9. Digitalisation and the future of work: a thematic focus

Recent decades have seen digitalisation transform socioeconomic and political realities. Alongside the integration of digital technologies, the world of work has changed – creating both opportunities and risks for gender equality. However, academic, public and policy debates on the digital future of work have often adopted gender-neutral perspectives that fail to address the central role of digitalisation in transforming gender relations in positive and negative ways (Scheele, 2005).

The EU digital strategy, 'Shaping Europe's digital future', presents a vision of digital transition that works for all, 'putting people first and opening new opportunities for business'.[1] The European Commission's Gender Equality Strategy 2020-2025 observes that integration of a gender perspective in this area is 'essential to reach the goal of gender equality' (p. 10 & 15). While a number of positive policy developments can be noted, major challenges remain to enhance gender equality in the digital world of work.

In 2019, EU countries committed to boosting participation of women in digital and technology sectors through the Ministerial Declaration of commitment on Women in Digital (WiD), with a strong focus on improving the representation of women in certain high-skilled, well-paid activities (notably Science, Technology, Engineering and Mathematics – STEM). While the WiD foresees systematic monitoring of progress, the mainstreaming of gender equality into other aspects of digitalisation is less developed. For example, policy literature has little to say about the implications of new platform work opportunities for gender equality (for an exception, see (European Commission, 2018e)). The WiD coverage of gender equality issues linked to digitalisation is also limited, often due to poor availability and quality of gender-disaggregated data (for additional suggestions of indicators to monitor, see Annex 5).

The limited treatment of equality issues in digital policy contrasts with feminist scholars' long-standing interest in this topic. Since the 1970s, feminist research has criticised the gender biases of scientific thought as dominated by the perspectives and interests of Western middle-class white men (Harding, 1986, 1991; Keller & Longino, 1996). The gendered, racial and class-based division of labour was associated with the prevailing gender-blind technological practices (Cockburn & Ormrod, 1993). The scope and understanding of the debate on gender and technology later expanded, with influential thinkers identifying the potential for transforming bodies beyond biological boundaries and transcending gender inequalities through the use of digital technologies (Haraway, 1984; Simians, 1991; Wajcman, 2004, 2015). At the same time, however, a number of studies of digital discourse of race and gender showed the persistence - and even emergence - of new forms of racist and sexist stereotyping online (Nakamura, 2013).

This research has highlighted links between gender, technology and the labour market, focusing on the different ways in which technology has substituted or transformed the work of women and men. Various forms of gender segregation have been identified, including vertical,

[1] Quoted from https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/shaping-europe-digital-future_en

horizontal and contractual segregation (e.g. in part-time or temporary work) (Rubery & Fagan, 1993). Further research built on this evidence and analysed how new kinds of technology-enabled work, such as telework or platform work, have reproduced or changed dominant patterns of gender segregation and inequality (Freeman, 2010; Mirchandani, 2010; Overseas Development Institute, 2019).

This thematic focus takes stock (briefly) of the research on the positive and negative consequences of digitalisation for gender equality in the world of work, particularly those consequences that are not (fully) addressed in the EU policy framework. It shows that digitalisation of work is likely to have profound implications for future progress towards gender equality across all Index domains, especially Work, Money and Knowledge. It concludes with several broad policy and research recommendations on promoting gender equality in the context of future digitalisation.

In addition, the report explores the gendered consequences of digitalisation for groups facing additional disadvantages, such as women with disabilities or women from migrant and ethnic backgrounds. It also reflects on variations in the impact of digitalisation across Member States. Finally, it explores how the COVID-19 crisis (ongoing at the time of writing) may affect the trends analysed here. The scope of this analysis is limited by: 1) data gaps - for some issues (e.g. platform work or the COVID-19 crisis), even basic gender disaggregated data is often missing; and 2) the brief, exploratory nature of the report that allows limited attention to detail.

The thematic focus is structured into three chapters. The first chapter provides a gender perspective on the use and development of digital technologies, exploring how women and men use technologies, gendered patterns in the development of digital skills, and the composition of the workforce driving technological change. The second chapter looks at the implications of the digital transformation of the labour market for gender equality. It analyses the prospects for women and men as new technologies replace or complement labour, increase work flexibility, and enable new forms of work, such as platform work. The final chapter discusses three broad technological developments to illustrate how these can affect gender equality: the increasing use of artificial intelligence (AI) algorithms, the emerging phenomenon of cyber violence, and the ways in which new technologies transform the world of care.

9.1 Who uses and develops digital technologies?

The spread of technology is having a colossal impact on the labour market and the types of skills needed in the economy and society (European Commision, 2019c). The creation of a Digital Single Market (DSM) has been a key EU policy since 2015. It aims to support an inclusive digital society, which requires the integration of information and communications technology (ICT) learning and skills acquisition across different sectors in order to provide women and men of all ages with opportunities to advance. The European Commission's Digital Skills and Jobs Coalition initiative promotes this objective by bringing together local and national authorities, educational and ICT companies, consumers and social partners, who collaborate to reduce digital skill gaps in civic participation, the labour market and education (European Commision, 2016a).

A study undertaken on behalf of the Commission, however, found that gender mainstreaming is not well-developed in DSM policies and substantial discrepancies persist between different EU Member States, depending (primarily) on national policy and legislation (European Commision, 2016a). The

Women in Digital (WiD) Scoreboard[2] is one of the actions put in place by the Commission to assess women's inclusion in digital jobs, careers and entrepreneurship. According to the Scoreboard, even in those Member States where gender mainstreaming is more advanced, 'stereotypes and preconceptions' continue to pose obstacles for women and girls (European Commision, 2019i). These findings confirm that gender inequalities continue to prevent women from reaching their full potential and hinder EU societies from taking full advantage of women's digital potential and current contributions (European Commision, 2018h).

The new College of Commissioners made a strong commitment to invest in digital skills and address the widening skills gap in its forthcoming Digital Education Action Plan and new Skills Agenda for Europe. A Communication on the Future of Research and Innovation and the European Research Area will look at how the EU can better pool resources, as well as deepen research, innovation and knowledge capacity in the digital age.

This chapter highlights numerous gender inequalities in the use and creation of technologies and digital skills. It is structured in three sections: the first focuses on gender patterns in the use of new technologies and reveals gender differences in confidence and concerns about technologies; the second looks at gender differences in digital skill levels and types; and the third presents some insights into control of the invention, design, evaluation, development, commercialisation and dissemination of digital services and goods.

9.1.1 Gendered patterns in use of new technologies

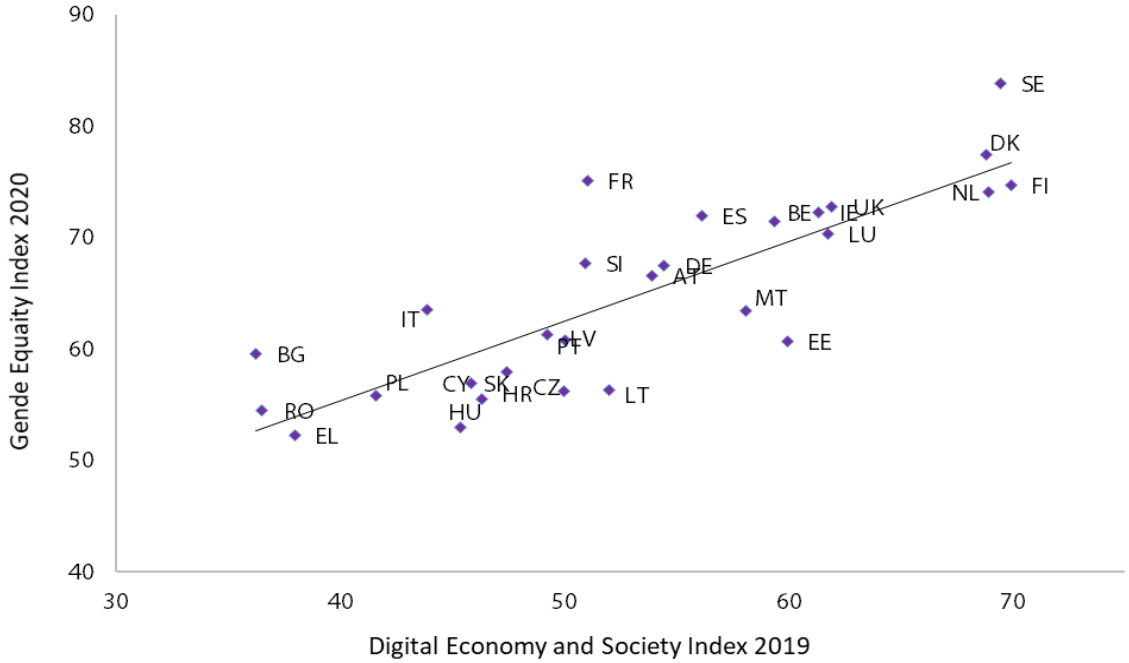
Technology can be perceived as gendered in many ways. For example, if the relationship between gender and technology is viewed as mutually constitutive: technological change is shaped and structured according to societal norms and relations, which are in turn influenced by technological transformations. On the one hand, this means that the types of technologies used in different historical, political and cultural contexts, their design and meaning are created within gender relations and thus reflect pre-existing gender inequalities. On the other hand, by offering different tools and methodologies for work, entertainment and care, technologies themselves shape those gender relations.

Digital transformation and technological innovation represent opportunities and challenges across Member States in relation to economic growth, productivity and employment (see section 9.2). The digital performance of the EU is measured by the Digital Economy and Society Index (DESI), which brings together a set of relevant indicators on Europe's current digital policies[3]. The correlation between the Gender Equality Index and DESI shows that societies with greater equality between women and men also perform better in the area of digital economy (Figure 1), which is vital for sustainable economic growth.

[2] Women in Digital (WiD) Scoreboard is a composite indicator combining 13 indicators under three dimensions: 1) internet use, 2) internet user skills, and 3) specialist skills and employment (https://ec.europa.eu/digital-single-market/en/women-digital-scoreboard).

[3] It captures five dimensions: connectivity; human capital and digital skills; use of Internet services by citizens; integration of digital technology by businesses; and digital public services. More information available at: https://ec.europa.eu/digital-single-market/en/desi.

Figure 1: Relationship between the Gender Equality Index and Digital Economy and Society Index (DESI)



Source: European Commission, Digital Economy and Society Index (DESI)

The best performing Member States in the Digital Economy and Society Index are Finland, Sweden, the Netherlands and Denmark, which are also among the Member States with the highest scores on the Gender Equality Index. The strong relationship between DESI and the Gender Equality Index suggests that digital performance can be improved while tackling the digital gender divide (e.g. gender gaps in access to and use of digital technologies, in digital-related education, in entrepreneurship, in ICT). Thus, advancements in the digital transformation can go hand-in-hand with advancements in gender equality.

Is confidence in technology gendered?

Gender analysis of the use of technology reveals a historically unequal power relationship between women and men. Differences in access to economic resources and knowledge, together with gender norms and perceptions of technology, can sideline women from technological developments.

Historically, women have provided a substantial contribution to technological innovation as programmers or computer scientists. Yet the role of those women in influencing computer history is often invisible and unrecognised. Presenting the field as overwhelmingly dominated by men creates a false and unfounded impression of ICT inferiority among women (Hicks, 2017). A literature review of gender differences in technology use shows women to be more anxious than men about IT use, reducing their self-effectiveness and increasing perceptions of IT requiring greater effort (Goswami & Dutta, 2015). 'Imposter syndrome' - or a fear of failure - has a real impact on women, with men's reactions to women's discomfort with technology is often mocking or dismissive, making many women more reluctant to engage (Tedesco, 2019).

Self-efficacy in the use of digital technologies is considered a key motivational construct underpinning their use (Rohatgi, Scherer, & Hatlevik, 2016). Women and men tend to differ in their levels of self-confidence in their capacity to acquire and use digital skills. EIGE research into

opportunities and risks of digitalisation for young people (EIGE, 2019b) shows that while digital skills and access to digital technologies is becoming less of an issue for young Europeans, boys consistently express higher self-confidence across a range of skills in relation to the use of digital technologies. In fact, boys tend to overestimate their performance and abilities, while girls underestimate both. This reflects the influence of wider gender norms on perceptions of technological self-efficacy (Huffman, Whetten, & Huffman, 2013).

The Eurobarometer (460) survey presenting European citizens' opinions on the impact of digitalisation and automation on daily life reveals that women are somewhat more concerned about, and have more negative perceptions of, digital technologies (European Commision, 2018h). For example, men are more likely to think newer digital technologies have had a positive impact on the economy (78 % vs. 72 % of women), or their quality of life (70 % vs. 63 %). Only one in two women (54 %) has positive views about robots and AI, compared to 67 % of men. Women also tend to be less informed than men about new technologies, which may contribute to their greater mistrust of them. In the case of AI, 41 % of women have heard, read or seen something about it in the last year, compared to 53 % of men. A gender gap also exists for other technological topics (European Commision, 2018h).

Explicit and implicit gender biases embedded in digital services and products have been researched in recent years, particularly in the area of software development (Wang and Redmiles, 2019). Research has shown that the needs of users whose characteristics match those of the designers (gender, age, dis/ability) tend to be best served by the software (Burnett et al., 2018). Three main types of biases were identified: bias in understanding who the user is and what their use might be; bias in the data used to enable the software, which can then deliver incorrect or biased suggestions for the user; and bias in the design of the product, making it unappealing or impractical for certain categories of users (Vorvoreanu et al., 2019). Gender biases have received attention, for example in relation to 'tracking and datafication of the body and daily activities, such as running, sleeping, walking and eating' (Søndergaard & Hansen, 2017) or to the Internet of Things (IoT)[4].

Multiple research findings suggest that exclusivity in the design of digital technologies and lack of testing on women contribute to women's reduced confidence in technologies. For example, extensive studies examined gender-based differences in the motion sickness experienced with virtual reality (VR) exposure. A recent study demonstrates that inter-pupillary distance contributed to motion sickness among women, as VR headsets were simply not designed for female physiology (Stanney, Fidopiastis, & Foster, 2020).

Growing connectivity does not reach everyone

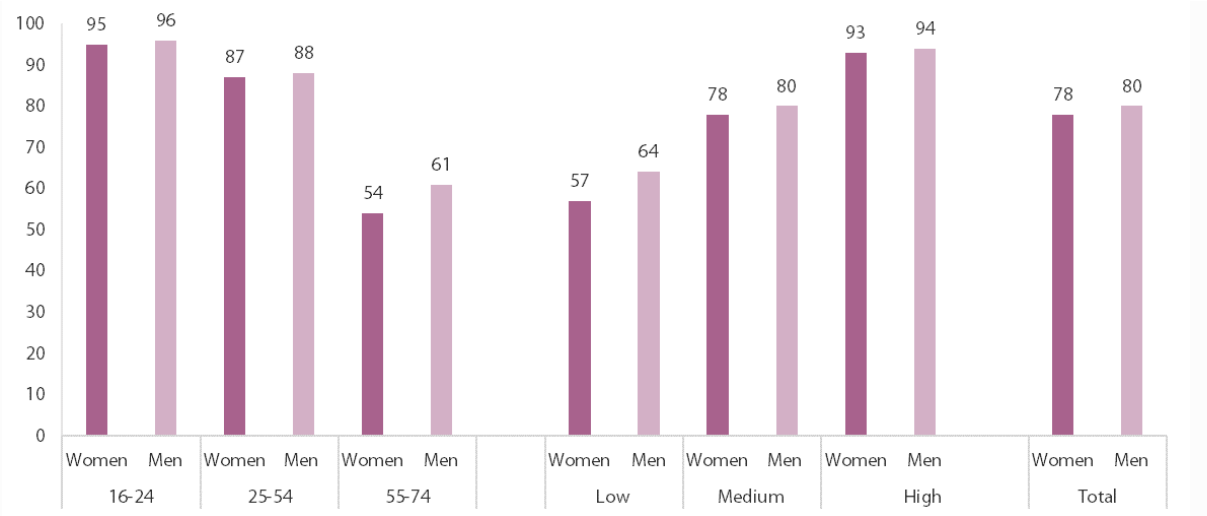
The ownership and use of digital technologies has substantial potential for economic empowerment of women and gender equality. Access to the internet, ownership of and access to digital devices can offer additional employment opportunities, income and knowledge. They can alleviate caring burdens and help with basic tasks, such as shopping for goods or services or banking online. However, the unprecedented growth in connectivity and use of the internet are not enjoyed equally. Certain

[4] Referring to everyday objects that are digitally enhanced, connected to the internet and collect use/user data.

groups of women, in particular, have unequal access to connectivity and digital technologies, contributing to the digital gender divide (OECD, 2018b).

EU-wide data shows that women fare more or less equally with men online: 78 % of women and 80 % of men use the internet daily (an increase from 49 % of women and 57 % of men in 2010). However, older women and women with lower education lag behind (Figure 2). In addition, 25 % of women aged 55-74 and 27 % of low-educated women never had the chance to use the internet, compared to 21 % of men aged 55-74 and 21 % of low-educated men[5]. Although these numbers have declined since 2010, equal connectivity continues to need attention.

Figure 2: Share of people who use the internet daily in the EU, by sex, age, and education level, (16-74, %, 2019)



Source: Eurostat, ISOC (isoc_ci_ifp_fu)

In a number of EU Member States, groups of women who most need opportunities for economic empowerment are nevertheless most cut off from those opportunities. The biggest gender gaps among daily internet users (to the detriment of women) are found in Austria (8 percentage points (p.p.)), Croatia (7 p.p.) and Luxembourg (6 p.p.). Older women (55-74) are particularly disadvantaged in Austria (gender gap - 20 p.p.), Luxembourg (13 p.p.) and Germany (12 p.p.). Women with lower education are clearly lagging behind in Austria (28 p.p.), Czechia (26 p.p.) and Croatia (20 p.p.).

Similar gender differences are observed in mobile connectivity, which is spreading quickly but not always equally (Yang, Lin, Huang, & Chang, 2018). In 2019, 74 % of women and 76 % of men had mobile internet access[6]. This is a substantial increase since 2012, when only 31 % of women and 40 % of men accessed the internet away from home or work.

The gender difference among older people (55-74) with mobile internet access is slightly higher (50 % of women and 54 % of men), although there are significant differences between countries. Older women in Denmark, the Netherlands and Sweden have the best access to mobile internet (around

[5] Eurostat, Individuals - internet use [isoc_ci_ifp_iu].

[6] Individuals who used a portable computer or handheld device to access the internet away from home or work. Eurostat, Individuals – places of internet use [isoc_ci_ifp_pu].

80 %) compared to women in Greece, Italy, Poland or Portugal (slightly above 20 %), but the gender gaps are greatest in Austria (14 p.p.), Greece (8 p.p.) and Luxembourg (8 p.p.).

Gender gaps in the use of mobile technologies have qualitative dimensions as well. For example, Yang et al. (2018) found that adolescent women (aged 16-20) exhibit significantly higher degrees of smartphone dependence and influence compared to adolescent men, who depend more on computers and videogame devices. EIGE research on youth and digitalisation shows that young women aged 16-24 are more likely than men to use technologies creatively for sharing online (EIGE, 2019b). For instance, they are more likely than young men to share self-created content (text, photos, music, videos, software, etc.) on websites (60 % vs. 56 %). This gender gap in favour of young women decreases with age (50 % for young women aged 25-29 compared to 48 % young men)[7]. The literature suggests that this could be linked to self-presentation behaviour, such as posting 'selfies', with increased expectations for young women to maintain an online presence displaying 'appropriate femininity' (Bailey & Steeves, 2015).

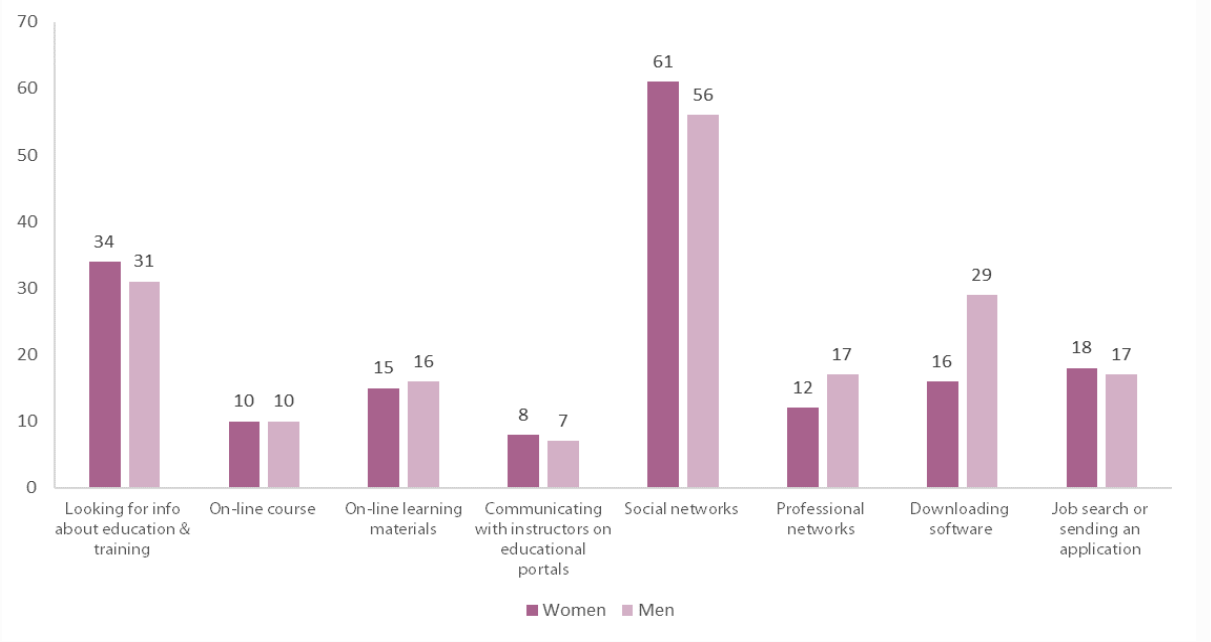
Numerous sources suggest that the quarantine measures and self-isolation policies associated with the COVID-19 pandemic have increased internet usage by 50-70 %. Women and girls are using the internet with greater frequency during the pandemic. Although many more women turned to the internet for work, school, services or social activities, ICT also facilitated the spread of gender-based abusive online material, where women and girls are over-represented. This may, in turn, restrict or alter women's use of the internet and access to services online. Research shows that women tend to restrict their engagement online for fear of cyber-aggression, sexualised cyber-bullying, gossip and hateful comments (EIGE, 2019b). The broader consequences of gender-based violence enabled by technology is discussed in section 9.3.2.

Online activities for professional empowerment: a narrowing gender gap?

Women and men alike go to the internet for a wide variety of activities. Men are slightly more likely to participate in professional networks, download software and look for online learning materials. Women outpace men in social networking and searches for information about education and training (Figure 3). Although - generally - women are quickly catching up with men in internet use, this progress is uneven across the Member States. The proportion of women engaged in online activities on a daily basis ranges from 95 % in Sweden to 66 % in Bulgaria.

Figure 3: Percentage of people engaged in online activities in the last three months for private purposes in the EU, by sex, (16-74, %)

[7] Eurostat, ISOC (isoc_ci_ac_i).



Source: Eurostat, ISOC (isoc_ci_ac_i)

Note: 2019 data is used for all activities except participation in professional networks (2017 data), downloading software (2015 data) and looking for information on education and training (2015 data).

Use of the internet for learning purposes reveals small gender gaps. Overall, women are slightly more engaged in e-learning activities for professional development, particularly looking for information about education, training or course offers. Overall, the highest women's engagement in various e-learning activities is found in Sweden, Finland, Estonia and UK, while the lowest is in Bulgaria and Romania. The highest increase in women's uptake of learning opportunities since 2015 is observed in Sweden, Malta and Ireland. For more on training activities to improve digital skills, see section 9.1.2.

Women and men were equally engaged in looking for a job or sending a job application in the three months preceding the 2019 survey (18 % and 17 %, respectively) (Figure 3). This online activity is most prevalent in Denmark (37 %), Finland (32 %) and Sweden (30 %). Using the internet for job searches is most underused by women in Romania, Czechia and Bulgaria. Women outnumber men in using the internet for job searches in Sweden, Malta, Slovakia, Croatia and France.

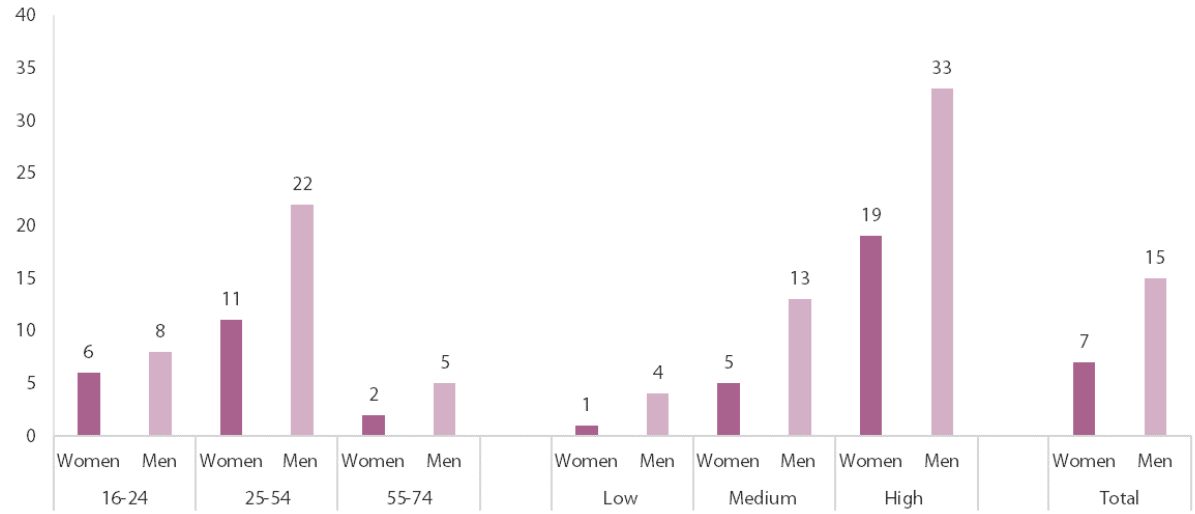
Participation in online professional networks (LinkedIn, Xing, etc.) reveals a larger gender gap (12 % of women compared to 17 % of men) and an overall increase in engagement since 2011 (from 6 % of women and 9 % of men). Women's participation ranges from 29 % in the Netherlands and 27 % in Denmark to as low as 2 % in Bulgaria and 3 % in Czechia, Romania and Slovakia. The biggest gender gaps are found in the Netherlands (9 p.p.), Sweden (8 p.p.), Luxembourg and Denmark (6 p.p. each). Since 2017, the biggest uptake of professional networks among women has been observed in the UK, Poland, Austria and the Netherlands. As of April 2020, 43 % of LinkedIn users were women and 57 % were men[8].

Data on users of mobile internet for professional purposes (via portable computer or handhold device) shows substantial gender differences. In 2012, twice as many men as women aged 25-54 (22 % and 11 %, respectively) used mobile internet for professional purposes (Figure 4). The gender

[8] https://www.statista.com/statistics/933964/distribution-of-users-on-linkedin-worldwide-gender/

gap increased with the level of education (Figure 4). In addition, highly educated men used mobile internet for professional purposes nearly twice as often as highly educated women (33 % and 19 %, respectively).

Figure 4: Percentage of people using mobile internet for professional purposes in the EU, by sex, age and education level (16-74, %, 2012)



Source: Eurostat, ISOC (isoc_cimobi_purp)

Using digital technologies for professional purposes is an important prerequisite for successful integration into the digitalised economy and more advanced forms of IT work. Overall in the EU, women are behind men in the use of various ICT technologies at work (see section 9.2). The COVID-19 crisis may well have brought substantial changes to online activity and the use of mobile internet for professional purposes by both women and men, especially parents with children under 12, and those changes remain to be assessed.

9.1.2 Digital skills and training

Digital skills have increasingly become a basis for global competitiveness, boosting jobs and growth. Digital societies require digital competencies if they are to ensure full participation of people in social and working life. The internet has been of paramount importance in working towards high-quality education at all levels, while the COVID-19 crisis has shown that most jobs can be done remotely using technology. The crisis has caused education and training to be moved online or digitalised, placing the digital skills and competence of learners and teachers/trainers front-and-centre when it comes to engaging in learning at all levels.

