The Policy Lab

Report

New Opportunities for Women in the Workforce in the age of AI and Automation

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Contents

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Executive summary

In the age of AI and automation, some jobs may be displaced by machines, yet new jobs will be created as technologies complement human work and improve its efficiency. Rather than focusing on the potential loss in employment caused by automations, this report attempted to explore the new job opportunities for women in the age of technological disruption.

The report first presented an overview of the job market in the age of technological disruption. It identified the occupations that receive relatively minimal impact by automation and AI in which women are safe to stay in, the industries that are expecting the biggest jobs gains, which are healthcare and PST (professional, scientific, technical) sectors, and new job opportunities created by increasing integration of technology, which are "frontier jobs" (including "trainer", "sustainer", and "explainer"), jobs created by marketization of previously unpaid work, wealth jobs, and last-mile work jobs.

The report then discussed the skill change in the jobs of the future by identifying the skills that are going to be less in demand, which are physical and manual skills and basic cognitive skills, as well as skills that are increasing in demand, which are higher cognitive skills, social and emotional skills, as well as technological skills.

Finally, the report discussed and recommended measures for governments, companies, and organizations to take in supporting the women in accruing the skill and education that are necessary for the future job market. It is recommended that governments, companies, and organizations to establish more Skill-building supports, reduce flexibility and mobility related barriers that women face, and work on improving women's access, skills, and representation in the technology field.

KEY RECOMMENDATIONS

1. **Skill- building supports**
   · Training and reskilling programs that are specifically targeting women
   · Training and reskilling subsidies
   · Building digital learning platforms

2. **Efforts in reducing flexibility and mobility related barriers**

   · Public spending on improving women's work flexibility and mobility
   · Address public safety concerns of women by enhancing safety measures

3. **Improve women's access, skills, and representation in technology**

   · Programs to encourage women to study and work in the tech field
   · Increase access to basic enabling technology

Introduction

In the age of rapid technological change, the wide adoption of automation and artificial intelligence (AI) in industries is transforming the way we work. Many may fear that the large displacement of human workers by machines will cause high unemployment. However, with some manual work being displaced by machines, there is still a great deal of new job opportunities that may come along with the adoption of automation and AI, which could compensate for the loss of employment. As men and women in the workforce tends to cluster in different occupations with their advantages in different skill sets, they are likely to be affected differently by the adoption of automation and AI. This report, in particular, attempts to answer the question of "what are the new opportunities for women in the workforce brought by the technological change and how can they be better prepared to seize the opportunities and attain swift job transitions?"

In attempting to answer the question, the report will first analyse the current job market by discussing the jobs that are receiving minimal impact of automation in which women are safe to stay, the existing occupations that are expecting job gains, and the new occupations that will be created by technology that women can take advantage of. In the following section, the report discusses the skill shift in the age of technological transformation by analysing the skills less in demand and skills that are more in demand for the future job market. And in the final section, the report discusses in detail on how governments, policy makers, companies, and organizations can help and support women in adapting new skills in transitioning smoothly to new job opportunities.

Report section I:
Job market in the age of AI and automation and where women are positioned

As technology continues to evolve, the types of occupations that are impacted by Automation and AI change over time. Till late 2020s, AI tools tend to automate clerical tasks, examples being the use of smarter email, automated assistants, smart calendar, and financial software in the secretary or administrative assistant type of roles (McKinsey Global Institute, 2019). As these types of occupations are currently female dominated, the effect of technological change on women in the workforce will be more significant in the short run. However, as the capabilities of AI continue to develop, over the mid-term (2020-2030s), more automation is predicted to lead to job losses in what are currently male-heavy industries, such as construction and transportation. Some examples are self-driving vehicles and smart construction tools (McKinsey Global Institute, 2019). Despite the potential displacement of certain occupations by automation, some occupations may still experience job gain as work efficiency improves, and entirely new job opportunities may also be created that women can take advantage of. The following subsections will discuss the occupations receiving relatively minimum impact by automation and AI so women are safe to stay, the occupations that are expecting job gains, and the new occupations will be created in the future.

1. Occupations that receive relatively minimum impact by automation and AI, in which women are safe to stay.

While the evolving technology gradually replaces an increasing amount of human manual work through automation and machine learning, emotional intelligence and advanced communication are the skills unique to humans and hard to be replicated by machines. Women, in particular, with their greater ability to sympathize and build emotional connections, are in an advantageous position in staying in the occupations that demand a great amount of emotional and communication skills (Autor, 2015). Examples of these occupations include speech pathologists, preschool teachers, and occupational therapists, etc. Given the nature of the emotional attributes of women, they already possess a bigger representation in such occupations compared to men. And because of that, skills such as empathy, high level of communication, and collaboration are among those that are hardest to recreate in AI tools, occupations that require these skills are likely to be safer from technological disruption. Thus, women who are in these occupations are safe to stay.

