is difficult to assess the data quality and accuracy for reporting countries.

Table 6.9
Status of sex-disaggregated data on general and ICT education, no. of countries reporting

	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
Primary education enrolment, Female (2015)	39	33	42	43	10	167
Secondary education enrolment, Female (2015)	31	33	34	43	8	149
TVET education enrolment, Female (2015)	26	22	32	41	4	125
Tertiary education enrolment, Female (2015)	25	28	31	37	2	123
Female graduates from ICT programmes in tertiary education (2015/2016)	17	19	28	31	1	96
Female graduates from STEM programmes in tertiary education (2015/2016)	18	19	28	31	1	97

Source: UNESCO Institute of Statistics, 2015-2016.

Case Study 6.3
Tracking data on female programmers in Argentina

Authors: Romina Colman, Cecilia Vazquez, Carolina Hadad, Mariana Varela, Yanina Paparella, and Melina Masnatta (Chicas Tecnologia)

Introduction. The non-profit organisation Chicas en Tecnología has been developing a range of programmes to bridge the gender digital gap by fostering knowledge and enthusiasm of young women in science, engineering, and technology. We are also creating a database to gather information on the professional profile of the population to inform public policymaking, collaborating with stakeholders who can provide (or facilitate access to) relevant data.

Methodology. Over a four-month period we collected information on new enrolments, re-enrolments, and graduations in 73 programming courses of studies between 2010 and 2015, at 84 public and private universities and university institutes. Surveys were done to gather profiles of women working in programming in Argentina's public organisations and major companies in the programming field. The Argentine Department of Production's 111 Mil Plan and Aprendé Programando, both governmental initiatives, were also analyzed. Buenos Aires City and national governmental organisations provided data about the country's universities, the university institutes and the two public programs chosen. In some cases, the educational institutions were contacted directly. A media advisory and dissemination strategy for social networks was implemented in order to encourage participation of companies and institutions. The data-tracking was carried out in association with Medallia.

Main findings

1. Although women outnumber men overall in new enrolments, the share of female enrolments in programming courses of studynever exceeded 17%. Between 2010 and 2014, five men were enrolled for every woman, and in 2015 (the year with the most female enrolments in Argentine universities), the male-to-female ratio increased to six to one.
2. The programs with the strongest presence of women were University Associate Technical Degree in Web Programming (38.5%) and University Associate Technical Degree in IT (35.3%). The programs with the lowest female presence was University Associate Technical Degree in Video-Game Development (5.5%).
3. The greatest number of females graduated in Information Systems Engineering (1,027, or 23%), followed by University Associate Degree of Systems Analyst (362, or 8%) and IT Engineering (321, or 7%).
4. A high percentage of companies refused to open data on gender distribution, but they all wanted to know the results of the survey. Among the 40% who shared data, only 13 had half their technical positions held by women. In 13 of the 78 organisations, men held more than 90% of technical positions, and four had no women in technical jobs. Most women work in Software Development profiles, and very few in Software Quality profiles.
5. There has been a significant increase in governmental strategic actions and promotion of studies in technological areas.

Challenges

- Some institutions lacked specific guidelines for public requests.
- Data had to be matched with established categories.
- Sex-disaggregated data for some years and institutions was not available, especially for new programmes.
- Different programme naming conventions, as well as variations in the graduate profile and teaching approach, make comparison difficult.
- Some documents, e.g., pdf files, were impossible to analyze as they could not be manipulated or modified. (Aprendé Programando initiative was not included in the final report, because the City Government did not provide the data in an open format.)

Recommendations

- Analyze the 111 Mil Plan activities and participants' motivations, to discover why the enrolments are almost double that of new female enrollments in programming-related courses.
- Compare female enrolments in programming courses to those in other fields.
- Analyze sex-disaggregated data on Master and Ph.D. degrees in Argentina to compare with undergraduate enrollments.
- Find out if any governmental statistics system has sex-disaggregated data on faculty of associate and undergraduate programs.
- Introduce legislation that requires companies to open data, especially on issues related to gender distribution in roles, salaries, career development, etc.

The *Chicas in Tecnología* database will be open and publicly accessible: http://mujeresprogramadoras.chicasentecnologia.org/

At the regional level, Eurostat and OECD publish internationally comparable sex-disaggregated data on STEM education. Such efforts are rare in other regions, such as Africa, Latin America, and Asia. (See Case Study 6.3 for an example from Argentina.)

Even for Europe and North America, it is difficult to make direct comparisons between regional or national data due to inconsistent ways of categorising the fields of tertiary education (despite the existence of the International Standard Classification for Education). For example, UIS categorises tertiary majors into 11 fields, including "Information Communications Technologies" as a separate specialisation. OECD, on the other hand, has more than 20 sub-categories of tertiary education majors. Eurostat also has more than 30 categories and includes "computing" instead of ICT as a distinct field (Table 6.10). National governments around the world also have their own categorisations, which may classify ICT with information technologies, information sciences, technology studies, etc. These differences make it difficult to understand how many female students globally have specialised in fields relevant to ICTs, and have thus obtained higher-level digital skills.

Table 6.10

Examples of different classification of STEM-related fields in higher education

UIS	OECD	EUROSTAT
Natural sciences, mathematics and statistics Information and communication technologies Engineering, manufacturing and construction	Science Life science Physical science Mathematics and statistics Computing Engineering, manufacturing and construction Engineering and engineering trades Manufacturing and processing Architecture and building	Science, mathematics and computing Life science Physical science Mathematics and statistics Engineering, manufacturing and construction Engineering and engineering trades Manufacturing and processing Architecture and building

Source: ITU WITD Database, 2017.

6.3.2.4 / Student performance and learning experiences

Most of the international data on ICT education focuses on enrolment or graduation levels. There is a lack of globally-comparable data on quality of education — student performance, learning experiences, motivation, aspiration, or discrimination. Assessing these measures would involve using various psychometric measures. PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) provide data on student performance and learning experiences at the secondary education level. Although the PISA is governed by the OECD, its participant countries include non-OECD economies; in 2015, over half a million students participated, from 72 countries representing several regions (Table 6.11). TIMSS is an international assessment of mathematics and science at the fourth and eighth grades that has been conducted every four years since 1995. In 2015, 57 countries participated, with relatively higher representation for Europe and Asia while other regions had low participation.

Table 6.11
Number of countries covered in PISA and TIMSS surveys*

	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
PISA 2015	3	12	19	36	2	72
TIMSS 2015	4	3	23	26	1	57

**Surveys on student learning experiences (sex-disaggregated data).*

6.4 / AVAILABILITY OF SEX-DISAGGREGATED DATA ON ICT LEADERSHIP

6.4.1 / OVERVIEW

As discussed in Chapter 3 on leadership, both practical and conceptual issues complicate collection of gender-disaggregated, industry-specific data on ICT. The primary source of global occupational data, the International Labour Organisation (ILO), includes some breakdowns by gender, sector, and occupation, its classification systems — as well as the quantities and types of data available — obscure the actual levels of gender participation in the ICT industry. Furthermore, some major countries such as the United States and Canada are generally not covered in the ILO databases. Some other global and regional organisations, such as the World Bank, UNESCO, OECD, and the Inter-Parliamentary Union, are alternative sources for some of the relevant data.

However, for several of the pertinent issues covered in this report, there are no official internationally comparable statistics. For example, while the ILO has good data coverage on female employment by skill level, this is not broken down by industry. Reports such as McKinsey's annual Women in the Workplace tend to have limited industry breakdown at best, and usually do not have an international focus. Table 6.12 summarises the state of data availability on issues related to women in ICT leadership. (See Chapter 3 for discussion of gender equality in ICT leadership.)

Table 6.12
Status of conceptualisation and collection of sex-disaggregated data on ICT leadership

INDICATOR	Source	Tier 1	Tier 2	Tier 3	Number of reporting countries	Note on tier classification
Proportion of seats held by women in national parliaments, 2018	IPU	√	-	-	193 (99%)	Classified by UN.
Proportion of females by occupation skill level, 2017	ILO	√	-	-	188 (97%)	Classified by author. Similar to others classified by UN.
Bank or mobile account ownership	WB	√	-	-	144 (74%)	Classified by UN.
Saved at financial institution	WB	√	-	-	144 (74%)	Classified by author. Similar to others classified by UN..
Borrowed from financial institution	WB	√	-	-	144 (74%)	Classified by author. Similar to others classified by UN.
Firms with female participation in ownership	WB	-	-	√	119 (61%)	Classified by UN.
Proportion of women in managerial positions, 2016	ILO	√	-	-	82 (42%)	Classified by UN.
Proportion of females, telecommunication industry, 2016	ILO	-	√	-	60 (31%)	Classified by author. Similar to others classified by UN.
Proportion of female senior & middle managers, 2016	ILO	√	-	-	59 (30%)	Classified by UN.
Proportion of female ICT professionals, 2016	ILO	-	√	-	53 (27%)	Classified by author. Similar to others classified by UN.
Proportion of female chief executives, senior officials & legislators, 2016	ILO	-	√	-	52 (27%)	Classified by author. Similar to others classified by UN.
Proportion of female electrical and electronic trades workers, 2016	ILO	-	√	-	51 (26%)	Classified by author. Similar to others classified by UN.
Proportion of female engineering & technology researchers, 2015	UNESCO	√	-	-	25 (13%)	Classified by UN.
Access to business training	OECD	-	-	√	38 (20%)	Classified by author. OECD data only.
Proportion of female STEM faculty	ITU	-	-	√	N/A	Classified by author. No global repository.
Proportion of female business school faculty	-	-	-	√	N/A	Classified by author. No global repository.
Proportion of female software developers	-	-	-	√	N/A	Classified by author. No global repository.
Proportion of males and females leaving ICT industry	-	-	-	√	N/A	Classified by author. No global repository.
Proportion of female managers, telecom companies	-	-	-	√	N/A	Classified by author. No global repository.
Proportion of female members and heads – Academies of Science	-	-	-	√	N/A	Classified by author. No global repository.
Proportion of females, ICT company boards	-	-	-	√	N/A	Classified by author. No global repository.
Access to venture capital	-	-	-	√	N/A	Classified by author. No global repository.
Proportion female heads of ICT regulatory agencies	-	-	-	√	N/A	Classified by author. No global repository.