Building on the various concepts used to define digital skills (Kaarakainen, Kivinen, & Kaarakainen, 2017) and the EU Digital Scoreboard, the analysis looks at gender differences in information,

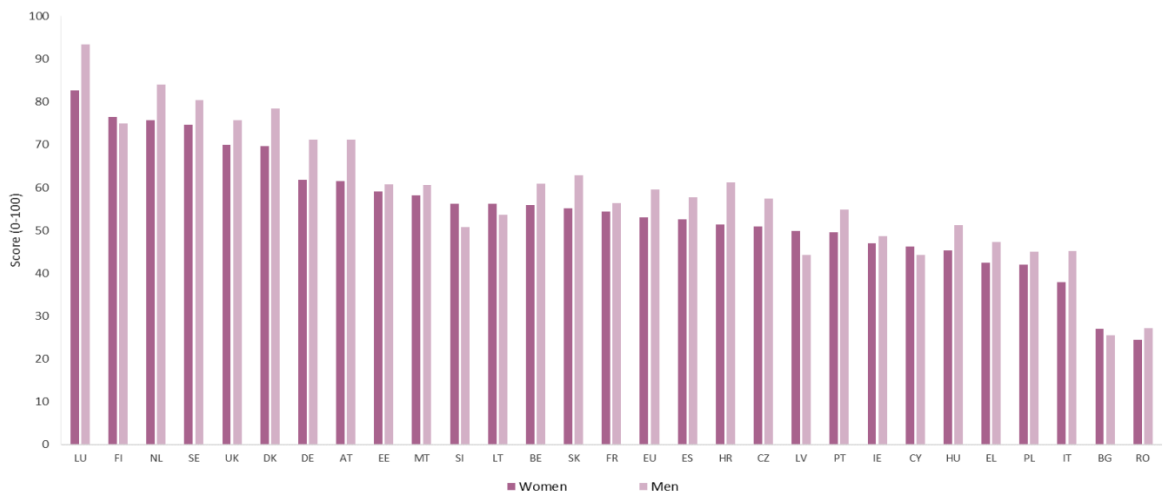
communication, problem-solving and software skills[9] and in training opportunities to advance those skills.

Advanced digital skills of women and gender equality go hand-in-hand

The Women in Digital (WiD) Scoreboard monitors women's participation in the digital economy. Its second dimension looks at women's internet use skills, as measured by three indicators - at least basic digital skills, above basic digital skills and software skills (Figure 5). Luxembourg, Finland, the Netherlands and Sweden have the highest scores in internet user skills, while Romania, Bulgaria, Italy and Poland score lowest. Only six Member States (FI, SI, LT, LV, CY, BG) show women scoring higher than men on internet user skills. The highest gender gaps (to women's disadvantage) are in Luxembourg, Austria, and Croatia.

The correlation between the Gender Equality Index and internet user skills suggests that these two areas reinforce one another. Women's internet skills are highest in Luxembourg, which ranks 10th on the Gender Equality Index, while Finland, the Netherlands, Sweden, the UK and Denmark are in the top ranks on both indices.

Figure 5: Internet user skills by sex, (scores, 2017)



Source: European Commission, Women in Digital (WiD) Scoreboard, dimension 2 (European Commision, 2019h). Scores for men based on EIGE calculation.

Note: WiD dimension 2 - internet user skills is calculated as the weighted average of the three indicators: 2.1 At least basic digital skills (33.3 %), 2.2 Above basic digital skills (33.3 %), 2.3 At least basic software skills (33.3 %).

Gender divide in digital skills is widening with age

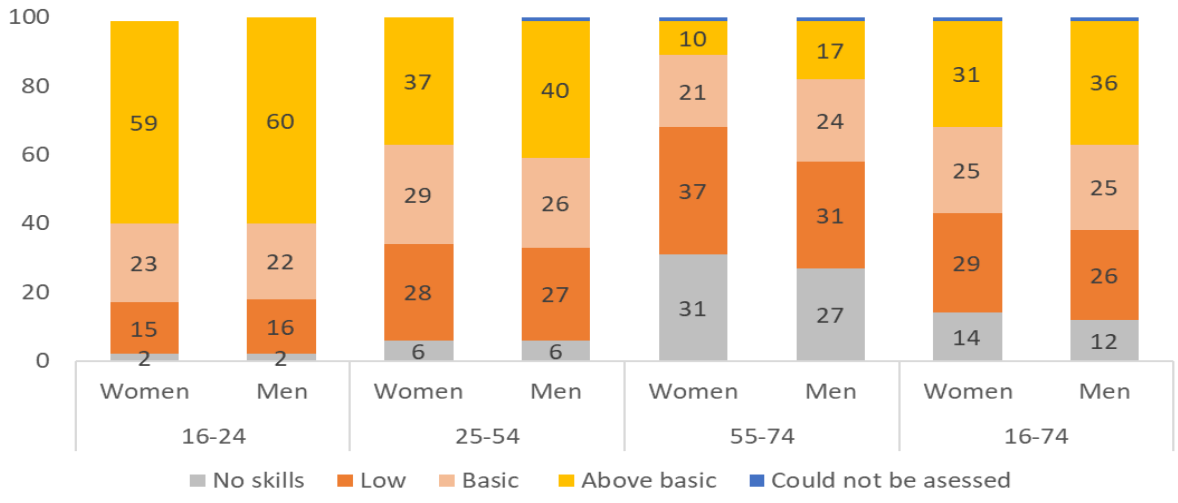
[9] Digital skills indicators are based on selected activities related to internet or software use performed by people in four specific domains (information, communication, problem-solving, software skills). It is assumed that individuals having performed certain activities have the corresponding skills. Therefore, the indicators can be considered a proxy for the digital competences and skills of individuals. According to the variety or complexity of activities performed, two levels of skills are computed for each of the four dimensions – 'basic' and 'above basic'.
Individuals with 'above basic' skills display them across all four dimensions; individuals with a 'basic' level of skills have at least one 'basic' skill level across the four dimensions. See Annex 4 for more information.

Given the likely future of jobs, it is important to distinguish between basic and advanced digital skills[10]. While basic digital skills, such as the use of search engines or digital bank services, are necessary, advanced digital skills open opportunities for access to well-paid jobs for which there is a significant demand in the European digital economy. Both types of skill are increasingly essential in the labour market. As noted by the OECD (2018a), workers who are successful in penetrating competitive labour markets typically have a mix of basic and advanced digital skills.

Within the EU, men often have more advantages than women when it comes to the digital skills (information, communication, problem-solving and software skills) necessary to thrive in the digitalised world of work. This is particularly evident among older people (aged 55+). Finland, the Netherlands, Denmark, the UK and Sweden all have the highest share of women with above basic digital skills, while Greece, Poland, Italy, Bulgaria and Romania have the lowest shares. The correlation between Gender Equality Index scores (domain of work, sub-domain of participation, domain of money) and the share of women with above-basic skills confirms that countries with high shares of digitally skilled women also have higher gender equality in the labour market.

Young women and men are the most digitally skilled generation and benefit equally from basic and above basic digital skills - 59 % of women and 60 % of men aged 16-24 hold above basic digital skills (Figure 6). Finland, Malta and Croatia have the highest shares of young women with above basic digital skills, while Italy, Bulgaria and Romania have the lowest share. However, at a later age, the gender divide widens, with most older people having low to basic digital skills. Finland, Denmark and Sweden have the highest shares of digitally skilled women aged 55-74, while Greece, Bulgaria and Romania have the lowest share. Aside from generational and country differences, women generally experience bigger obstacles in trying to improve their digital skills, due to factors such as gender stereotypes, family status, and the broader societal, economic and technological environment (OECD, 2018a).

Figure 6: Levels of digital skills of individuals in the EU, by sex and age group (%, 2019)



Source: Eurostat, ISOC (isoc_sk_dskl_i)
Note: Digital skills are measured in relation to performed activities across four domains of digital competence: information, communication, problem-solving and software skills. Individuals with 'above basic' skills display them across all four domains; individuals with a 'basic' level have at least one 'basic' levels of skills across four domains; individuals with 'low'

[10] See annex 4.

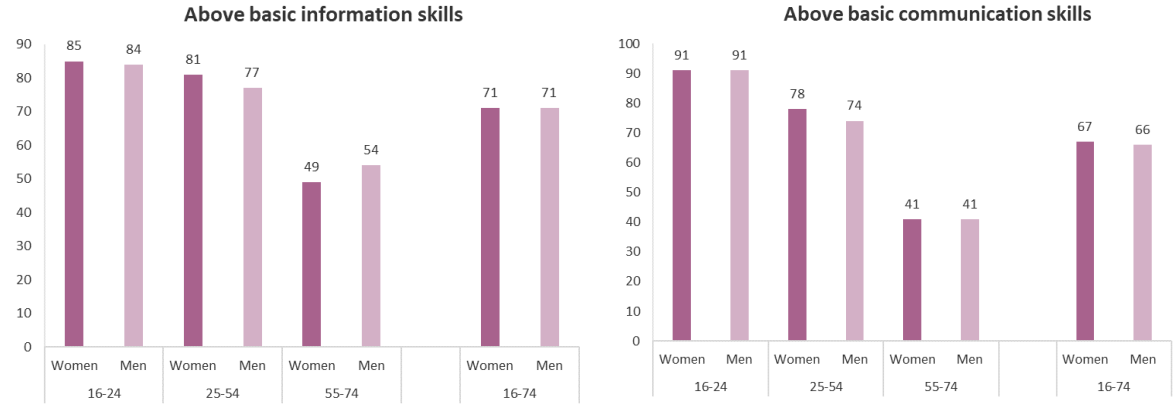
level of skills miss some type of basic skills, i.e. have from one to three 'no skills' across the four domains; individuals with 'no skills' did not perform any activities across all four domains, despite declaring having used the internet at least once during the last three months; digital skills could not be assessed for those who had not used the internet in the last three months. Here, EIGE used numerical data rounded to zero decimals by Eurostat, thus percentages might not add up to 100 %.

The digital skills of young people are improving quickly, with a somewhat faster pace observed for men than for women. Between 2015 and 2019, the share of women aged 16-24 with above basic digital skills increased by 7 p.p., compared to 9 p.p. for men, with no substantial gender gap observed during this period. Greece, Cyprus and Ireland made the greatest progress in four years, while the share of young women with above basic digital skills declined in Luxembourg, Denmark and Bulgaria. Across the EU, the gender gap decreased among those aged 25-54 (-4 p.p. in 2015, -3 p.p. in 2019). Cyprus, Austria, and Ireland progressed most, while Luxembourg, Latvia and Denmark showed least progress during this period. Among older people (aged 55+), progress was slower and older people still remain least digitally skilled, with a gender gap around -7 p.p. in 2019 (compared to-6 p.p. in 2015)[11].

In addition to gender differences in levels of digital skill in some age groups, women and men also acquire different types of digital skills (see section 9.1.1). The gender gap in overall digital skills is primarily associated with problem-solving digital skills[12], to the detriment of women. More men than women have above basic digital skills in problem-solving and software skills, with a smaller gap evident in information and communications skills. The Council Recommendation on Upskilling Pathways: New Opportunities for Adults seeks to improve low-qualified adults' access to basic skills, including basic digital skills (European Commission, 2016).

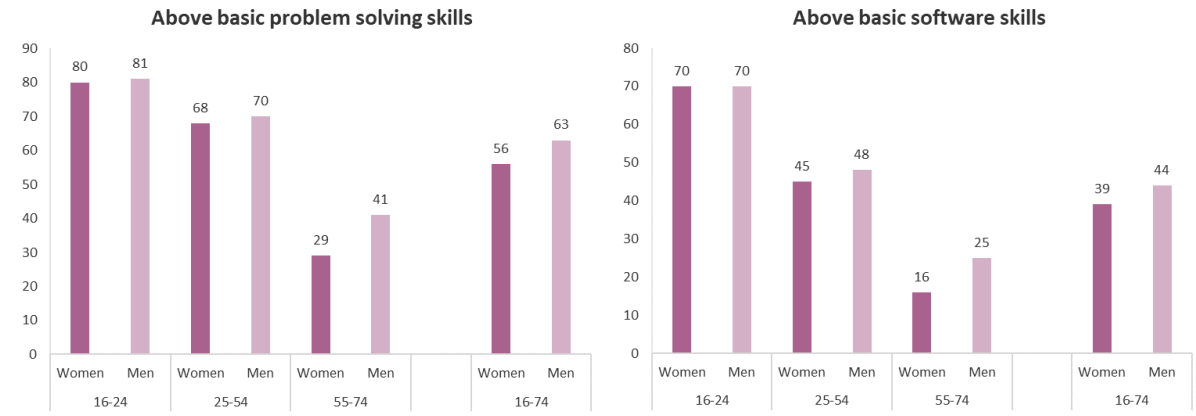
Differences are also relevant across age groups (Figure 7). Women aged 25-54 have higher information and communication skills than men, while the opposite is true for problem-solving and software skills. Older men outperform older women (aged 55+) on all dimensions except communications skills. There are almost no gender gaps among the younger generation, suggesting the importance of levelling digital problem-solving and software skills among women and men in older age groups in order to close the gender gap in overall digital skills (EIGE, 2019b).

Figure 7: Percentage of people with above basic digital skills in the EU, by type of skill, gender and age group (16-74, %, 2019)



[11] Eurostat, ISOC (isoc_sk_dskl_i).

[12] For example, making informed decisions on the most appropriate digital tools, solving conceptual and technical problems, updating own and others' competences.



Source: Eurostat, ISOC (isoc_sk_dskl_i)

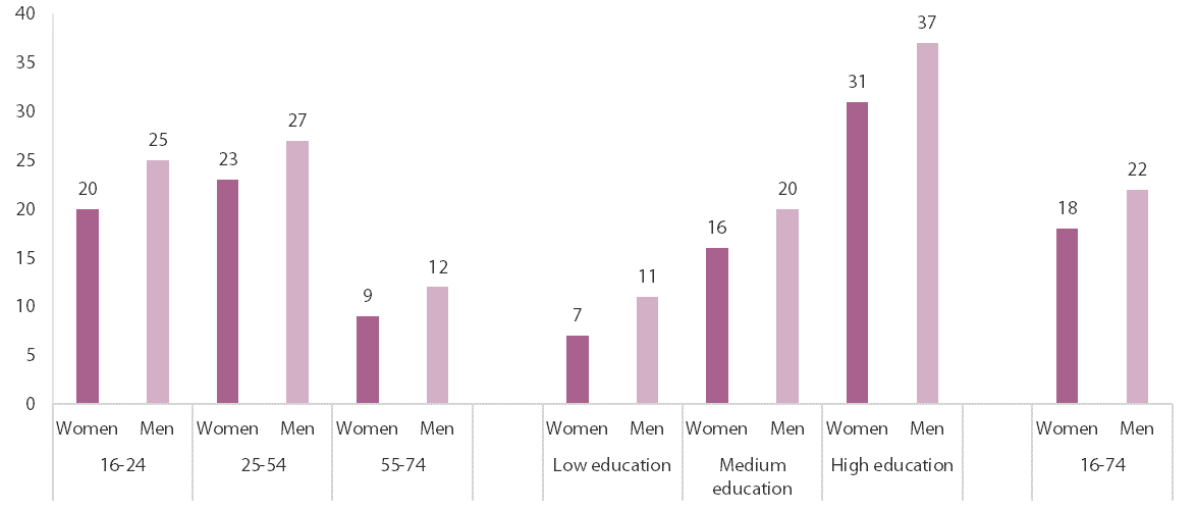
The digital skills of both women and men increase with education. Gender differences in all types of digital skills are largest among those with low education, particularly women. Across all levels of education, women have fallen behind in problem-solving and software skills.

Broader gender inequalities limit women's training opportunities

Given the extent to which digital innovations are progressing, workers must adapt by undertaking ongoing training to improve their digital skills, depending on their sector and specific tasks. It is also important to ensure that people entering the labour market have the necessary skills, meaning that education systems play a crucial role. While age influences participation in both basic and advanced skill enhancement activities, gender inequality tends to have a negative impact, especially in relation to lifelong learning and re-skilling or upskilling. Negative gender stereotyping often deters women from selecting ICT-related training. Even where women have access to advanced training opportunities through their existing professional networks, the burden of unpaid care or domestic responsibilities may prevent them from availing of these opportunities (EIGE, 2018a, 2018b).

In 2018, around one in five people (18 % of women compared to 22 % men) carried out at least one training activity in the last 12 months to improve skills relating to the use of computers, software or applications (Figure 8). Finland, Denmark and the Netherlands had the highest share of women who carried out at least one such training activity, while Greece, Italy, Hungary, Croatia and Cyprus had the lowest share. Men participated in training more often than women, in all age groups and across different levels of education. Women with higher education aged 25-54 were involved in training to increase their digital skills more often than other women.

Figure 8: Share of people who carried out at least one training activity to improve computer, software or application skills, by sex, age, and education level (16-74, %, 2018), EU



Source: Eurostat, ISOC (isoc_sk_how_i)

Although most women and men (62 % and 67 %, respectively) consider themselves sufficiently skilled with digital technologies to benefit from digital and online learning opportunities (European Commision, 2017), a range of barriers can put participation in training out of reach. For both women and men, lack of time is the most relevant barrier, usually due to work schedules, caring responsibilities and household duties. Although women aged 25-64 are more likely to participate in lifelong learning than men (12 % and 10 %, respectively), on average, 40 % of women - compared to 24 % of men of the same age - report that they cannot participate in in lifelong learning due to family responsibilities (in Cyprus, Malta Greece, Austria and Spain more than 50 % of women identified this reason)[13]. Work schedule conflicts are bigger barriers for men in most EU countries (EIGE, 2019c). Finally, around one in four Europeans perceive the lack of training opportunities as an obstacle to increasing their digital skills, highlighting awareness of the importance of digital skills' training. A similar proportion do not know what specific skills to improve (European Commision, 2020a).

9.1.3 Men dominate technology development

Gender differences in digital skills and use of digital devices are gradually levelling out, particularly among young people. However, the lack of gender diversity in the workforce likely to invent, design, evaluate, develop, commercialise and disseminate digital services and goods, remains striking. Two aspects are particularly relevant to the contribution of women and men to the development of digital technologies and the gender dynamics at play in that sector: the gender makeup of people with STEM skills and qualifications, particularly ICT[14]; and the gender composition of the research and development (R&D) sector.

Aspirations for ICT careers are strongly gendered

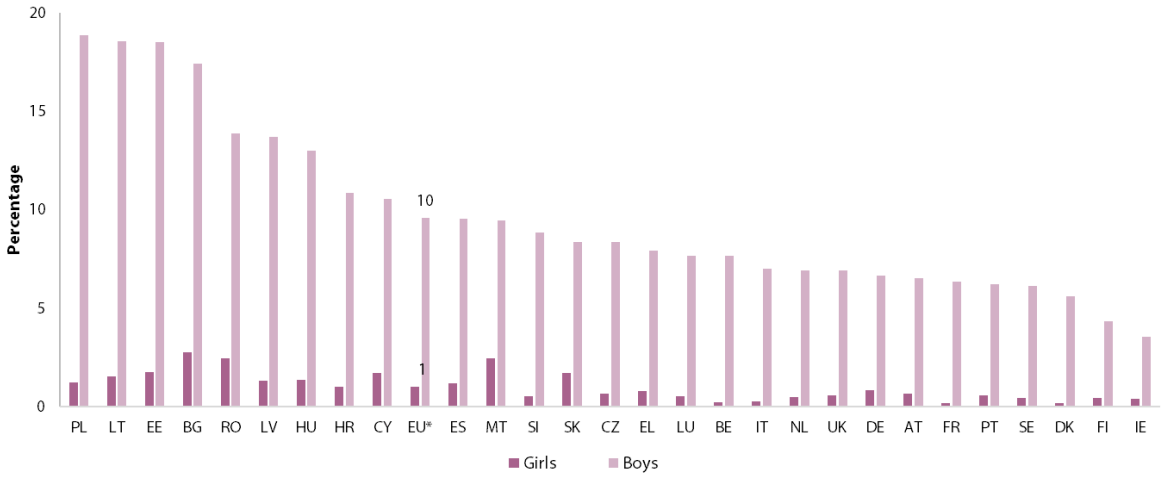
Gender attitudes to and confidence in digital skills and ICT are reflected in career aspirations, along with education choices. In 2018, only 1 % of girls, on average, reported wanting to work in ICT-related occupations, compared to 10 % of boys (Figure 9). In some Member States, including Bulgaria,

[13] Eurostat, EU LFS, 2019 (trng_lfs_01), AES, 2016, (trng_aes_176).

[14] ICT education, is defined as the achievement of formal qualifications at least at upper secondary level within the fields of computer use, computer science, database and network design and administration, or software and applications development and analysis (Eurostat, 2019a).

Estonia, Lithuania, and Poland, over 15 % of boys reported expecting to work in an ICT-related profession (OECD, 2019).

Figure 9: Share of 15-year olds expecting to work as ICT professionals at age 30, by country and gender (%, 2018)



Source: (OECD, 2019) based on PISA 2018 survey.
Notes: EU based on average of country percentages. Belgium uses data for the French Community only.

While women outnumber men among tertiary education students (54 % compared to 46 %), they tend to be unequally represented across study fields, a phenomenon referred to as gender segregation. In 2018, only 17 % of female students had opted to enrol in STEM studies, compared to 42 % of male students. As a result, STEM studies are largely dominated by male students (68 % vs. 32 % of female students)[15]. Stark levels of gender segregation among STEM students and graduates lay the ground for future gender segregation in labour markets and subsequent gender disparity in the development of digital products, for example.

Though some STEM fields, such as natural sciences, mathematics and statistics, are quite gender-balanced, ICT is characterised by the highest gender segregation, with 82 % of students being male. In 2018, 9 % of male students chose to study ICT, compared to only 1.5 % of female students in the EU (Figure 10). This level of under-representation of women among ICT students is hardly surprising, given the small number of young girls aspiring to become ICT professionals (Figure 9). Women represent only 19 % of graduates in ICT-related fields, representing 1.2 % of all women graduates of tertiary education, compared to 7 % of men graduates (Figure 11).

[15] EIGE calculations based on Eurostat, 2018, Students enrolled in tertiary education by education level, programme orientation, sex and field of education (educ_uoe_enrt03).

Figure 10: Share of ICT students (2018) and graduates (2017), of the total student population, by sex %

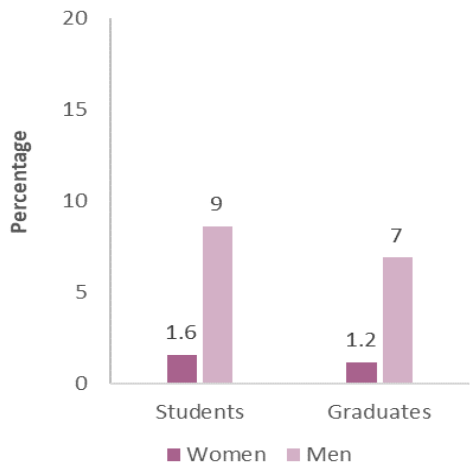
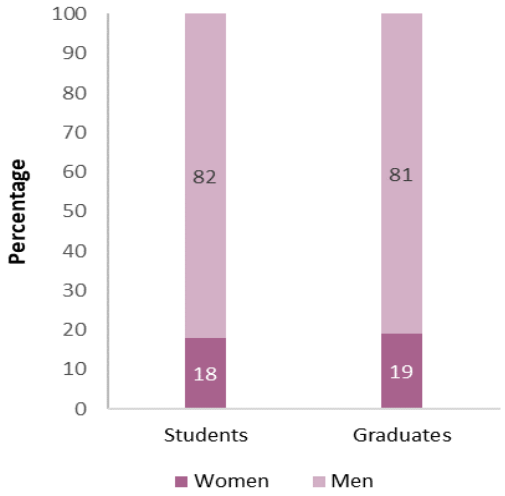


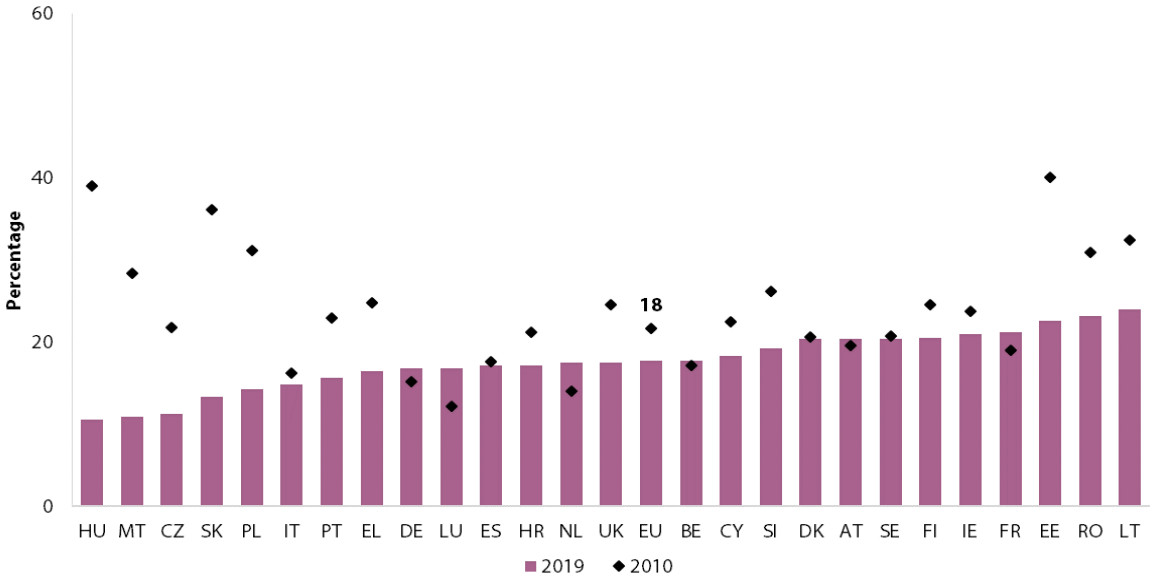
Figure 11: Share of women and men among ICT students (2018) and graduates (2017) %



Source: Eurostat, (educ_uoe_enrt03), (educ_uoe_grad02).

On average, over 8 in 10 ICT specialists[16] in the EU are men (Figure 12). Despite the overall growth of the ICT sector in recent decades, the share of women in ICT jobs in the EU has decreased by 4 % since 2010, standing at 18 % in 2019. High gender segregation within ICT jobs surpasses the gender imbalance within many other STEM jobs. For example, women represent about 27 % of science and engineering professionals in the EU[17].

Figure 12: Share of women among ICT specialists, 2010 and 2019, (15+, %)



Source: Eurostat (isoc_sks_itsps).

[16] Eurostat defines ICT specialists as workers who have the ability to develop, operate and maintain ICT systems, and for whom ICT constitutes the main part of their job.
[17] EIGE calculations based on EU-LFS 2018 microdata.

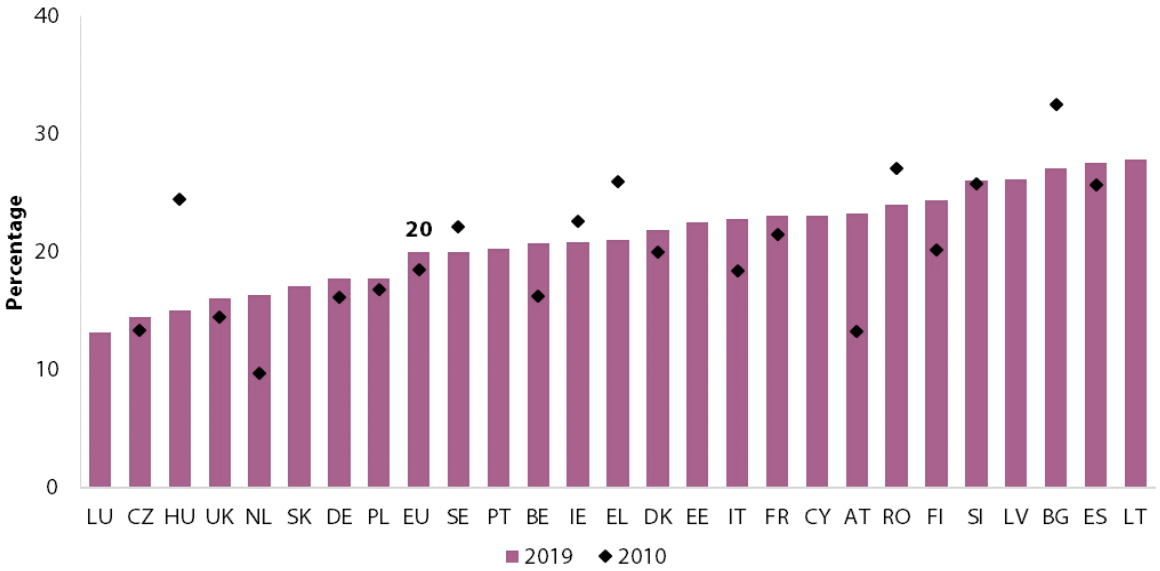
The data on entrepreneurship in the ICT sector points to even greater marginalisation of women. Only 7 % of self-employed ICT specialists with at least one staff member are women. Across all sectors, women entrepreneurs represent about 27 % of all self-employed with at least one employee[18].

Even though ICT skills are in high demand in the labour market (see section 9.2.2), women ICT professionals do not fare as well as their male counterparts. For women, the probability of being employed in the ICT sector with ICT-related studies decreases between 1 and 2 p.p., in comparison to women on other programmes of study (European Commision, 2016b). EIGE's research shows that only one third of recent STEM graduate women work in STEM occupations, compared to one in two men STEM graduates. Among vocational education graduates, the gap is more substantial, with only 10 % of women STEM graduates and 41 % of men STEM graduates working in STEM occupations. The majority continue on gender-segregated pathways, with 21 % of women with tertiary education working as teaching professionals and 20 % of women vocational education graduates working as sales workers (EIGE, 2018a).

Beyond ICT: women are under-represented in high-technology sectors

Beyond ICT, there are very few women scientists and engineers in the high-technology sectors likely to be mobilised in the design and development of new digital technologies. In 2019, across the EU, there were close to 32 million scientists and engineers employed in high-technology sectors[19], of which only one-fifth were women. That proportion has remained unchanged since 2010 (Figure 13).