Although many of these occupations receive a relatively low impact of automation that they are not in danger of being displaced, the character and the nature of many occupations may change with more technological tools assisting the work. As technologies are mostly used to complement human work, many jobs are experiencing partial automation. Although these occupations are still safe for women to stay, the way of work and skills that are required can be much different that women need to keep their skill sets up-to-date for these jobs. The

following examples detail the changes within jobs as the result of partial automation in a variety of industries that women work in including healthcare, education, and finance industry.

In the healthcare industry, many occupations are experiencing or expecting partial automations, including a large number of female-dominated professions. According to McKinsey Global Institute, "licensed practical and vocational nurses could experience the automation of activities taking up about 30 percent of their time at work" (2019, p.65). Since the majority of nursing jobs are taken by women, such job change brought by partial automation could have a bigger impact on women. Tasks within the professions that can be mostly automated are some of the manual works that follow a standard process like ordering medical equipment, maintaining medical facility records, and testing biological specimens (McKinsey Global Institute, 2019). However, tasks that require more social and emotional skills, collaboration skills, as well as management skills are less likely to be automated. Examples of such tasks include explaining medical procedures and providing personal care to patients. Given the current nature of the female-dominated professions within healthcare, women, with their strong social and emotional skills, are at advantageous positions in performing tasks that cannot be fully automated.

In the education industry, with the help of smart teaching technologies, many teaching jobs are experiencing partial automation. For example, "elementary school teachers could experience the automation of activities that currently take up about 40 percent of their time" (McKinsey Global Institute, 2019, p.65). Since women take up the majority of teaching jobs, the shifting in the constituent of the jobs as a result of partial automation affects female workers greatly. Tasks within teaching that can be automated mainly involves data collection and processing, such as maintaining student records and ordering course materials. On the other hand, tasks that are hard to be automated are the ones that use a great deal of the worker's creativity, emotional and management skills. It would be inefficient for AI systems to act on behalf of teachers in completing tasks such as advising students on academic matters or discussing students' progress with parents.

In the financial industry, many occupations are experiencing partial automation, and there is an increasing need for professionals within the industry to get better with working alongside machines. It is reported that "personal financial advisers could experience the automation of activities that currently take up about 40 percent of their time" (McKinsey Global Institute, 2019, p.66). Tasks within finance occupations that can be automated mainly involve cash or document processing, data collection and analysis. Examples of these tasks include cash handling, processing loan requests, and analysing client's financial status. Tasks that are hard to be automated require more social and emotional skills, such as building long-term relationships with clients and advising clients on financial matters. Women who use social, emotional, and management skills in their jobs in the finance sector are at advantage with the automation caused job change in the industry.

2. Occupations that are expecting job gains from the adoption of AI and Automations

a. Healthcare

In mature economies, 30 percent of the total jobs gained by women in the workforce could be in healthcare as the global demand for healthcare continues to increase (McKinsey Global Institute, 2019, p.48). Several factors contributed to the increasing demand for healthcare services around the world, to name a few: aging populations in many developed nations, the rise in contagious diseases, the expanding middle class with their demand for higher-quality healthcare. With more spending on healthcare, there is a higher demand for healthcare professionals. As women make up a higher percentage of workers in the healthcare sector, the higher demand indicates a significant job gain opportunity.

In addition, the integration of AI in healthcare could potentially further induce job gains in the sector. As the use of AI in healthcare organizations is mainly intended to assist with care provision, not to replace it, it helps to increase treatment efficiency and decrease treatment cost. With the improved efficiency in services like diagnostics, patient engagement, and precision medicine, a higher volume of care can be delivered. Moreover, as the integration of AI in healthcare continues to evolve, more jobs that require new skill sets that involve AI will be created.

b. Job gain in PST (professional, scientific, technical) Sectors

Occupations that are in professional, scientific, and technical sectors could expect job gains from the integration of AI and automations. Many view AI and Automations as substitutions for labour; however, it is important to realise that they also complement human labour. The rise in output as a result of the adoption of AI and automation can lead to higher demand for labour in the sectors that create, operate, and interact with the technology, and these sectors include professional, scientific, and technical.