6.4.2 / REGIONAL SUMMARY

6.4.2.1 / Employment

For the few ICT occupation indicators in ILO datasets, European countries tend to have the most data (Table 6.13). In North America, the U.S. and Canada track their own data quite extensively. Ffor example, the U.S. National Science Foundation and the Bureau of Labour Statistics compile detailed occupational data, often disaggregated by sex. Reasons for data scarcity are similar to those for other topics: institutional capacity, lack of interest, definitions of ICT occupations, and lack of a common methodology. One notable effort to address this data challenge is the UC Berkeley Women in Technology initiative to encourage technology companies to adopt and collect a set of common indicators tracking women's entry into and pathways through ICT jobs.

Table 6.13
Status of sex-disaggregated, internationally comparable data on ICT employment (no. of reporting countries)

	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
Employment by occupation skill level, 2017	53	33	51	40	11	188
Employees in telecommunications industry, 2016	4	10	9	34	3	60
Electrical and electronic trades workers, 2016	2	10	8	32	1	53
Engineering & technology researchers, 2015	3	6	9	31	2	51
Total management, 2016	3	2	15	5		25
Senior & middle management, 2016	6	17	19	38	2	82
Chief executives, senior officials & legislators, 2016	3	11	8	35	2	59
STEM faculty, members and heads of academies of science, business school faculty	2	7	9	32	2	52
Employees leaving ICT industry due to discrimination	-	-	-	-	-	-
Telecom company managers	-	-	-	-	-	-
Proportion of females, ICT company boards	-	-	-	-	-	-

At the heart of the difficulty of tracking women's participation in the ICT industry is the continually evolving nature of the industry, the diversity of occupations that could be classified as ICT jobs, the use of different measurement and classification approaches, and the lack of a central repository with comprehensive, internationally comparable data on this topic. Without a clearer view of the range of possible ICT occupations within and outside the ICT industry, and without common measurement and classification standards, it is difficult to come to definitive conclusions about the degree of female marginalisation in ICT employment. Furthermore, in most parts of the world it is nearly impossible to understand how gender equality in ICT leadership is changing (for better or for worse), because there is limited trend data.

6.4.2.2 / Entrepreneurship

None of the entrepreneurship-related data presented in this report is specific to the ICT industry. Even general entrepreneurship data is limited or non-existent for most countries (Table 6.14). In seeking insights on women's ownership of ICT firms, or on their access to business and finance opportunities in ICT, at present one can only make extrapolations from data on entrepreneurship in general. The Global Entrepreneurship Monitor (GEM), which has some analyses by gender as well as by ICT industry, does not break down by gender within the ICT industry. It also does not cover all countries: the last three GEM reports included 60 or fewer countries (Global Entrepreneurship Research Association, 2016, 2017, 2018, https://www.gemconsortium.org).

Table 6.14
Status of sex-disaggregated data on ICT entrepreneurship

CATEGORY	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
Access to and use of financial services (bank/mobile account)	47	25	46	39	2	159
Firms with female participation in ownership	33	30	32	22	2	119
ICT entrepreneurs	-	-	-		-	-
Access to business training	-	-	-	-	-	-
Access to venture capital	-	-	-	-	-	-

Source: World Bank Enterprise Surveys, 2017; Global Findex, 2017.

6.4.2.3 / Policymaking

The Inter-Parliamentary Union (IPU) is one of the main repositories of regularly updated statistics on women's participation in national governance. Almost all countries are represented in their datasets, covering the number of seats women hold in parliamentary bodies (Table 6.15). No agency currently monitors women's participation in ICT-related regulatory and policy making institutions.

Table 6.15
Status of sex-disaggregated data on ICT policymaking

INDICATOR	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
Seats held in national parliaments, 2018	54	46	48	47	19	214
Heads of ICT regulatory agencies, 2018						

Source: Inter-Parliamentary Union (2018), ipu.org.

6.5 / AVAILABILITY OF SEX-DISAGGREGATED DATA ON THE DARK SIDE OF ICTS

6.5.1 / OVERVIEW

Globally, data is not systematically collected on most gender issues related to the dark side of the digital age. The majority of indicators identified so far are conceptually unclear, lack an established methodology, or are not regularly collected by countries. There is also limited rigorous qualitative or quantitative research on a wide range of issues and contexts, such as negative and unintended consequences of gender-based initiatives. Table 6.16 summarises the state of data on the dark side of ICT access, skills, and leadership. (See Chapter 4 for a discussion of the dark side of ICTs.)

Table 6.16
Status of sex-disaggregated data on the dark side of ICTs

INDICATOR	Source	Tier 1	Tier 2	Tier 3	Number of reporting countries	Note on tier classification
Non-discrimination clause mentions gender*	World Bank	√	-	-	193 (99%)	Classified by UN.
Gender non-discrimination policies for employment (promotion or demotion, vocational training, equal pay)*	World Bank	-	√	-	193 (99%)	Classified by UN.
Paid leave policies for mothers of infants (availability, maximum replacement wage)*	World Bank/ World Policy Analysis Center	√	-	-	193 (99%)	Classified by UN.
Mothers of infants guaranteed breastfeeding breaks at work or paid breastfeeding options*	World Bank/ World Policy Analysis Center	√	-	-	193 (99%)	Classified by author. Similar to others classified by UN.
Legislation prohibiting sexual harassment in public places, education & employment*	World Bank	-	√	-	189 (97%)	Classified by UN.
Proportion of women subjected to physical and or sexual violence by a current or former intimate partner	UNSTAT/ UN Women	-	√	-	89 (46%)	Classified by UN.
Mean hours of work	ILO	-	√	-	66 (34%)	Classified by author. Similar to others classified by UN.
Proportion of time spent on unpaid domestic and care work	ILO	-	√	-	52 (27%)	Classified by UN
Proportion of women subjected to sexual violence by persons other than an intimate partner	UNSTAT/ UN Women	-	√	-	50 (26%)	Classified by UN.
Average hourly earnings: managers, professionals, technicians & associate professionals	ILO	-	√	-	17 (9%)	Classified by UN.
Experience workplace discrimination or harassment	-	-	-	√	N/A	Classified by author. No global repository.
Employees leaving ICT industry due to discrimination	-	-	-	√	N/A	Classified by author. No global repository.

** In this case, the number of countries for which data is available on whether the country has legislation on the issue.*
*** World Bank*

6.5.2 / REGIONAL SUMMARY

6.5.2.1 / General discrimination and gender-based violence

The broader environment of physical (IP and non-IP) VAWG can serve as possible proxy indicators of the extent of the dark side of ICTs. In general, data on the existence of pertinent legislation protection is more available than data on the actual incidence of discrimination or violence (Table 6.17).

Table 6.17
Status of sex-disaggregated data on general discrimination and sexual harassment (no. of countries reporting)

INDICATOR	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
Non-discrimination clause mentions gender	54	35	47	43	14	193
Legislation prohibiting sexual harassment in public places and education*	53	34	48	41	13	189
Proportion of women subjected to physical and/or sexual violence by a current or former intimate partner, in the last 12 months	26	11	15	30	7	89
Proportion of women subjected to sexual violence by persons other than an intimate partner, since aged 15	3	4	10	25	8	50

Source: World Bank; UNSTAT/UN Women.
*In this case, the number of countries for which data is available on whether the country has legislation on the issue.

For non-IP violence, the most recent data available for any country is from 2014; for some countries, the most recent data is more than a decade old (from as far back as 2000; Table 6.18). For both intimate and non-IP violence indicators, only one country has reported at least two data points over the last five years (Finland, for 2013 and 2014). Since 1995, only some 40 countries have conducted more than one survey on violence against women (UNSTAT, 2018).

Table 6.18
SDG indicators related to violence against women and girls

INDICATOR	Number of reporting countries	Coverage Period	Number of countries with at least 2 data points in the last 5 years (2013-2018)
Proportion of women subjected to physical and/or sexual violence by a current or former intimate partner, in the last 12 months	89	2005-2016	1
Proportion of women subjected to sexual violence by persons other than an intimate partner, since aged 15	50	2000-2014	0

*Source:*United Nations Statistics Division, 2018.

According to UNSTAT (2018), the availability of comparable data remains a challenge for several reasons: different survey methodologies and survey question formulations; uneven data collection efforts; different definitions of partner or spousal violence; lack of an internationally-agreed standard; and different categorisation of sexual violence by non-partners and forms of violence. Efforts to solve this problem include the creation of an Inter-Agency Group on Violence against Women Data, with a Technical Advisory Group (established jointly by WHO, UN Women, UNICEF, UNSD, and UNFPA), to establish a mechanism for compiling harmonised country level data (UNSTAT, 2018).

6.5.2.2 / Cyber violence against women and girls

Accounting for instances of technology-enabled gender-based violence (GBV) is complicated; currently, no single measure adequately captures its intricacies. Codifying and translating the various notions of cyber VAWG into measurable indicators remains a major challenge, as such data are not yet systematically collected and shared. While existing tools such as the Cyber Psychological Abuse Scale and the Revised Cyber Bullying Inventory provide tangible methods, they are limited in the sense that they measure specific cases of technology-enabled GBV and have been tested mostly in developed-country settings (Hinson et al., 2017).

