What policies could countries introduce to mitigate technological unemployment hence reducing robophobia?
A qualitative study.

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Abstract

Technological unemployment, in other words the substitution of human labor with automation, has become a growing concern today and is a large contributor to robophobia - the fear of robots. This paper aims to add value to existing research through a cohesive paper providing causes, practical example, and solutions to this global issue. South Korea and Germany were compared to highlight the varying impact of automation in different economic contexts and why one deals better with technological unemployment than another. In addition, the study suggests potential strategies and solutions to mitigate the negative impacts of technological unemployment, including investment in education and skills development, industry-government collaboration, and reassessment of labor costs and capital allocation. Ultimately, this paper highlights the importance of understanding and addressing technological unemployment to ensure a future in which automation and human labor coexist harmoniously, promoting a more equitable and inclusive society.

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1. INTRODUCTION

We are starting to live in a world where automation and artificial intelligence is surrounding us. The technological era we live in today which involves the rise of data analytics, human-machine interaction, digitization, and automation (Fonseca, 2018) is known as the fourth industrial revolution or industry 4.0 and we are now on the brink of it (Yang & Gu, 2021). According to McKinsey (2022), before 2014 the Google search term “Industry 4.0” was nonexistent. Although by 2019, 70% of respondent of a McKinsey survey were already piloting new technology where 68% of respondents regarded industry 4.0 as a top strategic priority (McKinsey, 2022). Studies show that between year 2000 and 2010, 85% of all jobs lost in the USA were due to the introduction of new technologies (Cocco, 2016). With that said, the study of technological unemployment is becoming more important.

Technology unemployment can be described as “a situation when people are without work and seeking work because of innovative production processes and labor-saving solutions” (Kochanska & Klimczuk, 2015). The term was first introduced in the 1930s when John Maynard Keynes predicted technological unemployment with the motivation “due to our discovery of means of economizing the use of labor outrunning the pace at which we can find new uses for labor” (Keynes, 1930). Ever since there has been extensive research on the concept. Looking back in history, the impact of technological unemployment is large. During 1970-1990 the annual employment losses in the USA was at 800,000 (Stettner, 2018). Fast forward to 2020, the employment losses stand at 2.5 million yearly, a three-time increase (Stettner, 2018).

With that said, the global spread of AI and automation is leading society to feel insecure about the future of their employment (Gee, 2021). This feeling of insecurity leads them to a great sense of robophobia or fear from robots. Considering this, a solution to technological unemployment is crucial to help reduce robophobia. By understanding what triggers robophobia in people and finding a solution to it, society can move forward with the future instead of resisting it.

However, research on what makes the fear of technological advancement differ from one country to another and what solutions can be placed to mitigate the threat is something that very few have studied such as (Vivarelli, 2012) and (Stevens & Marchant, 2017). Understanding why specific countries welcome robots and automation at low unemployment levels helps other countries to learn how to deal with their technological unemployment and therefore help propose solutions. For example, we can learn from South Korea how they managed to become one of the worlds most automated and technologically advanced country while maintaining low unemployment rates.

Furthermore, I will add more value to this paper by gathering literature regarding potential solutions that could solve the problem of high unemployment rates due to technological advancements. Therefore I will dedicate this research paper to further explore the research available regarding these topics and finding out the secret of why there are countries less affected by technological unemployment than others and what solutions/regulations can aid in solving this issue. While automation also comes with advantages this paper will only focus on the disadvantage of technological unemployment to narrow down the research and keep it specifically focused on one aspect of automation.

With that said the research question is as follows:

What policies could be countries introduce to mitigate technological unemployment hence reducing robophobia?

In order to answer the research question in a structured manner, I broke it down into three sub-questions.

Sub question 1: What are the causes of technological unemployment?
Sub question 2: What makes two highly automated countries have different unemployment rates?
Sub question 3: Which solutions to technological unemployment could be proposed?

2. LITERATURE REVIEW

In order to have a complete overview of the topic it is essential, to begin by including some knowledge about the theory of technological unemployment which is considered to be one of the main causes of robophobia or the fear of robots today.

2.1 Robophobia

The term robophobia could be defined as “a bias against robots, algorithms, and other non-human deciders” (Woods, 2022). It can also be defined as an “irrational anxiety about robots and other advanced automation machines” (Faulkner, 2019). It could simply be defined as the fear of robots/automation. This fear has been increasing during the last few years due to the development of technology. In 2014 Stephen Hawking told the BBC that “the development of full artificial intelligence could spell the end of the human race” (Sewell, 2017).

Furthermore, articles such as ‘AI Revolution is Coming-And It Will Take Your Job Sooner Than You Think’ and ‘New Study: Artificial Intelligence Is Coming for Your Job, Millenials’ (Liang et al., 2019) all lead to a widespread fear towards the job anxiety automation could cause (Woods, 2022).

2.2 Technological unemployment

Technological unemployment can be simply described as unemployment or loss of jobs due to technical progress (Black et al., 2009). The largest fear continuously connected to automation in research is the fear of unemployment (Gee, 2021).

The fear of AI or robophobia seems to stem from a few common causes: general anxiety about machine intelligence and the fear of mass unemployment (Schmelzer, 2019).

The fear of technological unemployment has been around for years with each new development. This is showcased throughout history. For example, in 1589, William Lee invented the stocking frame knitting machine although Queen Elizabeth I refused to grant him the patent due to unemployment concerns (Frey & Osborne, 2013). Furthermore, the adoption of manufacturing technologies in the 19th century led to the substitution of skilled workers with machinery (Frey & Osborne, 2013). Moreover, in the 20th century, car manufacturing has become majorly done by robots. Assembly line tasks such as painting and welding were migrated from humans to robots (Fleming, 2020).