Figure 13: Share of women scientists and engineers in high-technology sectors, 2010 and 2019, (25-64, %)



Source: hrst_st_nsecsex2
Notes: Data missing for Malta for both years. Data for 2010 missing for: Estonia, Cyprus, Latvia, Lithuania, Portugal and Slovakia.

[18] EIGE calculations based on EU-LFS 2018 microdata.
[19] High-technology sectors include high-technology manufacturing and knowledge-intensive high-technology services.

A closer look at more specific technologies reveals even more striking gender gaps. For instance, only about 12 % of leading machine learning researchers are women (Simonite, 2018). The World Economic Forum in collaboration with LinkedIn found that out of 40 % of all professionals employed in software and IT services and who possess some level of AI skills, women make up only 7.4 %. Globally, only 22 % of AI professionals are women, a trend that has remained fairly constant in recent years (World Economic Forum, 2018).

R&D plays an essential role in the creation of new knowledge and finding its concrete applications in innovative processes and devices. Data from the OECD and the Joint Research Centre (JRC) shows 'computers and electronics' as the second leading sector in terms of R&D workforce globally, representing 367 companies and accounting for 13 % of R&D employees globally (JRC-OECD, 2019). In addition, the IT services and telecommunications sector accounted for 4 % and 3 % of that workforce, respectively[20]. Despite its importance for the development of digital technologies, little is known about the representation of women among R&D personnel and researchers in high-technology sectors of the business industry, especially ICT.

Patenting activity is one of the most observable outputs of the R&D process. Of the top 50 patenting companies globally, 24 were operating in the 'computers and electronics' sector (JRC-OECD, 2019). The analysis of outputs of the research process in terms of patents, trademarks and scientific publications highlights a persistent under-representation of women as contributors to research and innovation. Women account for approximately 9 % of European patent applications (European Commision, 2019g).

The extent to which women and men collaborate on innovative activities reveals a substantial gender gap. In the EU (2013-2016), the majority of inventors worked in all-male teams (47 %), followed by those with one male only inventor (33 %). Only 5 % of teams were gender-balanced, while teams composed entirely or mainly of women accounted for 0.7 % and 1.6 %, respectively (European Commision, 2019g). The compound annual growth of gender-balanced teams since 2005 stands at only 0.7 %.

The gender gap in start-ups and venture capital investment is similarly striking. According to the EU Start-up Monitor 2018, only 17 % of start-up founders are women. OECD analysis shows that women-owned start-ups receive on average 23 % less funding than men-led businesses (European Commision, 2018d). On a positive note, the OECD observes that venture capital firms with at least one woman partner are more than twice as likely to invest in a company with a woman on the management team, and three times as likely to invest in women CEOs (OECD, 2018a). The evidence also shows that despite the scarcity of women entrepreneurs, women-led digital start-ups were more likely to be successful than those owned by men (Roland Berger & La Journée de La Femme Digitale, 2017), while investments in female-founded start-ups performed 63 % better than investments with all-male founding teams (Marion, 2016).

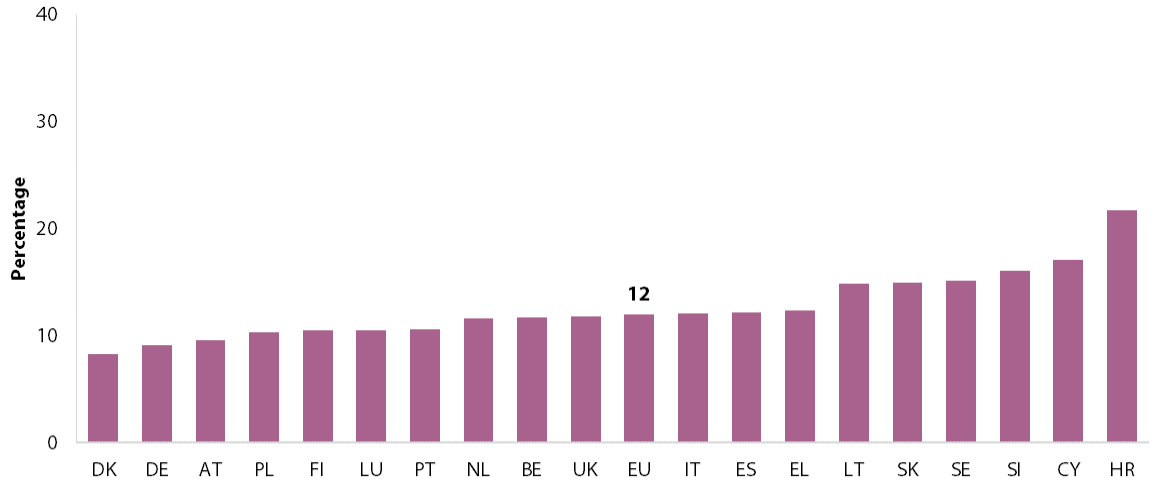
The data shows that for the period 2013-2017, one of the lowest ratios of women to men (0.4) as contributing authors of articles was observed in the field of engineering and technology in the EU (European Commision, 2019g). On average, at the beginning of their careers, women tend to publish almost as frequently as men in their field, but as seniority increases, male authors widen the gap and

[20] Total workforce of world's top R&D investors by sector, 2016. Source: JRC-OECD (2019). Calculations based on EU Industrial R&D Investment Scoreboard (2017).

publish more often than their female colleagues. While this trend holds true for all R&D fields, it is accentuated in engineering and technology (European Commision, 2019g).

The low share (12 %) of women academics in engineering and technology points to the stark under-representation of women in decision-making positions (Grade A staff) in R&D functions (Figure 14).

Figure 14: Share of women among Grade A staff in engineering and technology R&D, 2016, (%)



Source: Women in Science database, She Figures 2018, DG Research and Innovation.
Notes: Data unavailable for Bulgaria, Czechia, Estonia, Ireland, France, Latvia, Hungary and Romania. Data of low reliability for Malta.

While around half of research institutions in the EU have adopted a gender equality plan (European Commision, 2019g)[21], representation of women in decision-making positions in research still shows room for improvement. Men account for 78 % of heads of institutions[22], while boards of publicly funded research organisations have only 38 % of women members[23].

The persistent gender imbalance among key decision makers in large corporations remains a cause for concern. In 2018, 25 % of women held a managerial position in the EU ICT sector (17 % of women were chief executives)[24]. Across all economic sectors in 2020, the proportion of women on the boards of the largest listed companies in EU Member States has reached 29 %, but the top positions were still largely occupied by men, with women accounting for just 8 % of board chairs and 8 % of CEOs[25] (see chapter 6 on domain of power). Women thus face a systematic disadvantage in taking up jobs of higher responsibility. At the same age, with the same or better education, and with the same family and other circumstances, women still have 25 % lower odds of progressing to higher profile jobs (European Commision, 2018c).

Many factors influence the persistent gender segregation in STEM and R&D jobs. These include gender stereotypes, gender divide in digital skills, and educational background, but also masculine

[21] As part of its gender mainstreaming platform, EIGE has co-developed with DG Research and Innovation the Gender Equality in Academia and Research tool to support research institutions in their efforts to advance gender equality both in their institutions and research outputs.
[22] Proportion (%) of women among heads of institutions in the Higher Education Sector (HES), 2017, Women in Science database, She Figures 2018, DG Research and Innovation.
[23] Data cover presidents/heads and members of evaluation committees set up to assess the projects submitted in the latest call. EIGE, Gender Statistics Database, WMID, 2019. Data for IT and RO refer to 2018.
[24] EIGE calculation based on EU-LFS microdata, 2018.
[25] EIGE Gender Statistics database.

organisational culture, or a lack of work-life balance options and role models (Valenduc, 2011; Valenduc et al., 2004)see section 9.2.4). While data is scarce for the EU on the prevalence of sexual harassment in the science and technology sector, evidence from other parts of the world highlights systemic gender-based and sexual harassment (National Academies of Sciences & Medicine, 2018; Seiner, 2019).

9.2 Digital transformation of the world of work

Advances in digitalisation have had profound impacts on the labour market, chiefly resulting from the adoption of new ICT, increased use and storage of digitally codified information, and new developments in AI and robotics (Autor, 2015; Valenduc & Vendramin, 2017). Public debate on this transformation usually focuses either on its potential to boost economic productivity and growth or on the challenges it presents for workers, businesses and labour market regulation, paying only limited attention to gender equality prospects.

This chapter thus focuses on the gendered implications of several key advances in the digitalisation of the world of work. While most of these represent a continuation of long-term trends of labour market transformation (Valenduc & Vendramin, 2017), this chapter mostly addresses developments within the last decade and their implications for the future. These include, in brief:

- Job automation, i.e. a process in which human labour input is replaced by (digitally-enabled) machine input (Eurofound, 2018a). In the last decade, the 'exponential growth in the collection, storage, and processing of digitised information' (Valenduc & Vendramin, 2017, p. 124) enabled the development of powerful algorithms that exploit this data to 'learn' how to perform an increasing range of tasks. This has enhanced the capacity of machines to perform tasks previously done by workers (Autor, 2015; Frey & Osborne, 2017), encouraging further transformation of employment structures and content, as new technologies increasingly substitute or complement workers.
- Use of new technologies at work. With workers increasingly working alongside digitally enabled machines, there is higher demand for both basic and advanced digital skills in the labour market. This contributes to the growth of employment in certain well-paid sectors that require advanced digital skills, such as ICT. It also supports the use of new technologies in other sectors, often resulting in transformation of work practices, conditions and quality.
- Higher flexibility of work. The spread of portable devices (such as computers, tablets and smartphones) and improvements in internet connectivity and infrastructure enabled increasing amounts of work to be carried out at various places and times. This allows (and sometimes obliges) people to work 'anytime, anywhere' (Eurofound, 2020c).
- New forms of work. The remote working enabled by ICT has contributed to an increasing amount of work being contracted out (Howcroft & Rubery, 2018; Piasna & Drahokoupil, 2017), with new contracting practices recently emerging in the context of platform work.

Within the EU policy framework, the digital transformation of work is addressed under the European Pillar of Social Rights, which endorses the principles of fair working conditions, access to social protection and gender equality. Although the Pillar underlines the importance of supporting emerging business models, innovative forms of work, entrepreneurship and self-employment, supports for such new business models should entail quality working conditions and equal treatment of workers irrespective of the type of employment relationship. In 2018, the European Commission set up a high-level expert group to look at the process of digital transformation of the EU labour

market, provide analysis and explore policy options. To date, much of the gender equality focus has been on the gender segregation of some key sectors linked to digitalisation, such as ICT and STEM, notably within the context of the recent WiD declaration. When it comes to platform work, this is part of the Commission's Single Market Strategy and also part of the Digital Strategy. In its Communication on the European agenda for the collaborative economy (June 2016), the EU provided guidance for Member States on the application of existing EU rules to the platform economy, including fair working conditions, and adequate and sustainable consumer and social protection. More recently, the President of the European Commission stated that she 'will look at ways of improving the labour conditions of platform workers' (von der Leyen, 2019). Platform work will be covered by the preparations for the Digital Services Act[26], which should upgrade the liability and safety rules for digital platforms, services and products, and complete the DSM.

The analysis of gendered implications of digital transformation of work is structured in five sections. The first section looks at the broad labour market transformation resulting from automation of work and increased use of new technologies, and gives a broad overview of the gendered implications of these changes. It then provides a more detailed analysis of the challenges and opportunities for gender equality within the context of two economic activities closely linked to digitalisation – one usually offering well-paid, high-quality jobs (ICT sector), the other often providing low-paid, less secure but highly flexible opportunities (certain types of platform work). The second section analyses the employment prospects for women and men within these economic activities, while the third section discusses new forms of work and flexible working practices from a gender equality perspective. The fourth and fifth sections look at the implications of digitalisation for work-life balance and gender differences in pay, respectively.

As the analysis focuses chiefly on recent technological developments, it is often severely constrained by the availability of (gender-disaggregated) data. Quantitative data on platform work, for example, is limited to several recent surveys covering a number of EU Member States. There is no EU-wide survey and existing surveys suffer from a range of methodological weaknesses inherent in monitoring a newly emerging phenomenon. As gender-disaggregated data on platform work is extremely limited, the gender analysis relies on qualitative, and sometimes rather speculative, research. This is, to a considerable degree, true for the analysis of job automation as well.

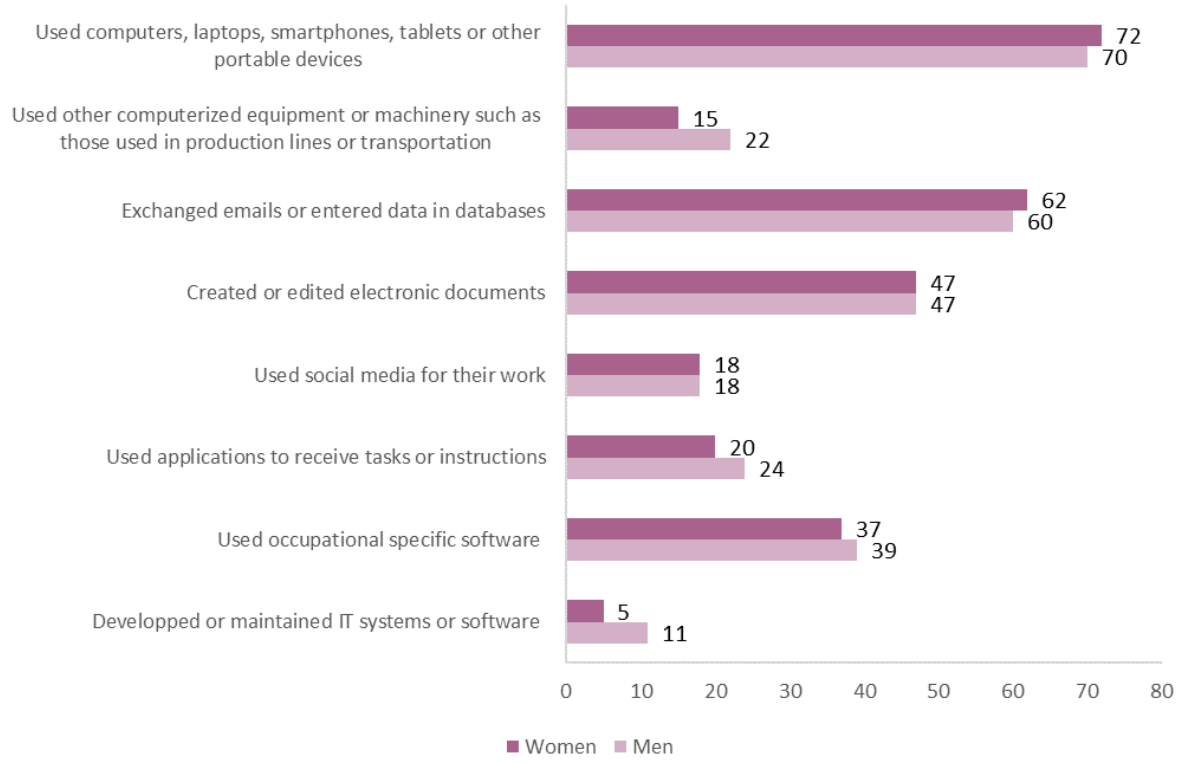
9.2.1. Job automation, use of new technologies and the transformation of the labour market

Much of the current policy debate about the future of work centres on the increased use of digital technologies and their capacity to substitute or complement workers in an ever-broadening range of tasks. The spread of new technologies is often seen as a way to increase the productivity and competitiveness of the EU economy. Notably, a range of time-consuming or physically demanding routine tasks have proven feasible to automate (JRC, 2020b), enabling some workers to focus on more creative aspects of their work, increasing added value and - in some cases - leading to improvements in working conditions (Eurofound, 2018c; JRC, 2019). However, technological progress also has the potential to be highly disruptive, as many jobs need to be reorganised and technology may completely replace workers in some instances (Eurofound, 2020a).

[26] https://ec.europa.eu/digital-single-market/en/digital-services-act-package

While digital technologies have transformed the majority of workplaces in the EU labour market, gender differences in the use of ICT at work persist. Eurostat data shows that 71 % of those in employment[27] use computers, laptops, smartphones, tablets or other portable devices at work, with the number reaching 95 % in some sectors[28]. The last five years have seen the use of digital technologies increase in almost nine out of ten workplaces in the EU (European Commision, 2016b). Yet, women continue to use some digital technologies less frequently than men (see Figure 15), which is likely to limit their employment prospects in jobs that depend on the use of such technologies.

Figure 15: Use of ICT at work and activities performed by employed women and men in the EU (16-74, %, 2018)



Source: Eurostat, ISOC (isoc_iw_ap)

Note : The chart presents the share of individuals who use ICT at work as a proportion of all employees and self-employed who used the internet within the last year.

Earlier estimates predicted that digitalisation could lead to alarmingly high rates of job loss due to automation in the next decade or so (Frey & Osborne, 2017; World Economic Forum, 2016), but these have since been tempered by more modest estimates for OECD economies of 10-20 % of jobs at risk (International Monetary Fund, 2018; OECD, 2016; PwC, 2019). Increasingly, it looks like many jobs will be transformed rather than fully automated, with workers switching to tasks that complement new technologies from tasks that are being replaced by them (Autor, 2015; European Commision, 2019e). Some entirely new jobs (or jobs transformed so profoundly as to effectively constitute new jobs) are also likely to appear (Eurofound, 2020a), for example in the STEM sector.

[27] Percentage of employees and self-employed who used the internet within the last year.
[28] Eurostat, [isoc_iw_ap].

This transformation is likely to have profound effects on the structure of the labour market, with two potential outcomes often discussed: job polarisation - where automation prompts the disappearance of middle-skilled jobs with high routine content, leaving the labour market increasingly divided into low and high-skilled employment (Autor, 2015; Goos, Manning, & Salomons, 2014; OECD, 2017b)); and job upgrading, where new technologies lead to demand for higher-skilled staff and therefore to skill upgrading of the employment structure (Oesch & Piccitto, 2019).

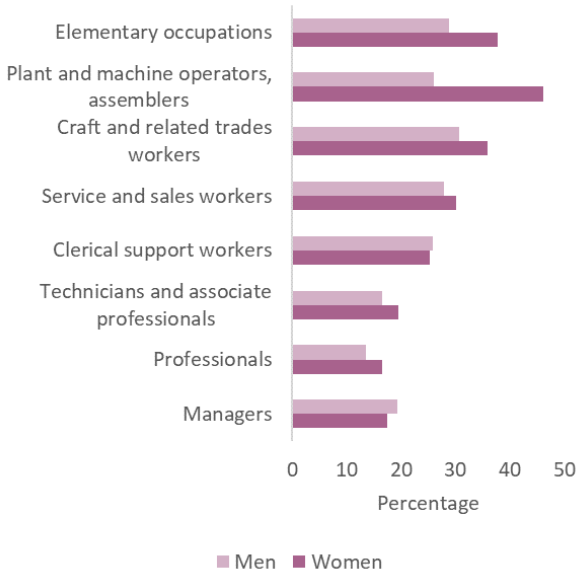
While the evidence is far from conclusive, the most recent findings from EU-based studies point towards a pattern of employment upgrading in recent years (Eurofound, 2017a; European Commision, 2019f; Oesch & Piccitto, 2019), especially among women (Eurofound, 2016; OECD, 2017a; Piasna & Drahokoupil, 2017). There are also some signs of job polarisation, however, and these are often more apparent among men. Changes in employment structure often depend on other factors than just technological progress – for example, the skill upgrading of jobs held by women may well be linked to the increased in participation of highly qualified women in the labour market (ibid). The pattern of change also varies a lot by country.

This transformation is likely to change the occupational and sectoral structure of EU employment and is thus likely to present different prospects for women and men whose employment follows well-established patterns of vertical and horizontal segregation. It is likely to have profound implications for gendered patterns in labour market participation, skill demand, and certain broader aspects of (gender) equality. It may well contribute to future changes in Gender Equality Index scores in several domains, primarily the domain of work.

Women face slightly higher risk of job loss due to automation

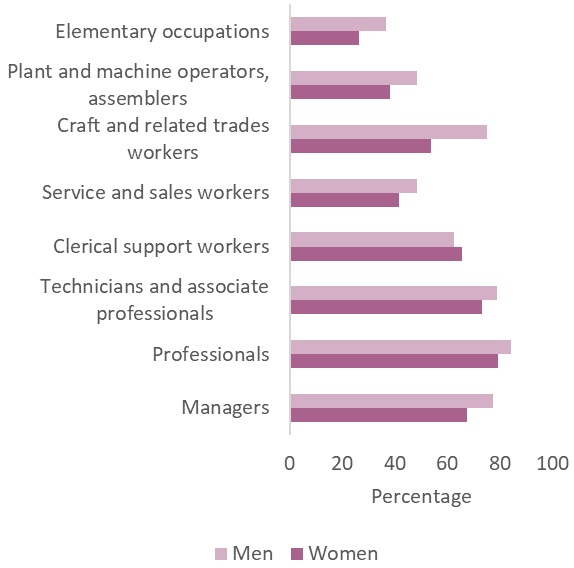
Women are usually reported to be at a slightly higher risk of job loss due to automation than men (International Monetary Fund, 2018; OECD, 2016; PwC, 2019). A recent International Monetary Fund (2018) study on the gendered impacts of automation found that around 11 % of employed women were at risk of job loss, compared to 9 % of men. This gap seems to be driven by significant differences in a few countries (e.g. Cyprus, Austria), while others show little or no differences (e.g. Belgium, Denmark, Germany, France, the UK). The higher risk of automation for women relates to gendered differences in work content – in the EU, women across different occupational categories were somewhat more likely to undertake routine, repetitive tasks and less likely to undertake complex tasks (Piasna & Drahokoupil, 2017) (Figure 16 and Figure 17). Another study also suggests that women are more vulnerable than men to automation in the future in some countries (Belgium, Czechia, Germany, Estonia, Cyprus, Luxembourg, Hungary, Austria, Finland, the UK), whereas they face the same risks in others (Greece, France, Croatia, the Netherlands, Slovenia) .

Figure 16: Share of workers undertaking repetitive tasks of less than 10 minutes, by sex and occupation, %, 2015



Source: Calculations based on European Working Conditions Survey (EWCS) presented in Piasna and Drahokoupil (2017).

Figure 17: Share of workers undertaking complex tasks, by sex and occupation, %, 2015



Source: Calculations based on EWCS presented in Piasna and Drahokoupil (2017).

In addition to being more exposed to the dangers of automation, women may also benefit less from the resulting changes in income distribution. Automation is likely to be a 'capital-intensive' process, relying on increasing use of new technologies and thus particularly benefitting owners of capital. Using data from advanced economies, similar technological changes have been linked to a decreasing share of national income flowing to workers (Dao, Das, Koczan, & Lian, 2017). Instead, income is likely to flow to owners of capital (ibid), who typically hold that capital indirectly through a range of financial products, such as stocks or shares (IPPR, 2019). This financial wealth tends to be highly concentrated among the wealthiest individuals, and among men in particular - there are sizeable gender gaps in financial wealth among the top 5 % wealthiest individuals in a number of EU Member States (Schneebaum, Rehm, Mader, & Hollan, 2018).

Automation is likely to affect both female and male-dominated occupations

The slightly higher overall risk posed by automation to women conceals considerable variation in how different occupations (and sectors) will be affected. Digitally-enabled machines are likely to replace human labour, particularly in routine, easily codifiable tasks (Autor, 2015; Frey & Osborne, 2017; Lordan, 2019), whose distribution varies considerably across occupations (Figure 16 and Figure 17). Less predictable tasks, such as abstract thinking or unstructured social interactions, are proving more difficult to automate, leaving some occupations at a much lower risk of automation than others (Autor, 2015; Frey & Osborne, 2017; Lordan, 2019).

Historically, automation was linked to elimination of clerical jobs and reduced availability of jobs in the retail and financial service sectors that, up to that point, had provided an expanding field of employment for women (Huws, 1982). At the same time, technological change began to de-skill many traditionally 'male' jobs (Cockburn, 1987), opening them up to women with newer

technological skills. This renewed interest in the statistical analysis of occupational segregation by gender. Research was carried out to identify horizontal and vertical patterns of segregation by occupation and industry, such as the concentration of women and men at different levels in organisational hierarchies (Rubery, 2010), and to identify ways in which new kinds of technology-enabled work reproduced and expanded dominant patterns of gender segregation and inequality (Howcroft & Richardson, 2009).

More recent studies covering EU Member States (Lordan, 2019) and OECD (International Monetary Fund, 2018) member countries show that some female and male-dominated occupations are unlikely to be substantially automated in the near future, as they typically involve a high degree of intellectual tasks or a mix of intellectual and social tasks. For example, some health, education and social service occupations dominated by women, such as schoolteachers or personal care workers in residential services, are considered difficult to automate. In fact, the number of personal care workers has risen substantially in recent years (Eurofound, 2017), mostly due to demographic shifts in the EU population that increased demand for such services. Some male-dominated occupations, such as ICT/engineering professionals or high-ranking managers, are also unlikely to face large job losses due to automation (Eurofound, 2017a; Lordan, 2019). For ICT/engineering professionals, technological progress instead drives job creation, as demonstrated by strong sustained growth in employment in these activities (see section 9.2.2). This makes the lack of women in these sectors particularly concerning.

Conversely, some female and male-dominated occupations are characterised by high levels of routine content and are thus at increased risk of automation. For example, certain key tasks carried out (mostly by men) in transport, storage and manufacturing activities (e.g. physical manipulation of heavy goods) may become automated (Eurofound, 2018c; Lordan, 2019). Clerical support work, carried out primarily by women, may also see an increasing share performed by machines (Lordan, 2019). This may lead to job loss in some cases, while, in others, it will prompt a profound job transformation that will require workers to perform new, often higher-skilled tasks ((Eurofound, 2018c).

Highly educated women often enter new jobs that are difficult to automate

While women face a somewhat higher risk of automation based on current employment patterns, there are signs that the structure of women's employment is changing, with high-skilled work increasingly prevalent. Women's educational attainment has grown rapidly and many of the past education gender gaps have already been eliminated, as seen from Gender Equality Index scores in the domain of knowledge. Women have begun to take most of the new high-skilled jobs[29] that are unlikely to be automated in the near future – around 8 million of the 12 million high-skilled jobs created between 2003 and 2015 in the EU went to women. This led to an 'upgrading in the female occupational structure, with the share of women in high skilled occupations [...] increasing' (Howcroft & Rubery, 2018; IPPR, 2019; Piasna & Drahokoupil, 2017, p. 7). This does not, however, mean that women are paid equally to men in these jobs.

Paradoxically, the fact that women have, on average, lower wages than men may favour them when it comes to automation (Rubery, 2018). Firstly, the low-paid nature of certain female-dominated

[29] These include jobs classified under ISCO-88 major groups 1, 2, and 3, namely: legislators, senior officials, and managers (group 1); professionals (group 2); and technicians and associate professionals (group 3).

occupations (such as domestic work) may slow down the pace of digital innovation, since such innovation can be, at least initially, quite costly and may not always pay off when labour costs are low (Rubery, 2018). This can protect some women against job loss at least in the short-term, although it brings little prospect of better pay or work conditions. Secondly, since women tend to earn less than men in the same occupations, this may provide them with new opportunities when male-dominated occupations become reorganised or restructured due to automation. In such cases, employers may favour hiring women into new positions due to their lower salary demands. Based on previous experience, this often results in 'first a period of desegregation of male-dominated jobs, followed by either the feminisation of the whole occupation or the emergence of new feminised subdivisions within the occupation' (Rubery, 2018). In the service sector, for example, programming tasks that were well-paid and highly skilled in the recent past may become 'feminised' - although more women are recruited, they continue to be treated as 'secondary earners' and their wages drop (Howcroft & Richardson, 2009). Thus, efforts to ensure equal pay for equal work will be needed if women are to fully benefit from such new opportunities.

The potential of automation to challenge existing gender inequalities remains unclear

Given the uncertain nature of the changes in technology and gender relations, it is difficult to go beyond stylised lists of factors likely to influence gender equality outcomes of automation in the future. Current literature mostly limits itself to speculating about the ways in which this process could affect gender equality, namely gender segregation, division of unpaid work, pay gaps and working conditions (see box below).

All of these speculative scenarios have something in common – they hold the potential to improve gender equality but their outcomes are highly uncertain and there is no guarantee that their promise will be fulfilled. Indeed, the research reviewed (Howcroft & Rubery, 2018; IPPR, 2019; Rubery, 2018) suggests that this is unlikely to happen without: 1) gender-sensitive regulation, institutions and policies; 2) challenging established gender stereotypes, such as those relating to ICT/STEM participation and caring activities; and 3) strengthening representation of women in key decision-making positions.

Potential of job automation to improve gender equality

Scenario 1 – Index domain of work: transformation of the labour market structure offers an opportunity **to change established gendered patterns of employment**, especially in the context of rapid growth of women's skills (IPPR, 2019; Rubery, 2018). However, evidence from the last decade shows little - if any - progress in the desegregation of the EU labour market (Piasna & Drahokoupil, 2017). Jobs within the STEM/ICT sector are a stark example of this lack of progress (see section 9.1.3).