Stakeholders have started laying the groundwork for developing valid and reliable measures of technology-facilitated GBV. For example, the World Bank Group and the Sexual Violence Research Initiative have engaged the Centre for Research on Women to develop a way to measure technology-facilitated GBV on a global scale (Hinson et al., 2017); while the European Institute for Gender Equality (EIGE) is advancing data collection and research agendas to improve knowledge on GBV in the EU.

6.5.2.3 / Workplace discrimination and work-life issues

As with general GBV discrimination, the most comprehensive data available on workplace discrimination and work/life issues relates to the policy environment, while data on other aspects is sparse (Table 6.19). Much of the available information on topics such as average earnings and mean hours of work relate to general labour trends — not specific to the ICT or technology industry — and it is not regularly collected or shared in most countries. While a few national and regional studies touch on some of these topics (e.g., Cutean & Ivus, 2017 on Canada; EIGE, 2018; other ongoing Europe-based research), there is currently no resource systematically tracking the types and extent of gender-based discrimination or related challenges within the ICT industry at a global level.

Table 6.19
Status of sex-disaggregated data on the work-related dark side of ICTs

TYPE OF DATA	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	TOTAL
Gender non-discrimination policy for employment (promotion or demotion, vocational training, equal pay)*	54	35	47	43	14	193
Paid leave available for mothers of infants, 2013*	54	35	47	43	14	193
Mothers of infants guaranteed breastfeeding breaks at work*	54	35	47	43	14	193
Maximum wage replacement rate of paid leave for mothers of infants*	54	35	47	43	14	193
Working mothers guaranteed options to facilitate paid breastfeeding for at least 6 months*	54	35	47	43	14	193
Legislation prohibiting sexual harassment in employment*	53	34	48	41	13	189
Mean hours of work	10	13	16	25	2	66
Proportion of time spent on unpaid domestic and care work	6	15	10	20	1	52
Average hourly earnings: managers, professionals, technicians & associate professionals	-	6	7	4	-	17
Experience workplace discrimination/harassment	-	-	-	-	-	-
Employees leaving ICT industry due to discrimination	-	-	-	-	-	-

**Number of countries for which data is available on whether the country has legislation on the issue.*

6.6 / POTENTIAL OF BIG DATA

The last decade has seen an exponential increase in the amount of digital data produced and captured. "Big data" is an umbrella term used to define large amounts of data generated as a by-product of our interaction with information-sensing devices and services, including mobile phones and social media. The large quantity of data produced, coupled with new approaches to analyzing these datasets, provide opportunities to reexamine social issues such as gender digital divides (Case Study 6.2, above). A 2018 report by UN Women, Gender Equality and Big Data, outlines a range of ways big data techniques are being used globally, highlighting successes and challenges entailed in the use of big data to improve the lives of women and girls. In this regard, organisations have started offering incentives to promote innovative thinking around the use of big data to fill gender data gaps. For example, Data 2x has awarded grants to projects that use mobile phone data to measure gender digital divides and assess financial inclusion.

The use of big data is not without risks and limitations. Issues related to privacy as well as access to key datasets are challenges that need to be addressed. In most cases, big data repositories are owned by private organisations, such as telecom operators and banks, that may be constrained in the type of data they can or are willing to share. Even when the data itself is free, the analytical tools and expertise needed to derive insights from the data could make the effort prohibitively expensive (UN Women, 2018).
Another problem with using big data to understand gender issues is that it ignores women who are not online, not using mobile phones, or not generating the online trails or features that can be captured by existing methodologies. Case Study 6.4 details some limitations of gender disambiguation methodologies.

Case Study 6.4
Gender in the Global Research Landscape Gender Disambiguation Methodology

Authors: Sarah Huggett (Elsevier)

Analysing critical issues related to gender disparity and bias require high-quality global data sources and analytical expertise. Elsevier (2017) has implemented an evidence-based examination of gender-relevant research worldwide in our report, "Gender in the Global Research Landscape" (https://www.elsevier.com/research-intelligence/campaigns/gender-17). As a proxy for researchers, we compiled authors of relevant publications (as indexed in Scopus®, Elsevier's indexing and abstracting database covering over 22,500 journals (https://www.elsevier.com/solutions/scopus). In addition to indexing scholarly output, Scopus indexes authors with an associated unique identifier. This identifier groups together all the documents published by an author, matching alternate spellings and variations of the author's name and distinguishing between authors with the same name by using data elements associated with their publications.

We combined Scopus data with other data sources to identify gender and country. We gather each author's list of papers in his or her first year of publication in Scopus, and then derive their country of origin based on the affiliations listed in their papers. (Author profiles without a first name, or with equal numbers of papers in two or more countries, are excluded from the gender disambiguation analysis.)

Genderise.io uses data from social media platforms to provide lists of first names as well as the number of people with this first name that are (self-reportedly) women or men in a given country. We use these lists to calculate the probability that each author's first name is feminine or masculine in the author's country of origin. An author's name needs to have appeared at least five times in the Genderize.io data and the probability that the name associates with a specific gender needs to be at least 85% for us to assign a gender to an author.

We utilise a second data source, NamSor™ Applied Onomastics, that uses sociolinguistic characteristics to mine Big Data sources with its name recognition software. It assigns a gender probability for a given name depending on the individual's location.

The use of Genderize.io and NamSor tends to work well for authors from Western countries or with Latin or Anglophone names. However, these methodologies are not sufficient for robustly determining the gender of names of authors of African, Arabic, or Asian descent. So, we use a third source for gender disambiguation of author names from Japan: a set of the most common masculine and feminine names from Wikipedia, also used by Larivière et al. (2013).

Gender disambiguation based on author's first name and country of origin presents challenges, especially for names originally written in non-Roman alphabets or languages using different character sets. The issue is particularly prominent for tonal languages such as Chinese; as the tone is lost in the transliteration, it becomes impossible to distinguish between masculine and feminine names.

6.7 / CONCLUSION

There is a serious lack of official statistics on most topics related to gender equality in ICT access, skills, and leadership. This data deficiency exists for most countries and is worst for the developing world. Coverage is best for ICT access, but even here we find large gaps. Where data are available, quality, reliability, and comparability are often issues of concern. Furthermore, an absence of longitudinal data inhibits insights into trends. Factors limiting the collection and usefulness of data include low data-gathering and analysis capacity of both public and private entities in most countries, as well as a diversity of potential indicators, definitions, and data collection methodologies that constrain international comparability.

The paucity of adequate data impedes policy makers from identifying good practices, benchmarking programme effectiveness, and making evidence-based decisions. Not surprisingly, therefore, most recommendations on closing gender digital divides stress the need to collect gender-disaggregated data and improve measurement tools. Such data needs to be routinely collected, analysed, and disseminated. Both supply-side and demand-side data are important in bridging knowledge gaps about the information lives of women. Demand-side data (such as GSMA's 2018a Global Consumer Survey and the "After Access" surveys, discussed in Part II Chapter 2) provide insights on users' characteristics, preferences, and habits. However, collecting global demand-side data especially at a global scale is an expensive exercise that is often spearheaded by private sector players, with their own commercial motivations and proprietary interest in keeping the data they collect confidential.

In addition, in-depth research is needed to surface and illuminate issues that may be unique to women (e.g., breastfeeding at work) or that may have invisible gender-based dimensions (e.g., owning a phone versus having control over use of the phone). These types of insights will be best generated through carefully designed studies drawing on multiple research disciplines. Efforts should be directed not only towards identifying and standardising indicators that can capture diverse aspects of ICT access, but also making the data collected openly available.

REFERENCES

A4AI. (2018). Measuring the digital divide: Why we should be using a women-centered analysis. Retrieved from: http://a4ai.org/measuring-the-digital-divide-why-we-should-be-using-a-women-centered-analysis/

Africa Development Bank. (2015). Gender Equality Index. Retrieved from: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/African_Gender_Equality_Index_2015-EN.pdf

Cutean, A., & Ivus, M. (2017). The digital talent dividend: Shifting gears in a changing economy. Ottawa, Canada: Information & Communication Technology Council (ICTC). Retrieved from: https://www.ictc-ctic.ca/wp-content/uploads/2018/01/ICTC-Report_The-Digital-Talent-Dividend-FINAL-ENGLISH-1.30.18.pdf

EIGE. (2018). Women and men in ICT: A chance for better work-life balance. Research note to support the Bulgarian presidency. Retrieved from: https://www.mlsp.government.bg/ckfinder/userfiles/files/politiki/ravni%20vyzmojnosti/publikacii/SUMMARY_EIGE_research%20note_ENG.pdf

Elsevier. (2017). Gender in the global research landscape. Retrieved from: https://www.elsevier.com/research-intelligence/campaigns/gender-17

European Commission. (2015). She figures. Retrieved from: https://ec.europa.eu/research/swafs/pdf/pub_gender_equality/she_figures_2015-final.pdf

Fatehkia, M., Kashyap, R., & Weber, I. (2018). Using Facebook ad data to track the global digital gender gap. World Development, 107, 189-209. Retrieved from: http://dx.doi.org/10.1016/j.worlddev.2018.03.007

Global Entrepreneurship Research Association. (2016). Global entrepreneurship monitor 2015/16. Retrieved from: https://www.gemconsortium.org/report/49480

Global Entrepreneurship Research Association. (2017). Global entrepreneurship monitor 2016/17. Retrieved from: https://www.gemconsortium.org/report/49812