In general, automation (computerization, introduction of robots and AI) predominantly affects routinized work in stationary and predictable environments. These jobs typically require mid-level skills concerning the execution of rules rather than creative use of information. The integration of AI systems, automation and advanced computerization only substitute the routine and "rule-based" tasks yet complement the non-routine and cognitive tasks. The non-routine and cognitive tasks typically are executed by high-skilled employees with high wages in the professional field. Therefore, with the complement of automation, there is an increased demand for high skilled labour in the professional field.

In addition, as automation and AI continues to be adapted by more industries, the sectors that are responsible for the supply of these technologies, which are the scientific and technical field, are expected to see a higher demand of its skilled labour. Occupations such as engineers,

software developers, robot designers are in higher demand as they are involved in developing, producing and supplying technology.

3. Opportunities for women to capture jobs in entirely new occupations

By 2030, 9 percent employed people could work in entirely new occupations, as different types of jobs are created with the continual integration of automation and AI (Lin, 2011). The new occupations fall in the categories: frontier jobs, "Marketization" of previously unpaid work", wealth jobs, and last-mile work jobs.

a. Frontier jobs

Frontier jobs refers to the jobs that involve the use and development of new technology. With modern technologies continuing to evolve, over the years, the new occupations created by the integration of technology that are considered frontier jobs are much different. For example, "Word Processing" work is considered frontier jobs in 1980s, and then it was Robotic Machine Operator in 1990s, Chief Information Officer in 2000s, Wind Turbines and Intelligence Analysts in 2010 (Autor, 2019). With the wider integration of AI, in 2020- 2030s the jobs that are in producing, installing, maintaining, and deploying new-generation technologies are going to be the frontier jobs of the time. Some examples of these frontier occupations include AI specialists, robotic machine operators, molecular physicists, wind-turbine technicians, and echocardiographers, etc.

Frontier jobs -Trainer

With the wider applications of AI in the next 10-20 years, frontier jobs could fall in three categories that involve working with AI and robotics. The first category is characterised as "trainer", which represents human workers performing tasks that are useful to train AI systems and teach AI systems how they should perform (Wilson, Daugherty, & Bianzino, 2019). The tasks that trainers work on range from fundamental AI training jobs like helping natural-language processors and language translators make fewer errors, to more sophisticated tasks like teaching AI algorithms how to mimic human behaviours.

As AI technology continues to develop, the trainer jobs are increasing in demand, and the tasks that trainers perform are shifting from the fundamental to sophistication. For example, when AI is used in communicating with customers, they need to be trained to understand the complexities and subtleties of human language expression. On top of the basic literary communication, AI language processing systems are trained to detect cues such as sarcasm as people do not always literally mean what they say. In addition, more training tasks are dedicated to teaching AI systems to express compassion, empathy, and even humour, so that AI systems learn the best responses overtime.

Frontier jobs - Explainer

The next category of the frontier jobs involving AI are "explainer", and their work is to interpret the outputs generated by AI systems to organisations that are using the systems (Wilson, Daugherty, & Bianzino, 2019). In companies that deploy advanced AI systems, explainers bridge the gap between machine algorithms and nontechnical business professionals. Taking into account factors such as individual characteristic, professional, and cultural variances, explainers help AI systems adapt to the specific business contexts and processes. In the case of AI recommending actions that go against the common sense or conventional wisdom, explainer helps to clarify the inner workings of complex algorithms to nontechnical professionals, so they understand the logic behind certain decisions made by AI. In cases like customers who question the decision that was made purely on an algorithm that affected them, explainers are there to provide explanation of the underlying rationale of the AI decision.

In addition, explainers also work to understand, and correct certain actions made by AI when the system made mistakes, or the actions have led to negative consequences. For example, forensics analysts need to conduct an "autopsy" on AI mistakes, so that they can pinpoint the data that led to a particular result, explain to the nontechnical users, and also correct the system.

Frontier jobs - Sustainer

The last category of the frontier worker is "sustainer", as they monitor the work of AI systems, ensuring that they work as designed to prevent and mitigate any unintended consequence (Wilson, Daugherty, & Bianzino, 2019). Since AI systems are relatively new to many companies, concerns still persist in verifying the safety, fairness, and auditability of the systems, and that's where sustainers play an important part.

One of the crucial tasks for sustainers is to ensure that AI systems comply with the human ethic code. They act as watchdog and ombudsman for upholding norms of human values and morals to the systems. Ethic compliance managers intervene and mitigate when systems act unethically such as when an AI system for hiring was discriminating against people in certain gender or ethnicities. In addition, sustainers can work with explainers to uncover the underlying reasons for the unethical decisions made by the AI system and then implement the appropriate solutions.

How can women take advantage of these frontier jobs?