Furthermore, according to a study by Bain and Company (2018), they believe that service sector automation could displace labor at 2-3 times the rate of past transformations.

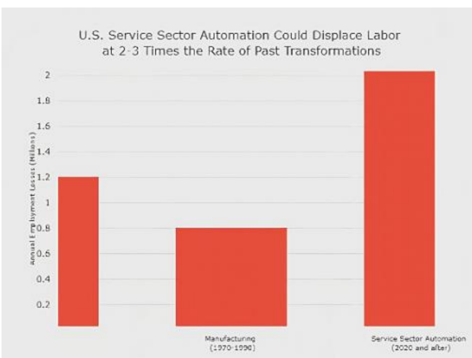

Figure 1.1 US Service sector unemployment across the years (Bain and Company, 2018)

Figure 1.1 showcases that during 1970-1990 the annual unemployment was at 800,000 in the US. Fast forward to 2020 the losses in employment stand at 2.5 million yearly, a three-time increase (Stettner, 2018). This increase magnifies the relevance of the topic and highlights that the situation is worsening as time passes.

To truly compare the size of this impact, we could look at the size of US labor during 1990 and 2020. During 1990 the labor force was at 126 million (Statista, 2023). In 2020, the labor force increased to 161 million (Statista, 2023). With that said, while the labor force increased (22%), the employment losses increased at a larger rate (68%).

The negative effects or disadvantages of unemployment generally also apply to technological unemployment. This includes social division, where there is a big gap between social classes. Furthermore, poverty levels increase, leading to poor social behavior such as mistrust, crime, and corruption (McClleand & Macdonald, 1998).

Nevertheless, the effects of technological unemployment in research are mixed. Some believe technological advancement will lead to newer jobs and less unemployment, while others believe the level automation will be far greater than the jobs thus it will lead to a greater unemployment. To support this statement, when looking at how many jobs could be automated in the next two decades, the literature provides estimates as low as 9% (Arntz et al., 2016) and as high as 50% (Chui et al., 2017) in the USA. (Arntz et al., 2016) estimated automations impact on occupation tasks by studying 21 nations that are part of the OECD which led to an unemployment risk of as low as 9% considering a task-based approach. Moreover, an article written by Chui et al., 2017 published on the Harvard Business Review and based on an analysis of 2,000 workplace activities across 800 occupations, states that about 50% of the activities (not jobs) that people do in the global economy can be automated. The most automatable activities according to the analysis were data collection, data processing, and physical work in environments like factories. This means that there are still jobs that will exist while automation will just aid in the productivity of some jobs.

On the other hand, Frey and Osborne estimated the impact on occupations by gathering information about 702 occupations using O*NET an online platform developed by the US Department of Labor (Frey & Osborne, 2013) and predicted that around 47% of occupations can be automated.

There is a strong link between Arnz et al., 2016 and Chui et al., 2017 since they both believe that not entire jobs would be automated but instead, job tasks would. This indicates that there are specific jobs that can be fully automated while the rest are partially affected. The next section looks at these types of jobs at risk.

2.3 Types of jobs at risk

The types of jobs at risk from automation helps set the picture of what tasks will become irrelevant. This information will play a role in the analysis of possible solutions later in the report.

David Autor and Price (Autor & Price, 2013) analyzed data from the US Department of Labor called O*NET database to examine which types of jobs are at greatest risk of being replaced by automation.

Table 1.1 Jobs at risk from automation, by task type (Stettner, 2018)

Jobs at Risk for Automation, by Task Type

	Cognitive	*Manual*
Routine	Endangered (Sales and clerical occupations)	Endangered (Production occupations)
Non-Routine	Safer Cognitive-Analytic (Professional and technical occupations) Cognitive-Interpersonal (Health care occupations)	Safer (Repair occupations)

According to table 1.1, they divided the tasks into two categories, cognitive or manual, and whether the work is routine or non-routine. Routine tasks are automated processes that are implemented more efficiently by robots. For example, hospitals are substituting human assistants with chatbots to deal with customer enquiries (the economist, 2020). Non-routine tasks are tasks that require human skills which apply to both cognitive and manual tasks. Professions that fall under the category of cognitive non-routine tasks include doctors, engineers, and scientists. Moreover, that jobs that are today available due to the advancement in technology, include fraud detection and civil infrastructure which fall under non-routine tasks.

Nevertheless, the threat of these jobs is increasing with the ever evolvement of technology. For example, diagnostics work, which is considered a non-routine task, is already being computerized. Oncologists at Memorial Sloan-Kettering Cancer Center are utilizing IBM's Watson computer to supply chronic care and cancer treatment diagnostics. Insights from 600,000 therapeutic prove reports, 1.5 million patient records and clinical trials, and two million pages of medical journals are used for benchmarking and pattern recognition. This permits the computer to compare each patient's person indications, hereditary qualities, family, and medicine history, etc., to analyze and create a treatment arrangement with the most elevated likelihood of success (Frey & Osborne, 2013).

On the other hand, an example that falls under the category of non-routine manual tasks is repair jobs that require variety of critical thinking skills due to the variety of situations. The types of jobs at risk showcase that their technological unemployment will affect certain types of jobs but not all. According to the table above, any routine job whether manual or cognitive is at risk of being automated.

2.4 Automation amongst different economies

Research has proven that countries are not affected by automation in the same manner particularly due to the country's demographic trends, growth aspirations, industry structure, and types of jobs performed. A study by Chui et al. (2017) examined the automation potential of individual work activities by adapting today’s technologies of 46 countries representing 80% of the global workforce (Chui et al., 2017).