Global Entrepreneurship Research Association. (2018) Global entrepreneurship monitor 2017/18. Retrieved from: https://www.gemconsortium.org/report/50012

GSMA. (2018a). Connected women, methodology: The mobile gender gap report 2018. Retrieved from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/04/GSMA-The-Mobile-Gender-Gap-Methodology-Report-2018_20pp_WEB.pdf

GSMA. (2018b). A toolkit for researching women's internet access and use. Retrieved from: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/05/GSMA-Women-and-Internet-Research-Toolkit_WEB.pdf

Highet, C., Skelly H., Tyers, A. (2017). Gender and information communication technology survey toolkit. Washington, DC: USAID. Retrieved from: https://www.usaid.gov/sites/default/files/documents/15396/Gender_and_ICT_Toolkit.pdf

Hinson, L., Mueller, J., O'Brien-Milne, L. (2017). Cyber violence: Disrupting the intersection of technology and gender-based violence. Washington, DC: World Bank. Retrieved from: http://blogs.worldbank.org/voices/cyber-violence-disrupting-intersection-technology-and-gender-based-violence

Intel. (2018). Women and the web report. Retrieved from: https://www.intel.com/content/dam/www/public/us/en/documents/pdf/women-and-the-web.pdf

Larivière, V., Ni, C., Gingras, Y., Cronin, B., & Sugimoto, C.R. (2013). Bibliometrics: Global gender disparities in science. Nature, 504(7479), 211-213. Retrieved from: http://dx.doi.org/10.1038/504211a

McKinsey. (2014). Offline and falling behind: Barriers to internet adoption. Retrieved from: http://www.mckinsey.com/Insights/High_Tech_Telecoms_Internet/Offline_and_falling_behind_Barriers_to_Internet_adoption

New York Academy of Sciences (n.d.). 1000 girls 1000 futures. Retrieved from: https://www.nyas.org/programs/global-stem-alliance/1000-girls-1000-futures/

UNCTAD (2015). Global assessment of sex-disaggregated ICT employment statistics: Data availability and challenges on measurement and compilation. UNCTAD Technical Notes on ICT for Development, No. 4. Retrieved from: https://unctad.org/en/PublicationsLibrary/tn_unctad_ict4d04_en.pdf

UNECE (United Nations Economic Commission for Europe). (2010). Developing gender statistics: A practical tool. Retrieved from: http://www.unece.org/fileadmin/DAM/stats/publications/Developing_Gender_Statistics.pdf

UNESCO. (2017). Gender and science. Retrieved from: http://www.unesco.org/new/en/natural-sciences/priority-areas/gender-and-science/improving-measurement-of-gender-equality-in-stem/stem-and-gender-advancement-saga/

UNSD. (2017). Minimum set of gender indicators. Retrieved from: https://genderstats.un.org/#/home

United Nations Statics Division (UNSTAT). (2018). Metadata 05-02-01. Retrieved from: https://unstats.un.org/sdgs/metadata/files/Metadata-05-02-01.pdf

World Wide Web Foundation. (2016). Women's rights online digital gender gap audit. Retrieved from: https://webfoundation.org/research/digital-gender-gap-audit/

APPENDIX A: COUNTRY PROFILES

AUTHORS: LISANDRA FESALBON, DON RODNEY JUNIO & ARABA SEY, WITH BEI JU (UNU-CS)

INTRODUCTION

The digital gender divide manifests in different ways. Across different countries, varying local institutional constraints and endowments including culture, legal framework, and resources help shape the ways women and girls are disadvantaged in their access and use of digital technologies or their meaningful participation in the digital economy. In a way, no two gender digital divides look alike.

While the main report looks at the digital gender divide at the global scale, this appendix views the issues at the country level. What does gender digital inequality look like in different countries?

Three countries from three different geographical regions (Africa, the Americas, and Asia Pacific) were selected to illustrate how gender digital divides play out in various contexts. Aside from geographical diversity, one of the main considerations in selecting a country to profile was to select a country where EQUALS coalition members had indicated plans to work on the ground. In this regard, Argentina, Indonesia, and Rwanda were chosen for the case studies. These countries provide an interesting study of contrast regarding the state of gender digital inequality in different parts of the world.

Argentina is one of the few countries where public-private sector commitment to narrow the gender gap has resulted in tangible outcomes. The data bear this out: the case study of Argentina illustrates a situation where the digital gender divide is narrowing or even approaching parity on some indicators. As the head of the G20 in 2018, Argentina has prioritised gender digital equality (https://responsiblefinanceforum.org/wp-content/uploads/2018/01/GPFI-Argentina-Priorities-Paper-2018.pdf)

Indonesia is one of the largest countries in Asia and the Pacific in terms of population and economy. It is also one of the most dynamic markets for ICTs, with mobile phone diffusion reaching 174 per 100 inhabitants. However, gender digital inequality remains substantial owing to many problems including its geographical size and the gender divide in access to education. This gender divide goes beyond ICT access, skills, and leadership issues. The issue cuts across the Indonesian society despite a strong top-down political commitment to address the problem such as by establishing a full ministry in charge of women's empowerment.

Among the three countries profiled in this report, Rwanda ranks the highest in the Gender Gap Report of the World Economic Forum ranking 4th out of 144 countries. However, indicators relevant to ICT access and skills still show substantial gap in women's access vis-à-vis men. Women lag substantially behind men in educational attainment which would affect women's participation in the country's nascent ICT sector.

By examining local data and resources where available, these country profiles provide a broad overview of gender digital inequality across a broad spectrum of cases: where substantial progress has been made in addressing gender digital divides (Argentina); where the issue persists despite a dynamic ICT market (Indonesia); and where the problem remains substantial despite having high gender equality in other areas (Rwanda). To be sure, these examples are but some of the many forms that the problem of gender digital inequality can take. However, as the data tables below show, there is insufficient official sex-disaggregated data to fully demonstrate the state of gender digital inequality in all three countries.

ARGENTINA
CONTEXT

From as early as 1985, with Argentina's accession to CEDAW, the country has made continuous efforts towards achieving gender equality. Numerous policies and programs have since been implemented, including gender quotas in labour unions and the creation of the National Women's Council. With regard to women in ICTs, there exist various academic institutions and civil society organisations that conduct research and encourage women's participation in the field. These include the Argentine Network of Gender, Science and Technology, and the Center of Studies on Science, Development and Higher Education. These government policies and public-private collaboration have had positive results. In the 2017 Gender Gap Report of the World Economic Forum, Argentina ranked 34th out of 144 countries in gender parity. It has performed well on some measures of gender parity: ranking 1st in the area of women's health and survival, 21st in political empowerment, and 44th in educational attainment. However, the country ranked 111th in women's economic participation.

ACCESS

Argentina is one of the few countries in the world where the digital gender divide in basic access is relatively marginal. According to the latest available data from ITU, there are more women (80%) than men (79%) using a mobile. While more men than women use the computer and internet, the difference is only 2%.

Even in aspects of meaningful use, women's access to and use of complex ICT services are comparable to men's. In 2017, Argentina was one of only four countries in the world where there were more women than men owning a bank account (including mobile money accounts), according to data from the Global Findex survey. Based on the same dataset, overall, more women than men have reportedly made or received digital payments in the past year.

SKILLS

Unfortunately, the ITU database of gender-disaggregated data on digital skills has no data for Argentina. However, a report by Accenture notes that women's digital fluency- or the extent to which they embrace and use digital technologies to become more knowledgeable, connected, and effective- is higher than that of men.

According to OECD, the share of 25-34 year-olds who had completed their upper secondary education reached 38% for both men and women in 2014. However, more women than men were expected to graduate from upper secondary education in their lifetime at 69% compared with 49% for men. Tertiary education remained limited with only 21% (2014) of 24-64 year-olds having attained a tertiary education – which was less than the OECD average of 37% but still higher than other Latin American countries like Brazil (15%) and Mexico (17%). In 2013, most first-time graduates were women at the bachelor's (62%), masters' (58%), and doctoral (56%) level. However, there is a high gender imbalance in fields such as education and humanities where majority of graduates are women. In the field of STEM, Argentina has more gender equality than OECD countries on average, but this is against the backdrop of an overall low share of STEM graduates (14%, which is well below the OECD average of 23%).

LEADERSHIP

On the political front, women's participation and representation has increased steadily over the years with a female president being elected and reelected between 2007 and 2015. Argentina became a pioneer in women's political participation by instituting a quota system in 1991 which required 30% of all candidates for elections to be women. In 2018, 40% of seats in Argentina's national parliament were held by women, ranking 17th globally. However, more work needs to be done to ensure that women are more fully engaged in running the public sector.

In decision-making positions, specifically in the public sector at national science and technology institutions and in higher education, women's representation is lower than men. In 2013, women made up 36% of the Science, Technology, and Productive Innovation Commission of the lower house of parliament. In the same year, the proportion of women in the Ministry of Science, Technology and Innovation (MINCYT) for all categories of staff was at 52%. But women only accounted for one third of staff working in the management and coordination of MINCYT. In the National Scientific and Technical Research Council in 2013, there were only 2 females out of 8 board members. In higher education decision-making positions, there were only 8 female rectors among Argentina's 53 national universities in 2014. Similarly, in the same year, there were 47 male vice-rectors and only 9 were female.

Women's participation in the economy is low relative to men with the labour force participation rate for women at only 56% for women compared to 82% for men in 2017. Nonetheless, there are sectors where the proportion of women workers is relatively high. For example, in high-skills occupations, 49% of workers are women. However overall, women are less represented in management positions with only 31% female managers in total management positions (2013), 36% categorised as chief executive, senior officials, and legislators (2014), and 39% in senior and middle management positions (2015).