Scenario 2 – Index domain of time: potential job loss due to automation has sparked debates about more **balanced distribution of paid and unpaid work among women and men** (Howcroft & Rubery, 2018; IPPR, 2019; Rubery, 2018). If machines substitute a significant share of human work input, this may reduce the overall amount of jobs available. To better distribute the remaining work, proposals to reduce the duration of the working week are frequently discussed, with potential positive outcomes for gendered division of unpaid work. In this context, the recognition of women and men as equal-earners-equal-carers across the life cycle will also be important.

Scenario 3 – Index domain of money: automating some routine tasks can free up more time for tasks requiring interpersonal, creative or advanced ICT skills (Howcroft & Rubery, 2018; IPPR, 2019). This is an opportunity to **upskill certain low paid jobs held by women and perhaps even achieve higher wages and reduced pay gaps**.

9.2.2. Employment prospects in the ICT sector and platform work

Apart from its potential to replace human work, digitalisation offers a range of new opportunities, either by transforming existing jobs or creating entirely new ones. Access to such opportunities is likely to be highly gendered, given the segregated nature of the EU labour market, the variety of gender stereotypes around employment in certain jobs and related gender differences in career expectations. This section analyses the differences in participation of women and men in two quite different types of job opportunities linked to digitalisation.

Firstly, the increasing digitalisation of work has created a growing demand for high-skilled workers with advanced digital skills, apparent across all economic sectors. This section looks particularly at the job prospects of women and men in the ICT sector, in view of the high demand for ICT specialists during the last decade or so (Eurostat, 2019b) and the fact that the workforce remains male dominated.

Perhaps less obvious is the fact that digitalisation enables the creation of a broad range of low-skilled opportunities, for example in the context of certain forms of platform work. While platform work includes some well-paid, high-skilled opportunities (Eurofound, 2018b), there are many poorly paid jobs that serve only to supplement income from other sources (Huws et al., 2019; ILO, 2018c; JRC, 2018). Women are currently under-represented in platform work, with employment structure following the well-established patterns of gender segregation from the broader economy.

Definition of platform work

There are many definitions of platform work, resulting in a lack of consistency in use of the term. This report adopts Eurofound's understanding of **platform work as a 'form of employment that uses an online platform to enable organisations or individuals to access other organisations or individuals to solve problems or to provide services in exchange for payment'** (Eurofound, 2018b, p. 9). According to this definition, platform work has several key features:

- Paid work is organised through an online platform;
- Three parties are involved: the online platform, the client and the worker;
- The aim is to carry out specific tasks or solve specific problems;
- The work is outsourced or contracted out;
- Jobs are broken down into tasks;
- Services are provided on demand.

Generally, platforms can be divided into those where work is delivered purely online (such as Amazon Mechanical Turk) and those where work is delivered on-site (e.g. Uber). The most common tasks performed include: 1) professional tasks (e.g. software development or translation); 2) transport (e.g. personal transport or food delivery); 3) household tasks (e.g. cleaning or plumbing); and 4) micro tasks (e.g. tagging images online).

Full potential of the ICT sector cannot be realised without gender equality

Recent decades have seen EU Member States gradually transform their labour markets, reflecting the trends towards digitalised and knowledge-based economies. STEM and especially ICT sectors have increased in importance in the overall economy and secured their status as providing well-paid, secure and high-quality jobs. From 2008 to 2018, the employment growth of ICT specialists was more than 12 times the average employment growth in the EU, with the share of ICT specialists in total employment increasing by 1.1 p.p. (from 2.8 % to 3.9 %) (Eurostat, 2019b). The ICT sector was one of the few that withstood the effects of the financial crisis and continued to experience growth. However, of the 9 million ICT specialists, only around 18 % are women, and the share of women in ICT jobs in the EU has decreased by 4 % since 2010 (see section 9.1.3).

An even higher growth of the ICT sector has been limited by the substantial mismatch between high demand and relatively low supply of ICT specialists in the EU labour market. The majority of EU Member States report difficulties in finding a sufficient number of science, engineering and ICT professionals (European Commision, 2014). A recent estimate suggested that the EU faced a shortage of some 600 000 ICT specialists in 2018 (European Commision, 2018g). This mismatch between the supply of ICT specialists and employer demand is likely to remain for some time, as STEM and especially ICT specialists continue to be in high demand (Cedefop, 2018).

With the ICT sector heavily gender segregated and facing a huge demand for new specialists, greater involvement of women seems to be a policy strategy with obvious economic and social benefits. EIGE has estimated that attracting more women into the STEM and ICT sectors would lead to economic growth in the EU, with more jobs (by up to 1.2 million by 2050) and increased Gross Domestic Product (GDP) over the long-term (by up to EUR 820 billion by 2050) (EIGE, 2017).

Growth in personal and household services provided via platforms could support women's employment

The platform economy[30] in the EU is, as yet, a relatively small phenomenon. In 2015, revenue in the five key sectors of the platform economy[31] were estimated at roughly EUR 4 billion (European Commision, 2019b), with the highest revenues recorded for peer-to-peer transport (EUR 1.7 billion) and accommodation (EUR 1.2 billion). These revenues were predicted to grow rapidly in the coming years (PwC, 2016), but this may turn out to be overly optimistic in the light of the COVID-19 pandemic.

The scant early information on impacts of the COVID-19 pandemic on the platform economy available at the time of writing indicates that there will be negative consequences. Early survey statistics published by the World Economic Forum[32] show that, globally, as much as half of platform workers may have lost their jobs, and a further 26 % have seen their working hours decrease. Impacts seem to be particularly harsh in certain on-site services, such as ride-hailing or accommodation

[30] Denoting for-profit companies using platforms, apps and other digital technologies to organise exchanges. Note that this is broader definition than that of platform work, which refers to online platforms matching the supply of and demand for paid labour.

[31] P2P accommodation, P2P transport, on-demand household services, on-demand professional services, collaborative finance.

[32] https://www.weforum.org/agenda/2020/04/gig-workers-hardest-hit-coronavirus-pandemic/

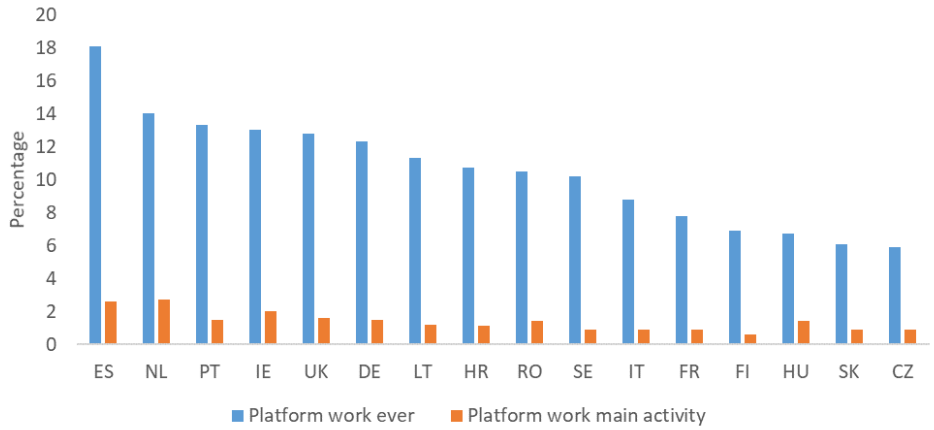
rental[33]. Other services, such as delivery or online work, appear less affected[34]. However, there are some concerns about the influx of newly unemployed people into the platform economy, resulting in lower wages and reduced work available per worker[35].

Despite the uncertainty about future growth of the platform economy, it is interesting to note that on-demand personal and household services (cooking, cleaning, plumbing, etc.) were estimated to have the highest growth potential (PwC, 2016). This suggests that there is a considerable demand for outsourcing unpaid domestic work via platforms. This could support the labour market participation of women (Overseas Development Institute, 2019). Highly qualified women whose participation in the labour market is held back by their disproportionate share of unpaid work may decide to outsource this work, often to poorer women from migrant backgrounds (EIGE, 2020a). However, questions remain about the domestic tasks more likely to be outsourced and under what working conditions (see section 9.2.3). Serious concerns have been raised about the precarious, exploitative nature of domestic work provided by women, especially when they are excluded from safe employment due to their legal migration status or discrimination (European Parliament, 2017; FRA, 2018).

Platform work seems to reproduce the usual gender segregation patterns

While data on platform work in the EU is incomplete and difficult to compare, it suggests that a relatively small share of the EU population is involved in platform work. From three recent surveys carried out in multiple EU Member States (Huws et al., 2019; JRC, 2018, 2020a), it appears that around 10 % of the EU population has ever provided some services via platforms, but this constitutes a main employment activity for only around 2 % of the population. The share of platform work varies substantially by country (Figure 18).

Figure 18: Participation in platform work, % of adult population, 2017



[33] See e.g. https://www.businessinsider.com/uber-announces-layoffs-3700-job-cuts-14-percent-employees-coronavirus-2020-5, https://www.forbes.com/sites/jonathankeane/2020/05/22/from-the-us-to-india-the-gig-economy-job-cuts-went-even-deeper-this-week/#4b165abc6999 or https://news.airbnb.com/a-message-from-co-founder-and-ceo-brian-chesky/

[34] See e.g. https://time.com/5836868/gig-economy-coronavirus/ or https://www.eurofound.europa.eu/publications/article/2020/coronavirus-highlights-sick-pay-void-for-platform-workers

[35] https://time.com/5836868/gig-economy-coronavirus/

Source: (JRC, 2020a).
Note: Platform work is considered a main activity where individuals work at least 20 hours a week on platforms or when they get at least 50 % of their monthly income via platforms.

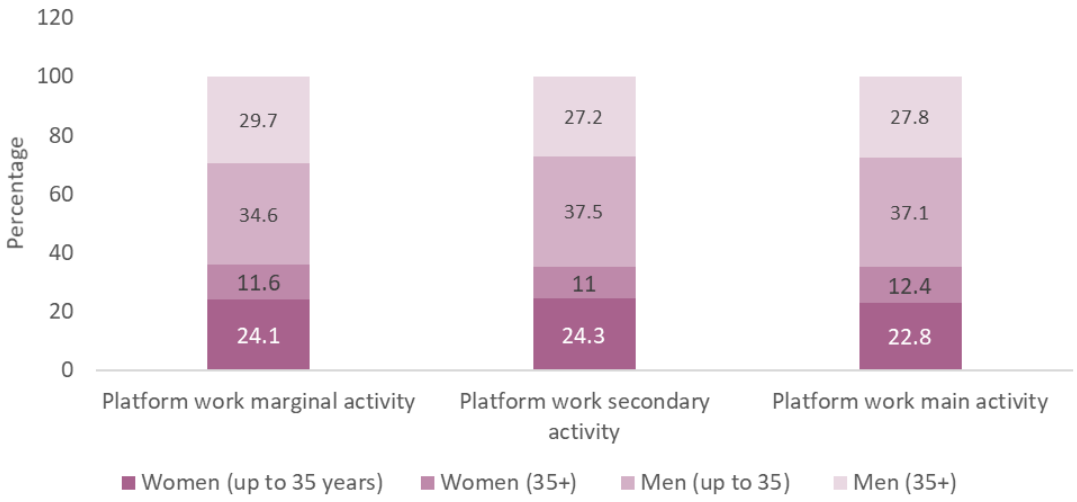
The majority of platform workers dedicate only a few hours a week to this work and use it to supplement income from other, more important sources (Huws et al., 2019; JRC, 2018, 2020a). Their work often consists of several tasks on different platforms that top-up their income from primary jobs. Thus, a substantial share of platform workers seem to piece together their livelihood from whatever opportunities may bring extra money, using platform work as a minor income supplement to improve their economic situation.

Platform workers deliver a broad range of services, whose provision mostly seems to follow well-known patterns of gender segregation. Services can be broadly divided into those delivered purely online (such as software development or tagging of images online) and those requiring physical presence on location (such as cleaning or personal transport)[36]. Most platform workers in the EU are engaged in online professional tasks (e.g. accounting, legal, project management services or translation) and clerical tasks (e.g. customer service, data entry or transcription) (Huws et al., 2019; JRC, 2018, 2020a). The survey data indicates that gender plays an important role when choosing which services to provide: for example, men dominate in software development and transport services, whereas women work more frequently in certain on-site services, such as personal or household services, and in translation (JRC, 2018).

Women are under-represented in platform work

Based on the most recent EU data, around one in three platform workers are women, regardless of platform work intensity (JRC, 2020a) (Figure 19). The share of women who undertake platform work as a main or secondary activity increased somewhat since 2017. Platform workers are usually young and well educated, and their educational attainment often exceeds the low-skilled nature of certain types of platform work (ILO, 2018c; JRC, 2018, 2020a).

Figure 19: Proportion of women and men in platform work by intensity, %, 2018



Source: (JRC, 2018, 2020a)

[36] See https://www.eurofound.europa.eu/observatories/eurwork/industrial-relations-dictionary/platform-work for more detailed breakdowns.

Note: Percentages are reported out of the total number of workers per degree of intensity, i.e. women account for 35.2 % of workers for whom their platform job is a main job, with men accounting for the rest. Platform work is considered a main job when it accounts for at least 50 % of monthly income or is performed for more than 20 hours per week. Platform work is considered marginal if it accounts for less than 25 % of monthly income and is performed for less than 10 hours a week. Platform work is considered a secondary activity in the remaining cases.

As many as half of platform workers live in a couple with children, often aged under five (ILO, 2018c; JRC, 2018, 2020a). Based on global data on online platform work, the proportion of workers with small children at home appears to be much higher among women, who also more frequently report the need to work from home due to combining work with caring responsibilities (see section 9.2.4). Platform work can give them an additional opportunity to do this.

Yet, such generalisations obscure a lot of diversity among the platform workforce, whose composition often depends on specific platforms and types of service provided. For example:

- Some (US-based) studies indicate that workers who rely on low-wage platform work as a main source of income often come from low-income, less educated households and are more likely to have minority ethnic backgrounds (Smith, 2016; Van Doorn, 2017). Most recent EU data indicates that around 15 % of platform workers are foreign-born, a higher proportion than in overall employment (JRC, 2020a).
- Online platform work performed from home also offers opportunities for people with health limitations that prevent them from working outside of the home. A global survey found that almost one in five online platform workers reported health limitations (ILO, 2018c).

9.2.3. New forms of work and flexible working practices in the context of the ICT sector and platform work

For several decades, advances in digitalisation have been associated with two closely related processes: increased flexibility of work and emergence of new forms of work. Increases in work flexibility date back to the 1980s, when the introduction of ICT transformed the world of work by enabling home-based and other forms of remote labour, such as teleworking (Huws et al., 1996). In 2002, the European Framework agreement on telework was negotiated by the social partners, establishing teleworking as a way for companies to modernise their work organisation and for workers to reconcile work with other aspects of their lives. As the use of portable computers, tablets and smartphones spread throughout the labour market, and internet infrastructure and connectivity improved, a growing proportion of the workforce adopted flexible working patterns, working 'anytime, anywhere' (Eurofound, 2020b; Eurofound & ILO, 2017).

At the same time, the adoption of different remote working practices contributed to the emergence of new forms of work. The possibility to manage work remotely allowed employers to outsource and offshore an increasing amount (Rubery, 2015). This signalled a move away from the standard full-time open-ended contract with fixed working time towards less secure forms of employment situated within a 'complex and multi-faceted network of relations between "independent contractors", clients and intermediaries' (Bergvall-Kåreborn & Howcroft, 2014; Piasna & Drahokoupil, 2017; Rubery, 2015). It led to the increasingly fragmented nature of work, which was often broken down into 'highly specified services and tasks' to be delivered via 'one-off contracts' (Howcroft & Rubery, 2018). The past decade saw this process culminate in the emergence of platform work, which usually involves self-employed people working on multiple small-scale tasks mediated via online platforms, often alongside other, more stable jobs.

These changes can impact gender equality both positively and negatively. On the one hand, the increased flexibility of work is hailed as a promising way to support further participation of women and certain disadvantaged groups in the labour market (De Stefano, 2016; Overseas Development Institute, 2019), potentially leading to improvements in the Gender Equality Index domain of work. This is because flexible working is often the only option for people to combine substantial unpaid care responsibilities (primarily taken on by women) with paid employment, and because it can encompass those who cannot work outside the home, such as people with certain disabilities. More broadly, the increasing flexibility of work is seen as a way to improve work-life balance (see section 9.2.4) and potentially reduce gender inequalities in the distribution of unpaid work (and thus contribute to gender equality in the Index domain of time). On the other hand, some new forms of employment deprive workers of much of the traditional labour and social protections crucial for achieving gender equality (Howcroft & Rubery, 2018; ILO, 2018c; Overseas Development Institute, 2019; Piasna & Drahokoupil, 2017).

The remainder of this section examines the gendered consequences of changes in the form and flexibility of work enabled by digitalisation in two dynamic and growing segments of the economy: the ICT sector and platform work.

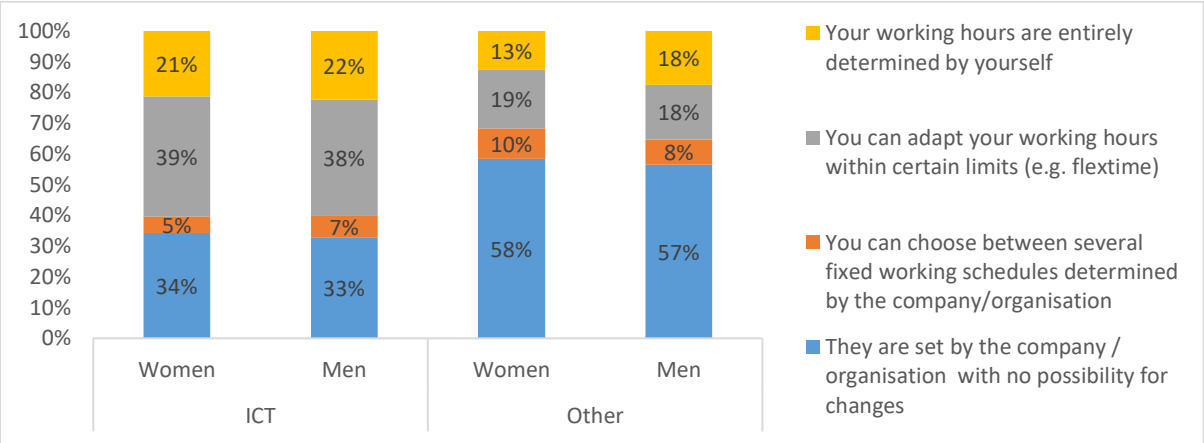
ICT jobs offer favourable working conditions but few women benefit

Newly emerging high-skilled occupations in the STEM and ICT sectors tend to offer somewhat safe and flexible working conditions, but few women have joined these sectors and benefitted. The standard employment relationship is highly prevalent in ICT: 93 % of women and 88 % of men ICT specialists are employees, are more likely to work a standard 40-hour week than the rest of the working population, and few have temporary work contracts (8 % of women and men)[37]. Only 7 % of women and 12 % of men in ICT are self-employed, which is lower than other occupations (10 % of women and 18 % of men)[38]. Evidence from literature suggests that women and men tend to choose self-employment for different reasons. Women are more likely to opt for it due to the potential for better working time flexibility, work-life balance and opportunities to combine care and work responsibilities, while men are more likely to be self-employed for career-related reasons, such as to control their own work or to earn more money (IPSE, 2019). Despite the rather standard form of employment, teleworking and mobile work arrangements are highly prevalent in the ICT sector, especially among the self-employed, indicating a high degree of flexibility in work arrangements in this sector (Eurofound, 2020c).

ICT jobs generally offer favourable working conditions: they are relatively well paid, require less work during atypical working hours, and give workers considerable flexibility and autonomy to arrange their working time (EIGE, 2018b). For instance, 83 % of women and 80 % of men in ICT find it very easy or fairly easy to arrange an hour or two off during working hours to take care of personal or family matters. There is also significant overall working time autonomy. Only one-quarter of ICT sector employees have their working time arrangements strictly set by the company with no possibility for change (compared to almost 60 % of the rest of the working population). The remaining ICT sector employees enjoy various amounts of flexibility or even full autonomy (Figure 20).

[37] EIGE calculations based on EU-LFS 2018 microdata.
[38] EIGE calculations based on EU-LFS 2018 microdata.

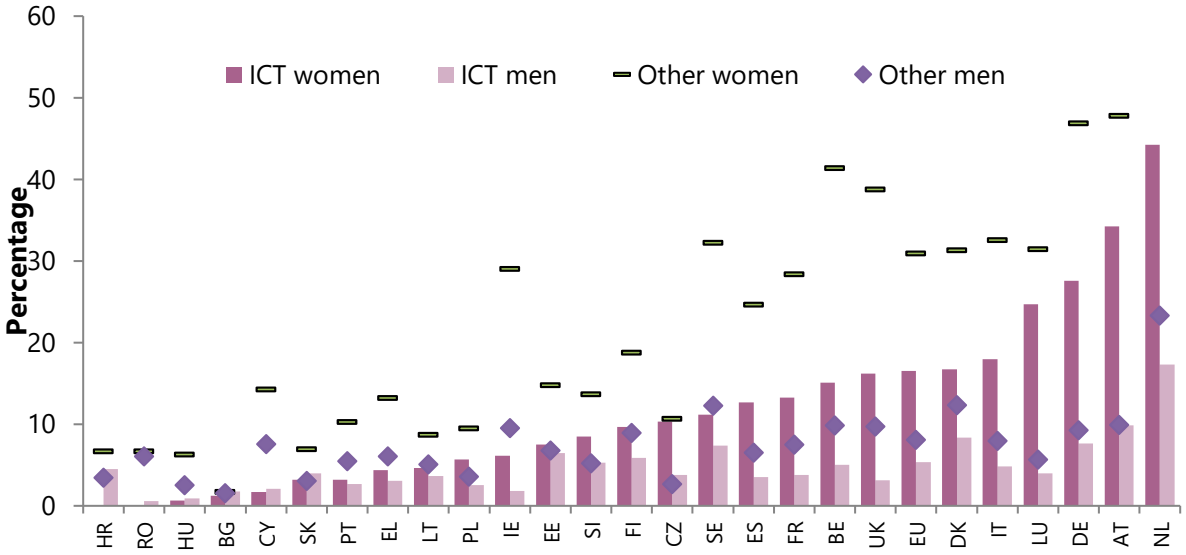
Figure 20 Women and men in ICT and other sectors, by working time arrangements (20-64, %, 2015)



Source: EIGE calculation based on EWCS 2015 microdata

However, part-time work – which, in some cases, facilitates better work-life balance - is less common among ICT specialists than in other occupations in many Member States, suggesting lower availability (i.e. due to high shortage of ICT specialists) or lower need (i.e. many employees forgo care duties). In ICT, 17 % of women and 5 % of men work part-time (Figure 21), compared to 31 % of women and 8 % of men in other occupations. Around two-thirds of women in ICT jobs work part-time due to their care responsibilities, while only one-quarter of men choose to work part-time for this reason (EIGE, 2018b). Similar to self-employment, women and men are likely to use their control of their working time differently - women tend to use it to achieve better work-life balance, while men use it to increase their work commitments (Hofäcker & König, 2013).

Figure 21: Percentage of people working part-time in ICT and other occupations, by gender and country (20-64, %, 2018)

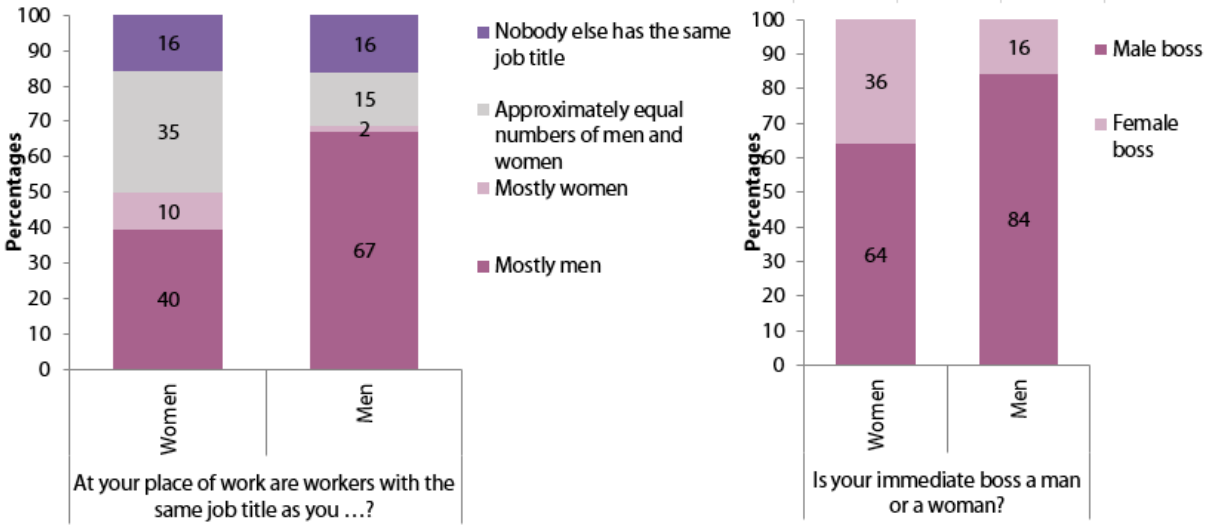


Source: EIGE calculation based on EU-LFS 2018 microdata.

Note: ICT represents the total of ICT service managers, professionals and technicians. EU excludes Malta (data not available). Latvia is not presented due to low number of observations. Bulgaria, Poland and Slovenia: data for service managers not available. *For the Netherlands, the share of women in part-time work among other employees is off the scale of this graph, with the actual level at 74 %.

Despite rather favourable working conditions, few women choose a career in the ICT sector, with women holding only 2 in 10 ICT jobs in the EU. Many different factors contribute to gender segregation in the ICT sector (see section 9.1.3), including a highly gendered organisational culture. This often consists of prejudices and institutionalised or informal barriers established in personnel practices, job descriptions, mobility ladders and professional networks (Reimer & Steinmetz, 2009). Only 15 % of men have jobs in workplaces with approximately equal numbers of women and men with the same job title, while 39 % of women (67 % of men) have mostly male co-workers within the same function (Figure **22**). This may indicate that there are still ICT jobs that are predominantly held by men and that only certain occupations in ICT are more open to women (EIGE, 2018b). In addition, women in ICT often work under female supervision, despite an overall small share of women in this sector (Figure **22**). Such workplaces may be more open to having women as both employees and leaders (EIGE, 2018b).

Figure 22. Gender composition of ICT specialists' workplaces in the EU (20-64, %, 2015)



Source: EIGE calculations based on EWCS 2015 microdata.

Platforms can both empower and exploit workers, with a range of gendered consequences

While there are some well-paid, high-skilled services performed via platforms (such as software development), most platform work does not seem to fit into this category. In the absence of robust quantitative data, recent studies explored the earnings of platform workers qualitatively and indicated that they are often insufficient to make a decent living (Eurofound, 2018b). Some forms of platform work seem to be particularly poorly paid. For example, income for providing small-scale online services via platforms (also called 'clickwork') is very low for the majority of workers (Hara et al., 2018), with a significant proportion earning below the local minimum wage. This may not always be a problem for the 70-80 % of platform workers who use small 'gigs' to top up their income from other jobs, but there is now a non-negligible share of the EU adult population (around 2 %) that rely on platform work as their main employment activity (Huws et al., 2019; JRC, 2018). When these workers work in a precarious, poorly paid jobs, this is likely to have severe consequences for their overall well-being and quality of life.

The debate on the extent to which platforms empower or exploit their workers is controversial, and is currently characterised by a number of ongoing court cases in the EU around platform worker status (Eurofound, 2018b). Much of the discourse surrounding platforms describes them as providing

empowering entrepreneurship that gives workers' greater autonomy over their workplace and schedule and thus supports work-life balance (ILO, 2018a; Overseas Development Institute, 2019). Most platforms routinely classify their employees as self-employed or 'independent contractors' who bear responsibility for key aspects of their work (Overseas Development Institute, 2019). In practice, platforms focusing on certain services (such as personal transportation or clickwork) commonly adopt practices to disempower workers and limit their autonomy (ILO, 2018a). Here, the entrepreneurship discourse can be seen as a strategy to lower workforce-related costs (De Stefano, 2016; Overseas Development Institute, 2019) - classifying platform workers as self-employed shifts much of the work-related risks (and mitigation costs) to workers and denies them important work and social protection (De Stefano, 2016; Overseas Development Institute, 2019).

Much of the debate overlooks the fact that platform practices are likely to affect women and men in different ways because of gendered employment patterns in platform work and the implications of some work and social protection (such as parental leave) for gender equality. The rest of this section briefly reviews the gendered consequences of platform practices related to:

- Work security and autonomy of platform workers;
- Discrimination, harassment and violence at work;
- Access of platform workers to social protection; and
- Collective representation of workers.

Platform practices that restrict worker autonomy can reduce women's participation

Platform work can be an opportunity to enhance the participation of women in the labour force (De Stefano, 2016; Overseas Development Institute, 2019). It can offer workers considerable autonomy in terms of their workplace and schedule, including the freedom to choose which tasks they do, their working time, and how to organise and perform their work (Eurofound, 2018b). This can benefit women in particular, supporting them to combine work with their disproportionate share of care and family responsibilities.