Table 2.1 showcases the countries where the potential for automation is highest (Chui et.al, 2017).

AFRICA		ASIA/AUSTRALIA		EUROPE		NORTH AMERICA		SOUTH AMERICA	
Kenya	51.9%	Japan	55.7	Czech Rep.	52.2	Mexico	51.8	Peru	53.2
Morocco	50.5	Thailand	54.6	Turkey	50.4	Costa Rica	51.7	Colombia	53.0
Egypt	48.7	Qatar	52.0	Italy	50.3	Barbados	48.7	Brazil	50.1
Nigeria	45.7	South Korea	51.9	Poland	49.5	Canada	47.0	Chile	48.9
South Africa	41.0	Indonesia	51.8	Spain	48.5	U.S.	45.8	Argentina	48.2
		India	51.8	Germany	47.9				
		Malaysia	51.4	Greece	47.8				
		China	51.2	Austria	47.4				
		Russia	50.3	Switzerland	46.7				
		Philippines	47.9	Sweden	46.0				
		U.A.E.	47.3	Netherlands	45.4				
		Oman	46.8	France	43.1				
		Bahrain	46.1	U.K.	42.8				
		Saudi Arabia	46.0	Norway	42.4				
		Australia	44.9						
		Singapore	44.2						
		Kuwait	41.1						

SOURCE MCKINSEY GLOBAL INSTITUTE © HBR.ORG

This difference reflects differences in the mix of industries and, within industries, the mix of occupations that are more or less likely to be automated. According to Figure 1.1, Japan, Thailand, and Peru have the largest potential for automation in the decades ahead. According to Chui et al. (2017) when comparing Japan with the USA, Japan has an overall automation potential of 56% of hours worked compared to 46% in the United States. Most of the difference can be attributed to the Japanese manufacturing industry, which has a particularly high potential for automation.

In Japan's manufacturing industry, working hours are slightly concentrated in manufacturing jobs (54% of the time in Japan vs. 50% of the time in the US) and clerical and managerial positions (16% vs. 9%)(Chui et.al, 2017). On the other hand, the US has greater working hours in the fields of management, architecture, and engineering jobs which have less potential for automation since they require expertise that computers and robots are not currently able to perform.

China and India’s labor force are more than 700 million workers, together these countries account for the largest potential for technological unemployment taking into account size of their labor force and large automation potential of 51% and 52% respectively. Likewise, Europe has a very large risk of technological unemployment since 60 million employees are associated with automatable activities in (France, Germany, Italy, the United Kingdom, and Spain) according to the Harvard Business Review (Chui et.al, 2017). Germany for example, is ranked the fourth most automated country in the world (Wessling, 2021) with an unemployment rate of 5.7% (Statista, 2023) higher than OECD average of 4.8%, and lower than the EU average of 6.5% (OECD, 2023). Moreover, compared to a highly automated country like South Korea, it is considered significantly higher where Korea stands at 3.65% (IMF, 2023).

Yongjun Choi and Bud Baker have written a report called “The Impact of Automation on Business and Employment in South Korea” which predicts a new factor that can affect technological unemployment in South Korea compared to other countries. South Korea has invested heavily in education after its war with North Korea. Today it's one of the world’s most highly educated populations (OECD, 2020).

The authors state that countries that invest heavily in education such as South Korea, would have the most resistance to technological advancements compared to countries with a less educated population since automation would hit lower-educated people harder (Karlsson & Sunesson, 2020). This is particularly because "jobs requiring a bachelor's degree involve a greater number of transferable skills that are less easy to automate" (Hess, 2023). Therefore a country like China would be more affected than South Korea since there is a greater population of non-educated people and most automated work would be offshored from South Korea to China where more automation exists. This article is relevant to the research since it shines a light on education and its connection to resistance towards technological unemployment. When a country's population is well educated, they perform complex jobs less likely to be automated, hence the resistance to automation, and vice versa.

According to the Harvard Business Review after a study to understand the countries most and least affected by technological advancements, the authors divided the economies into three categories, each of which could use automation to achieve their national economic growth objectives.

2.4.1 Advanced economies

Advanced economies are highly developed economies with an aging workforce. Italy, Japan, and Germany are a few examples. With an aging population comes lower employment levels, but with automation, a productivity boost could be achieved that can help meet economic growth that they would have difficulty attaining. For example, a 2017 study by McKinsey states that 60% of all occupations have at least thirty technically automatable activities. Therefore, salespeople for example, can automate administrative tasks and use their energy elsewhere (Maout, 2021). A study by Froymovich (2019) shows that automation improves job productivity. A Highly automated workplace was at 80% productivity compared to 59% for a highly manual workplace. Therefore such economies highly seek rapid automation although may suffer from high unemployment if not managed properly (Chui et al., 2017).

2.4.2 Emerging economies

Such economies experience economic growth gaps which are combined with a decline in their working population. Such countries are China, Russia, and Argentina. Automation would lead to increased productivity and maintain their current GDP per capita. Since these economies have growth aspirations, automation would help achieve faster growth. Hence they would demand automation and seek to have it integrated into their economies (Chui et al., 2017).

2.4.2 Emerging economies with a younger population

Saudi Arabia, India, and Turkey all have a growing young population. Automation is necessary for them to remain competitive globally and achieve their high growth aspirations. In addition, education will also play a crucial in these economies to foster the young population and develop their skills to be able to cope with the future.