As the frontier jobs detailed above are largely unprecedented and will be required by almost all industries that utilise AI technology, they bring new employment opportunities to the labour force including women. Traditional education may not be up to date for the professions that work around AI, thus technology focused training may need to be implemented at an earlier stage.

With new job opportunities open, women, with their stronger ability in showing compassion and empathy, are in advantage in taking roles that train AI systems to mimic human emotions. An example of these types of occupation is AI empathy trainer, it may not need a college degree as the job mostly requires the individual to have higher emotional intelligence rather than specialized skills. On the other hand, other types of frontier jobs such as ethics compliance manager may require advanced degrees and highly specialized skill sets as they need to understand the algorism of the AI system. More details of the types of skill sets will be needed for women to prepare for the future jobs is discussed in section III.

b. Technology leads to "Marketization" of previously unpaid work that creates new jobs

Today, much work done in households, such as care work for children, elderly, and sick, and domestic chores, is unpaid and not accounted into a country's economic output. As new technologies create avenues for the previously unpaid work to be marketized, when more home-production transitions to market-production, more jobs are created.

Women, in particular, is disproportionately affected by the domestic unpaid work that About 75 percent of the world's total unpaid care is undertaken by women (McKinsey Global Institute, 2015), and all over the world on average, women do more than two more hours of unpaid work per day comparing to men (Alonso et al, p.8). Many of these domestic burdens fall on women often due to a series of barriers and constraints including gender wage gap, cultural norms, lack of public services and infrastructure, and insufficient family leave policies.

However, given the fast-paced modern lifestyle and wider utilization of technology by middle class households, some of these barriers and constraints can be lighted or even removed in the next 10-20 years. This in turn, leads to more unpaid jobs performed by women transition to marketized paid work and encourages a higher female labour force participation. A higher female labour force participation rate can further promote the marketisation of unpaid domestic work, thus creating a positive feedback loop for female job creation. For example, looking back in history, the introduction of labour-saving durables, such as washing machines and vacuum cleaners, has drastically increased the productivity of home chores has freed up some of the working hours of women that would otherwise be spent on unpaid work. As a result, female labour participation rate has increased. Study has found that there is a positive relationship between the availability and productivity of home electrical appliances and the female labour supply (Roser, 2013). As the home labour-saving durables continue to become more automatic with the integration of AI, the female labour force participation is expected to continue to rise, and more unpaid domestic work is going to be marketized thus creating more jobs available to women.

The development of technology is also enabling more unpaid work to become marketized through the construction of digital "sharing economy" platforms. Sharing economy platforms

make it possible for consumers to purchase many household and personal services more conveniently and cheaply, making paying in exchange for many of the previously unpaid domestic jobs more cost effective and thereby increase its demand further. Current sharing economy platforms mainly fall into the 4 categories: recirculation of goods, increased utilization of durable assets, exchange of services, and sharing of productive assets (Schor, 2014). Although all categories help to create market exchange activities to some extent, exchange of service platforms are the ones to boost marketized job opportunities. Some examples of such service exchange digital platforms include Airtasker, Task Rabbit, and Zaarly that they list household jobs as paid tasks and pair users who need tasks done with people who do them with a mutually agreed price.

Research has found that the digital service exchange platforms help to increase employment in the industry by presenting a variety of opportunities for traditional workers who are already working in providing these services, as well as encouraging more newly self-employed workers enter the market (Codagnone et al, 2016). These service exchange digital platforms have not only marketized previously unpaid jobs, but also increased work flexibility. As many of these services are project-based with a time that's accepted by both parties, it allows greater flexibility for the job takers to arrange their work schedule. And women in particular, can benefit greatly in flexibility of the job opportunities. With the digital sharing platform continuing to develop, thanks to the utilization of AI technology, it is expected that more job opportunities can be created.

c.   Wealth-Work Jobs

As the adaptation of new technology continues to transform the job market, wealth-work jobs become one of the newly created job categories. Wealth work is referring to service work, yet it is services that are provided to affluent consumers in a more labour intensive and personalised manner (Autor, 2019). Wealth-work jobs tend to cluster in the areas where the highest-paid frontier workers reside, which usually is a high-wage urban area. This is because as more technologically skilled workers take the highly paid frontier jobs, their aggregate income rises and so does their demand for lifestyle related services, as a result, more wealth jobs are created in the area.

With the ever-evolving technology being used in work productions, the kind of occupations that are considered as wealth work change from time to time. For example, back in the 80s, gift wrappers were considered as a wealth job. Then there were marriage counsellors in the 90s, baristas and oyster preparers in the 00s, and sommeliers and exercise physiologists in the 10s (Autor, 2019). Some of the wealth jobs at current year as well as in the next few years could be personal stylists, yoga instructors, pet care workers, nail artists, and personal dietitians, etc.