However, the autonomy and flexibility of platform work varies significantly depending on the type of service provided and work management practices of individual platforms (Eurofound, 2018b; ILO, 2018a). Representation of women and men varies across the different types of services and platforms (see section 9.2.2), and their degree of autonomy is likely to do so as well. For example, men currently dominate the provision of certain platform services associated with higher work autonomy, such as software development. Other workers are likely to face platform practices that impose a combination of low work/pay security and limited work autonomy. This may well put people with significant caring and family responsibilities at a disadvantage and is likely to have negative consequences, particularly for women's participation.

Some examples are provided below to better illustrate the variation in work autonomy for different types of platform work and its gendered implications.

- The control that platforms assume over work schedules and work practices varies significantly, depending on the features of a given platform design. For example, the algorithms used to manage workforces determine: whether workers have to search for tasks or customers search for workers; the degree to which customers and workers can set a

schedule for performing a task; or the ability of customers to reject work of poor quality (Eurofound, 2018b).

- There is an important distinction between services carried out online and on-site. Most[39] platform work performed online, such as translation or software development, has a higher degree of flexibility and control over working hours and place (Eurofound, 2018b). On-site work, such as ride-hailing or personal and household services, usually offers some flexibility in work schedules, but the place of work is determined by the customers.
- More autonomy is often found in high-skilled services involving complex tasks (e.g. software development, dominated by men). Work autonomy may well be a mirage for workers providing low-skilled, highly standardised services (Eurofound, 2019; ILO, 2018a; Overseas Development Institute, 2019), especially those depending on platform work as a major source of income. Here, platforms often encourage work patterns that do not combine well with caring and family responsibilities (ILO, 2018a; Smorto, 2018), such as long or unsocial working hours, intense work at times and places of high demand, and immediate availability to perform irregular work (De Stefano, 2016; Overseas Development Institute, 2019).
- The limited autonomy of platform work for low-skilled services is exacerbated by low job and pay security, reducing workers' capacity to resist the control platforms exert over their work (ILO, 2018a, 2018c). Platforms usually retain control over workers' job access, in some cases even price setting, with at least some not hesitating to use this as an effective leverage to influence worker behaviour (ILO, 2018a; Smorto, 2018). For example, pay and job access can depend on achieving desirable outcomes in tools used to monitor workers, such as customer ratings or key performance criteria (De Stefano, 2016; ILO, 2018a; Overseas Development Institute, 2019).

Gendered consequences of platform practices that limit worker autonomy

Example 1: Ride-hailing platforms, such as Uber or Bolt, often exert considerable control over their workers to ensure immediate availability of their services to customers. They commonly retain the power to set prices for rides and can use this to influence workers' driving patterns by applying price surges to periods and places of high demand (ILO, 2018a). In some cases, they use worker-monitoring systems to promote immediate availability among drivers - drivers who decline or cancel ride requests face the risk of deactivation (i.e. employment loss). In other cases, they encourage longer availability of drivers on the platform (e.g. rewards for certain number of drives in a day), even though this leads to longer periods of (unpaid) waiting for rides.

Gendered consequences: Such practices do not favour combining (well-paid) ride-hailing work with caring responsibilities, and may help to explain the gender pay gaps (Cook, Diamond, Hall, List, & Oyer, 2018) and employment gaps (Huws et al., 2019; JRC, 2018) in ride-hailing services.

Example 2: Platforms focusing on small online tasks (so-called **clickwork**, such as Amazon Mechanical Turk), tend to grant workers more autonomy in terms of their work schedule and place. However, they still adopt practices that favour workers who work longer, without interruption and on demand (Adams & Berg, 2017). They usually gather online tasks from clients and invite workers to bid for these. The tasks often need to be completed quickly and

[39] Except, for example, work on platforms focusing on micro tasks (see box on this page).

are posted at ad hoc times that suit clients. This requires workers to spend unpaid time searching for tasks and to then bid for them quickly once available (ILO, 2018c). Platforms sometimes monitor whether workers work without interruptions - for example, by taking screenshots of workers screens or recording keystrokes and mouse clicks (ILO, 2018a).
Gendered consequences: Such working patterns are not suitable for women who wish to combine platform work with care responsibilities, and are likely to contribute to the gender pay gap (Adams & Berg, 2017).

Platform workers may face discrimination and harassment in some settings

Work-related discrimination in the highly diverse platform economy is a complex, multi-faceted topic, with outcomes often heavily dependent on the type of service provided and the workforce practices of a given platform. Nevertheless, several broad points emerge from the literature and are reviewed here. This is not intended as a comprehensive review but, rather, an illustration of ways in which platform work can foster or constrain discrimination based on gender or other grounds.

Firstly, platform work poses challenges for the application of the EU's gender equality and non-discrimination legislation, making it difficult for platform workers to prove discrimination on gender or other grounds. This is primarily due to the fragmentation of work into small tasks performed for different clients on an irregular basis (Countouris & Ratti, 2018). Such fragmentation makes it difficult to identify comparable workers or the sources of discrimination when dealing with discrimination claims[40].

Secondly, to the extent that platform work enables anonymous interactions between workers and clients in virtual settings, this can help to reduce discrimination based on individual worker characteristics such as gender or ethnicity (De Stefano, 2016; Eurofound, 2019). However, many platforms regularly publish workers' personal information online, including their name, age, gender and photos. Where such information is available, it allows people to make decisions reflecting their own personal biases based on gender, ethnicity or other grounds (Rosenblat, Levy, Barocas, & Hwang, 2017; Schoenbaum, 2016). One US-based study found, for example, that Airbnb hosts from Asian backgrounds were found to earn 20 % less than their white counterparts. In some cases, platforms may even promote or enforce certain gendered choices by design or advertisement. For example, Lyft began as a ride-sharing service for women only, and in 2014, Uber 'offered a promotion in France for rides with "Avions de Chasse" ("hot chick" drivers) with the tagline "Who said women don't know how to drive?"' (Schoenbaum, 2016).

Thirdly, platforms often use reputation systems (such as customer ratings) to encourage worker accountability and inform customer choices (Rosenblat et al., 2017), but these may actually become a vehicle of customer bias. Research has found gender and ethnicity biases in the context of online market places (Ayres, Banaji, & Jolls, 2015; Doleac & Stein, 2013), in performance evaluations by managers (Castilla, 2008; Elvira & Town, 2001); in online evaluation of teachers (Mitchell & Martin, 2018) and in online hiring decisions (Uhlmann & Silberzahn, 2014). It is highly likely that such biases

[40] The scope of the new ILO Violence and Harassment Convention No. 190 is considerably broader than the workplace, covering, for example, individual exchanges with customers. Those are also covered by the anti-harassment provisions of the Goods and Services Directive. The process of authorising Member States to ratify the Convention is pending at the Council.

also creep into customer ratings of platform workers (Rosenblat et al., 2017), which may penalise workers for their gender, ethnicity and/or other characteristics. This is particularly concerning for those platforms where workers lack the ability to contest customer ratings, where reputation systems only apply to workers, with no possibility to flag problematic customer behaviour and where customer ratings directly affect workers' ability to continue using the platform (e.g. Uber) and/or their remuneration (e.g. Handy, n.d.[41]). For example, the system used by Uber to rate drivers enables customers to 'directly assert their preferences and biases in ways that companies would be prohibited from doing directly. In effect, [platforms] may perpetuate bias without being liable for it, as the grounds for firing or "deactivating" a particular driver may be derived from a large corpus of individual ratings, whose discriminatory character is currently impossible to verify or oversee by researchers external to the company' (Rosenblat et al., 2017, p. 8).

Finally, serious concerns have been raised about the prevalence of sexual harassment and gender-based violence in certain types of platform work, such as ride-sharing or home rental (see section 9.3.2). Beyond the immediate impacts on victims' mental and physical health, this is also likely to have broader labour market consequences. For example, a recent large-scale study of Uber drivers in the US shows that women drivers are less willing to drive in areas with higher crime and more drinking establishments, which contributes to the gender pay gap in ride-hailing (Cook et al., 2018).

Platform workers often lack access to key social and work protections, including parental leave

Due to the fragmented nature of their work and their self-employed/independent contractor status, many platform workers lack access to key social and work protections. While eligibility varies considerably by Member State, a substantial share of platform workers have little or no access to sickness and healthcare benefits, unemployment benefit, paid holiday entitlements, insurance against work-related accidents and illnesses, old age and invalidity benefits, and maternity and paternity benefits (Eurofound, 2018d; European Commision, 2019a; ILO, 2018c; Overseas Development Institute, 2019).

This is particularly an issue for those platform workers who do not combine platform work with other employment that provides them access to social and work protections. Available data on platform work as a sole source of employment is usually not gender disaggregated, but it may well be this is a more common situation for women than men – for example, men providing online services via platforms are more likely to do so to top-up income from other work than women (Adams & Berg, 2017). For a notable share of platform workers, social protection coverage is ensured via their main jobs in the traditional economy, but here women are observed to have less social insurance coverage than men (Behrendt, Nguyen, & Rani, 2019).

The lack of access to social protection linked to childbirth and care has a particularly strong gender dimension, as it limits women's ability to stay in employment and prevents more equal sharing of unpaid care responsibilities. According to a study by the European Commision (2015), only around half of self-employed women aged 15-49 were entitled to maternity benefits. EIGE's study on eligibility for parental leave (EIGE, 2020c) similarly found that in a number of Member States, access was lacking among people who are self-employed or without a stable employment relationship. Access to some other benefits is also likely to have a gendered dimension. For example, women's lack

[41] For example, see remuneration system on Handy: https://prohelp.handy.com/hc/en-us/articles/217290407-Payment-tiers

of access to old age and disability benefits may be particularly problematic, as they tend to live longer and to spend more years living with disabilities (EIGE, 2020a).

Platform workers' poor access to certain types of social protection, such as sick pay or unemployment benefits, has come to the fore during the COVID-19 pandemic[42]. This applies especially to workers for whom platform work is their main source of income and who were affected by work stoppages caused by various isolation and lockdown requirements (e.g. in on-location services such as ride-hailing or accommodation rental). A number of media reports detailed the problematic situation of these workers who, in the absence of statutory sick pay, were often faced with an extremely difficult choice between losing vital income or exposing themselves and others to health risks[43]. Initial evidence suggests that platforms took only limited steps to protect their workers. For example, only 5 in 120 platforms surveyed by Fairwork introduced some form of financial compensation for earnings lost due to COVID-19[44]. Early evidence also indicates that platform workers often could not access government income support schemes[45]. This highlights the importance of certain recent EU policy actions, such as the adoption of the proposal for a Council Recommendation on access to social protection for workers and the self-employed.

Low collective representation of platform workers can increase gender-based pay inequalities

Representation of platform workers by trade unions is generally weak, even if there are now some examples[46] of trade unions representing or supporting platform workers at Member State level (Eurofound, 2018d)[47]. Less formal worker-organised initiatives seem much more common (Eurofound, 2018d; ILO, 2018a).[48] One of the key obstacles to platform workers joining or organising unions is the fact that they are self-employed and are thus, in some jurisdictions, excluded from the right to collective bargaining (Eurofound, 2018d). Another complication is the piecemeal structure of platform work, which often relies on isolated workers with very limited communication with one another (Eurofound, 2018d; ILO, 2018a). Finally, the lack of job security is likely to inhibit workers' efforts to organise, as platforms often reserve the right to terminate workers' access to the platform without giving a reason (Eurofound, 2018d; ILO, 2018a).

Poor union coverage of platform workers is likely to have gendered consequences, for example in terms of pay. This is because women generally fare poorer in settings that rely on individual negotiations when it comes to pay (see section 9.2.5) (Barzilay, 2018; Barzilay & Ben-David, 2016; Piasna & Drahokoupil, 2017). Low worker representation can make it more difficult to resist platforms' exploitative practices that limit worker autonomy and flexibility (ILO, 2018a), in turn

[42] https://www.eurofound.europa.eu/publications/article/2020/coronavirus-highlights-sick-pay-void-for-platform-workers

[43] See for example, https://www.theguardian.com/technology/2020/mar/25/uber-lyft-gig-economy-coronavirus, https://www.theguardian.com/world/2020/mar/16/coronavirus-unions-attack-paltry-sick-pay-for-self-isolating-couriers or https://www.wired.com/story/covid-19-pandemic-aggravates-disputes-gig-work/

[44] https://www.transformationalupskilling.org/post/the-gig-economy-and-covid-19-fairwork-report-on-platform-policies

[45] https://voxeu.org/article/covid-19-inequality-and-gig-economy-workers

[46] For a more detailed list of initiatives, see: https://www.eurofound.europa.eu/data/platform-economy/initiatives#organisingworkers

[47] For a sample list of crowdworkers' unions, see: http://faircrowd.work/unions-for-crowdworkers/

[48] For example, online forums and social network groups available for workers on certain platforms (such as Amazon Mechanical Turk or Uber) to talk, support each other and share information; setting up worker-led organisations to promote workers' rights; or online protests against platform policies and strikes (often by workers providing ride-hailing and food delivery services).

making platform work less attractive for people (mostly women) with significant caring responsibilities.

Platform work in the care sector: opportunities and challenges

Platform work in the care sector has the potential to provide new solutions to some of care work's longstanding problems. In fact, platforms act as intermediaries, matching demand and supply more efficiently, minimising geographical distance and allowing both parties to select flexible work arrangements (Trojansky, 2020). It offers new opportunities for the provision of home-based care, which has become a priority in the process of 'deinstitutionalisation' in the EU (EIGE, 2020d). At the same time, however, platforms alone cannot resolve the vulnerability of care professionals, and their disadvantaged working conditions (Ticona & Mateescu, 2018b).

Care services mediated through platforms are usually performed by medium-skilled workers, who are often selected manually by users', rather than being matched with users entirely through algorithms (Eurofound, 2018b). Platforms therefore offer intermediation services between care demand and supply, replacing offline agencies (e.g. nanny agencies) and reducing transaction costs (Nurvala, 2015). This allows a closer personal relationship between the caregiver and care seeker over time, compared to the rapid one-off interaction typical of, for example, food delivery services (Trojansky, 2020). The composition of the workforce providing care via platforms reflects the overall care industry, being female-dominated (Eurofound, 2018b; Schwellnus, Geva, Pak, & Veiel, 2019).

The most striking difference between the provision of care services and most other types of services via platforms is the care industry itself, which is known for a high prevalence of irregular employment, informal and precarious work arrangements, heavy workloads and low wages. The workforce is predominantly female, mostly composed by women from a migrant background and often undocumented (EIGE, Forthcoming; Trojansky, 2020). The deprivation of social and employment protections observed in other types of platform work does not apply as strongly to care services mediated through platforms. In fact, platforms could introduce job formalisation and standard payment procedures, as well as increased market visibility for care workers (Ticona & Mateescu, 2018b). This new work paradigm thus has the potential to improve care providers' working conditions and remuneration, in sharp contrast with some other sectors (e.g. transport and food delivery), where digital employment undermined previously fair working arrangements and higher worker protection standards (Trojansky, 2020).

There are important limits to the potential for such positive transformation. The opportunities for improvement that platform work offers in terms of higher salaries and employment formalisation do not offset the risks. Extreme job flexibility can easily turn into uncertainty, given the lack of a stable employer and the absence of social security (due to workers' self-employed status) (Eurofound, 2018b). These risks are exacerbated by the fact that care workers are a vulnerable group, chiefly migrant women, who receive low wages, little to no social recognition and who carry heavy workloads. While platforms may bring about some improvements for these workers, they are unlikely to change the overall dynamic of exploiting cheap labour prevalent in the sector (Ticona & Mateescu, 2018b).

9.2.4. Digitalisation and work-life balance

The use of mobile devices, digitalisation of working processes and online communication allow for more flexibility in where and when people work. Flexible working arrangements typically relate to how much, when and where employees can work (Eurofound, 2017b; Laundon & Williams, 2018).

This flexibility in time and place is typically assumed to allow work to fit better around home and family responsibilities (Eurofound, 2020c). There is indeed evidence that the use of ICT (smartphones, tablets, laptops, desktop computers) to work outside of the employer's premises can help to facilitate better work-life balance. Workers report shorter commuting times, greater working time autonomy, more flexibility in working time, better productivity and improved overall work-life balance (Eurofound & ILO, 2017). There is evidence that mothers using flexitime and teleworking are less likely to reduce their working hours after childbirth (Chung & Van der Horst, 2018).

The European Commission's Work-Life Balance Directive (adopted in 2019) sees flexible working arrangements as one of the key tools to reconcile work and life for parents and carers and to contribute to the achievement of equality between women and men in the labour market. The Gender Equality Index 2019 showed that work-life balance challenges are closely linked to gender (in)equalities, and flexible working arrangements can increase gender-equal opportunities (EIGE, 2019c). A strong link was established between the domain of time (which measures gender equality in engagement in care and social activities) score and the availability of some flexible working arrangements, such as women's ability to set their own work hours.

The relationship between flexible working and work-life balance is not self-evident, however (Chung & Van der Lippe, 2018). The impact of using ICT and teleworking depends on how it is implemented - while regular home-based teleworkers show better work-life balance than those who always work at their employers' premises, highly mobile workers (i.e. with very extensive use of technology and no fixed working place) have poorer work-life balance. For parents or others with family responsibilities, the occasional opportunity to telework is particularly beneficial (Eurofound, 2020c)

The use of technology promotes work-life balance only under certain conditions (e.g. when childcare is available) and it carries major drawbacks and risks. Flexible and non-standard working arrangements may have negative impacts, depending on the kind of flexibility and employees' control over the working arrangements (EIGE, 2018b). Some studies show that working from home leads to more work/family conflict (Chung & Van der Lippe, 2018), while often going hand-in hand with working overtime (Eurofound, 2018e). Some evidence shows that working from home and flexible work schedules are more effective for single people, less so for families with children (Ten Brummelhuis & Van Der Lippe, 2010). The overall impact of flexible working arrangements on work-life balance is highly gendered (Chung & Van der Lippe, 2018), as is the actual use of flexible working arrangements. For instance, more women do regular home-based telework than their male partners in order to combine work and domestic demands (Eurofound, 2020c). This is presumably to accommodate their disproportionate burden of household work, despite also being in paid work (see the chapter on the domain of time).

The COVID-19 pandemic, and particularly the resulting quarantine, created a natural experiment, where the limits of extensive teleworking have been explored. By April 2020, 35 % of men and 39 % of women had begun to work from home due to the pandemic, while only 11 % of men and 10 % had done so previously. Among younger women (aged 18-34), as many as 50 % started working from home (compared to 37 % of men that age) (Eurofound, 2020b). The situation has shown the unused potential of technology, as well as the limitations of such arrangements for work-life balance. For instance, taken together with tele-schooling and closure of childcare facilities, it has intensified work-life conflicts for many families with children (Eurofound, 2020b)(Eurofound, 2020b)(ibid). Telework is evidently not a sustainable solution to solve shortage in care or other work-life balance policies.

The rest of this section investigates how technology-based flexibility supports or undermines workers' work-life balance. Again, the focus is on the ICT sector and platform work, where technology plays a particularly important role.

High flexibility and autonomy in ICT, but also more work-life spillover effects

The first condition for technology-driven flexibility to support work-life balance is workers' autonomy and control over their working time and place. The Work-Life Balance Directive foresees giving workers the right 'to request flexible working arrangements for the purpose of adjusting their working patterns, including, where possible, through the use of remote working arrangements, flexible working schedules, or a reduction in working hours, for the purposes of providing care.' In other words, the Directive calls for flexibility controlled by the employee, rather than the employer.

In the ICT sector, digitalisation provides the greatest opportunities for work that is flexible in both time and location (see section 9.2.3). In spite of above average flexibility and control over their working time, women and men in ICT are only slightly more satisfied with the fit between their working hours and other responsibilities: 87 % of women and 84 % of men in ICT view their working hours as fitting well or very well with their family or social commitments outside work, which is only somewhat higher than among other employed women and men (84 % and 79 %, respectively)[49].

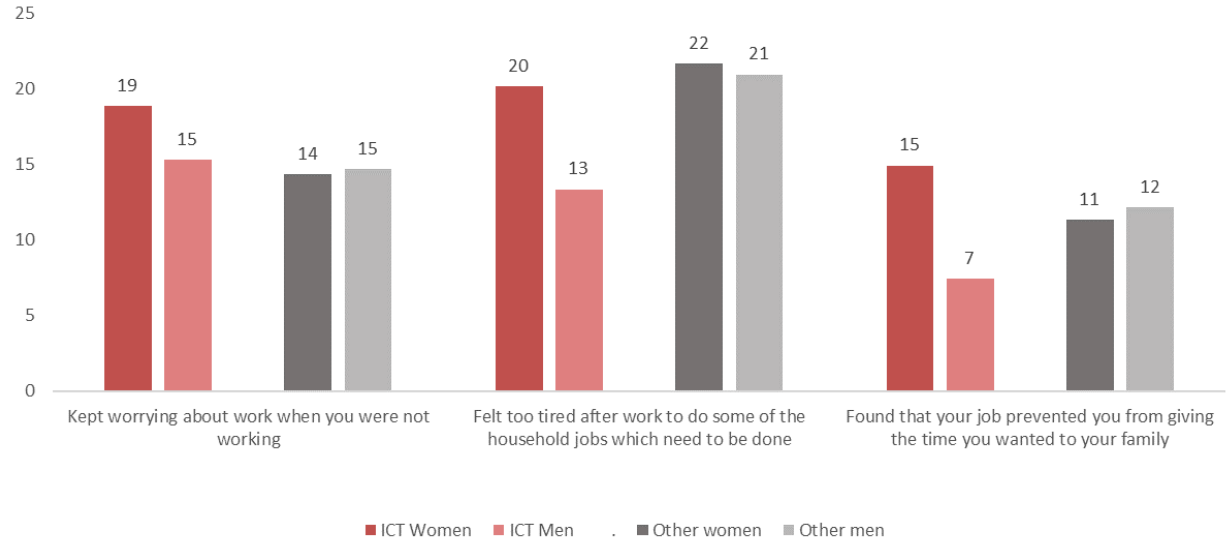
One reason may be that the use of technology can blur the boundaries between work and private life. Early on, temporal and physical boundaries existed between work and home (McCloskey, 2016), but digital technology has now created both the possibility and the expectation of being constantly online and available. The use of smartphones can create high after-hours availability pressure (Ninaus, Diehl, Terlutter, Chan, & Huang, 2015), difficulties with psychologically detaching from work during free time (Mellner, 2016), and can have a negative impact on work-life balance and stress levels (Harris, 2014). Personal demands by family members while teleworking at home can be made while working (McCloskey, 2016), which increase the need to multitask and blur boundaries (Glavin & Schieman, 2012; Schieman & Young, 2010).

Data suggests that this spillover effect is more often felt by women working in ICT than their male ICT peers or women in other sectors, although the differences are not dramatic (Figure 23). There may be several reasons for such gaps. One may be that women in ICT – like in the rest of the economy - hold primary responsibility for home and family affairs. This double burden may be particularly challenging while teleworking from home or with the requirement to be constantly available for

[49] EIGE calculations, EWCS 2015.

work. For men, however, the spillover effects are smaller when they work in ICT, compared to men in other sectors. Some studies indicate that women's motivation to work from home (or to take-up self-employment) is to obtain the flexibility and autonomy that will better accommodate work and family responsibilities, while men reported labour market and job-related motivations (Hilbrecht, Lero, Schryer, Mock, & Smale, 2017). Women's time tends to be fragmented and characterised by blurred boundaries between leisure time and unpaid care, with phenomena such as contamination (leisure time spent in the presence of children) and fragmentation (interruption of leisure time to care for children)(European Parliament, 2016).

Figure 23 Share of employees frequently perceiving spillover from work to home and family in the EU, by occupational group and gender (20-64, %, 2015)



Source: EIGE calculation based on EWCS 2015 microdata (Q45: How often in the last 12 months, have you …)

The slightly higher spillover felt by women working in the ICT sector is all the more remarkable, given that they are on average younger and have fewer daily or weekly childcare responsibilities compared to women working in other sectors. In 2015, 34 % of women and 28 % of men in the ICT sector cared for children daily, in comparison to 42 % and 25 %, respectively, in other sectors[50]. It has been suggested that younger generations of women working in ICT may delay having children, with the postponement of parenthood generally greater among women who work in higher paid jobs or non-standard contracts (EIGE, 2018b).

Several studies have shown that flexible working results in the expansion of the work sphere (Chung & Van der Lippe, 2018). Digitalisation can contribute to overall intensification of work and overworking (Peña-Casas, Ghaliani, & Coster, 2018), as can self-managing - workers with apparent high levels of autonomy work beyond their limits, burning out and severely harming their health and personal relationships (Pérez-Zapata, Pascual, Álvarez-Hernández, & Collado, 2016). Women experience work-related burnout more frequently than men, and feeling more emotional exhaustion, while men tend to feel burnout as depersonalisation (distancing themselves psychologically from clients and co-workers) (Purvanova & Muros, 2010). Working in male-dominated jobs may add to the overall stress for women, for reasons such as conflicting gender-role expectations of male-type

[50] EIGE calculationss for age group 20-64, EWCS 2015.

occupations while being female and a carer. Inconsistency between the requirements of women's work and gender roles may result in elevated role conflict (Purvanova & Muros, 2010).

Certain forms of platform work can support or undermine work-life balance

> *I can only work from home because my husband is away the whole day at work and I have to take care of my children and home.*
> (Respondent on CrowdFlower, Italy)
> Source: (ILO, 2018c)

Although platforms vary significantly in their design and the autonomy they provide to their workers, they are nevertheless often characterised by a higher degree of flexibility and autonomy than 'regular' work as employees. Indeed, flexibility of when and where to work is among the most significant reasons to pick up platform work (JRC, 2018). For example, women are more likely to perform online tasks via platforms because it is difficult for them to work outside the home, while men are more likely to do so to top-up income from their other work (Adams & Berg, 2017). 15 % of women and 5 % of men, working across five English-speaking microtask platforms, say they only can work from home due to care responsibilities (ILO, 2018c). One in five women had a child under five years old, while 30 % of women and 10 % of men platform workers were engaged in caring activities prior to taking up platform work. The flexibility of platform work provides opportunities to take up some work and to combine it with childcare and other care responsibilities.

As reflected in section 9.2.3, platforms vary significantly in the autonomy they afford their workers. The degree of control workers' have over their own working time, place and arrangements is the key to successful work-life balance. For example, platforms providing certain services (such as ride-hailing or clickwork) often adopt practices that limit worker autonomy and flexibility, especially for workers who rely on platform work as their main source of income (Eurofound, 2018b; ILO, 2018a). Employer-oriented flexibility - where either the platform or the client is in charge - creates unpredictable and unreliable schedules, often involving a considerable amount of unpaid time spent searching for work and the need to be available on-demand (Eurofound, 2018b; ILO, 2018a). This undermines work-life balance (Ropponen, Hakanen, Hasu, & Seppänen, 2019). Women have been shown to suffer particularly from higher work-life spillover effects of employer-oriented schedules (Lott, 2018), with negative effects on working time quality and increased stress levels (Eurofound, 2019). Directive 2019/1152/EU (European Parliament, 2019) on transparent and predictable working conditions is a direct follow-up to the proclamation of the European Pillar of Social Rights and states (among other things) that workers with very unpredictable working schedules (e.g. on-demand work) need reasonable notice of when work will take place.

> *I feel in control of the work but have no control over when work will be available.*
> Source: (ILO, 2018c)

Women often take up platform work alongside unpaid care work, and such arrangements may support work-life balance but may also present challenges. While platform work provides opportunities to take up jobs in between care and other responsibilities, highly flexible schedules may require complex logistics that involve commuting, pre-agreed appointments, or arranging childcare for a specific time, often at short notice. Arranging, scheduling, and providing childcare for on-call workers makes coordination of work and family responsibilities more difficult to sustain (Cherry, 2010; Harris, 2009). At the same time, fragmented and occasional work may perpetuate the gendered division of unpaid and paid work instead of questioning or challenging such arrangements. Women

may use it to take on small pieces of work around their caring responsibilities, while men may use it to top up their income from other employment or as a full-time employment source.

Platform work is not a systemic solution to gender inequalities in un/paid work

While full autonomy with no time constraints or rules on working time and arrangements makes platform work sound appealing, the downside to such freedom creates an 'autonomy paradox' (Huws et al., 1996; Pérez-Zapata et al., 2016; Shevchuk, Strebkov, & Davis, 2019). High autonomy and flexibility often lead to unsocial working hours (Ropponen et al., 2019) - platform workers often work unsocial hours (at evenings, nights, weekends) to optimise their income, match the time preferences of clients in different time zones, or meet work-life balance challenges. Nearly half of platform workers report working at night (43 % work between 10 p.m. and 5 a.m.) and in the evening (68 % work between 6 p.m. and 10 p.m.), either in response to task availability or due to other commitments. About 18 % of workers report working over two hours at night for more than 15 days per month (ILO, 2018c).

The same paradox applies to freelancers and independent contractors in general, and was pointed out long before platform work (Huws et al., 1996). Self-employed translators who seemed to be fully autonomous found that they actually had little or no control over their workflow and that their working times were externally driven by deadlines set by their clients (Huws et al., 1996). In 2017, translation was one of the most female-dominated area of platform work (JRC, 2018).