CONCLUSION

Overall, Argentina has done well in narrowing the digital gender divide in access and skills but not in leadership. The digital gender divide in basic access, and even some aspects of meaningful use where data are available, is getting narrower or even approaching parity. For STEM training, the problem is more related to the overall low level of people studying STEM subjects and pursuing higher education rather than a gender divide issue. While Argentina was the first country in the world to introduce a quota law ensuring 30% of candidates standing for election are women, women continue to face obstacles to meaningful participation in the nation's political life, with little representation in decision making processes in the public sector. Similarly, in the private sector, there are far fewer women represented in senior management roles compared to men.

REFERENCES

Bonder, Gloria. National assessments in gender and STI: Argentina report. Women in Global Science and Technology. Retrieved from: http://wisat.org/wp-content/uploads/Argentina_GE-KS.pdf

Databases consulted:

- ILOSTAT
- ITU Statistics
- OECD Education at a Glance country notes: http://www.oecd.org/education/educationataglance2017-countrynotes.htm
- UNESCO UIS
- World Economic Forum (2017) Global gender gap report
- Women in national parliaments, situation as of 1st June 2018. Accessed from: http://archive.ipu.org/wmn-e/classif.htm
- World Bank Global Findex Database 2017 https://globalfindex.worldbank.org/
- World Bank Women, Business and the Law 2018

INDONESIA
CONTEXT

Discussions on gender issues have been a part of the development discourse in Indonesia for more than two decades now and a number of government policies have been instituted to support greater participation of women in the economic, social, and political life of the country. Indonesia ratified CEDAW more than three decades ago and the constitution recognises equality before the law. Indonesia is also one of a select few countries with a ministry dedicated to women's empowerment. However, this top down embrace of gender policies has not resulted in gender parity. In the 2017 Global Gender Gap Report, Indonesia ranked 84th out of 144 countries. The gender divide cuts across many spheres of Indonesian society and is observable in access to and participation in the digital economy. Factors that explain the gender digital divide include low level of digital media literacy of women compared to men, lack of education, lack of opportunities, less income and subsequently less free time for women, as well as the predominantly male dominated social structure of the country.

ACCESS

Basic access to ICTs is a challenge in Indonesia owing to the physical scale, geography, and archipelagic nature of the country. The problem is compounded by the country's large population which stood at 250 million in 2016. Mobile phones are the main means of accessing digital content in the country. In 2017, mobile subscribers per 100 inhabitants stood at 174. Despite this, there is a gender gap in mobile phone ownership. Only 52% of women owned a mobile phone compared to 64% for men in 2016. There were also fewer women accessing the internet and using a computer.

One aspect of meaningful use where data are available is in use of digital financial services. Based on data from the World Bank Findex (2017), Indonesia is one of only four countries in the world where there are more women than men owning a bank account (including mobile money account). There are also more women than men who have made or received digital payments in the past.

SKILLS

Access to education and low digital literacy have been cited as key barriers that exacerbate the gender digital divide in Indonesia. Unfortunately, ITU does not have gender-disaggregated data on basic ICT skills for the country. Nonetheless, this problem of low digital literacy and skills is being addressed by the government through formal educational channels. The national education curriculum includes specific objectives for a subject on basic computing skills at the primary and secondary levels to improve. Women lag behind men across primary, secondary, and tertiary educational attainment. In fields related to STEM and ICT, the number of female tertiary graduates in these areas also falls behind male graduates. Of the total graduates in tertiary STEM programme in 2014, only 38% were women. In the field of ICT and engineering/manufacturing and construction, the percentage share of women graduates stood at 36% in 2014. The reverse is true in health and welfare programs where there are more women graduates than men.

In Indonesia, there is political commitment to promote the integration of ICT in education. The national policy and national plan include strategies to integrate ICTs in education at the primary and secondary levels. Outside traditional educational routes, non-government and for-profit organisations have been active in urban areas in promoting alternative pathways to ICT skills upgrading through coding boot camps, she-hacks (or hackathons exclusive to women) among others.

LEADERSHIP

The gender gap in political and economic leadership positions remain substantial. From 2009 to 2014, women made up 18% of the total members of parliament while female members of the cabinet made up 12%. In 2018, Indonesia ranked 101st out of 193 countries in terms of female representation in parliament, with 20% of seats in national parliament held by women. In the public sector, women also tend to hold positions that are seen as “soft” such as those relating to women’s issues.

Women are similarly underrepresented in economic leadership positions. In 2015, women accounted for only 22% of total management positions. In senior and middle management positions and amongst chief executives, senior officials, and legislators, the proportion of women is even lower at 21% and 15% respectively. According to the ILO in 2017, women made up 46% of workers classified under high-skill occupations. Specific to ICT and related industries, women’s participation remains low. In 2016, female employment in ICT occupations was at just 5%. Among electrical and electronic trades workers, women made up 12% of the total workforce. The situation is slightly better in the telecommunications industry where women made up 38% of the workforce.

CONCLUSION

The state of the gender digital divide across access, skills, and leadership in Indonesia remains an ongoing concern. Incomplete data on meaningful access prevent us from drawing a holistic picture of the state of the gender digital divide beyond basic access. Top-down embrace of policies related to women empowerment has not resulted to the desired outcome of greater gender parity. Structural issues including digital literacy, access to education and economic opportunities are some of the underlying issues that are seen as contributing to the gender digital divide.

REFERENCES

Hermawati, W. & Saari, R. (2011). National assessment on gender equality and the knowledge society in Indonesia. Centre for Science and Technology Development Studies, Indonesian Institute of Sciences. http://wisat.org/wp-content/uploads/Indonesia_GE-KS_Final.pdf

Suwana, F., Lily. (2017). Empowering Indonesian women through building digital media literacy. Kasetsart Journal of Social Sciences, 38 (3), 212-217.

Databases consulted:

- ILOSTAT
- ITU Statistics
- OECD Education at a Glance country notes: http://www.oecd.org/education/educationataglance2017-countrynotes.htm
- UNESCO UIS
- World Economic Forum (2017) Global gender gap report
- Women in national parliaments, situation as of 1st June 2018. (2018). Accessed from: http://archive.ipu.org/wmn-e/classif.htm
- World Bank Global Findex Database 2017 https://globalfindex.worldbank.org/
- World Bank Women, Business and the Law 2018

RWANDA *CONTEXT*

Rwanda has made efforts in recent years to attain gender equality through implementation of numerous policies and commitments at different levels of society. At the international level, Rwanda is committed to the Convention on the Elimination of All Forms of Discrimination against Women and has adopted the Beijing Platform for Action. On a national level, the Ministry of Gender and Family Promotion was established in 2003 to promote gender equality throughout the development process of the country. In 2010, the National Gender Policy was initiated which requires each government ministry to have a gender sector policy and strategic plan. At both the national and community level, the National Women's Council (an organ under the Ministry of Gender and Family Promotion) facilitates forums and development activities for women's empowerment. In addition, there are Faith Based Organisations at the community and family level that create dialogues for healthy gender relations. These efforts have resulted in positive outcomes leading to Rwanda ranking 4th out of 144 countries in the 2017 Global Gender Gap Report. Despite these efforts, there are still significant gender digital divides in Rwanda.

ACCESS

While the ITU does not have gender disaggregated data on access and use of ICTs in Rwanda, we can glean the state of gender digital divides in the country using data from the Integrated Household and Living Condition Survey (EICV) 4 administered by the National Institute of Statistics of Rwanda in 2015. In general, women lag behind men in basic access. In 2015, female-headed households had lower access to ICT assets such as mobile phones (51% versus 68% for male-headed households) and computers (2% versus 3%). The percentage of households whose members had access to the internet was also lower for female-headed household (8% as compared to 10% for male-headed households).

The EICV 4 data also notes that the percentage of the population aged 15 years and above that is computer literate is lower for females (7%) as compared to males (10%). In terms of meaningful access, 33% of females made or received digital payments in the past year which is much lower than male respondents (45%). Barriers to basic and meaningful ICT access include cultural norms that assign women traditional gender roles, such as responsibility for household chores and child care activities. This results in women not having enough free time to access or use ICTs. Men also have the traditional role of being the sole financial providers for the family, which contributes to women's lack of finances for ICT access. The unequal distribution of ICT facilities in rural areas discourages women accessing these facilities due to the long walking distances. Women have relatively lower English language skills, creating an additional barrier since English is the main language used on computers. Additionally, negative perception of ICTs, such as associating them with pornography, put off women from using ICTs.

Rwanda has proposed national ICT initiatives to improve access to ICTs, such as Multipurpose Community Centres which promote public access to computing facilities. In addition, initiatives have been set up to improve staff recruitment and advancement at village knowledge centers in rural areas.

SKILLS

Despite ranking 4th overall in the 2017 global gender gap, Rwanda ranked 113th in educational attainment, based on the same ranking. This is primarily influenced by the substantial gender gap in tertiary enrolment and overall literacy rates (65% female versus 72% male).

Based on EICV 4 data, in 2015 there was almost gender parity in basic education and more women enrolled in primary (50%) and secondary levels (53%) in Rwanda. However, there were fewer women enrolled at the tertiary level where 43% of total enrolment was female. This gender gap was especially evident in science and technology-based disciplines. There were more men than women enrolled in science programs (32% women), and engineering/manufacturing and construction programs (19%). The reverse was true for other programs such as social sciences, business, and law where 54% of enrolled students in 2015 were female, and in services-related programs, where female share of enrolled students stood at 58%.