Wealth-work jobs are neither technologically novel nor broadly demanding of technical skills or high levels of education, yet they increase in importance as income in the area rises (Autor, 2019). As wealth-work jobs cater to the comfort and well-being of the high-income frontier workers, the size of the wealth jobs in the labour market is larger than frontier jobs, although the wage level is lower. That workers in wealth work occupations typically earn close to the mean of the wage distribution within their local labour markets (Autor, 2019). The wealth jobs are often disproportionately taken by women, that around 62 percent of hours in wealth jobs are completed by women (McKinsey Global Institute, 2019). As different types of occupations within wealth jobs continue to be created given the ever-changing demand, there is more opportunity for women to take these wealth jobs. Although these wealth jobs are not highly paid, they pose opportunities to non-college workers and can be particularly suitable to the non-technical skilled but service focused workers.

d. Last-mile workers

Finally, there are last-mile workers being created as a new job category as a result of automation and the use of AI technology. Last-mile workers carry out tasks that have been largely automated by machine work yet still have a last human component left to do (Autor, 2019). An example of a last-mile worker in today's age could be the human worker who stands around in the grocery store and helps customers scan the items when the automatic checkout machine has an error. As automation evolves throughout times, the occupations that are considered as last-mile works change over time. For example, they were the tamale-machine feeders in the 80s, the vending-machine attendants in the 90s, the chat room monitors in the 00s, and the underground utility cable locators in the 10s (Autor, 2019). Some of the last-mile workers from current year to the next few years could be call-centre operators, order fulfillment workers, and online content monitors.

Last-mile works often do not require face-to-face interaction with customers, thus such work can be outsourced to low wage labour markets. Given the content of the work of the last-mile worker that they fill in the last component of a largely automated process so that it is more cost-efficient for the employers, these jobs do not require high technical skill nor college education. That in fact, only about 15 percent of hours within last-mile works were taken by people with a college degree or higher, and around 43 percent of hours are supplied by women (McKinsey Global Institute, 2019). Last-mile jobs can be an entry point for women with low technical skills to enter the job market. However, with the technology continuing to develop, these job opportunities may decrease in size when AI software are able to take over the task completely.

Although most last-mile works are well recognised, there is a subset of last-mile works that support the automation technology but designed to stay anonymized. Researchers have named these jobs "ghost work", that they are "human labour powering many mobile phone apps, websites, and artificial intelligence systems" (Shestakofsky, 2019, p.1285). The content

of work for these ghost jobs can vary depending on the demand of the businesses and customers. For example, Ghost workers work to monitor the content on social media platforms for any pornography, hate speech, and violent videos ; they review identification pictures uploaded to the system for verification purposes when AI fails to do so, and they recognize and remove duplicate listings on accommodation websites such as Airbnb and TripAdvisor. One would imagine that these works mentioned above were already fully taken over by AI technology, yet many of these tasks remain difficult and costly for businesses to fully automate so that human assistance is still widely needed. However, they are called ghost work because the projects often intentionally anonymize their workers and hide the labour "from the view of both the companies that hire them and the customers who ultimately use the products to which ghost workers contribute" (Shestakofsky, 2019, p.1283). Thus, ghost works often exist in the regulatory grey zone, that they are contract based and lack employment protection (Shestakofsky, 2019, p.1283). The ghost work could remain relevant in the labour market in the next few years. However, as the automation process continues to develop, that once the work can be fully carried out by AI technology, these ghost work face the danger of diminishing.

Section II:
Skill shift and what are the new skills women need to equip?

Since the nature of many jobs changed and new jobs created as the result of automation and AI technologies, the skill requirements for the jobs in future is also evolving. This section discusses in detail the skill shift for jobs in future by analysing the skills that are less in demand and skills that are more in demand.

1. Skills that are less in demand for future jobs

a. Physical and manual skills

The demand for physical and manual skills at work has been declining since the last 20 year when the automotive machines were first used in industries. As technologies continue to develop that more manual work can be automated, demand for these skills will decline further. According to the McKinsey Global Institute research that demand for physical and manual skills will decline by "11 percent overall in the United States and by 16 percent overall in Europe between 2016 and 2030" (2018, p.13). The study has identified that general equipment operation and navigation, inspecting, and monitoring skills are among the fastest declining skill sets within physical and manual skills (McKinsey Global Institute, 2018, p.13). Some examples of other physical and manual skills that are declining in demand include general equipment repair and mechanical skills, craft and technician skills, and motor skills etc. Since there are more male workers with physical and manual skills compared to female workers in general, therefore the decline in demand of such skill sets will affect women less.

b. Basic cognitive skills

As automation continues to advance and machines increasingly take over straightforward works, the basic cognitive skills will decrease in demand for future jobs. For example, Basic data input and processing skills is estimated to fall "by 19 percent in the United States and by 23 percent in Europe in the 2016 to 2030 period" (McKinsey Global Institute, 2018, p.13). Other basic cognitive skills such as basic literacy, numeracy, and communication skills will remain useful overall but will not be sufficient in the future without additional skill sets. The future job activities will increasingly shift from using only basic to higher cognitive skills.