There is evidence that full autonomy of working arrangements leads to the highest degree of work-to-home spillover, higher even than for fixed and fully inflexible schedules. This is particularly true for men, mainly due to the increases in overtime hours men work when having working-time autonomy (Chung & Van der Lippe, 2018). People may set themselves unrealistic work schedules that lead to increased workload and eventually have negative consequences for work-life balance, health and well-being (Ropponen et al., 2019). There is a connection between working time and leisure time for recovery and sleeping. Keeping work and leisure time separate enables detachment from work during leisure time, which is important for recovery, particularly when the worker is heavily stressed (Ropponen et al., 2019).

> *I haven't really had a time when I rest. I don't know what holiday means. […] I also work when I am travelling. It is just that if you have regular clients, you need to do everything in order to keep them. And if you don't respond immediately to their emails then you can easily lose them. It is relatively harsh to be honest.'*
>
> Source: (Huws, Spencer, Coates, Sverre Syrdal, & Holts, 2019).

An ILO survey of workers performing online tasks via platforms shows that women with young children (0-5 years) spend on average about 19.7 hours working on platforms in a week, while men with small children work over 30 hours. 36 % of these women work at night (10 p.m. to 5 a.m.) and 65 % work during the evening (6 p.m. to 10 p.m). 14 % of women with young children reported working for more than two hours at night for more than 15 days in a month (ILO, 2018c).

While platform work can improve work-life balance, especially for parents, other carers or those who face other obstacles to their full participation in the 'traditional' labour market, it is necessary to ensure that it does not further polarise the labour market and marginalise these groups of people in

more precarious jobs. It cannot be seen as a substitute for proper support to carers or as a solution to the unbalanced division of care between women and men. It is important to point out that such arrangements – while being preferred and beneficial for some - may reinforce gender imbalances and inequalities in the labour market. Women who have heavy loads of care and other unpaid work take up 'job bites' around their care and home responsibilities, when in fact they would benefit more from proper care services and more balanced division of unpaid work at home. Work-life balance policies need to take this into account and provide comprehensive services and measures that support women's participation in work, rather than relying on women to take odd jobs in order to earn some income alongside their unpaid work.

9.2.5. Gender pay gap in ICT and platform work

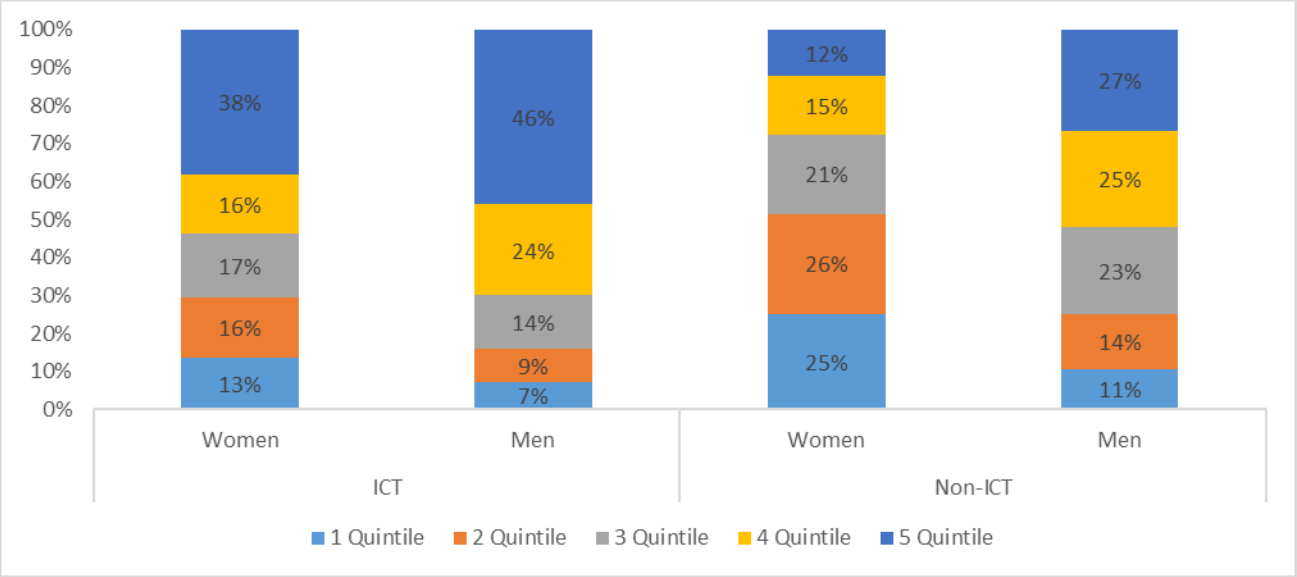
Despite recent policy actions at EU and Member State level, the gender pay gap persists. In 2018, on average, women's gross hourly pay was 14.8 % lower than men's (Eurostat, 2020). The pay gap stems from a combination of factors, including occupational and sectoral segregation, part-time or temporary work, gender stereotypes and norms, difficulties in reconciling work and private life, discrimination, opaque wage structures, and undervaluing of women's work and skills (European Commision, 2009, 2018a, 2018f). Major labour market biases, such as horizontal and vertical segregation in education and the labour market, are crucial factors underpinning the pay gap (EIGE, 2019d; Eurostat, 2018). A large share of the pay differences (around one-third) results from the fact that women and men work in different economic activities and occupations (Eurostat, 2018), with those that are female-dominated often underpaid and undervalued.

Both women and men are well paid in ICT but the gender pay gap persists

Attracting women to high-paid ICT and STEM jobs is seen as an important policy tool to reduce the gender pay gap (EIGE, 2019d). In these generally male-dominated jobs, the pay tends to be higher than in much of the EU labour market, including the equally high-qualified jobs in which women tend to work, such as in the health sector (EIGE, 2018b). In 2015, the average monthly income of both women and men working in ICT was higher than the average income of women and men working elsewhere (Figure 24). 70 % of men working in ICT fell into the top two income quintiles with their monthly income (52 % of men working elsewhere), compared to 54 % of women working in ICT (28 % of women working elsewhere)[51].

Figure 24 Income distribution of women and men working in ICT and non-ICT sectors (20-64, %), 2015

[51] EIGE calculations, EWCS 2015.



Source: EIGE calculations, EWCS.
Note: ICT definition as per EIGE ICT health study.

Despite earning more than other female workers, women in ICT have lower monthly earnings than men. This reflects gender differences in the average working hours of women and men, their different positions within the ICT sector, and differences in their hourly pay. In 2014 in the EU, the gender pay gap among ICT professionals and technicians was 11 %. This is among the lowest occupational gender pay gaps across the EU (EIGE, 2019d). In all Member States, the gender pay gap in the STEM sector is lower than the general pay gap, except in Ireland and Czechia (EIGE, 2019d). Overall, smaller gender pay gaps in occupations with very few women employees might not necessarily point to gender-equal opportunities but, rather, to large differences in educational qualifications (and thus pay) among the average employed women and men.

Gender pay gaps are often reproduced within the context of platform work

The general assumption has been that platform work will help to eliminate the gender pay gap and gender inequalities by improving women's access to the labour market (Barzilay & Ben-David, 2016). For instance, using gender-blind algorithms has the potential to promote equal access to jobs and more flexible work schemes that would allow women to assume dual roles as employees and caregivers (Barzilay & Ben-David, 2016; Liang, Hong, Gu, & Peng, 2018). 86 % of female platform workers in the US believe that gig work offers the opportunity to earn equal pay to their male counterparts (41 % of female gig workers believe that traditional work offers this opportunity) (Hyperwallet, 2017).

Recent studies suggest that the platform economy is not an easy remedy for the gender pay gap (Silbermann, 2020). Estimates vary, with studies showing a pay gap from 4 % in the EU online labour market (PeoplePerHour) (Gomez Herrera & Müller-Langer, 2019) to 7 % in Uber (Cook et al., 2018) to 20 % in Amazon Mechanical Turk (Adams, 2020). An ILO study of five platforms in 2017 showed mixed results, with women having a higher hourly pay rate than men on one platform (Microworkers), an almost equal pay rate on another (Clickworker) and a pay gap of between 5-18 % on other platforms (AMT, Crowdflower, Prolific) (ILO, 2018c). Just as in the 'traditional economy', a low gender pay gap may hide a number of imbalances, such as lower pay for

women despite their higher educational qualifications or skills. There is evidence that the wage gap is concentrated among women with young children, particularly when their domestic responsibilities impact their ability to plan and complete work online (Adams, 2020).

The ILO (2018c) study accounts for both the paid and unpaid work that underpins platform work - searching for tasks, taking unpaid qualification tests, researching clients to mitigate fraud and writing reviews, as well as unpaid or rejected tasks and tasks ultimately not submitted. In a typical week, both women and men spend about six hours doing unpaid tasks, while women (on average) do fewer hours of paid work (around 16 hours) compared to men (close to 20 hours) (ILO, 2018c).

Gender segregation and other gendered practices are common on platforms

Depending on the platform, pay inequalities can be due to several factors, including biased algorithms and behaviours – on the part of both workers and clients - that reflect broader biases in the traditional labour market. The segregation of the labour market is reflected in platform work, with the imbalanced division of care between women and men restricting women's choices more than those of men. Gender segregation within and between platforms (see section 9.2.2) persists, due to very strong gender stereotyping in platforms, with women more likely to be selected for female-type jobs (writing, translation) and less likely to be selected for male-type jobs (software development) than equally qualified male candidates (Galperin, 2019).

There are some signs that customer ratings – which often impact pay levels (ILO, 2018c) - can discriminate on racial and gender grounds (Rosenblat et al., 2017), favouring men over women (Kim, 2018). Hannák et al. (2017) report that workers' race and gender impact the social feedback that they receive, although the impact is different on each platform. A survey carried out in the US showed that one-third of female platform workers adopted a gender-neutral username in order to maintain anonymity (Hyperwallet, 2017). However, data from an online crowdworking platform in which workers' gender is not revealed to the employer, shows that women earned on average 82 % of men's earnings (Adams & Berg, 2017). This shows that while direct gender discrimination may have a role to play in pay inequality, other factors are also at play.

Studies often conclude that women's behaviour and personal choices in doing platform work are the reason for their unequal pay (Liang et al., 2018). A study on Uber concluded that the pay difference experienced by women and men was explained by the fact that men drove faster, allowing them to complete more rides per hour. Men were also more likely to drive in less safe areas and during times that yielded a higher fee (Cook et al., 2018). Similar reasons were given to explain older drivers' (aged 60+) earning almost 10 % less than drivers who are 30 years old (Cook et al., 2018). Where platform workers themselves set the pay, women tend to set their rates at lower levels (Barzilay & Ben-David, 2016; Liang et al., 2018) and, in general, take up lower paid jobs (Foong, Vincent, Hecht, & Gerber, 2018). While the cause is not entirely clear from the available research, it is likely due to women's lower propensity to negotiate salary, alongside gendered expectations of remuneration (among both workers and employers) (Piasna & Drahokoupil, 2017).

The explanation for lower pay cannot be reduced to individual behaviour. There is a structural bias in the gender division of unpaid work and care, restricting women's choices in the labour market in general, including platform work. For instance, women appear less able to select longer, more complex tasks - some of which require a quiet working environment - because of interruptions from young children or adult family members (Adams & Berg, 2017). The platform may prefer to allocate

work to those with higher ratings, restricting the ability of those with lower ratings to make a decent living (Ropponen et al., 2019). This disadvantages those who are working fewer hours, particularly women with care responsibilities, or those with poor health. A study of the Amazon Mechanical Turk platform showed that women earned 20 % less per hour on average, with half of the gap explained by the fact that women have more fragmented work patterns, with consequences for their task completion speed (Adams, 2020). Weak collective representation of platform workers (see section 9.2.3) prevents efforts for collective salary negotiation, often leaving the responsibility for salary negotiation to workers. This is likely to put women at a disadvantage, as discussed above.

9.3 Broader consequences of digitalisation

While earlier chapters discussed digitalisation primarily within the context of work, knowledge and skills, some technological trends have broader implications for gender equality. The availability of high computing power and broadband connections, the emergence of 'big data', cloud computing, robotics, AI algorithms and other digital trends have transformative potential for healthcare systems, public transport and other public services, new generation of products and services, a more sustainable and eco-friendly economy, and better informed public policies. However, largely positive discussions about the impact of digital technologies often lack assessments of their broader social, economic and political implications, especially from a gender perspective.

This chapter aims to close this gap by discussing three broad trends in digitalisation that may have significant consequences for gender equality: (1) the ever-increasing use of AI algorithms; (2) ways in which digital technologies may enable violence against women in the context of work; (3) the potential of digital technologies to transform the world of care.

9.3.1 Digitalisation and equal rights – the role of AI algorithms

AI is being developed at an unprecedented rate, with decision-making algorithms becoming an intrinsic part of our everyday lives. AI refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely software-linked, acting in the virtual world (e.g. voice assistants, image analysis software, search engines, speech and face recognition systems) or AI can be embedded in hardware devices (e.g. advanced robots, autonomous cars, drones or IoT applications) (European Commision, 2018b). AI systems have the power to create an array of opportunities for European society and the economy but also pose new challenges. The increasing use of AI in every aspect of people's lives requires reflection on its ethical implications and assessment of potential risks, such as algorithmic gender bias and discrimination.

AI has been high on the EU agenda since the European Commission launched the European Strategy on Artificial Intelligence, which set the basis for discussions on a coordinated EU approach to address the challenges and opportunities of these new technologies (European Commision, 2018b). In her political guidelines, the Commission President highlighted the need for a coordinated European approach to the human and ethical implications of AI while prioritising investments (von der Leyen, 2019). In 2020, the Commission's 'White Paper on Artificial Intelligence' proposed a policy framework for the creation of a dynamic and trustworthy AI industry. It recognised the need to increase the number of women trained and employed in this area, as well as the risk of bias and discrimination against women by AI systems (European Commision, 2020c). In the EU Gender Equality Strategy 2020-2025, the Commission reiterated the importance of AI as a leading driver of economic progress

and the relevance of women as creators and users in order to avoid gender bias (European Commision, 2020b).

Gender bias in AI puts gender equality at risk

There is growing concern that AI tools may be harmfully biased against certain groups, determined by characteristics such as gender, ethnicity, age or disability. Existing biases within society, organisations and individuals - particularly those engaged in the development of AI - can be built into the systems and algorithms, with or without intent. The lack of gender diversity in the science and technology workforce (see section 9.1.3), especially in sectors developing digital technologies, has been credited with enabling and aggravating explicit and implicit gender biases embedded in digital services and products (Wang & Redmiles, 2019). Recent research into gender biases in software development point to the fact that the needs of users whose characteristics (gender/age/disability) match those of the design team tend to be best served by the software (Burnett et al., 2018).

Algorithms, an automated data processing technique, are the basis of AI and require the right governance mechanisms. Automated decision-making is certainly helpful, but when it produces a gender-biased (or otherwise wrong) decision, detection could come too late or its decision could be impossible to change. The term 'black box' is used to describe how algorithms work – neatly encapsulating the fact that while inputs and outputs can be seen and understood, everything in-between - what happens inside the 'black box' - is unfathomable. The complexity of an algorithm is such that even full access would not bring any clarity as to how the output was created, not even for the developers of the algorithm themselves (Bathaee, 2017). This lack of transparency poses considerable challenges for the evaluation and regulation of algorithms, which are important, particularly for the community that will be ultimately affected by algorithmic decisions (Al-Amoudi & Latsis, 2019; Goodman & Flaxman, 2017).

The quality of data is an important risk factor for bias in AI. Unprecedented data availability, especially through online collection, has seen much attention paid to the quantity of data available rather than its quality. Problems may arise, such as accurate representation - when data does not represent the population intended - or in measurement - when data does not measure what it aims to (FRA, 2019). When it comes to algorithms, the correct input is a prerequisite for a correct output (known in data science as the 'garbage in, garbage out' principle). The use of data that reflects existing biases can lead to unfair treatment of certain individuals, resulting in discrimination based on gender, age, dis/ability, ethnic origin, religion, education and sexual orientation (LIBE Commitee, 2018).

Use of AI may have gendered consequences in a wide range of settings

Word embedding (a type of algorithm) is used to power translations and autocomplete features in everyday technology. These are trained on a body of data of ordinary human language, usually from online sources such as news articles (Bolukbasi, Chang, Zou, Saligrama, & Kalai, 2016; Caliskan, Bryson, & Narayanan, 2017). The real novelty of word embedding is that it tries to understand and calculate the relationship between words, instead of taking a word-by-word approach (Nissim, van Noord, & van der Goot, 2019). Alongside its innovative nature, word embedding is an example of how the blind application of machine learning risks amplifying gender bias. For instance, one study testing analogies resulted in 'man is to computer science as woman is to homemaker' (Bolukbasi et al., 2016). One use of this tool can result in gender bias against occupations that should be gender neutral, with

different results given when paired with 'he' (doctor) or 'she' (nurse) (Lu, Mardziel, Wu, Amancharla, & Datta, 2018). It is not gender bias alone that surfaces, but other problematic cultural associations, too. Fortunately, there is a push to develop tools to detect and eliminate such bias (Bolukbasi et al., 2016; Chakraborty, Badie, & Rudder; Lu et al., 2018; Prates, Avelar, & Lamb, 2019).

AI is increasingly used in hiring or pre-employment assessments, which constitute a clear determinant for economic opportunity for any individual (Bogen & Rieke, 2018; Metz, 2020). AI hiring tools not only offer employers reduced costs but might also help to address or mitigate bias, giving (more) equal opportunities to future and current employees. One of the selling points for such technology is the ability to assess candidates objectively, without human bias. However, if the algorithm is built without taking into account sensitive characteristics or learns from data of previous biased hiring decisions, it will reproduce institutional and systematic bias while providing the appearance of objectivity (Bogen & Rieke, 2018; Raghavan, Barocas, Kleinberg, & Levy, 2020). Such cases have already appeared in the labour market: recently, several US companies were found to use algorithms that disadvantaged women candidates, having learned from the hiring history of a company and failed to identify relevant and sensitive characteristics from the data, thus reinforcing gender bias and segregation (Dastin, 2018). The potential for AI to correct discrimination and deliver workplace diversity is undeniable but it can only be fully put to use through awareness, transparency and oversight.

AI has substantial potential to change healthcare through the increasing availability of data and analytical techniques. AI can learn from a large volume of healthcare data, self-correcting to improve its accuracy and the accuracy of medical diagnoses and therapy, all while providing the latest medical information to health professionals (Jiang et al., 2017). However, medical research is a field historically lacking gender sensitivity, where the low representation of women in clinical research has translated into gender-blind or biased healthcare services (EIGE, 2020a). When applying AI to the healthcare sector, bias may arise from the data used to create, train and run the algorithms, while limitations of the AI tool can easily translate into inaccurate, incomplete or skewed results. The complexity of the systems makes it difficult to identify and regulate discriminatory practices, despite their widespread use and the potential to worsen lives. The absence of gender analysis in designing, implementing and evaluating the application of AI in health policy can result in existing health and gender inequalities being overlooked, or new inequalities being created (Sinha & Schryer-Roy, 2018).

9.3.2 Gender-based violence enabled by digital technology: a new occupational hazard?

The use of digital technologies has become an integral part of the professional lives of women and men across various work circumstances. It is therefore logical that common experiences affecting women in the workplace, such as sexual harassment, are increasingly mediated by digital technologies (European Commision, 2019d; European Parliament, 2018a, 2018b). Online abuse affecting women in their work context is getting increased attention from both researchers and policy makers (Council of Europe, 2016; European Commision, 2019d; European Parliament, 2018a, 2018b). While the magnitude of the phenomenon is unknown, a FRA survey on violence against women asked respondents about their experience of online gender-based violence. While 14 % of women who experienced such harassment could not identify the perpetrator, 9 % were harassed by someone from their work context (FRA, 2014). This section will highlight two forms of violence affecting

women at work that are enabled by digital technology: online abuse of women public figures and gender-based violence affecting platform workers.

Online abuse against women active in the public sphere

Section 9.2.1 highlighted that 9 % of employed women and 11 % of employed men use social media in the context of their work. Increasingly, various industries including media, politics, arts and culture, public administration and academia expect or require their employees to maintain a strong online presence. In this context, insults, defamation, threats and hate speech are enabled and facilitated by digital technologies. While abuse against public figures predates the emergence of digital technologies, the volume of abuse and increased anonymity are strong enabling factors. Such abuse disproportionately affects women, people of colour and members of the LGBTI community, all of whom are attacked for their personal characteristics (gender, ethnicity, sexual orientation) while abuse directed at men from the dominant group is more often based on their opinion or status in society (FRA, 2017).

Most of the literature on online abuse against women in professional contexts covers journalists (Edstrom, 2016; European Parliament, 2018b; Ferrier & Garud-Patkar, 2018; Henrichsen, Betz, & Lisosky, 2015; Posetti, 2017; Rego, 2018), political figures and human rights' defenders, including feminist activists (Inter-Parliamentary Union, 2018; Lewis, Rowe, & Wiper, 2017) and academics (Kavanagh & Brown, 2019). A 2018 study by the Inter-Parliamentary Union in 45 European countries found that over half of the women parliamentarians and parliamentary staff interviewed (58 %) experienced sexist attacks on social media, including repeated misogynistic insults and incitement to hatred, nude photomontages or pornographic videos. This was the leading form of gender-based violence experienced by study respondents but fewer than 10 % of them had reported the incidents. Half of the respondents (47 %) had experienced death or rape threats. In the majority of cases (76 %), the perpetrators were anonymous males (Inter-Parliamentary Union, 2018).

In other instances, attacks are orchestrated by peers to humiliate and degrade the professional reputation of women in their fields[52]. Other cases include cybermob harassment against female journalists, where users of online forums - mostly young men - are called to collectively attack a specific individual through digital means (Edstrom, 2016; European Parliament, 2018b; Ferrier & Garud-Patkar, 2018). Such forms of abuse exemplify the potential scale of online harassment, with thousands of insults and threats received in a few hours (FRA, 2016).

Online violence is used against women in positions of power, especially where they are young or belong to an ethnic or sexual minority, in a bid to delegitimise their power and influence (Lehr & Bechrakis, 2018; Zeid, 2018) and to reaffirm the notion that they do not belong in public spaces (FRA, 2017). Literature reveals the far-reaching impact of abuse on women's professional and personal lives, with many affected women choosing to opt-out of certain social networks despite their usefulness in their profession, to write only anonymously, to avoid disseminating their work and to withdraw from an exposed profession altogether.

Abuse of women online is so rampant that witnessing abuse can affect young women's online behaviour and affect their likelihood of considering a career in public affairs. After witnessing or

[52] Recent examples include secret online groups of French male journalists using social networks such as Twitter to harass fellow journalists, especially women, gay men and men from ethnic minorities, in a bid to compromise their career opportunities (Breeden, 2019).

experiencing online hate speech or abuse, 51 % of young women and 42 % of young men in the EU hesitated to engage in social media debates, out of fear of experiencing abuse, hate speech or threats. Cyber harassment from peers and strangers often makes young people, especially girls, less willing to be politically active online (EIGE, 2019a).

Women platform workers placed at risk

Section 9.2.3 examined how the emergence of platform work and the gig economy has shifted some of the traditional power dynamic between employers and employees (De Stefano, 2016; Johnston & Land-Kazlauskas, 2018). With the employment status of workers in the platform economy shifting towards 'independent contractors', for many workers, power relations are now between 'service provider' and 'service purchaser', i.e. between platform workers and users/clients, mediated by technology (Drahokoupil & Fabo, 2016; Overseas Development Institute, 2019). The sense of impunity and anonymity given to clients of 'on demand' platforms has been seen as placing vulnerable workers in a precarious situation, including putting them at risk of gender-based biases, discrimination and abuse (Van Doorn, 2017).

Although there is a lack of quantitative data on the abuse and violence experienced by women platform workers, research has highlighted ways in which women engaged in the platform economy are exposed to risk of violence from users. This is particularly the case in roles where platform workers interact with users and clients in enclosed spaces with no third party present, such as ride-hailing, home-sharing or personal and household services (Overseas Development Institute, 2016, 2019; Schoenbaum, 2016; Ticona & Mateescu, 2018a).

Women working in these sectors are routinely exposed to the risk of sexual harassment and assault, and the physical and sexual abuse of women platform workers is often facilitated or enabled by certain aspects of platform design and terms of services. For example, rewarding platform workers with the most detailed profile encourages them to share a significant amount of private information, such as their name, location, age, photograph for users to use as selection criteria (Ticona & Mateescu, 2018a). Some platforms also prevent workers from accessing information that would help them to assess the safety of a 'gig' before accepting it, a strategy referred to as 'information asymmetry'. As described by Van Doorn (2017) , 'the orchestration of information asymmetries that skew power relations to the advantage of requesters rather than workers. The provider interface usually offers very minimal information about service requesters and frequently even the most basic information becomes available only after the provider has accepted the request and thus commits to taking on the gig' (Van Doorn, 2017, p. 902). Similarly, workers are usually prevented from accessing other workers' ratings on particular clients (in the rare cases where clients can be rated), which can limit workers' ability to avoid risky encounters with clients already identified as abusive. Turning down tasks or gigs for safety concerns can also lead to women platform workers receiving negative ratings, which can decrease pay or lead to suspension (see section 9.2.3).

While some platforms have reacted to the safety concerns of female users and service providers by offering possibilities of women-only interactions or through increased outreach to women platform workers (Schoenbaum, 2016), these efforts are considered insufficient. Accounts from female drivers in ride-hailing contexts highlight that sexual harassment is a systemic issue for women drivers and determines their driving behaviour, including avoiding night-time and certain areas as a way to

minimise risk (Rapier, 2019). They also point to the inaction of platforms in preventing or addressing incidents of gender-based violence (Sainato, 2019).

Digitally-enabled violence against women affects women very differently depending on their professional circumstances. Notwithstanding this variation, it is testing the limits of legal instruments of both occupational safety (ILO, 2017) and gender-based violence prevention (Council of Europe, 2011).

9.3.3 New technologies and care

In coming years, the number of people needing long-term care will increase, given the ageing population and increasing life expectancy across the EU (EIGE, 2020d; Iancu & Iancu, 2017; Stavrotheodoros, Kaklanis, Votis, & Tzovaras, 2018). In order to contain costs and allow the long-term care system to sustain the pressure of growing patient numbers, independent living in any care setting (residential, home or community-based) is promoted. Policy solutions are being developed, together with technological options (Grabowski, 2006). The COVID-19 pandemic has emphasised the key role of the care sector in the good functioning of welfare states, and how a shortage of healthcare and long-term care professionals, as well as insufficient stocks of medical equipment, puts the safety of entire countries at risk. Technology-based solutions were at the forefront of public health strategies for containing the pandemic.

Assistive technology can improve long-term care

Assistive technology (AT) has been defined as 'any item, piece of equipment or product system, whether acquired commercially off the shelf, modified, or customised, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities' (Gamberini et al., 2006, p. 288). The application of AT solutions to the specific needs of an ageing population is called 'gerontechnology', in addition to which there are a wide range of general technologies that can be converted for use by elderly people, e.g. Alexa and Siri (Piau, Campo, Rumeau, Vellas, & Nourhashemi, 2014; Woyke, 2017). These solutions are designed to play a growing role in the provision of residential and formal home-based care while maintaining high quality standards (Koop et al., 2008; Micera, Bonato, & Tamura, 2008).

In practical terms, AT allows improved service provision by identifying individuals at risk (e.g. fall, isolation), monitoring health conditions through sensors, monitoring daily life activities (e.g. social and physical activities), helping to manage daily tasks, and developing a safer environment (Iancu & Iancu, 2017; Medrano-Gil et al., 2018). The greatest advantage of these devices is their ability to collect large amounts of data from the environment, thus interacting with patients in a smart way, providing personalised interventions and improving service efficiency (Medrano-Gil et al., 2018). AT's benefits thus go beyond the medical sphere, increasing people's independence, facilitating social interaction and access to information, and reducing loneliness and isolation (Iancu & Iancu, 2017).

Women are the primary beneficiaries of these technological innovations, as they are significantly more likely to be in need of long-term care. In fact, despite their longer life expectancy, they spend fewer years living in good health compared to men, and are more likely to develop health problems and live with disabilities (EIGE, 2020b). Longer life expectancy, combined with the fact that women tend to marry older men, means that they often outlive their partners and, unlike men, are unable to count on their spouses' assistance during their later life stages (Bisdee, Daly, & Price, 2013; Markson & Hollis-Sawyer, 2000). AT is therefore an incredibly valuable resource for providing long-term care

to older women living alone, as it allows medical professionals to improve standards of home-based care without relying on formal care institutions.

Technology can alleviate women's 'caregiver burden'

Technology presents many advantages for the well-being of care recipients, but even more for caregivers. Caring (paid or unpaid) for an old person takes a considerable toll on the caregiver's welfare, at a physical, psychological and emotional level. The phenomenon is known as 'caregiver burden' and it encompasses a wide range of symptoms, including physical and mental health problems, financial problems, social isolation, depression, anxiety, fear, task difficulty, stress and burnout (Lopez-Hartmann, Wens, Verhoeven, & Remmen, 2012; Madara Marasinghe, 2016). Poor caregiver well-being has direct consequences for the care seeker as well, who ends up not receiving the appropriate assistance (Madara Marasinghe, 2016). Several studies have confirmed that the use of ICT-based solutions can significantly alleviate caregiver burden by taking on some of the care tasks (Lopez-Hartmann et al., 2012; Madara Marasinghe, 2016). For example, digital solutions are a substantial support to people with Alzheimer's disease (AD), helping caregivers to better understand the disease process and to manage critical situations more effectively (Martínez-Alcalá, Pliego-Pastrana, Rosales-Lagarde, Lopez-Noguerola, & Molina-Trinidad, 2016). Such technologies can also help caregivers to monitor the status of frail old people. Starting with the data they collect, these devices can conduct physical activity tracking, fall risk assessment, isolation risk assessment, behavioural analysis (to assess cognitive decline), outdoor tracking (using walking patterns to detect erratic navigation as an indication that the user is lost) (Medrano-Gil et al., 2018). Having access to this kind of information can significantly support caregivers in their daily activities and alleviate the burden imposed by such care.