LEADERSHIP

In terms of leadership, women are well represented in the public sector but not in the economic sphere. Rwanda currently leads the world with the highest number of women elected to parliament. As of June 2018, the lower house consisted of 61% women and the upper house 38% women. However, the proportion of women in government ministerial positions was lower than men at 40% in 2016. There were also more women governors in Rwanda as of 2016 (60% women governors) but only 17% of mayors were women.

Women are under-represented in economic leadership positions. The economy of Rwanda is primarily agriculture-based, and this is where majority (79%) of female workers over the age of 16 are found. In 2014, only 14% of total management positions were held by women. About 40% of positions in high skills occupations were held by women. Based on the 2016 National Gender Statistics Report of Rwanda, only 0.1% of female workers work in the information and communication sector and 0.2% work in professional, scientific and technical activities (compared to 0.3 and 0.6% respectively for men). The report also shows that in 2014 there were only 28 female managers of information and communication establishments, compared to 375 male managers. The number of female managers of professional, scientific and technical establishments was less than half that of males (308 compared to 654).

CONCLUSION

The problem of basic access in Rwanda is true for both men and women but is more acute for women. In general, Rwanda has fared well in narrowing gender gaps in educational attainment especially at the primary and secondary levels. However, challenges remain at the tertiary level where there are less women enrolled in tertiary programs and especially in STEM related programs. Women are visible and well represented in the political sphere but not in economic activities. The low participation of women in ICT-related economic activities is related to the general composition of the economy – the main national industries are agriculture, forestry, and fishing. To ensure appropriate policymaking and interventions, more official statistics and rigorous research are needed on the state of female access to ICTs and participation in the digital economy.

REFERENCES

International Telecommunications Union (2017). Country profiles, Rwanda.

Masanja, V. G., Masanja, J. K., Masanja, R. K., (2016). Report of the gender equality and the knowledge society in Rwanda. Women in Global Science and Technology, Organization for Women in Science for the Developing World. Retrieved from: http://wisat.org/wp-content/uploads/National-Assessment-on-Gender-and-STI-Rwanda.pdf

Mumporeze, N., & Prieler, M. (2017). Gender digital divide in Rwanda: A qualitative analysis of socioeconomic factors. Telematics and Informatics, 34(7), 1285-1293.

The Republic of Rwanda & National Institute of Statistics of Rwanda. (2016). National gender statistics report 2016. Retrieved from: http://www.statistics.gov.rw/file/4922/download?token=VHhPzzF-

The Republic of Rwanda & National Institute of Statistics of Rwanda. (2016). Rwanda integrated household and living conditions survey (EICV), 2013/2014 thematic report - Gender. Retrieved from: http://www.statistics.gov.rw/file/4461/download?token=clOlX88O

Databases consulted:

- ILOSTAT http://www.ilo.org/ilostat/
- ITU Statistics https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx
- OECD Education at a Glance country notes: http://www.oecd.org/education/educationataglance2017-countrynotes.htm
- UNESCO Institute for Statistics http://uis.unesco.org/ World Economic Forum (2017) Global gender gap report. https://www.weforum.org/reports/the-global-gender-gap-report-2017
- Inter Parliamentary Union: Women in national parliaments, situation as of 1st June 2018. (2018). Accessed from: http://archive.ipu.org/wmn-e/classif.htm
- World Bank Global Findex Database 2017 https://globalfindex.worldbank.org/
- World Bank Women, Business and the Law 2018. https://wbl.worldbank.org/

DATA TABLE

ACCESS

Table A.1

Mobile and internet access, by country

INDICATOR	DATA SOURCE	Argentina	Indonesia	Rwanda
Basic Access (ITU indicators, 2017)				
Fixed-telephone subscriptions per 100 inhabitants	ITU	21.5	4.2	0.1
Mobile-cellular subscriptions per 100 inhabitants	ITU	139.8	173.8	72.2
Using a mobile phone (%), Female (Male) 2016	ITU	80 (79)	N/A	N/A
Owning a mobile phone (%), Female (Male) 2016	ITU	N/A	52 (64)	N/A
Fixed-broadband subscriptions per 100 inhabitants	ITU	15.2	1.2	0
Mobile-broadband subscriptions per 100 inhabitants	ITU	78	95.6	35
Households with a computer (%)	ITU	66	19.1	4.5
Households with Internet access at home (%)	ITU	71.8	47.2	9.3
Individuals using the Internet (%), Female (Male) 2016	ITU	70 (72)	24 (28)	20
Individuals using the computer (%), Female (Male) 2016	ITU	46 (48)	16 (48)	N/A
Meaningful Access 2017				
Used the internet to pay bills or to buy something online in the past year (% age 15+; male/female %)	World bank	19 (21/16)	11 (9/13)	5 (6/3)
Used a mobile phone or the internet to access an account (% age 15+; male/female)	World bank	10 (14/8)	8 (7/8)	29 (34/24)
Made or received digital payments in the past year (% age 15+)	World bank	40 (38/42)	35 (34/35)	39 (45/33)
Violence against Women				
Is there domestic violence (covering physical, sexual, emotional and economic) legislation? Do protection orders for domestic violence exist?	World bank	YES YES	YES YES	YES NO
Is there legislation that specifically addresses sexual harassment? Is there sexual harassment legislation in public places? Are there civil remedies for sexual harassment inemployment?	World bank	YES YES NO	NO NO NO	YES NO NO
Subjected to a current/former intimate partner (%)	UN Women	N/A	N/A	20.4

SKILLS

Table A.2
Skills and education, by country

INDICATOR	DATA SOURCE	Argentina	Indonesia	Rwanda
Net Enrolment, secondary (% Female, 2016)	World Bank	91%	78%	30%
Net Enrolment, secondary (% Male, 2016)	World Bank	86%	76%	25%
Net Attendance Rate: Upper Secondary (% Females, 2015)	DHS	NA	NA	16.3%
Net Attendance Rate: Upper Secondary (% Males, 2015)	DHS	NA	NA	12.5%
School life expectancy at secondary Females (years, 2015)	UIS	6.65	5.27	2.35
School life expectancy at secondary Males (years, 2015)	UIS	6.28	5.23	2.18
Percentage of Female students in secondary education enrolled in vocational programs (%, 2016)	World Bank	NA	16%	14%
Percentage of Male students in secondary education enrolled in vocational programs (%, 2016)	World Bank	NA	20.8%	18.8%
Gross Enrolment, Tertiary (% Female, 2016)	UIS	107%	29%	7%
Gross Enrolment, Tertiary (% Male, 2016)	UIS	65%	26%	9%
Tertiary graduates by level of education (number, 2016,2016, 2015)	UIS	235.555	1.145.276	19.969
Percentage of graduates in Tertiary level STEM programme who are Female (% 2014)	UIS	NA	37.5%	NA
Tertiary graduates in ICT (% Female, 2014)	UIS	NA	6.7%	NA
Tertiary graduates in ICT (% Male, 2014)	UIS	NA	13.1%	NA
Percentage of tertiary graduates in ICT who are Female (2014)	UIS	NA	36%	NA
Tertiary graduates in Natural Sciences, Mathematics and Statistics (% Female, 2014)	UIS	NA	1.7%	NA
Tertiary graduates in Natural Sciences, Mathematics and Statistics (% Male, 2014)	UIS	NA	1.4%	NA
Percentage of tertiary graduates in Natural Sciences, Mathematics and Statistics programme who are Female (%, 2014)	UIS	49.5%	57.1%	NA
Tertiary graduates in Engineering, Manufacturing and Construction (% Female, 2014)	UIS	NA	6.4%	NA
Tertiary graduates in Engineering, Manufacturing and Construction (% Male, 2014)	UIS	NA	12.5%	NA
Percentage of tertiary graduates in Engineering, Manufacturing and Construction who are Female (%, 2014)	UIS	35.4%	35.8%	23.2%
15-24 year olds enrolled in vocational secondary education (% Female, 2015)	UIS	NA	8.34%	NA
15-24 year olds enrolled in vocational secondary education (% Male, 2015)	UIS	NA	10.65%	NA
PISA Science Performance mean score (Girls: Boys)	OECD	NA	405:401	NA
PISA Mathematics Performance mean score (Girls: Boys)	OECD	NA	387:385	NA
PISA Reading Performance mean score (Girls: Boys)	OECD	NA	409:386	NA
% of total researcher female	OECD	52.6%	NA	NA