3. METHODOLOGY

The research will be conducted through gathering literature from various sources to come up with possible solutions to technological unemployment in a highly automated environment. With that said I will gather both qualitative and quantitative data to have a balanced discussion.

Due to time and financial constraints, primary sources will not be collected, instead I will rely on secondary sources. Secondary sources are existing data that have been previously published, helping me gain insight on various expert perspectives (Rabianski, 2003).

Qualitative data will be gathered through articles, and research papers. Examples of such sources are Scopus, Research Gate, and Google Scholar as they provide a wide variety of research papers. Search terms such as "technological unemployment", "policies to mitigate technological unemployment", "solutions to technological unemployment", "causes to technological unemployment" etc. will be used. In addition, a subject filter will be applied focusing on economics, business management, and social sciences. This will narrow down results revolving around business studies. This type of data will be crucially important in identifying the main drivers of technological unemployment and the solutions that can be introduced to reduce the negative effects of automation.

On the other hand, quantitative data will be gained from governmental organizations and statistical websites. For example, the OECD or (the Organisation of Economic Co-operation and Development) contains authentic publicly accessible data regarding the economic development of countries and their unemployment levels. Another authentic website that will be used is Statista, which also offers information about various numerical factors of an economy. Finally reports from Mckinsey and Harvard Business Review will be used to collect quantitative and qualitative industry data useful for this research.

All these sources combined will aid in understanding why countries can have a low unemployment rate but high automation adoption and the solutions that can be proposed to countries struggling with that.

3.1 Research framework

Part 1 of the analysis presents the causes of technological unemployment.

Part 2 compares two economies with different unemployment levels and link them to their automation levels. The goal will be to find out why a highly automated country like South Korea has a lower unemployment level than Germany which is considered a highly automated country too. I only compares two countries to narrow down the research.

Part 3 proposes solutions that can be introduced by countries to minimize the risk of technological unemployment in advanced economies or countries equipped with high automation but also high unemployment.

4. ANALYSIS AND DISCUSSION

4.1 Causes

To answer sub question 1, there are numerous factors that trigger technological unemployment. Finding the causes sets the right foundation when connecting them with possible solutions.

4.1.1 Fast pace of technology

Today's technologies come in the form of software which is quickly scalable across the world compared to the technologies of the previous industrial revolutions such as steam machines in the first industrial revolution, the introduction of mass production machinery in the second industrial revolution, and digital electronics during the third industrial revolution (Sedai, 2019). Today we are on the verge of industry 4.0 with the introduction of robotics, machine learning algorithms, self-driving cars, 3D printing and many other labor-saving innovations.

4.1.2 Skill mismatch

With that said, the fast change that occurs due to the quick improvement of technology around the world creates a skill mismatch. "Digital technologies are changing rapidly although skills and organization are nor keeping up with such change" (Sedai, 2019). The already acquired skill of employees become irrelevant as new skills must be obtained to cope with modern technology. Therefore, employees become incapable of coping with the pace of technology due to the large skill matching that is constantly required and hence the technology takes over the employee's position.

4.1.3 Cost of Labor

Aside from the fast pace of technology and the skill mismatch there is a huge motive for companies to move towards automation to save on cost of labor. "The cost of Labor is the sum of all wages paid as well as the cost of employee benefits and payroll tax" (Investopedia, 2020). Labor comes with a great cost to companies. In fact, it's one of the largest costs to companies averaging around 50-60% of overall company spending according to a study by Deloitte. Social security taxes in Europe account for 20% on average (European HR, 2023). This already magnifies the economic advantage of substituting humans for robots. Nevertheless, the savings on costs of labor highly depend on the type of job. If a job is not automatable, the cost of labor will still exist.

4.1.4 Concentration of power in technology companies

Finally, the last factor that can accelerate technological unemployment is the fact that much of our digital technology is controlled by very few companies in few countries. China and the USA are the two most dominant economies in the field of digital technology solutions. For the field of AI for example, which is playing a significant role in the current automation wave, these are the companies controlling the space: Apple, Microsoft, Google, Meta, Amazon and Nvidia (Kabir, 2022) all of which are in the USA alone. With that said, all the power is in their hands hence technological change is left to be determined by these profit maximizing companies. Many people rely on these companies' outsourcing activities (Corpuz, 2016). When these companies stop outsourcing to developing countries due to high automation levels in the developed countries these companies operate in, many people may be left without jobs. From that perspective, technological unemployment is a consequence of the use of capital freed up by automation to maximize profits. Changing the way of thinking towards capital in these corporations would avoid technological unemployment. Capital would be invested in human improvement instead of increasing the richness of very few people (Naastepad & Budd, 2022).

4.2 South Korea vs Germany

As part of the goals of this research, sub question 2 aims to understand why two highly automated countries perform differently in adapting to technological unemployment judged by their unemployment levels. A notable example for this comparison is South Korea and Germany which is the largest economy in Europe (World Economic Forum, 2023). The reason these two countries were chosen is due to their similarity in economic and technological developments and difference in their unemployment.

4.2.1 South Korea/Germany economies

While the two countries might look similar, they perform very differently in terms of employment. South Korea has an unemployment rate of 3.65% (IMF, 2023) compared to 5.7% (Statista, 2023) in Germany.

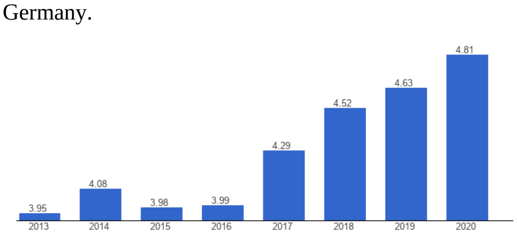

Figure 2.1 Korea gross expenditure on Research and Development as a percentage of GDP (The United Nations, 2020)

According to figure 2.1, South Korea invested about 4.81% in 2020 of its GDP on research and development compared to Germany's 3.14% in 2020 (Vankar, 2022). This is also an indicator of their eagerness for technological excellence.