2. Skills that are more in demand for future jobs

a. Higher cognitive skills

As automation takes over some of the routine and straightforward work activities, demand for higher cognitive skills in future jobs is expected to increase rapidly. Skills such as critical thinking, decision making, project management, complex information processing and interpretation, as well as creativity are becoming particularly important to jobs in future (Ra et al, 2019). McKinsey Global Institute has estimated that starting at year 2018, the demand for the above-

mentioned skills will increase by 19 percent in the United States and by 14 percent in Europe by 2030 (2018, p.11). Although the higher cognitive skills are overall experiencing increased demand, some types of these skills are expected to have a slower increase in importance (if not remain stable) for the works in future. They are advanced literacy and writing, and quantitative and statistical skills (skills involve less human decisioning or creativity). The reason being that as AI technology becomes more advanced, the quality and standard of work in terms of advanced writing and analysis that machines produce will be highly comparable to human works.

b. Social and emotional skills

Social and emotional skills will be relatively difficult for machines to fully master in the near future, and workers are expected to spend more time on activities that requires these skills. According to McKinsey Global Institute that "between 2016 and 2030, demand for these social and emotional skills will grow across all industries by 26 percent in the United States and by 22 percent in Europe" (2018, p.11). As work activities in the future will evolve more nonroutine interpersonal and creative tasks, skills such as advanced communication and negotiation, empathy, leadership, adaptability, and team management will be increasingly valuable in applying to the jobs of the future. It is worth noting that among many skills within the social and emotional category, demand for entrepreneurship and initiative taking is becoming the fastest growing trend, that it is estimated there will be an increase of 33 percent in the United States and 32 percent in Europe (McKinsey Global Institute, 2018, p.13). Since women are generally better equipped with social and emotional skills, it is to their advantage to fully practice those skills in adapting to the work of the future (McKinsey Global Institute, 2015).

c. Technological skills

As companies increasingly deploy automation, robotics, AI systems, and other new technologies in improving their work efficiency, workers are expected to understand and work along with the technologies more (Frontier Economics, 2018). Therefore, in future jobs, there will be a growing demand for all technological skills, both advanced and basic. Advanced technological skills entail the ability to not only understand the technologies, but also to develop, innovate, and renovate them. Occupations that demand the advanced technological skills the most include big data scientists, IT professionals and programmers, technology designers, engineers, mathematics, and scientific researchers (McKinsey Global Institute, 2018). Study had estimated that between 2016-2030, the working time spent on advanced technological skills will increase by "50 percent in the United States and by 41 percent in Europe" (McKinsey Global Institute, 2018, p.8). In addition to the advanced technological skills, basic technological skills such as operating digital applications and software are also growing in demand across almost all sectors.

Section III:
How can companies, organizations, and governments help women in adapting new skills and the job transition?

Having identified new job opportunities brought by the increasing adoption of automation and AI technologies, as well as the skill shift for future jobs, it is important to discuss how governments, companies, and organizations should support women in adapting the new skills for a smooth job transition in the age of automation. This section suggests that women in the job market can be supported through the following efforts, which are providing new skill-building supports, addressing labour mobility constraints, and increasing women's representation and access to technology.

1. Skill- building supports

As people increasingly work alongside automated systems, adapting to technological changes in the workplace, and transitioning to new occupations and sectors, equipping skills that are in demand is extremely important in getting ready for the job market of the future. Female workers, compared to their male counterparts, are generally at disadvantage in having the same level of education and skills due to various economic, social, and cultural constraints. Therefore, the skill-building support from government, companies, and organizations should be designed with women's specific needs in mind.

A few social and economic factors have been identified which made it is more challenging for women in job reskilling. To begin with, in many emerging countries, a rather large gender gap in education still persists and "even more so in the skills that women will need in the labour market of the future" (McKinsey Global Institute, 2019, p. 96). Although in developed nations, the education completion rate for women is similar (if not higher) to their male counterpart, that according to the World Economic Forum that on average more women in developed economies than men graduate with at least a secondary degree (2019). There are not as many women studying the subjects that will be highly in demand for jobs of the future. For example, in the United Kingdom only 37 percent of female first year university students studied science subjects in 2016–17, compared with 48 percent of male students (McKinsey Global Institute, 2019, p. 96).