LEADERSHIP

Table A.3

Women in employment, entrepreneurship, and policymaking, by country

INDICATOR	DATA SOURCE	Argentina	Indonesia	Rwanda
Proportion of females in high-skill occupations, 2017	ILO	48.9%	45.7%	40%
Proportion of females, Telecommunications industry, 2016	ILO	N/A	37.8%	N/A
Proportion of female ICT Professionals	ILO	21.4% (2014)	5.3% (2016)	N/A
Proportion of female Electrical and Electronic Trades Workers, 2016	ILO	N/A	12.2%	N/A
Proportion of female STEM Faculty				
Proportion of female business school faculty				
Proportion of female Engineering & Technology Researchers, 2015	UNESCO Institute for Statistics	N/A	N/A	N/A
Proportion of female Software Developers				
Proportion of females leaving ICT industry due to discrimination				
Proportion of female managers, Total management	ILO	30.6% (2014)	22.4% (2015)	14.1% (2014)
Proportion of female managers – Senior & middle management	ILO	38.6% (2016)	21.5% (2015)	N/A
Proportion of female managers – chief executives, senior officials & legislators	ILO	35.7% (2014)	15.4% (2016)	N/A
Proportion of female managers – Telecom, other ICT companies				
Proportion of female members and heads – Academies of Science				
Proportion of females, ICT company boards				
Gender pay gap: managers, professionals, technicians & associate professionals	ILO	N/A	N/A	N/A
Mean hours of work (female/male): - Managers - Professionals - Technicians/ associate professionals	ILOSTAT	73/89 (2014) 54/70 (2014) 74/84 (2014)	40/42 (2017) 33/37 (2017) 41/44 (2017)	47/57 (2014) 42/40 (2014) 42/38 (2014)
Proportion of time spent on unpaid domestic and care work (female/male)	ILO	23.7%/8.2% (2013)	N/A	N/A
Nondiscrimination clause mentions gender	WB Women, Business & the Law (WB WBL) 2018	No	Yes	Yes
Maternity leave, paid breastfeeding options at work (infant's first 6 months)	WB WBL 2018; World Policy Research Center	Paid leave – 90 days, 100% of wages; Paid breastfeeding breaks	Paid leave – 90 days, 100% of wages; Paid breastfeeding breaks	Paid leave – 84 days, 100% of wages; Paid breastfeeding breaks
Law prohibits gender discrimination in employment	WB WBL 2018	Yes	Yes	Yes
Equal pay for equal work policy	WB WBL 2018	Yes	No	No
Policy prohibiting sexual harassment in employment	WB WBL, 2018	Yes	No	Yes
Experience workplace discrimination/harassment				
Entrepreneurship				
Firms with female participation in ownership	World Bank	38%	22%	42,70%
Access to business training	OECD	N/A	N/A	N/A
Bank/mobile account ownership, 2017 (female/male)	WB Global Findex 2017	50.8%/ 46.5%	51.4%/ 46%	45%/ 55.7%
Saved at financial institution, 2017 (female/male)	WB Global Findex 2017	4.9%/ 9.8%	22.3%/ 20.7%	15.6%/ 22.7%
Borrowed from financial institution (female/male), 2017	WB Global Findex 2017	7.6%/ 7%	16.8%/ 17.6%	6.4%/ 9%
Access to venture capital	WB Global Findex 2017			
Policymaking				
Proportion of seats held by women in national parliaments	Inter Parliamentary Union	40%	20%	61%
Heads of ICT ministries/regulatory agencies (female/male)	UNU-CS desk research	1-ene.	0/2	0/2

APPENDIX B: BASIC ICT INDICATORS BY GENDER

Table B.1

Africa, Americas, Oceania: Basic ICT Access Indicator, Most Recent Year (2014–2016)

REGION	COUNTRY	Using a computer		Using the internet		Individuals using a mobile cellular telephone		Owning a mobile phone	
		F%	M%	F%	M%	F%	M%	F%	M%
Africa	Botswana			34	41			85	85
	Burundi			1	1			7	16
	Cape Verde	31	34	50	51			71	74
	Egypt	47	51	38	44	88	91	84	91
	Mauritius	48	53	50	55	80	85		
	Morocco	43	52	54	63	90	94	87	91
	Niger	1	1	1	2				
	Sudan			11	17			54	70
	Zimbabwe	11	15	15	18	69	67		
Americas	Argentina	46	48	70	72	79	79		
	Bolivia	34	39	32	37	69	72		
	Brazil	16	16	61	61	88	87	84	82
	Colombia	49	50	58	58	87	85	73	71
	Costa Rica	46	47	66	66	87	87	86	86
	Cuba	31	28	40	35				
	Ecuador			54	55			55	57
	El Salvador	25	29	26	28	78	80	78	81
	Jamaica	37	34	45	39	85	83		
	Mexico	45	49	58	61	72	76	70	73
	Panama	47	44	53	50	83	82		
	Paraguay	26	24	49	48	82	81		
	Peru			43	48				
	Puerto Rico	66	68	70	68				
	United States			75	74				
	Uruguay	62	62	64	65	78	76	80	78
Oceania	Australia			85	84				

0 - 20% | 21 - 40% | 41 - 60% | 61 - 80% | 81 - 100%

Note: Red indicates less than 50% of men/women reporting ability to perform specific digital skill.
Purple indicates more than 50% of men/ women reporting ability to perform specific digital skill.
Data source: ITU WITD Database, 2017.

Table B.2 Asia

Basic ICT Access Indicators, Most Recent Year (2014-2016)

COUNTRY	Using a computer		Using the internet		Individuals using a mobile cellular telephone		Owning a mobile phone	
	F%	M%	F%	M%	F%	M%	F%	M%
Azerbaijan			75	82			70	77
Bahrain	73	70	99	98	100	100	100	100
Bangladesh	4	7	5	8	77	85		
Brunei Darussalam	58	58	90	90			99	99
Cambodia	27	27	32	32				
Cyprus	68	72	74	78			96	97
Georgia	55	58	57	60			81	87
Hong Kong	80	83	86	89	95	97	95	97
Indonesia	16	18	24	27			52	64
Iran	40	42	52	54	72	84	65	78
Israel	72	72	79	81				
Japan	72	81	92	95	72	81		
Kazakhstan	72	76	73	76	89	90	85	86
Macao	52	57	81	83	92	92	92	93
Malaysia	67	71	77	80	96	99	93	96
Oman	78	80	67	72	81	86	73	80
Pakistan	4	11	10	15	82	88		
Palestine	55	65	48	60			65	82
Qatar	89	86	92	94	100	100	100	100
Saudi Arabia	72	68	93	94	96	99	65	86
Singapore	73	75	84	85	88	90	88	91
South Korea	72	83	91	95	99	100	88	92
Taiwan	77	79	79	80				
Thailand	33	32	47	48	81	82	79	80
Turkey	36	53	57	73				
United Arab Emirates			89	92			99	99

0 - 20%	21 - 40%	41 - 60%	61 - 80%	81 - 100%

Note: Red indicates less than 50% of men/women reporting ability to perform specific digital skill. Purple indicates more than 50% of men/women reporting ability to perform specific digital skill.
Data source: ITU WITD Database 2017

Table B.3 Europe

Basic ICT Access Indicators, Most Recent Year (2014–2016)

COUNTRY	Using a computer		Using the internet		Individuals using a mobile cellular telephone		Owning a mobile phone	
	F%	M%	F%	M%	F%	M%	F%	M%
Armenia	67	69	63	66				
Austria	80	88	81	88				
Belarus	71	72	71	71	97	95		
Belgium	83	87	85	88	97	97		
Bulgaria	56	57	59	61				
Croatia	64	72	69	77				
Czech Republic	79	81	75	78			97	97
Denmark	96	96	98	96			83	83
Estonia	87	89	87	90				
Finland	93	92	87	89			98	99
France	81	83	86	86				
Germany	86	92	81	88				
Greece	64	69	67	71				
Hungary	71	74	78	80				
Iceland	98	98	98	98				
Ireland	78	77	86	84			83	83
Italy	57	66	57	66			90	93
Latvia	78	79	79	81				
Lithuania	74	73	75	74			96	96
Luxembourg	96	98	97	99				
Macedonia	66	72	71	74				
Malta	74	76	77	77				
Moldova			67	76				
Montenegro	62	71	66	72	93	95		
Netherlands	92	92	89	93			82	86
Norway	94	96	97	97				
Poland	72	74	73	74				
Portugal	66	73	69	72				
Romania	55	60	57	62				
Russian Federation	71	71	73	74				
Serbia	65	69	65	69	91	93	90	90
Slovakia	77	78	79	82				
Slovenia	71	75	74	77				
Spain	72	76	79	83				
Sweden	90	91	89	90				
Switzerland			86	92				
Ukraine			47	52				
United Kingdom	88	92	95	95				

0 - 20% | 21 - 40% | 41 - 60% | 61 - 80% | 81 - 100%

Data source: ITU WITD Database, 2017.

APPENDIX C: INDIVIDUALS WITH ICT SKILLS, BY TYPE OF SKILLS AND GENDER

Table C.1

Individuals with ICT skills, by type of skills by gender (%): Africa, Americas, Asia

COUNTRY		Copying or moving a file or folder		Using copy and paste tools to duplicate or move information within a document		Sending e-mails with attached files		Using basic arithmetic formula in a spreadsheet		Connecting and installing new devices		Finding, down-loading, installing and configuring software		Creating electronic presenta-tions with presentation software		Transferring files between a computer and other devices	
		F%	M%	F%	M%	F%	M%	F%	M%	F%	M%	F%	M%	F%	M%	F%	M%
Africa	Egypt	15,3	11,4	10,6	7,8	5	3	2,1	1,5	1,5	1,1	1,7	0,9	0,2	0,1	3,8	2,5
	Morocco	47,9	42,2	46,4	42,1	30,6	27,3	18,9	18,5	29,1	23,9	34,2	29	17	15,2	26,5	21,2
	Zimbabwe	6,5	3,9	4,5	2,7	5,3	3,3	2,3	1,4	2,2	1,2	2,4	1,2	2,2	1,3	4,1	2,3
Americas	Brazil	26,1	22,8	22	20,4	23,2	21,4	15,6	11,1	14,2	8,6	22,4	14,9	12,2	11,1	21,5	16,6
	Colombia	40,4	39,4	37,8	37,2	37,4	37,2	26,8	27	30,9	29,6			28,4	29,2	32,7	31,9
	Jamaica	16,1	17,9	15	17,8	15,7	19,5	3,8	4	6,2	6,7	8,1	7,5	3,5	4,1	9,4	9,3
	Mexico	38	33,6			37,1	33,8	27,7	23,7	25,6	17,9	19,9	13,9	32,6	29,6		
Asia	Bahrain	88,7	69,4	63	42,9	82,6	57,9	57,7	32,7	57,6	47,3	58,3	40,2	55,9	44,6	58,2	34,6
	Brunei Darussalam	89	89	68	68	70	70	25	25	45	45	57	57	34	34	63	63
	Cyprus	49,9	49,7					19,3	23,2			50,7	44,5	23,6	27,4	44	42,2
	Georgia	44,2	43,1	44,2	43,7	33,7	31,9	15,9	15,6	27,1	21,1	22,7	18,6	13,8	15,9	30,8	28,5
	Iran (I.R.)	29,8	27,8	17,6	17,7	20,3	18,2	2,8	1,5	6,5	4,2	13,2	9,4	7,4	5,8	13,1	13,2
	Kazakhstan	27,5	24,6	14,2	12,3	44,5	43,2	32,9	32,9	13	10,7	12,1	11,3	16,3	16,3	19	16
	Korea (Rep.)					70,4	58,7	66,1	55	51,4	35,7	62,9	49,3			57,9	44,8
	Pakistan	8,1	2,9	5,9	2,1	5,5	2	2,9	1,3			4,9	2,1	2,3	1,1	3,5	1,4
	Qatar	65,7	56,1	32,9	34	59,6	52,5	36,6	27	25,3	29,4	34,9	39,7	26,9	25,8	46,8	40,1
	Singapore	57,1	51,3	52,7	49,4	61	58,6	37,8	36,5	40	33,1	46,8	38,9	38,2	34,3	49	40,7
	Turkey	50,9	34,1							43,1	28			33,2	22,2	45	29,1