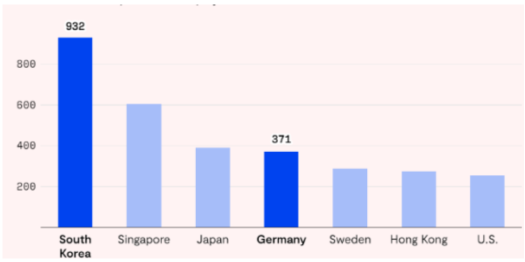

Figure 2.2 Robot density per 10,000 employees (International Federation of Robotics, 2020)

Furthermore, South Korea has the highest robot density in the world at 932 robots per 10,000 employees, compared to Germany's 371 robots per 10,000 employees. This significant difference further magnifies the level of technological adoption and advancement that South Korea has reached.

Although how South Korea deals with such high adoption of technology while maintaining a particularly good unemployment rate is can be explained by several reasons. The initiatives and efforts taken by the South Korean government sets an example of how policies can help facilitate people's preparedness for future jobs.

4.2.2 Education in advanced skillsets

South Korea invests highly in the education of information technologies to prepare society for the jobs of the future. An example is bringing technology into the classroom. Virtual reality (VR) empowered classrooms and abilities preparing is an extraordinary case. The university of Technology and Education of South Korea (KoreaTech) is conveying Virtual reality empowered learning. Such preparing is utilized for rehashed practicing of disassembling or reassembling equipment without actual – often expensive or large-scale equipment (Cho, 2020). The real capital in this case is the human and not the machine. This is a mindset that few including South Korea got right, they invest in long term skillset.

In contrast, Germany's dual education system combines theoretical education with practical on-job training. In addition, apprenticeship programs are widely offered offering job training lasting two to three years (Fleckenstein et al., 2023). Although South Korea addresses employer demands pro-actively. They offer programs called Leaders in Industry University Cooperation (LINC) and the Program for Industry Needs-Matched Education (PRIME) which aim to create a link between cooperation and universities, prioritizing employability and keeping up with industry trends and needs (Fleckenstein et al., 2023).

On the other hand, South Korea also has examples of leveraging technology to support employee and student enhancement. The labor market information technology system brings data analytics and AI technology to enable improved efficiency and accuracy of public employment services. These services aid in providing relevant information to the jobseeker, the required vocational training of employees for the job, and on the job support. The big data analytics provided by these services are used to set labor and skills policies. For example, HRD-Net is a job training portal that provides training courses, qualification tests, all connected to a job matching platform. In this manner, jobseekers receive training and job market information at the same time (Cho, 2020). This governmental initiative plays a key role in setting the right standard through meeting the right skillsets amongst the South Korean population. Such an initiative reduced vulnerability of workers being infiltrated by robots.

However, while training is offered the economic value of humans is placing a burden on South Korean companies. "Speefox", South Korea's largest manufacturer of capacitors have 75% of their factory automated. Part of the drive to the high automation is the increased labor costs that come within, with South Koreas minimum wage rising 5% in 2022 (Boroweic, 2022). This is an example of the cause outpowering the initiatives.

4.2.3 Job opportunities for elder age groups

South Korea's unemployment rate dropped a record low as older aged workers enter the job market mainly 60 years of age and over (Yoo, 2023). South Korea is very good at offering elderlies good work choices and wages. Thirty-six percent of people aged 65 and over are employed which is twice the OECD average standing at 15.5% (Caton & Kim, 2022). Compared to Germany, the population of 65–69-year-olds employed stand at just 17% (DeStatis, 2023). This is a significant difference of 19% when compared to South Korea's employment, almost two times greater.

4.2.4 Governmental initiatives

The South Korean government has implemented initiatives to promote the job creation and reduce unemployment. These efforts include investments in SME's and infrastructure projects. For example, a state lead incubation program called TIPS (Tech incubator Program for Startups) discovers, nurtures, and matches them with government funding (Yoon, 2022) creating a supportive entrepreneurial community. In addition, the South Korean Ministry of SME's placed €78 million euros to help support startups and SME's. In addition, the Ministry of Science and ICT will invest over €38 billion by 2025 focusing on the markets of AI, Big Data, Cybersecurity, and Blockchain (Kyei, 2022). With these initiatives, there is also large incentives for companies to help them expand and hire more employees.

Nevertheless, Germany has also implemented several government initiatives towards supporting startups and other projects. For example, the German government is placing a great amount of funding targeted at startups in their growth stage. The federal government will support technology-based startups with €10 billion euros of public funding until 2030. Energy startups for example, are supported through initiatives like the SET hub which includes mentoring, access to a vast network, think tanks and pilot programs (Akanshka, 2022). In addition, the government works with private investors to mobilize thirty billion euros to flow into key innovative areas such as, artificial intelligence, Quantum Technology, Hydrogen, Medicine, Sustainable Mobility, Bioeconomy, Climate energy, circular economy, and environmental technology.

Moreover. the country is attracting foreigners through easier immigration laws to support skilled labor and entrepreneurs to further create an innovative and skilled society (BWMK, 2022). Such new initiatives will aid in creating new job opportunities hence lower unemployment rates in the long term.

Nevertheless, South Korea is investing more than Germany in a shorter period, although it cannot be ignored that the German government is placing a large effort.