Besides higher education, in vocational training and other reskilling programs women are also less capable of enrolling and more likely to drop out due to constraints such as cost, access to transportation, and family obligations. As mentioned in the previous section, that women take more unpaid domestic work, balancing between unpaid and paid work makes it more difficult for women to fully commit to reskilling programs and make the job transition afterwards. Studies have found that due to the social, economic, and culture barriers, there were less women taking entry-level jobs after the completion of education, even where the graduation rate between women and men are roughly the same (McKinsey Global Institute, 2019).

a. Training and reskilling programs that are specifically targeting women

Taking into account the gender specific challenges that women face in skill-building, skill-building strategies are suggested for companies, governments, and organizations to better support women. First, companies and organizations should establish training and reskilling programs that are specifically targeting women, they should have the aim of enabling more women to seize new employment opportunities which have different or changing skill requirements. A good example of such programs that is designed specifically for women in the workforce is named "Women Will" in Japan. As it is identified that 2/3 of women in Japan did not return to work after having children, the program "helps new mothers return to the workforce by leveraging technology, such as internet-enabled tools, to allow for a more flexible work style" (World Economic Forum, 2020).

b. Training and reskilling subsidies

Given that many women are unable to participate in the training and reskilling programs due to financial constraints, it would be helpful for governments and organizations to subsidize the cost of their training. The subsidies can be rolled out through a partnership of government and industries with an aim of preparing workers for specific growth sectors and occupations. An example of such training subsides programs for women is Singapore's national initiative called SkillsFuture. The program addressed the issue that women lag behind men in skills development and provides a credit of 500 Singapore dollars for approved work-related skills programs (Skillsfuture, 2019).

c. Building digital learning platforms

Making digital learning platforms more widely available can help to eliminate problems such as transportation, financial, and time constraints to reskilling. Companies can also use online courses to supplement their skills training, making on job upskilling more easily accessible. In developing countries, as women generally lag behind in access to technology and education levels, having digital learning platforms more available to them would be very helpful in providing accessible training opportunities to women (Marengo, 2019). For example, Goldman Sachs' 10,000 Women initiative has launched a global online learning platform, providing female entrepreneurs and business owners with free digitized curriculums in emerging markets (Goldman Sachs, 2018).

2. Efforts in reducing flexibility and mobility related barriers

Beside the financial constraints discussed earlier, barriers on mobility and flexibility of women at work have also been identified as the major factors that discouraged women from participating in the reskilling program or staying in the labour force. Women, in general, have less time to take on paid work or to undertake training courses as they bear a disproportionate share of domestic unpaid work. According to McKinsey Global Institute, 75% of the world's

unpaid care work, "including childcare, elder care, cooking, and cleaning, falls to women" (2018, p.109). The need to juggle between unpaid work and paid employment inevitably make women less flexible and mobile than men to take training and new career opportunities. In addition, concerns on Women's physical security is a significant factor that negatively affects women's participation and representation in the labour market. Many women are reluctant to travel to work due to the fear of their physical security. The issue of sexual harassment is also compromising women's ability to maximise their opportunities at the job market.

a.   Public spending on improving women's work flexibility and mobility

Having the concerns on the flexibility and mobility of women's work identified, it is important for companies, governments, and organizations to establish measures to improve women's labour market flexibility and mobility. First, priority should be given to programs that help women balancing between paid and unpaid domestic work. For governments, it is important in taking into account all aspects of work that women take unpaid at home and provide support when planning their budgets. Government spending on providing paid maternity leave, childcare, and family sick and care leave is crucial in encouraging women to take paid employment when possible. For companies, providing more flexible work options can not only encourage more women to join the workforce, but also help the companies to retain female employees. Examples of flexible work options include telecommuting, work-from-home days, employer-subsidised childcare, and longer maternity leaves. For instance, when Google increased paid maternity leave by 6 weeks (and increased paid paternity leave by 5 weeks), the rate at which new mothers left the company dropped by 50 percent (McKinsey Global Institute, 2019).

b. Address public safety concerns of women by enhancing safety measures

Having the physical safety of women been identified as a major concern that prevented women from participating in employment, it is necessary for governments to introduce measures to improve women's safety and increase women's mobility. Countries like japan, have introduced women- only underground trains and other gender-segregated travel options to prevent sexual assault on public transport (Bianca and Dominguez Gonzalez, 2015). Investment on infrastructures such as public transportation and public surveillance systems can be very helpful in boosting the confidence level of women in their physical safety.