0 - 20%	21 - 40%	41 - 60%	61 - 80%	81 - 100%

Note: Red – less than 50% of men/women reporting ability to perform specific digital skill. Purple – more than 50% reporting ability to perform skill.
Data Source: WITD Database, 2017.

Table C.2

Individuals with ICT skills, by type of skills by gender (%): Europe

COUNTRY	Copying or moving a file or folder		Using copy and paste tools to duplicate or move information within a document		Sending e-mails with attached files		Using basic arithmetic formula in a spreadsheet		Connecting and installing new devices		Finding, down-loading, installing and configuring software		Creating electronic presenta-tions with presentation software		Transferring files between a computer and other devices	
	F%	M%	F%	M%	F%	M%	F%	M%	F%	M%	F%	M%	F%	M%	F%	M%
Austria	71,4	60											48,1	40,2	65,8	53,5
Belgium	74,1	67,1	67,9	62,5			48,7	40,3	54,9	37,4			37,5	31,5	61,4	52,5
Bulgaria	38,8	38,1											13,5	14,4	36,9	35,7
Croatia	67	55	61,4	51,7			53,1	42,6			57,8	45	44,5	37,9	64	52,4
Czech Republic	61,7	56,3	57,4	55,3			46,1	42,6			37,4	19,4	33,9	28,9	60,8	51,9
Denmark	76,8	71,8	70,4	66,5			64,3	55,6			75,2	67,3	60	56,9	70,2	61,9
Estonia	57,4	55,5									52,3	37,7	32,5	34,9	57,3	49,1
Finland	68,6	64	67,4	71			56,1	48			69,9	57,7	46,8	44,8	68,6	64,8
France	57,3	54,7	53,4	53,2			41,7	39			50,2	39,3	35,4	34,7	60,7	57,1
Germany	72,7	63,8	65,9	58			43,6	31,7			70,2	56,2	42,7	35,5	67,9	55,6
Greece	57,7	54,6	51,8	51,8			42,8	38,7			25,3	19	28,6	24,8	52	46,9
Hungary	60,3	51,4	52,8	49,4			37,4	34,5			42,3	27,1	27,4	23,6	58,5	50,9
Iceland	75,9	69,8	78	82,4			69,1	69,1	78,9	53,2			57,1	59,3	78	69,2
Ireland	43,3	36,5	43,1	40,7			28,6	22,7			45,2	37,6	30,9	26,3	40,5	31,6
Italy	52,8	45,3	44,7	39,4			35,2	26,3			40,5	29,5	33,6	28,4	47,7	38,7
Latvia	66	63,1											20,9	26,6	63,9	59,6
Lithuania	56,3	56,1					39,1	38,3			38,7	27,6	29,1	28,6	56,3	52,6
Luxembourg	84,4	72,5					77,2	59,1	80,3	65,2					79,7	69
Malta	50,4	45					37	31,5			49,6	42,1	29	30,7	50,9	45,1
Montenegro	70,8	65									32,5	22	23,6	18,4	68,2	60,9
Netherlands	75,9	68,1	76,9	71,8			62,8	48,8			75,3	67,9	49,1	39,4	67,9	61,9
Norway	63,7	54,3	70	65,4			59,4	47,5			68,5	64,8	51,4	47,4	55,6	48,7
Poland	53	48,5					28,6	27,2			39,4	26	25,2	25,1	50,4	43,1
Portugal	52,3	45,4	50,5	44,7			38,9	32,9			37,1	27,1	34,4	34,3	47,8	41,4
Romania	63	57,8	21,7	19,6			13,2	12			21,1	16,3	13,2	11,8	62,1	57,9
Russia							20,6	24,9	11,8	6,3	4,2	1,6	7,8	9,1	30,8	27,4
Serbia	54,4	52,5					30,1	28,3					24,1	25,7	48,4	45,6
Slovakia	62,7	58,1	52,3	50,5			41,7	38,7			34,3	20,5	32,4	31,9	62,2	53,8
Slovenia	52,5	52,8	50,8	52,3			41,8	42,8			35,3	24,9	31,9	34,1	49,6	48
Spain	59,6	52,5									57,1	46,8	40	35,4	57,3	49,6
Sweden	58,7	49,9	68,8	67,9			49,4	40			70,7	65,2	34,3	34	67	59,1
Switzerland					77,7	70,3										
Macedonia	41,7	38,9	31,1	32,1			21,6	21,3			19,4	15,7	20,6	21,5	40,8	39,7
United Kingdom	66,4	59,4	63,5	60			48,5	45,6			63,8	57,5	47,1	47,3	57,4	51,5

0 - 20%	21 - 40%	41 - 60%	61 - 80%	81 - 100%

Note: Red – less than 50% of men/women reporting ability to perform specific digital skill. Purple – more than 50% of men/ women reporting ability to perform specific skill. Data source: WITD Database, 2017.

APPENDIX D: SAMPLE ILO SECTOR AND OCCUPATION CLASSIFICATIONS

International Standard Industrial Classification of All Economic Activities (ISIC), Rev.4

C – Manufacturing (23 subcategories including):
- 26 - Manufacture of computer, electronic and optical products
- 27 - Manufacture of electrical equipment
- 33 - Repair and installation of machinery and equipment
- H - Transportation and storage
- 49 - Land transport and transport via pipelines
- 50 - Water transport
- 51 - Air transport
- 52 - Warehousing and support activities for transportation
- 53 - Postal and courier activities

M - Professional, scientific and technical activities
- 69 - Legal and accounting activities
- 70 - Activities of head offices; management consultancy activities
- 71 - Architectural and engineering activities; technical testing and analysis
- 72 - Scientific research and development
- 73 - Advertising and market research
- 74 - Other professional, scientific and technical activities
- 75 - Veterinary activities

J - Information and communication
- 58 - Publishing activities
- 59 - Motion picture, video and television programme production, sound recording and music publishing activities
- 60 - Programming and broadcasting activities
- 61 - Telecommunications
- 62 - Computer programming, consultancy and related activities
- 63 - Information service activities

R - Arts, entertainment and recreation
- 90 - Creative, arts and entertainment activities
- 91 - Libraries, archives, museums and other cultural activities
- 92 - Gambling and betting activities
- 93 - Sports activities and amusement and recreation activities

S - Other service activities
- 94 - Activities of membership organizations
- 95 - Repair of computers and personal and household goods
- 96 - Other personal service activities

International Standard Classification of Occupations (ISCO 08), major & sub-major groups

1 Managers
- 11 - Chief Executives, Senior Officials & Legislators
- 12 - Administrative & Commercial Managers
- 13 - Production & Specialized Services Managers
- 14 - Hospitality, Retail and Other Services Managers

2 Professionals
- 21 - Science and Engineering Professionals
- 22 - Health Professionals
- 23 - Teaching Professionals
- 24 - Business and Administration Professionals
- 25 - Information and Communications Technology Professionals
- 26 - Legal, Social and Cultural Professionals

3 Technicians and Associate Professionals
- 31 - Science and Engineering Associate Professionals
- 32 - Health Associate Professionals
- 33 - Business and Administration Associate Professionals
- 34 - Legal, Social, Cultural and Related Associate Professionals
- 35 - Information and Communications Technicians

4 Clerical Support Workers
- 41 - General and Keyboard Clerks
- 42 - Customer Services Clerks
- 43 - Numerical and Material Recording Clerks

5 Services and Sales Workers
- 51 - Personal Services Workers
- 52 - Sales Workers
- 53 - Personal Care Workers
- 54 - Protective Services Workers

6 Skilled Agricultural, Forestry and Fishery Workers
- 61 - Market-oriented Skilled Agricultural Workers
- 62 - Market-oriented Skilled Forestry, Fishery and Hunting Workers

7 Craft and Related Trades Workers
- 72 - Metal, Machinery and Related Trades Workers
- 73 - Handicraft and Printing Workers
- 74 - Electrical and Electronic Trades Workers

8 Plant and Machine Operators and Assemblers
- 81 - Stationary Plant and Machine Operators
- 82 - Assemblers
- 83- Drivers and Mobile Plant Operators

9 Elementary Occupations

10 Armed Forces Occupations

Source: https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27