4.3 Solutions to causes

Through connecting part 1 and 2 of this research we can conduct the final part of the research which proposes solutions backed by the previous sections. The causes of technological unemployment and the example of South Korea compared to Germany has led me to generate various solutions that can be linked to every cause stated earlier. We can learn from the examples of South Korea and Germany to help produce possible solutions to technological unemployment. Hence, some solutions were inspired by South Korea’s successful implementation of automation while maintaining a low unemployment rate. Below are solutions to the causes of technological unemployment stated in section 4.1.

4.3.1 Solutions to the fast pace of technology and skill mismatch

As stated in section 4.1.1 the rapid pace of technological advancement is outpacing the workers pace to acquire new skills needed for the job. This leads to a skill mismatch and the displacement of human workers as mentioned in section 4.1.2. To help prevent these causes education is vital.

4.3.1.1 Co-bots

One of the solutions proposed by the research is augmenting workers instead of replacing them (Chomanski, 2019). Cobots is when humans and robots work together to achieve a certain task. In this manner, workers will function as a middleman or intermediary. While this solution cannot be offered to every job role, it will prove beneficial in the case of factory operations for example. To implement that, intensive education must be implemented to educate current and future employees of ways to interact with robots.

South Korea set the example for educational methods to implement the cobot concept to adapt to the future of automation. Automation requires maintenance, supervision, and will always require the human skills to be there as this is a factor that cannot be replaced by artificial intelligence.

With that said, countries should finance and support educational systems to invest in the field of robot knowledge, how to deal with them and leverage their capabilities. The skills obtained to cope with this is digital skills. This will open new vacancies for robot management hence making up for the loss of jobs due to the integration of robots in the workplace. As the workforce become more skillful, their wages will decrease and greater demand for them will be available. Therefore, there will be job opportunities whilst it being economically feasible to companies (Walsh, 2018). Therefore, one solution is to invest heavily in the work of the future, the work that requires us (humans) to interact with robots.

Moreover, the implementation of cobots aids in reducing working hours, hence increasing human efficiency, and reducing labor cost. For example, in year 2000 the French Government introduced the shift of working hours from 40-35 hours. Jobs were near minimal wage, but income is better off than being laid off completely (Sedai, 2019). While cobots do not eliminate technological unemployment, it only acts a way to minimize it.

4.3.1.2 STEM education

While shifting to the needs of the market, Universities should also provide short training courses focused on retraining workers according to the new market demands. The curriculum should be based on science, technology, engineering, and mathematics (STEM). This approach can help employees work with the machines at their workplace.

There are two parties that can play a role in this innovative approach to learning. Firstly, governments should fund higher education institutions to promote the implementation of this approach. Secondly private companies will be a main driver to implementing this new approach since the private sector pays a role in establishing the curriculum, employing graduates, and is the driver of automation, so they know exactly what the skills are required. Funding and support from them will be vital to the widespread of this new way of education.

4.3.1.3 Tracking occupational change

Tracking occupational change is a solution to figure out the outdated skills that are required to be improved. For this solution, I will take the USA as an example. Higher educational institutions can start tracking the new demanded skills in the corporate world aiding to a more effective education that can be put into practice immediately. A suggestion is to propose an early warning system that examines the Bureau of labor statistics to detect how occupations are shifting through tracking information on the new job descriptions, and regular direct surveys to access their hiring necessities in terms of skills and tasks (Walsh, 2018). In this way, society is up to date with what is expected in the mark (Fleckenstein et.al, n.d.) can live up to this expectation.

4.3.2 Solutions to cost of labor

A great advantage of automation is the labor cost saving, which drives companies to replace human workers. Although there are tax systems and ways of thinking that can help prevent this cause from happening.

4.3.2.1 Fiscal Policies

Automation has led to economic growth but displaced many low skilled workers benefitting capital owners which has also led to inequality in society. A tax system is a solution that would cause society to tradeoff growth for equality. There are four fiscal packages that can be implemented. Firstly, is the redistribution of capital gains from automation to low skilled labor instead of capital owners (capital income tax). Secondly, a tax on excess corporate profits also known as a markup tax. Thirdly, a tax on robots. Lastly, eliminating wage tax on unskilled labor (Gueorguiev & Ryota Nakatani, 2021).

According to figure 2.1, the markup tax, robot tax, and unskilled labor wage tax cut have shown modest productivity in the short term with reduced inequality. While in the long term, capital accumulation and productivity begin to slow down. The robot tax proved to be the most powerful in reducing inequality, since it slows down the replacement of labor with robots hence more work opportunities, although on the other hand, slower output due to lower productivity that robots. Likewise, a tax cut on wages is beneficial in the short run as it raises productivity of labor and reduces inequality. Although in the long run, the productivity lacks as they are less productive than robots, thus lower output in the long run.

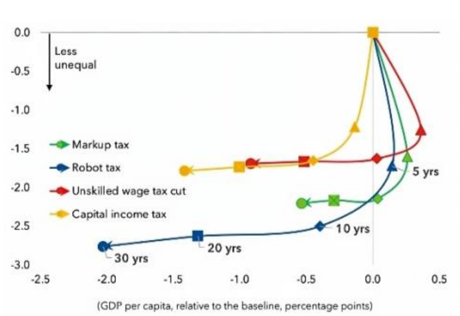

Figure 3.1 Taxes to help reduce the inequalities of automation (Gueorguiev & Ryota Nakatani, 2021)

A robot tax can could reduce inequality over a longer period than the rest but would reduce output for a longer period too. With that said, fiscal policies can reduce inequality although the cost of this tradeoff will be long term growth. These fiscal policy solutions will highly depend on the society's preference regarding growth and equality.