This positive effect is highly relevant to gender equality, as women are the majority of caregivers, across all care settings (ILO, 2018b). It is estimated that in the EU, only 17 % of social workers who provide home-based professional care to people with disabilities and to older people are men (EIGE, 2020d). The caregiver burden is especially heavy for those who are not professionals: the mothers, daughters, wives and sisters who are required to interrupt or give up entirely their professional career to reinvent themselves as unpaid caregivers when a member of the family needs assistance (Martínez-Alcalá et al., 2016). Forthcoming EIGE research highlights how the gender care gap is the 'missing link' in the analysis of the gender pay gap and gender inequalities in the labour market generally (e.g. labour market participation, quality of employment). Technology could help to decrease the disproportionate amount of care work for which women are responsible and thereby reduce gender inequalities in the overall economy (EIGE, Forthcoming).

Technology and the healthcare sector during COVID-19

During the COVID-19 pandemic, technology was effectively deployed to track and trace the spread of the virus among the population in order to plan the most suitable medical response. In France, for example, some online platforms were developed for remote monitoring of infected patients isolated at home (e.g. COVIDOM and COVID AP-HM). These services were designed by local health precincts to aggregate and analyse data submitted twice a day by patients, and helped to provide adequate interventions tailored to the needs of the community (Mouterde, 2020). Data collection

through devices such as smart thermometers proved to be one of the greatest advantages of technology, as the optimal allocation of scarce resources was a key determinant of success in containing the emergency (Statucki, 2020).

Another crucial application of digital technology was the possibility to monitor and treat patients with mild symptoms remotely, without exposing healthcare professionals directly to the risk of contagion. One of the biggest challenges of COVID-19 was the high infection rate among doctors and nurses, causing a medical staff shortage in several countries (Nugent, 2020). Given its highly contagious nature, some healthcare facilities placed sensors under patients' pillows to monitor their status, reducing human contact to the minimum.

COVID-19 played a crucial role in shedding light on the dire working conditions faced by healthcare workers across the EU, most of whom (76 %) are women. They bear heavy workloads, long shifts (including nights and weekends) and physically demanding tasks, for very low wages. The little economic value assigned to care is due to cultural norms (care is stereotypically considered women's natural role within the household, not valued as 'work'), as well as cutbacks in public spending, which translate into low wages across the whole care industry (ILO, 2018b). In addition, during the pandemic they were disproportionately exposed to the risk of infection and were asked to reduce their time off in order that hospitals might cope with the increased workload. Here, technological solutions were essential in helping them to face these challenging circumstances and secure safe work arrangements insofar as possible.

10. Concluding remarks

Using and developing digital technologies

Digitalisation has a profound effect on the lives of women and men. Together with new opportunities and high social transformational potential, digitalisation carries the promise of change for gender relations. Yet, rapidly evolving technological innovations remain strongly embedded in pre-existing gender stereotypes and biases. Too few women are engaged in high-technology industries, research and innovation. Here, even when women are recruited, they face gender prejudices and work-life balance strains that contribute to the gender pay gap and to horizontal and vertical segregation. It is imperative to take measures to actively shape digital change and use the potential of digitalisation in a way that promotes gender equality and women's rights across all aspects of social, economic and political life.

The impacts of digitalisation on gender equality have rarely been explicitly recognised in EU digital policy, although, as shown in this report, societies with greater equality between women and men also perform better in the digital economy. The new Gender Equality Strategy 2020-2025 reaffirms the EU commitment to integrating gender perspective in all major European Commission initiatives, including the digital transition (European Commision, 2020b). The EU has recognised that fighting gender bias and opening new jobs for women in high-technology industries is a question of innovation, social equality and justice that requires targeted interventions across all levels of education, up to and including the highest stages of research careers. Crucially, integration of the gender dimension in digital transition is a way to increase the responsibility and trustworthiness of new technologies and digital innovation. Current initiatives to bring more women into the ICT sector

and address specific labour market needs can be considered an initial step in addressing the digital gender divide.

Gender differences in digital skills and use of digital devices, particularly among young people, are gradually levelling out. Young women and men are the most digitally skilled generation and benefit equally from digital skills. The gender divide widens with age, however. Women generally experience bigger obstacles than men in developing or updating their digital skills. Although women are more likely to participate in learning than men, they consistently report that they cannot participate in in lifelong learning due to their family responsibilities.

Women tend to indicate somewhat lower confidence in their digital skills and use of technologies. Despite representing 58 % of tertiary graduates in the EU across all study fields, women make up only 19 % of graduates in ICT-related fields. Gender stereotypes affect young people's career aspirations and occupational choices, leading to gender segregation in education and subsequently in the labour market.

The Digital Education Action Plan and the Updated Skills Agenda for Europe provide a promising basis to address gender stereotypes in relation to the use of digital technologies and take concrete measures to address the gender gap in digital skills and competences, including in self-confidence. It is necessary to take steps to prevent and combat gender stereotypes and gender segregation in education, as well as to raise awareness of the empowering potential of digitalisation.

Further analysis of intersectional inequalities in the acquisition of certain digital skills (problem-solving and software skills) is needed, especially given the fast pace of digitalisation and risk of exclusion. This is particularly relevant in closing the gender gaps for older and low-educated groups. Lack of training is another obstacle to increasing and updating digital skills for women and men, highlighting the importance of increased attention and resources for digital skills training.

The European Commission and the Member States have made some progress in implementing gender targets and quotas in research and innovation. However, the gender differences at higher levels of scientific careers remain striking. The EU and national government bodies should maintain and reinforce the structural change approach as a sustainable policy framework for integrating gender equality in research and innovation. Research and innovation organisations, together with funding organisations and the business sector, need to take specific action to overcome persistent gender gaps in scientific careers and ensure gender balance in decision-making. Equally crucial is the integration of gender analysis into all phases of research, from deciding which technologies to develop, to gathering and analysing data, and transferring ideas to market. The EU has recognised the concept of 'gendered innovations', which refers precisely to the potential to radically alter scientific knowledge and technological production by introducing gender perspectives, approaches and methodologies (European Commision, 2013; Schiebinger, Klinge, Sánchez de Madariaga, Schraudner, & Stefanick, 2011). The untapped potential of talented female scientists, alongside gender-blind research, prevents full realisation of technological and scientific advances.

Digital transformation of the world of work

While gender segregation in research and innovation receives some attention in EU policy, the impacts of digitalisation on gender equality in the labour market are frequently overlooked. This is striking, as digitalisation brings about a profound labour market transformation, with many jobs

automated or reorganised, often along highly gendered sectoral or occupational lines. Notably, women are at a slightly higher risk of job loss due to automation, many new jobs emerging in the context of this transformation are concentrated in male-dominated sectors (ICT, STEM), and much of the benefit may end up in the hands of the wealthiest capital owners (primarily men).

Yet, digitalisation of work holds some prospects for gender equality. It offers opportunities to break down old patterns of segregation, to upskill certain low-skilled jobs usually held by women (with associated rises in pay), and to contribute to a more balanced distribution of paid and unpaid work among women and men. For such benefits to be realised, a number of policy interventions are needed. Firstly, it will be necessary to ensure gender equality in support of workers displaced by digitalisation – historically, such policies were often inadvertently biased against women, focusing on industrial sectors dominated by men rather than the service sector. Secondly, it will be necessary to involve women in the management of this transformation, for example by adopting the proposed Directive for gender balance on corporate boards to ensure women's representation in business leadership. Thirdly, the benefits of the transformation need to be broadly distributed among workers (e.g. through pay rises, expansion of employee ownership of businesses, and better collective representation of workers), rather than reaped solely by the wealthiest capital owners. Finally, efforts will be needed to make new job opportunities available to all, e.g. by breaking occupational gender stereotypes and promoting sustainable employment that allows good work-life balance. Ensuring full transposition of the Work-Life Balance Directive at Member State level will be a good starting point in this context.

Women may face other challenges than being substituted by machines, stemming primarily from some of the flexible modes of working that digitalisation enables, such as certain types of platform work. While flexibility can enable women with unpaid care responsibilities to undertake paid employment, it is often coupled with unstable working arrangements, including short-term, part-time and precarious forms of labour for the less privileged segments of the female workforce. These are associated with a lack of social protection, limited access to welfare entitlements (including benefits and paid leave) and worker exploitation. Such precarious employment is common in certain forms of platform work, with a range of consequences for gender equality. For example, exploited workers cannot fully enjoy the work-life balance benefits associated with increased work flexibility, lack of access to social benefits prevents workers from using maternity, paternity or parental leaves, and certain workforce management practices expose workers to discrimination based on gender and other grounds. To date, platform work seems to replicate rather than challenge the inequalities in the traditional labour market, such as the gender pay gap and segregation.

Alongside measures to promote the participation of girls and women in STEM and ICT education, policies should urgently address the lack of stable working arrangements, as well as work and social protections in the context of new forms of digitised work, such as platform work. More generally, it will be necessary to implement the ILO Decent Work Conventions and associated instruments to create a robust policy framework around the platform economy. This framework should be supported by high quality, gender-disaggregated data on platform work comparable across Member States. As yet, only piecemeal data from surveys with limited coverage is available, which severely limits the understanding of challenges faced by platform workers. Comprehensive, gender-disaggregated data would support more robust gender analysis of these challenges.

For the policy framework around platform economy to be gender-sensitive, it will need to ensure that.

1) traditional labour market policies to tackle pay gaps and gender segregation apply within the context of the platform economy;
2) EU gender equality and non-discrimination legislation applies to the platform economy to prevent discriminatory practices based on gender and other grounds;
3) platform workers have access to the social and work protections that are crucial for gender equality, such as parental leave or contributory pension schemes;
4) flexible working arrangements meet workers' work-life balance needs (and prevent exploitative practices that limit worker autonomy);
5) even the most vulnerable workers have decent working conditions, such as the migrant women who are the group meeting the sharp growth in the demand for domestic services provided via platforms.

Some steps have been taken in this direction, including highlighting the importance of mainstreaming gender into digitalisation policies in the Gender Equality Strategy 2020-2025, the provision of policy guidance and recommendations through the Commission's Communication 'A European agenda for collaborative economy', the adoption of a Council Recommendation on access to social protection for workers and the self-employed, and the adoption of the Directive on transparent and predictable working conditions in the European Union. However, these documents pay little attention to the different ways in which women and men are affected by the new forms of work. Much remains to be done if the principles of fair working conditions, access to social protection and gender equality, as outlined in the European Pillar of Social Rights, are to become a reality within platform work.

Broader consequences of digitalisation

The effects of digitalisation on women's and men's lives extend far beyond the worlds of work and education. The increased presence of highly powered AI technologies creates huge opportunities to transform our economy and society, but also recreates old risks and poses new challenges for fundamental rights and gender equality. A recent Commission Communication on Europe's digital future addressed both the challenges and the opportunities of digitalisation, highlighting that only trustworthy development of technologies can ensure sustainable growth and foster an open and democratic society. Further steps have been taken in this direction with the release of the AI White Paper, the Ethics guidelines for trustworthy AI and the European Data Strategy. However, scope for broader action remains, for example, in promoting the participation of diverse groups of women and men in the development of AI, or supporting and building the capacity of national equality bodies to detect and address discrimination in the context of digitalisation, especially AI.

More effort is required to combat cyber violence, which has become a common and often traumatising dimension of women's work and lives. The EU and all Member States' ratification of the Istanbul Convention would be a positive step forward. As the Convention does not cover the most pervasive forms of online violence, synergies with other Council of Europe conventions (Budapest Convention, Lanzarote Convention and their respective Committees) could be explored with respect to protection from, and prevention and prosecution of cyber violence against women and girls (EIGE, 2020a; European Parliament, 2018b). In line with data collection commitments enshrined in both the

Istanbul Convention and the Victims' Rights Directive, more emphasis should be placed on data collection to better grasp women's exposure to this form of violence and to design adequate responses. The inclusion of this form of violence in the upcoming EU-wide survey on gender-based violence will provide much needed information on women's experiences of cyber violence in different contexts.

AT solutions are likely to play a growing role in the provision of (in)formal home-based care. AT facilitates home-based medical and social care by monitoring health and daily life activities of care recipients and by creating better conditions for independent living. Broader use of AT is highly relevant from a gender equality perspective, as women account for 83 % of the social workers who provide home-based professional care to people with disabilities and older people. Women are also in greater need of long-term care as they live longer than men and are more likely to develop serious health problems. AT has potential to decrease the disproportionate amount of formal and informal care work that falls to women, but this alone is not sufficient. Work in the care sector is hugely devalued, underpaid and characterised by a high rate of precarious and irregular work. Improving working conditions and attracting more men into the care sector (to overcome horizontal segregation) are essential steps to guaranteeing more equity, not within the care industry alone but in the overall economy and society.

11. References

Adams, A. (2020). The Gender Wage Gap on an Online Labour Market: The Cost of Interruptions.

Adams, A., & Berg, J. (2017). When home affects pay: An analysis of the gender pay gap among crowdworkers. *Available at SSRN 3048711*.

Al-Amoudi, I., & Latsis, J. (2019). Anormative black boxes: Artificial intelligence and health policy. *Post-human institutions and organizations: Confronting the matrix. London: Routledge*.

Autor, D. (2015). Why are there still so many jobs? The history and future of workplace automation. *Journal of economic perspectives, 29*(3), 3-30.

Ayres, I., Banaji, M., & Jolls, C. (2015). Race effects on eBay. *The RAND Journal of Economics, 46*(4), 891-917.

Bailey, J., & Steeves, V. (2015). *eGirls, eCitizens: Putting Technology, Theory and Policy into Dialogue with Girls' and Young Women's Voices*: University of Ottawa Press/Les Presses de l'Université d'Ottawa.

Barzilay, A. R. (2018). Discrimination without Discriminating: Learned Gender Inequality in the Labor Market and Gig Economy. *Cornell JL & Pub. Pol'y, 28*, 545.

Barzilay, A. R., & Ben-David, A. (2016). Platform inequality: gender in the gig-economy. *Seton Hall L. Rev., 47*, 393.

Bathaee, Y. (2017). The artificial intelligence black box and the failure of intent and causation. *Harv. JL & Tech., 31*, 889.

Behrendt, C., Nguyen, Q. A., & Rani, U. (2019). Social protection systems and the future of work: Ensuring social security for digital platform workers. *International Social Security Review, 72*(3), 17-41.

Bergvall-Kåreborn, B., & Howcroft, D. (2014). Amazon Mechanical Turk and the commodification of labour. *New technology, work and employment, 29*(3), 213-223.

Bisdee, D., Daly, T., & Price, D. (2013). Behind closed doors: Older couples and the gendered management of household money. *Social Policy and Society, 12*(1), 163-174.

Bogen, M., & Rieke, A. (2018). Help Wanted: An Examination of Hiring Algorithms, Equity, and Bias. In: Upturn.

Bolukbasi, T., Chang, K.-W., Zou, J. Y., Saligrama, V., & Kalai, A. T. (2016). *Man is to computer programmer as woman is to homemaker? debiasing word embeddings.* Paper presented at the Advances in neural information processing systems.

Breeden, A. (2019). Facebook Group of French Journalists Harassed Women for Years. Retrieved from https://www.nytimes.com/2019/02/12/world/europe/la-ligue-du-lol-sexual-harassment.html

Burnett, M., Sarma, A., Mendez, C., Oleson, A., Hilderbrand, C., Steine-Hanson, Z., & Ko, A. J. (2018). Gender biases in software for problem-solving.

Caliskan, A., Bryson, J. J., & Narayanan, A. (2017). Semantics derived automatically from language corpora contain human-like biases. *Science, 356*(6334), 183-186.

Castilla, E. J. (2008). Gender, race, and meritocracy in organizational careers. *American Journal of Sociology, 113*(6), 1479-1526.

Cedefop. (2018). *Skills forecast: trends and challenges to 2030*. Retrieved from https://www.cedefop.europa.eu/en/publications-and-resources/publications/3077

Chakraborty, T., Badie, G., & Rudder, B. Reducing gender bias in word embeddings. *Online] Computer Science Department, Stanford University. Available: http://cs229. stanford. edu/proj2016/report/[Accessed: March 15, 2018]*.

Cherry, M. A. (2010). A taxonomy of virtual work. *Ga. L. Rev., 45*, 951.

Chung, H., & Van der Horst, M. (2018). Women's employment patterns after childbirth and the perceived access to and use of flexitime and teleworking. *human relations, 71*(1), 47-72.

Chung, H., & Van der Lippe, T. (2018). Flexible working, work–life balance, and gender equality: Introduction. *Social Indicators Research*, 1-17.

Cockburn, C. (1987). Machinery of dominance. *Capital & Class, 11*(2), 170-181.

Cockburn, C., & Ormrod, S. (1993). *Gender and Technology in the Making*: SAGE Publications Ltd.

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* (0898-2937). Retrieved from

Council of Europe. (2011). Convention on preventing and combating violence against women and domestic violence, Council of Europe Treaty Series - No. 210.

Council of Europe. (2016). Combating Sexist Hate Speech.

Countouris, N., & Ratti, L. (2018). The Sharing Economy and EU Anti-discrimination Law. In: Cambridge University Press.

Dao, M., Das, M., Koczan, Z., & Lian, W. (2017). Drivers of Declining Labor Share of Income. Retrieved from https://blogs.imf.org/2017/04/12/drivers-of-declining-labor-share-of-income/

Dastin, J. (2018, October 10, 2018). Amazon scraps secret AI recruiting tool that showed bias against women. *Reuters*. Retrieved from https://www.reuters.com/article/us-amazon-com-jobs-automation-insight/amazon-scraps-secret-ai-recruiting-tool-that-showed-bias-against-women-idUSKCN1MK08G

De Stefano, V. (2016). The rise of the just-in-time workforce: On-demand work, crowdwork, and labor protection in the gig-economy. *Comparative labor law and policy journal, 37*(3), 461-471.

Doleac, J. L., & Stein, L. C. (2013). The visible hand: Race and online market outcomes. *The Economic Journal, 123*(572), F469-F492.

Drahokoupil, J., & Fabo, B. (2016). The platform economy and the disruption of the employment relationship. *ETUI Research Paper-Policy Brief, 5*.

Edstrom, M. (2016). The trolls disappear in the light: Swedish experiences of mediated sexualised hate speech in the aftermath of Behring Breivik. *International Journal for Crime, Justice and Social Democracy, 5*(2), 96.

EIGE. (2017). *Economic benefits of gender equality in the European Union, Literature review: existing evidence and methodological approaches*. Retrieved from http://eige.europa.eu/sites/default/files/documents/ti_pubpdf_mh0116176ennpdfweb_20170516164243.pdf

EIGE. (2018a). Study and work in the EU: set apart by gender - Review of the implementation of the Beijing Platform for Action in the EU Member States. ISBN 978-92-9493-894-7. Retrieved from https://eige.europa.eu/rdc/eige-publications/study-and-work-eu-set-apart-gender-report

EIGE. (2018b). *Women and men in ICT: a chance for better work-life balance. Research note*. Retrieved from https://eige.europa.eu/publications/women-and-men-ict-chance-better-work-life-balance-research-note

EIGE. (2019a). *Gender equality and youth: opportunities and risks of digitalisation – Main report*. Retrieved from

EIGE. (2019b). Gender equality and youth: opportunities and risks of digitalisation. Beijing Platform for Action. Retrieved from https://eige.europa.eu/publications/gender-equality-and-youth-opportunities-and-risks-digitalisation

EIGE. (2019c). *Gender Equality Index 2019. Work-life balance.* Retrieved from https://eige.europa.eu/publications/gender-equality-index-2019-work-life-balance

EIGE. (2019d). *Tackling the gender pay gap: not without a better work-life balance*. Retrieved from https://eige.europa.eu/publications/tackling-gender-pay-gap-not-without-better-work-life-balance

EIGE. (2020a). *Beijing + 25: the fifth review of the implementation of the Beijing Platform for Action in the EU Member States*. Retrieved from https://eige.europa.eu/publications/beijing-25-fifth-review-implementation-beijing-platform-action-eu-member-states

EIGE. (2020b). Covid-19 and gender equality. Retrieved from https://eige.europa.eu/topics/health/covid-19-and-gender-equality

EIGE. (2020c). *Eligibility for parental leave in EU Member States*. Retrieved from https://eige.europa.eu/publications/eligibility-parental-leave-eu-member-states

EIGE. (2020d). *Gender Equality and Long-Term Care at home: Research note to the Croatian Presidency*. Retrieved from

EIGE. (Forthcoming). *Research Note to the German Presidency*. Retrieved from

Elvira, M., & Town, R. (2001). The effects of race and worker productivity on performance evaluations. *Industrial Relations: A Journal of Economy and Society, 40*(4), 571-590.

Eurofound. (2016). *What do Europeans do at work? A task-based analysis: European Jobs Monitor 2016*. Retrieved from https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1617en.pdf

Eurofound. (2017a). *Occupational change and wage inequality: European Jobs Monitor 2017*. Retrieved from https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1710en.pdf

Eurofound. (2017b). *Work-life balance and flexible working arrangements in the European Union*. Retrieved from https://www.eurofound.europa.eu/publications/customised-report/2017/work-life-balance-and-flexible-working-arrangements-in-the-european-union

Eurofound. (2018a). *Automation, digitisation and platforms: Implications for work and employment*. Retrieved from

https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef18002en.pdf
Eurofound. (2018b). Employment and working conditions of selected types of platform work. Retrieved from https://www.eurofound.europa.eu/publications/report/2018/employment-and-working-conditions-of-selected-types-of-platform-work
Eurofound. (2018c). *New tasks in old jobs: Drivers of change and implications for job quality*. Retrieved from https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/fomeef18004en.pdf
Eurofound. (2018d). *Platform work: Types and implications for work and employment - Literature Review*. Retrieved from https://www.eurofound.europa.eu/data/platform-economy/records/platform-work-types-and-implications-for-work-and-employment-literature-review
Eurofound. (2018e). *Striking a balance: Reconciling work and life in the EU*. Retrieved from https://www.eurofound.europa.eu/publications/report/2018/striking-a-balance-reconciling-work-and-life-in-the-eu
Eurofound. (2019). *Platform work: Maximising the potential while safeguarding standards?* . Retrieved from https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef19045en.pdf
Eurofound. (2020a). *Game-changing technologies: Transforming production and employment in Europe*. Retrieved from https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef19047en.pdf
Eurofound. (2020b). Living, working and COVID-19 dataset Retrieved from https://www.eurofound.europa.eu/data/covid-19
Eurofound. (2020c). *Telework and ICT-based mobile work: Flexible working in the digital age*. Retrieved from https://www.eurofound.europa.eu/publications/report/2020/telework-and-ict-based-mobile-work-flexible-working-in-the-digital-age
Eurofound, & ILO. (2017). *Working anytime, anywhere: The effects on the world of work*. Retrieved from https://www.eurofound.europa.eu/publications/report/2017/working-anytime-anywhere-the-effects-on-the-world-of-work
European Commision. (2009). *Opinion on the effectiveness of the current legal framework on Equal pay for equal work or work of equal value in tackling the gender pay gap*. Retrieved from https://ec.europa.eu/social/BlobServlet?docId=3176
European Commision. (2013). *Gendered Innovations: How Gender Analysis Contributes to Research. Report of the Expert Group "Innovation through Gender"* Retrieved from http://ec.europa.eu/research/science-society/document_library/pdf_06/gendered_innovations.pdf.
European Commision. (2014). *Mapping and analysing bottleneck vacancies in EU labour markets*. Retrieved from https://ec.europa.eu/eures/downloadSectionFile.do?fileId=8010
European Commision. (2015). *Non-standard employment and access to social security benefits. Research note 8/2015*. Retrieved from https://ec.europa.eu/social/BlobServlet?docId=15687&langId=en
European Commision. (2016a). *The Digital Skills and Jobs Coalition. Members Charter*. Retrieved from https://ec.europa.eu/digital-single-market/sites/digital-agenda/files/digital_skills_and_jobs_coalition_members_charter_0.pdf
European Commision. (2016b). *ICT for work: Digital skills in the workplace*. Retrieved from https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=44434

European Commision. (2017). Special Eurobarometer 460: Attitudes towards the impact of digitisation and automation on daily life. Retrieved from https://data.europa.eu/euodp/en/data/dataset/S2160_87_1_460_ENG

European Commision. (2018a). *2018 Report on Equality between Women and Men in the EU.* . Retrieved from https://op.europa.eu/en/publication-detail/-/publication/950dce57-6222-11e8-ab9c-01aa75ed71a1

European Commision. (2018b). *Artificial Intelligence for Europe*. (COM(2018) 237 final). Brussels Retrieved from https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe

European Commision. (2018c). *Employment and social developments in Europe: annual review 2018*.

European Commision. (2018d). EU-Startup Monitor. Retrieved from http://startupmonitor.eu/EU-Startup-Monitor-2018-Report-WEB.pdf

European Commision. (2018e). *Gender equality and the collaborative economy*. Retrieved from https://www.equalitylaw.eu/downloads/4573-gender-equality-and-the-collaborative-economy-pdf-721-kb

European Commision. (2018f). *Gender Pay Gap in EU Countries Based on SES (2014)*. Retrieved from https://ec.europa.eu/info/sites/info/files/aid_development_cooperation_fundamental_rights/report-gender-pay-gap-eu-countries_october2018_en_0.pdf

European Commision. (2018g). Pilot project monitors online vacancies for ICT specialists in real-time. Retrieved from https://ec.europa.eu/digital-single-market/en/news/pilot-project-monitors-online-vacancies-ict-specialists-real-time

European Commision. (2018h). *Women in the Digital Age*. Retrieved from Luxemburg: Publications Office of the European Union https://op.europa.eu/en/publication-detail/-/publication/84bd6dea-2351-11e8-ac73-01aa75ed71a1

European Commision. (2019a). *Access to social protection for workers and self-employed.* . Retrieved from https://ec.europa.eu/social/BlobServlet?docId=20982&langId=en

European Commision. (2019b). *Assessing the size and presence of the collaborative economy in Europe*. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/2acb7619-b544-11e7-837e-01aa75ed71a1

European Commision. (2019c). Digital Skills & Jobs. *Shaping Europe's digital future.* Retrieved from https://ec.europa.eu/digital-single-market/en/policies/digital-skills

European Commision. (2019d). #DigitalRespect4Her. Retrieved from https://ec.europa.eu/digital-single-market/en/digitalrespect4her

European Commision. (2019e). Final report of the High-Level Expert Group on the Impact of the Digital Transformation on EU Labour Markets. Retrieved from https://ec.europa.eu/digital-single-market/en/news/final-report-high-level-expert-group-impact-digital-transformation-eu-labour-markets

European Commision. (2019f). *Labour market and wage developments in Europe: annual review 2019*. Retrieved from https://ec.europa.eu/social/BlobServlet?docId=21904&langId=en

European Commision. (2019g). She Figures 2018. Gender in Research and Innovation. Retrieved from https://ec.europa.eu/info/publications/she-figures-2018_en

European Commision. (2019h). Women in Digital. *Shaping Europe's digital future.* Retrieved from https://ec.europa.eu/digital-single-market/en/women-ict

European Commision. (2019i). Women in Digital Scoreboard 2019 - Country Reports. *Shaping Europe's digital future.* Retrieved from https://ec.europa.eu/digital-single-market/en/news/women-digital-scoreboard-2019-country-reports

European Commision. (2020a). Special Eurobarometer 503: Attitudes towards the impact of digitalisation on daily lives. Retrieved from https://data.europa.eu/euodp/en/data/dataset/S2228_92_4_503_ENG

European Commision. (2020b). *A Union of Equality: Gender Equality Strategy 2020-2025*. (COM/2020/152 final). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2020%3A152%3AFIN

European Commision. (2020c). *White Paper on Artificial Intelligence - A European approach to excellence and trust*. (COM(2020) 65 final). Brussels Retrieved from https://ec.europa.eu/info/sites/info/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf

European Commission. (2016). Resolutions, recommendations and opinions. *Official Journal of the European Unione, 59*(C 484), 1. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2016:484:FULL&from=LT

European Parliament. (2016). Differences in men's and women's work, care and leisure time.