3.   Improve women's access, skills, and representation in technology

Improving women's access in technology can help to overcome many of the previously mentioned difficulties that women face, so that more women are enabled to participate in reskilling programs, take advantage of employment opportunities, and be better prepared for the future job transitions. Better access and training in technology can help women in the

following ways. First, as PST (professional, scientific, technical) sectors are expecting the biggest job growth in the future as the result of AI and automation, technological skills will be crucial to have for workers in these fields. Therefore, by equipping women with strong technology skills will enable them to take advantage of the new job opportunities in the PST sectors. Second, the access of technology improves flexibility at work by enabling work from home and virtual meeting options. As it helps women to overcome the difficulties of work-home balance and addresses their safety concerns, women's participation in the job market will be increased. Last but not least, better training and access to technology will encourage and empower women to take entrepreneurial work opportunities such as building digital influence and establishing e-commerce businesses.

However, women still lag behind men in their access, education, and representation in technology, and the case is especially severe in emerging countries. Around the world, there are 33 percent less women who have access to the internet compared to men (McKinsey Global Institute, 2019, p.107). Besides the less access to technology, women also lag behind men on their education and skill building in technology, that globally, women only accounted for 35 percent of STEM students in higher education (EQUALS Global Partnership, 2018). Thus, helping women to increase their representation in technology, companies, governments, and organizations should primarily focus on providing better access to technology as well as more education and training.

a.   Programs to encourage women to study and work in the tech field

In addressing the gap between men and women's representation in the STEM field, intervention and support for women to study STEM subjects should start at an early stage of education. Governments and schools should work together in encouraging girls and women to study and pursue careers in the tech field, and also work to reduce the stereotype that women are less fit for STEM occupations. In addition, companies should take measures to increase the representation of women in management and leadership positions, so that more women can envision a clear career path in the tech field, and thus be more enticed to join.

b.   Increase access to basic enabling technology

In many emerging countries, inequality between men and women in their access to basic technologies such as the internet and mobile phones is very prominent. The inequality can be partly explained in the culture attitude of the countries. For example, 60 percent of men in New Delhi, India, agreed that they have priority over women in internet access (McKinsey Global Institute, 2019, p.107). Governments and organizations should work on raising the awareness of women's need for basic technology access as it is crucial in improving women's digital literacy for the future job market. In addition, more investment in infrastructures that provide more technology access overall is necessary and highly important in enabling more women to work in the tech field.

Conclusion

In the age of AI and automation, some jobs may be displaced by machines, yet new jobs will be created as technologies complement human work and improve its efficiency. Rather than focusing on the potential loss in employment caused by automations, this report attempted to explore the new job opportunities for women in the age of technological disruption.

The report first presented an overview of the job market in the age of technological disruption. It has identified the occupations that receive relatively minimal impact by automation and AI in which women are safe to stay, which are the occupations that demand a great amount of emotional, advanced communication and interpersonal skills. It then identified the industries that could expect the biggest jobs gains thanks to automation and advanced AI systems, which are healthcare and PST (professional, scientific, technical) sectors. And finally, the section identified the entirely new job opportunities that would be created by increasing integration of technology, which are "frontier jobs" (including "trainer", "sustainer", and "explainer"), jobs created by marketization of previously unpaid work, wealth jobs, and last-mile work jobs.

The report then followed to discuss the skill change in the jobs of the future. It has identified the skills that are going to be less in demand, which are physical and manual skills and basic cognitive skills. The skills that are going to be more in demand are higher cognitive skills, social and emotional skills, as well as technological skills.

Finally, the report discussed and recommended measures for governments, companies, and organizations to take in supporting the women in accruing the skill and education that are necessary in the future job market. The measures will also help to lift the financial, work flexibly and mobility constraints that women face, so that they can maximise their opportunities in the future job market and make smooth jobs transitions when needed. The recommendations were given in 3 major areas. First, governments, companies, and organizations should establish more Skill-building supports, including building training and reskilling programs that are specifically targeting women, provide subsidies to the reskilling programs, and building digital learning platforms. Second, more efforts should be given in reducing flexibility and mobility related barriers that women face. Specifically, governments should increase the public spending on infrastructure and programs that improve women's work flexibility and mobility and address public safety concerns of women by enhancing safety measures. And last but not least, governments, companies, and organizations should work on improving women's access, skills, and representation in the technology field, specifically by encouraging women to study and work in STEM fields and increasing women's access to basic enabling technologies.

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