4.3.2.2 Human to human business models

When automation is widespread around the world, people would demand human labor business models. "The model calls for interaction between humans (emotional level) and move to the business level (task at hand) and finish the interaction on a human level" (Vedarthan, 2021). This type of business model is used today in hospitality businesses such as cafés and restaurants, and in brick-and-mortar stores. Today its normal to see humans serving you, tomorrow the normal would-be robots. Today we see robots as the cool way of doing business, tomorrow we could see human interaction as the cool way of doing business. With that said, a solution to the cost of labor problem is to value the cost thus value the human interaction as in the future, people might turn back to this type of interaction.

As automation takes over a greater number of jobs in the future, a demand for traditional jobs rises due to a rejection in technology thus potential nostalgia as stated in the example above. This effect could increase jobs in the traditional field such as handcrafted products, human labor café's etc. We must search for innovative ideas to create a market for human labor (Kim & Scheller Wolf, 2021). With that said, we must start to highlight the importance of human-to-human business model as a solution for the future.

4.3.3 Solution towards the high concentration of power in the largest technology companies

The dominance of very few powerful technology companies can prioritize automation and boost their own economies while ignoring the negative consequences of their actions to workers well-being and employment worldwide. An approach would be fostering entrepreneurship and supporting Small medium enterprises (SME's). Such companies offer job opportunities that can cover up for the jobs that are lost due to the large dominant companies in control of the change in the market. Developing countries can become more dependent on itself through the nurturing of their local companies and startups.

In South Korea, there were 29,561 startups according to Kate Park- a TechCrunch reporter (Park, 2023). Linking this number with South Korea's low unemployment rate emphasizes the importance of startups in an economy. Therefore, offering a painless process for setting up a business, ease of finding finance, and a startup infrastructure that supports and promotes startups would be a solution that would drive startup growth in the future.

5. CONCLUSION

In conclusion, the study of technological unemployment has been a complex issue for years. This research paper aimed to play a key role in understanding the causes of this issue, the difference in its impact between a developed and developing country, and the solutions that would help mitigate the causes of technological unemployment hence reducing robophobia.

The causes of technological unemployment can be attributed to several factors. The fast pace of technological advancement, outpacing the workers ability to acquire new skill leading to a skill mismatch, hence jobs become obsolete. Furthermore, the cost of labor motivates companies to substitute humans with robots to save costs and gain a profit advantage. Finally, the concentration of power in technology companies makes them in control of the pace of technology and the impact of their decisions is felt worldwide.

When taking the case of South Korea and Germany to compare technological unemployment in a developing and a developed country, it became clear that the adoption and impact varies. South Korea stood out with their high technological advancement and low unemployment rate. This can be attributed to factors such as a highly educated society, the government initiatives towards innovation and entrepreneurship, their workplace competency, and the population of elderlies working, all played an important role in their success against technological unemployment today. In contrast, a country like Germany despite their advanced economy, faced higher unemployment rates and lower automation levels.

The solutions to technological unemployment that were collected after the analysis on the causes and the South Korean case were several. Firstly, investment in education and development of labor skills is essential ensuring workers can adapt to the changing technological landscape. Through providing the right skill set training, the problem of skill mismatch can be mitigated. Furthermore, part of the education needs to involve learning how to collaborate with robots. The cooperation between robots and humans will improve employability and productivity through introducing fewer working hours for employees. Additionally, policies that offer collaboration between industry, governments, and labor will help track occupational change and improve the overall clarity of the labor market.

Furthermore, governments can offer four fiscal policies that can support human employment. A robot tax and a capital tax are two examples that will offer long term equality. Moreover, the cost of labor is one of the largest costs for a business. Although companies need to prioritize investments in human improvement and well-being instead of focusing on solely maximizing profit. Therefore, re-evaluating the distribution of their human capital will lead to a more equitable and inclusive society.

To conclude, technological unemployment is one of the largest disadvantages of this new revolution and a major player to robophobia. It’s a complex issue influenced by major factors. Understanding the causes sets the foundation for the possible solutions. Using real life examples is essential to learn and improve. By implementing policies that prioritize human improvement, education, skills development, and the equitable distribution of resources can help mitigate the negative effects of technological unemployment and foster a future where robots and humans coexist.

6. LIMITATIONS AND FUTURE RESEARCH

Many other factors could have affected the low unemployment and the high unemployment of Germany although this would increase the size of this research which was not possible. In addition, the research only focused on South Korea and Germany which does not represent the global situation. With that said causes can vary significantly from one country to the other. Furthermore, the report had primary data limitations since I did not have time and money access company employees and study the extent of robophobia in the workplace. Furthermore, the feasibility of solutions can differ from one country to another, hence the solutions are more generalized than specific.

For future research purposes, money and time will be required to study to a greater extent robophobia in the workplace and interview current employees regarding the topic. Further research can also present strategies to address skill mismatch and approaches for reskilling and upskilling to facilitate the transitioning of labor in the everchanging labor market. Lastly, an evaluation of the outcomes of each solution/policy that has been introduced in the report could be conducted for future research purposes when more data is available.