European Parliament. (2017). Report on working conditions and precarious employment (2016/2221(INI)). Retrieved from https://www.europarl.europa.eu/doceo/document/A-8-2017-0224_EN.html

European Parliament. (2018a). *Bullying and sexual harassment at the workplace, in public spaces, and in political life in the EU. A study requested by the FEMM committee*. Retrieved from http://www.europarl.europa.eu/RegData/etudes/STUD/2018/604949/IPOL_STU(2018)604949_EN.pdf

European Parliament. (2018b). *Cyber violence and hate speech online against women. Women's Rights & Gender Equality. A study for the FEMM committee*. Retrieved from http://www.europarl.europa.eu/RegData/etudes/STUD/2018/604979/IPOL_STU(2018)604979_EN.pdf

European Parliament. (2019). *Directive (EU) 2019/1152 of the European Parliament and of the Council of 20 June 2019 on transparent and predictable working conditions in the European Union*. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019L1152

Eurostat. (2018). *A decomposition of the unadjusted gender pay gap using Structure of Earnings Survey data. 2018 edition*. Retrieved from https://ec.europa.eu/eurostat/documents/3888793/8979317/KS-TC-18-003-EN-N.pdf/3a6c9295-5e66-4b79-b009-ea1604770676

Eurostat. (2019a). ICT education - a statistical overview. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_education_-_a_statistical_overview&oldid=454538

Eurostat. (2019b). ICT specialists in employment. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php/ICT_specialists_in_employment

Eurostat. (2020). Gender pay gap statistics *Statistics Explained.* Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Gender_pay_gap_statistics

Ferrier, M., & Garud-Patkar, N. (2018). TrollBusters: Fighting online harassment of women journalists. In *Mediating Misogyny* (pp. 311-332): Springer.

Foong, E., Vincent, N., Hecht, B., & Gerber, E. M. (2018). Women (still) ask for less: Gender differences in hourly rate in an online labor marketplace. *Proceedings of the ACM on Human-Computer Interaction, 2*(CSCW), 1-21.

FRA. (2014). *Violence against women: an EU-wide survey. Main results*. Retrieved from https://fra.europa.eu/sites/default/files/fra_uploads/fra-2014-vaw-survey-main-results-apr14_en.pdf

FRA. (2016). *Violence, threats and pressures against journalists and other media actors in the EU. Contribution to the second Annual Colloquium on Fundamental Rights - November 2016.* Retrieved from https://fra.europa.eu/sites/default/files/fra_uploads/fra-2016-threats-and-pressures-journalists_en.pdf

FRA. (2017). *Challenges to women's human rights in the EU. Gender discrimination, sexist hate speech and gender-based violence against women and girls*. Retrieved from

FRA. (2018). *Out of sight: migrant women exploited in domestic worK*. Retrieved from https://fra.europa.eu/sites/default/files/fra_uploads/fra-2018-migrant-women-labour-exploitation-domestic-work_en.pdf

FRA. (2019). *Data quality and artificial intelligence – mitigating bias and error to protect fundamental rights*. Retrieved from https://fra.europa.eu/en/publication/2019/data-quality-and-artificial-intelligence-mitigating-bias-and-error-protect

Freeman, C. (2010). Respectability and flexibility in the neoliberal service economy. In *Work and Life in the Global Economy* (pp. 33-51): Springer.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? *Technological forecasting and social change, 114*, 254-280.

Galperin, H. (2019). "This Gig Is Not for Women": Gender Stereotyping in Online Hiring. *Social Science Computer Review*, 0894439319895757.

Gamberini, L., Raya, M. A., Barresi, G., Fabregat, M., Ibanez, F., & Prontu, L. (2006). Cognition, technology and games for the elderly: An introduction to ELDERGAMES Project. *PsychNology Journal, 4*(3), 285-308.

Glavin, P., & Schieman, S. (2012). Work–family role blurring and work–family conflict: The moderating influence of job resources and job demands. *Work and Occupations, 39*(1), 71-98.

Gomez Herrera, E., & Müller-Langer, F. (2019). Is There a Gender Wage Gap in Online Labor Markets? Evidence from Over 250,000 Projects and 2.5 Million Wage Bill Proposals. *Evidence from Over, 250*, 19-07.

Goodman, B., & Flaxman, S. (2017). European Union regulations on algorithmic decision-making and a "right to explanation". *AI magazine, 38*(3), 50-57.

Goos, M., Manning, A., & Salomons, A. (2014). Explaining job polarization: Routine-biased technological change and offshoring. *American economic review, 104*(8), 2509-2526.

Goswami, A., & Dutta, S. (2015). Gender differences in technology usage—A literature review. *Open Journal of Business and Management, 4*(1), 51-59.

Grabowski, D. C. (2006). The cost-effectiveness of noninstitutional long-term care services: Review and synthesis of the most recent evidence. *Medical care research and review, 63*(1), 3-28.

Hannák, A., Wagner, C., Garcia, D., Mislove, A., Strohmaier, M., & Wilson, C. (2017). *Bias in online freelance marketplaces: Evidence from taskrabbit and fiverr.* Paper presented at the Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing.

Hara, K., Adams, A., Milland, K., Savage, S., Callison-Burch, C., & Bigham, J. P. (2018). *A data-driven analysis of workers' earnings on Amazon Mechanical Turk.* Paper presented at the Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems.

Haraway, D. (1984). A cyborg manifesto: Science, technology, and socialist-feminism in the late 20th century. In *The international handbook of virtual learning environments* (pp. 117-158): Springer.

Harding, S. (1986). *The science question in feminism*: Cornell University Press.

Harding, S. (1991). Whose science? Whose knowledge? Thinking from women's lives. Ithaca, NY: Cornell University Press.

Harris. (2009). Theorizing class, gender, and the law: Three approaches. *Law & Contemp. Probs., 72*, 37.

Harris, T. R. (2014). *The impact of smartphones on work-life balance.* Middle Tennessee State University,

Henrichsen, J. R., Betz, M., & Lisosky, J. M. (2015). *Building digital safety for journalism: A survey of selected issues*: UNESCO Publishing.

Hicks, M. (2017). *Programmed inequality: How Britain discarded women technologists and lost its edge in competition.* . London, England: The MIT Press.

Hilbrecht, M., Lero, D. S., Schryer, E., Mock, S. E., & Smale, B. (2017). Understanding the association between time spent caregiving and well-being among employed adults: testing a model of work–life fit and sense of community. *Community, Work & Family, 20*(2), 162-180.

Hofäcker, D., & König, S. (2013). Flexibility and work-life conflict in times of crisis: a gender perspective. *International Journal of Sociology and Social Policy, 33*(9/10), 613-635.

Howcroft, D., & Richardson, H. (2009). *Work and life in the global economy: A gendered analysis of service work*: Springer.

Howcroft, D., & Rubery, J. (2018). Gender equality prospects and the fourth industrial revolution. In M. Neufeind, O'Reilly, J., Ranft, F (Ed.), *Work in the Digital Age. Challenges of the fourth industrial revolution* (pp. 63): Rowman & Littlefield.

Huffman, A. H., Whetten, J., & Huffman, W. H. (2013). Using technology in higher education: The influence of gender roles on technology self-efficacy. *Computers in Human Behavior, 29*(4), 1779-1786.

Huws, U. (1982). *New Technology and Women's Employment. Case Studies from West Yorkshire*: ERIC.

Huws, U., Podro, S., Gunnarsson, E., Weijers, T., Arvanitaki, K., & Trova, V. (1996). *Teleworking and Gender*: ERIC.

Huws, U., Spencer, N., Coates, M., Sverre Syrdal, D., & Holts, K. (2019). The Platformisation Of Work In Europe: Results from research in 13 European countries.

Hyperwallet. (2017). *The Future of Gig Work is Female A study on the behaviors and career aspirations of women in the gig economy*. Retrieved from https://www.hyperwallet.com/app/uploads/HW_The_Future_of_Gig_Work_is_Female.pdf?mkt_tok=eyJpIjoiTVRjMU9UQmlOakk1TW1WaSIsInQiOiJYaVQrNEtTTzUzNWliUzZOSTQ3R2wxTnlwY00xZG9MZmErTnVXUkJVdGhMRm9EUW9GWTFcL1huaXZPbnBmdGN1RnBaWjAwa2tjTW5PXC82NnR5Z0o1VFcrOFhWbEZMbVd3UGcramZvdTg0Y1Y0Q3orMjlcL1wvVUpJaFBROVhMeXRyU1QifQ%3D%3D

Iancu, I., & Iancu, B. (2017). Elderly in the digital era. theoretical perspectives on assistive technologies. *Technologies, 5*(3), 60.

ILO. (2017). *Ending Violence and Harassment Against Women and Men in the World of Work.* Paper presented at the Report V (1), International Labour Conference, 107th Session, 2018.

ILO. (2018a). *The architecture of digital labour platforms: Policy recommendations on platform design for worker well-being*. Retrieved from https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_630603.pdf

ILO. (2018b). *Care work and care jobs for the future of decent work*. Retrieved from https://www.ilo.org/global/publications/books/WCMS_633135/lang--en/index.htm

ILO. (2018c). *Digital labour platforms and the future of work. Towards decent work in the online world*. Retrieved from http://wtf.tw/text/digital_labour_platforms_and_the_future_of_work.pdf

Inter-Parliamentary Union. (2018). Sexism, harassment and violence Against Women in Parliaments in Europe. *Issue Brief: IPU*.

International Monetary Fund. (2018). *Gender, technology, and the future of work* (1484379810). Retrieved from https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2018/10/09/Gender-Technology-and-the-Future-of-Work-46236

IPPR. (2019). *The future is ours. Women, automation and equality in the digital age*. Retrieved from https://www.ippr.org/files/2019-07/the-future-is-ours-women-automation-equality-july19.pdf

IPSE. (2019). *Women in self-employment: Understanding the female self-employed community*. Retrieved from https://www.ipse.co.uk/resource/women-in-self-employment.html

Jiang, F., Jiang, Y., Zhi, H., Dong, Y., Li, H., Ma, S., . . . Wang, Y. (2017). Artificial intelligence in healthcare: past, present and future. *Stroke and vascular neurology, 2*(4), 230-243.

Johnston, H., & Land-Kazlauskas, C. (2018). Organizing on-demand: Representation, voice, and collective bargaining in the gig economy. *Conditions of work and employment series, 94*.

JRC-OECD. (2019). *World Corporate Top R&D investors: Shaping the Future of Technologies and of AI*. Retrieved from https://ec.europa.eu/jrc/en/publication/world-corporate-top-rd-investors-shaping-future-technologies-and-ai

JRC. (2018). *Platform Workers in Europe. Evidence from the COLLEEM Survey*. Retrieved from https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/platform-workers-europe-evidence-colleem-survey

JRC. (2019). *How computerisation is transforming jobs*. Retrieved from https://ec.europa.eu/jrc/sites/jrcsh/files/jrc117167.pdf

JRC. (2020a). *New evidence on platform workers in Europe. Results from the second COLLEEM survey*. Retrieved from https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118570/jrc118570_jrc118570_final.pdf

JRC. (2020b). *A Taxonomy of Tasks for Assessing the Impact of New Technologies on Work*. Retrieved from https://www.eurofound.europa.eu/sites/default/files/wpef20007.pdf

Kaarakainen, M.-T., Kivinen, A., & Kaarakainen, S.-S. (2017). *Differences between the genders in ICT skills for Finnish upper comprehensive school students: Does gender matter?* Paper presented at the Seminar. net.

Kavanagh, E., & Brown, L. (2019). Towards a research agenda for examining online gender-based violence against women academics. *Journal of Further and Higher Education*, 1-9.

Keller, E. F., & Longino, H. E. (1996). Feminism and science.

Kim, L. (2018). Gender Bias in Online Marketing: Data Shows Women Are Undervalued by 21%. Retrieved from https://www.wordstream.com/blog/ws/2014/05/13/gender-bias

Koop, C. E., Mosher, R., Kun, L., Geiling, J., Grigg, E., Long, S., . . . Rosen, J. M. (2008). Future delivery of health care: Cybercare. *IEEE Engineering in Medicine and Biology Magazine, 27*(6), 29-38.

Laundon, M., & Williams, P. (2018). Flexible work: barrier to benefits? *Financial Planning Research Journal, 4*(2), 51-68.

Lehr, A., & Bechrakis, M. (2018). Against The Odds: Overcoming Online Harassment of Women in Politics. Center for Strategic & International Studies. Retrieved from https://www.csis.org/analysis/against-odds-overcoming-online-harassment-women-politics

Lewis, R., Rowe, M., & Wiper, C. (2017). Online abuse of feminists as an emerging form of violence against women and girls. *British journal of criminology, 57*(6), 1462-1481.

Liang, C., Hong, Y., Gu, B., & Peng, J. (2018). Gender wage gap in online gig economy and gender differences in job preferences. *Available at SSRN 3266249*.

LIBE Commitee. (2018). *Opinion of the Committee on Civil Liberties, Justice and Home Affairs for the Committee on Industry, Research and Energy on a comprehensive European industrial policy on artificial intelligence and robotics*. (2018/2088(INI)).

Lopez-Hartmann, M., Wens, J., Verhoeven, V., & Remmen, R. (2012). The effect of caregiver support interventions for informal caregivers of community-dwelling frail elderly: a systematic review. *International journal of integrated care, 12*.

Lordan, G. (2019). *What work disappears? Automation and the changing nature of work*. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/1246be88-329a-11ea-ba6e-01aa75ed71a1/

Lott, Y. (2018). Does flexibility help employees switch off from work? Flexible working-time arrangements and cognitive work-to-home spillover for women and men in Germany. *Social Indicators Research*, 1-24.

Lu, K., Mardziel, P., Wu, F., Amancharla, P., & Datta, A. (2018). Gender bias in neural natural language processing. *arXiv preprint arXiv:1807.11714*.

Madara Marasinghe, K. (2016). Assistive technologies in reducing caregiver burden among informal caregivers of older adults: a systematic review. *Disability and Rehabilitation: Assistive Technology, 11*(5), 353-360.

Marion, T. J. (2016). 4 Factors That Predict Startup Success, and One That Doesn't. *Harvard Business Review, May, 3*.

Markson, E. W., & Hollis-Sawyer, L. A. (2000). *Intersections of aging: readings in social gerontology*: Roxbury Publishing Company.

Martínez-Alcalá, C. I., Pliego-Pastrana, P., Rosales-Lagarde, A., Lopez-Noguerola, J., & Molina-Trinidad, E. M. (2016). Information and communication technologies in the care of the elderly: systematic review of applications aimed at patients with dementia and caregivers. *JMIR rehabilitation and assistive technologies, 3*(1), e6.

McCloskey, D. W. (2016). Finding work-life balance in a digital age: An exploratory study of boundary flexibility and permeability. *Information Resources Management Journal (IRMJ), 29*(3), 53-70.

Medrano-Gil, A. M., de los Ríos Pérez, S., Fico, G., Montalvá Colomer, J. B., Cea Sáncez, G., Cabrera-Umpierrez, M. F., & Arredondo Waldmeyer, M. T. (2018). Definition of technological solutions based on the internet of things and smart cities paradigms for active and healthy ageing through Cocreation. *Wireless Communications and Mobile Computing, 2018*.

Mellner, C. (2016). After-hours availability expectations, work-related smartphone use during leisure, and psychological detachment. *International Journal of Workplace Health Management*.

Metz, R. (2020, 15 January, 2020). There's a new obstacle to landing a job after college: Getting approved by AI. *CNN Business*. Retrieved from https://edition.cnn.com/2020/01/15/tech/ai-job-interview/index.html

Micera, S., Bonato, P., & Tamura, T. (2008). Gerontechnology. *IEEE Engineering in Medicine and Biology Magazine, 27*(4), 10-14.

Mirchandani, K. (2010). Gendered hierarchies in transnational call centres in India. In *Work and Life in the Global Economy* (pp. 78-98): Springer.

Mitchell, K. M., & Martin, J. (2018). Gender bias in student evaluations. *PS: Political Science & Politics, 51*(3), 648-652.

Mouterde, P. (2020). Des plates-formes assurent le suivi des malades infectés par le coronavirus à domicile. *Le Monde*. Retrieved from https://www.lemonde.fr/planete/article/2020/04/01/des-plates-formes-assurent-le-suivi-des-malades-du-covid-19-a-domicile_6035153_3244.html

Nakamura, L. (2013). *Cybertypes: Race, ethnicity, and identity on the Internet*: Routledge.

National Academies of Sciences, E., & Medicine. (2018). *Sexual harassment of women: climate, culture, and consequences in academic sciences, engineering, and medicine*: National Academies Press.

Ninaus, K., Diehl, S., Terlutter, R., Chan, K., & Huang, A. (2015). Benefits and stressors–Perceived effects of ICT use on employee health and work stress: An exploratory study from Austria and Hong Kong. *International journal of qualitative studies on health and well-being, 10*(1), 28838.

Nissim, M., van Noord, R., & van der Goot, R. (2019). Fair is better than sensational: Man is to doctor as woman is to doctor. *arXiv preprint arXiv:1905.09866*.

Nugent, C. (2020). 'It's Like Being a War Medic.' A Madrid Doctor Speaks Out About Grave Shortages in Protective Gear. Retrieved from https://time.com/5813848/spain-coronavirus-outbreak-doctor/

Nurvala, J.-P. (2015). 'Uberisation'is the future of the digitalised labour market. *European View, 14*(2), 231-239.

OECD. (2016) The risk of automation for jobs in OECD countries: a comparative analysis. In. *OECD Social, Employment and Migration Working Papers No. 189*.

OECD. (2017a). *Going Digital: The Future of Work for Women* Retrieved from https://www.oecd.org/employment/Going-Digital-the-Future-of-Work-for-Women.pdf

OECD. (2017b). *How technology and globalisation are transforming the labour market*. Retrieved from https://www.oecd-ilibrary.org/employment/oecd-employment-outlook-2017_empl_outlook-2017-en

OECD. (2018a). Bridging the digital gender divide: include, upskill, innovate.

OECD. (2018b). *Empowering women in the digital age. Where do we stand?* Retrieved from https://www.oecd.org/social/empowering-women-in-the-digital-age-brochure.pdf

OECD. (2019). *PISA 2018 Results (Volume II). Where All Students Can Succeed*. Retrieved from http://www.oecd.org/publications/pisa-2018-results-volume-ii-b5fd1b8f-en.htm

Oesch, D., & Piccitto, G. (2019). The Polarization Myth: Occupational Upgrading in Germany, Spain, Sweden, and the UK, 1992–2015. *Work and Occupations, 46*(4), 441-469.

Overseas Development Institute. (2016). *A good gig? The rise of on-demand domestic work*. Retrieved from https://www.odi.org/publications/10658-good-gig-rise-demand-domestic-work

Overseas Development Institute. (2019). *Gender and the gig economy. Critical steps for evidence-based policy*. Retrieved from https://www.odi.org/publications/11272-gender-and-gig-economy-critical-steps-evidence-based-policy

Peña-Casas, R., Ghaliani, D., & Coster, S. (2018). The impact of digitalization on job quality in European public services. The case of homecare and employment service workers. *European Social Observatory, European Public Service Union. Available at: https://www. epsu. org/sites/default/files/article/files/FINAL% 20REPORT% 20EPSU% 20DI GITALISATION*.

Pérez-Zapata, O., Pascual, A. S., Álvarez-Hernández, G., & Collado, C. C. (2016). Knowledge work intensification and self-management: the autonomy paradox. *Work Organisation, Labour and Globalisation, 10*(2), 27-49.

Piasna, A., & Drahokoupil, J. (2017). Gender inequalities in the new world of work. *Transfer: European Review of Labour and Research, 23*(3), 313-332.

Piau, A., Campo, E., Rumeau, P., Vellas, B., & Nourhashemi, F. (2014). Aging society and gerontechnology: A solution for an independent living? *The journal of nutrition, health & aging, 18*(1), 97-112.

Posetti, J. (2017). Fighting Back Against Prolific Online Harassment: Maria Ressa in Kilman, L.(Ed) An Attack on One is an Attack on All. *UNESCO). Accessed, 30*, 03-18.

Prates, M. O., Avelar, P. H., & Lamb, L. C. (2019). Assessing gender bias in machine translation: a case study with Google Translate. *Neural Computing and Applications*, 1-19.

Purvanova, R. K., & Muros, J. P. (2010). Gender differences in burnout: A meta-analysis. *Journal of vocational behavior, 77*(2), 168-185.

PwC. (2016). The sharing economy presents Europe with a €570 billion opportunity. Retrieved from https://www.pwc.com/hu/en/pressroom/2016/sharing_economy_europe.html

PwC. (2019). *Will robots really steal our jobs? An international analysis of the potential long term impact of automation* Retrieved from https://www.pwc.com/hu/hu/kiadvanyok/assets/pdf/impact_of_automation_on_jobs.pdf

Raghavan, M., Barocas, S., Kleinberg, J., & Levy, K. (2020). *Mitigating bias in algorithmic hiring: evaluating claims and practices.* Paper presented at the Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency.

Rapier, G. (2019). Female drivers for Uber and Lyft say sexual harassment is the norm — and getting help from the companies isn't easy. Retrieved from https://www.businessinsider.com/female-uber-lyft-drivers-say-sexual-harassment-is-rampant-2019-6

Rego, R. (2018). Changing Forms and Platforms of Misogyny: Sexual Harassment of Women Journalists on Twitter. *Media Watch, 9*(3), 472-485.

Reimer, D., & Steinmetz, S. (2009). Highly educated but in the wrong field? Educational specialisation and labour market risks of men and women in Spain and Germany. *European Societies, 11*(5), 723-746.

Rohatgi, A., Scherer, R., & Hatlevik, O. E. (2016). The role of ICT self-efficacy for students' ICT use and their achievement in a computer and information literacy test. *Computers & Education, 102*, 103-116.

Roland Berger, & La Journée de La Femme Digitale. (2017). *Digital equality? Women in the digital revolution*. Retrieved from https://lajourneedelafemmedigitale.fr/wp-content/uploads/2019/12/Digital-Equality_SOUCED.pdf

Ropponen, A., Hakanen, J. J., Hasu, M., & Seppänen, L. (2019). 3 Workers' Health, Wellbeing, and Safety in the Digitalizing Platform Economy. *Digital Work and the Platform Economy: Understanding Tasks, Skills and Capabilities in the New Era*.

Rosenblat, A., Levy, K. E., Barocas, S., & Hwang, T. (2017). Discriminating tastes: Uber's customer ratings as vehicles for workplace discrimination. *Policy & Internet, 9*(3), 256-279.

Rubery, J. (2010). *Women and Recession (Routledge Revivals)*: Routledge.

Rubery, J. (2015). Change at work: feminisation, flexibilisation, fragmentation and financialisation. *Employee Relations, 37*(6), 633.

Rubery, J. (2018). A gender lens on the future of work. *Journal of International Affairs, 72*(1), 91-106.

Rubery, J., & Fagan, C. (1993). *Occupational segregation of women and men in the European Community*: European Communities.

Sainato, M. (2019). Female drivers feel abandoned by Uber and Lyft after reporting a sexual assault. Retrieved from https://www.theguardian.com/technology/2019/jun/19/uber-lyft-female-drivers-sexual-assault

Scheele, A. (2005). The future of work–what kind of work? Impacts of gender on the definition of work and research methodology. *Transfer: European Review of Labour and Research, 11*(1), 014-025.

Schiebinger, L., Klinge, I., Sánchez de Madariaga, I., Schraudner, M., & Stefanick, M. (2011). Gendered innovations in science, health & medicine, engineering, and environment. *Available at genderedinnovations. stanford. edu/what-is-gendered-innovations. html. Accessed January, 21*, 2015.

Schieman, S., & Young, M. (2010). Is there a downside to schedule control for the work-family interface? *Journal of Family Issues, 31*(10), 1391-1414.

Schneebaum, A., Rehm, M., Mader, K., & Hollan, K. (2018). The gender wealth gap across European countries. *Review of Income and Wealth, 64*(2), 295-331.

Schoenbaum, N. (2016). Gender and the sharing economy. *Fordham Urb. LJ, 43*, 1023.

Schwellnus, C., Geva, A., Pak, M., & Veiel, R. (2019). Gig economy platforms: Boon or Bane?

Seiner, J. A. (2019). Harassment, Technology, and the Modern Worker. *Emp. Rts. & Emp. Pol'y J., 23*, 85.

Shevchuk, A., Strebkov, D., & Davis, S. N. (2019). The autonomy paradox: how night work undermines subjective well-being of internet-based freelancers. *ILR Review, 72*(1), 75-100.

Silbermann, J. (2020). Gender-based pay gaps in the gig economy Retrieved from https://harvardjlg.com/2020/02/gender-based-pay-gaps-in-the-gig-economy/

Simians, C. (1991). Women: The Reinvention of Nature. In: New York: Routledge.

Simonite, T. (2018). AI is the future–but where are the women. *Retirado de https://www. wired. com/story/artificial-intelligence-researchers-gender-imbalance*.

Sinha, C., & Schryer-Roy, A.-M. (2018). Digital health, gender and health equity: invisible imperatives. *Journal of Public Health, 40*(suppl_2), ii1-ii5.

Smith, A. (2016). Gig work, online selling and home sharing. *Pew Research Center, 17*.

Smorto, G. (2018). Protecting the weaker parties in the platform economy. *Cambridge Handbook on Law and Regulation of the Sharing Economy (Nestor Davidson, Michèle Finck and John Infranca eds., 2018, Forthcoming)*.

Søndergaard, M. L. J., & Hansen, L. K. (2017). Designing with Bias and Privilege. *Nordes 2017, 7*.

Stanney, K., Fidopiastis, C., & Foster, L. (2020). Virtual Reality is Sexist: But It Does Not Have to Be. *Frontiers in Robotics and AI, 7*, 4.

Statucki, T., Howard, N., Ackerman, W. & Kuhn, C. (2020). The Potential Benefits of Digital Health Technology in Managing COVID-19. *Covington Digital Health*. Retrieved from

https://www.covingtondigitalhealth.com/2020/03/the-potential-benefits-of-digital-health-technology-in-managing-covid-19/
Stavrotheodoros, S., Kaklanis, N., Votis, K., & Tzovaras, D. (2018). *A smart-home IoT infrastructure for the support of independent living of older adults.* Paper presented at the IFIP international conference on artificial intelligence applications and innovations.
Tedesco, C. (2019). Confidence Not Competence: What Holds Women Back from Embracing Tech in Development. Retrieved from https://dai-global-digital.com/confidence-not-competence-what-holds-women-back-from-embracing-tech-in-development.html
Ten Brummelhuis, L. L., & Van Der Lippe, T. (2010). Effective work-life balance support for various household structures. *Human Resource Management: Published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management, 49*(2), 173-193.
Ticona, J., & Mateescu, A. (2018a). How Domestic Workers Wager Safety In The Platform Economy. Retrieved from https://www.fastcompany.com/40541050/how-domestic-workers-wager-safety-in-the-platform-economy
Ticona, J., & Mateescu, A. (2018b). Trusted strangers: Carework platforms' cultural entrepreneurship in the on-demand economy. *New Media & Society, 20*(11), 4384-4404.
Trojansky, A. (2020). *Towards the "Uber-isation" of care? Platform work in the sector of long-term care and its implications for workers' rights*. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/95798e0e-59dc-11ea-8b81-01aa75ed71a1:
Uhlmann, E. L., & Silberzahn, R. (2014). Conformity under uncertainty: Reliance on gender stereotypes in online hiring decisions. *Behavioral and Brain Sciences, 37*(1), 103-104.
Valenduc, G. (2011). Not a job for life? Women's progression, conversion and dropout in ICT professions. *International Journal of Gender, Science and Technology, 3*(2), 483-500.
Valenduc, G., & Vendramin, P. (2017). Digitalisation, between disruption and evolution. *Transfer: European Review of Labour and Research, 23*(2), 121-134.
Valenduc, G., Vendramin, P., Guffens, C., Ponzellini, A. M., Lebano, A., d'Ouville, L., . . . Tolar, M. (2004). *Widening women's work in information and communication technology*: European Commission Brussels.
Van Doorn, N. (2017). Platform labor: on the gendered and racialized exploitation of low-income service work in the 'on-demand'economy. *Information, Communication & Society, 20*(6), 898-914.
von der Leyen, U. (2019). Political Guidelines for the next European Commission 2019-2024. In E. Commission (Ed.).
Vorvoreanu, M., Zhang, L., Huang, Y.-H., Hilderbrand, C., Steine-Hanson, Z., & Burnett, M. (2019). *From gender biases to gender-inclusive design: An empirical investigation.* Paper presented at the Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems.
Wajcman, J. (2004). Technofeminism. Cambridge: Polity.
Wajcman, J. (2015). *Pressed for time: The acceleration of life in digital capitalism*: University of Chicago Press.
Wang, Y., & Redmiles, D. (2019). *Implicit gender biases in professional software development: An empirical study*. Paper presented at the 2019 IEEE/ACM 41st International Conference on Software Engineering: Software Engineering in Society (ICSE-SEIS).
World Economic Forum. (2016). The Future of Jobs. Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution. Retrieved from https://www.weforum.org/reports/the-future-of-jobs
World Economic Forum. (2018). *The Global Gender Gap Report*. Retrieved from http://www3.weforum.org/docs/WEF_GGGR_2018.pdf
Woyke, E. (2017). The Octogenarians Who Love Amazon's Alexa.

Yang, S.-Y., Lin, C.-Y., Huang, Y.-C., & Chang, J.-H. (2018). Gender differences in the association of smartphone use with the vitality and mental health of adolescent students. *Journal of American college health, 66*(7), 693-701.

Zeid, A. (2018). The impact of online violence on women human rights defenders and women's organisations. Statement by UN High Commissioner for Human Rights. 38th session of the Human Rights Council. Retrieved from https://www.ohchr.org/EN/HRBodies/HRC/Pages/NewsDetail.aspx?NewsID=23238&LangID=E