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8. REFERENCES

Fonseca, L. M. (2018). Industry 4.0 and the Digital Society: Concepts, dimensions and envisioned benefits. *Proceedings of the International Conference on Business Excellence*, *12*(1), 386–397. https://doi.org/10.2478/picbe-2018-0034

McKinsey & Company. (2022, August 17). *What are industry 4.0, the Fourth Industrial Revolution, and 4IR?*.McKinsey&Company. https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-are-industry-4-0-the-fourth-industrial-revolution-and-4ir

Yang, F., & Gu, S. (2021). Industry 4.0, a revolution that requires technology and National Strategies. *Complex & Intelligent Systems*, *7*(3),1311–1325. https://doi.org/10.1007/s40747-020-00267-9

Cocco, F. (2016, December 2). *Most US manufacturing jobs lost to technology, not trade*. Financial Times. https://www.ft.com/content/dec677c0-b7e6-11e6-ba85-95d1533d9a62

McClelland, Allison, and Fiona Macdonald. Social Consequences of Unemployment - BSL Catalogue. https://library.bsl.org.au/jspui/bitstream/1/266/1/social_consequences_of_unemployment_AMcClelland.pdf.

Klimczuk-Kochanska, M., & Klimczuk, A. (Eds.) (2015). . (Vols. 1-5). SAGE Publications, Inc, https://doi.org/10.4135/9781483345727

"Using Primary and Secondary Sources." Using Primary and Secondary Sources | Learn It, https://thinkport.org/tps/mod1/learn-it.html#:~:text=The%20purpose%20of%20secondary%20sources,why%20an%20historical%20event%20happened.

Black, John, et al. A Dictionary of Economics. Oxford University Press, 2017.

WNPR. (2015, December 23). Technological unemployment: The facts, fears, and future. ConnecticutPublic. https://www.ctpublic.org/business/2015-12-22/technological-unemployment-the-facts-fears-and-future

The Economist Newspaper. (2020, July 30). *The fear of robots displacing workers has returned*. The Economist. https://www.economist.com/finance-and-economics/2020/07/30/the-fear-of-robots-displacing-workers-has-returned

SwisslogInspire, S. F. (2019, July 14). *Robophobia in society*. Swisslog. https://www.swisslog.com/en-us/about-swisslog/newsroom/news-press-releases-blog-posts/2019/06/blog-post-robophobia

Woods, A. (2022, March 17). University of ColoradoLawReview. https://lawreview.colorado.edu/printed/robophobia/#III_Explaining_Robophobia

Stevens, Y., & Marchant, G. E. (2017). *Policy Solutions to Technological Unemployment*.

Vivarelli, M. (2012). *Innovation, employment and skills in advanced and developing countries: A survey of the literature*. IZA.

Frey, C. B., & Osborne, M. A. (2013, September 17). *The future of employment: How susceptible are jobs to computerisation?*. Oxford Martin School. https://www.oxfordmartin.ox.ac.uk/publications/the-future-of-employment/

Wessling, Brianna. "10 Most Automated Countries Worldwide." The Robot Report, 15 Dec. 2021, https://www.therobotreport.com/10-most-automated-countries-wordlwide-in-2020/.

Sewell, D. (2017, August 16). *Are humans plagued by "Robophobia"?* Industrial Equipment News. https://www.ien.com/automation/article/20972720/are-humans-plagued-by-robophobia

More, R., & Martinez, M. (2023, January 31). *German unemployment rate remains stable at 5.5% inJanuary*.Reuters. https://www.reuters.com/markets/europe/german-unemployment-rate-remains-stable-55-january-2023-01-31/

Fleming, S. (2020, September 3). *A short history of jobs and automation*. World Economic Forum. https://www.weforum.org/agenda/2020/09/short-history-jobs-automation/

Chui, M., Manyika, J., & Miremadi, M. (2017, September 20). *The countries most (and least) likely to be affected by automation*. Harvard Business Review. https://hbr.org/2017/04/the-countries-most-and-least-likely-to-be-affected-by-automation

Rabianski, J. S. (2003, January). Primary and secondary data: Concepts, concerns, errors, and issues.

Karlsson, L., & Sunesson, D. (n.d.). The effect of innovation on unemployment levels in different educational groups. https://www.diva-portal.org/smash/get/diva2:994607/FULLTEXT01.pdf

Statista Research Department. (2023a, February 23). *U.S. Labor Force 1990-2022*. Statista. https://www.statista.com/statistics/191750/civilian-labor-force-in-the-us-since-1990/

Unemployment rate in Germany 2023. Statista. (2023, March3). https://www.statista.com/statistics/227005/unemployment-rate-in-germany/

Oecd. "OECD Statistics." OECD Statistics, https://stats.oecd.org/.

Dudovskiy, John. "Questionnaires." Business Research Methodology, https://research-methodology.net/research-methods/survey-method/questionnaires-2/.

Bhat, Adi. "Questionnaires: Definition, Advantages &Examples."QuestionPro,9Feb.2023, https://www.questionpro.com/blog/what-is-a-questionnaire/.

Sedai, A. (2019, November). History of anxiety and possibility revisiting Keynes's technological ... https://www.researchgate.net/publication/337289918_History_of_Anxiety_and_Possibility_Revisiting_Keynes's_Technological_Unemployment

"Why Are We Scared of Robots?" Wise Robotics, 28 June 2022, https://wiserobotics.com/blog/why-we-are-scared-of-robots/.

"Important Inventions of the Industrial Revolution." Foundations of Western Culture, 2016, foundations.uwgb.org/inventionsoftheindustrialrevolution/#:~:text=Three%20of%20the%20most%20influential,in%20many%20parts%20of%20Europe.

"The Laborwise Solution Unlocks Hidden Sources of Labor Overspend". Deloitte. https://www2.deloitte.com/content/dam/Deloitte/us/Documents/human-capital/us-cons-laborwise-core-data-sheet.pdf

Team, T. I. (2022, December 16). *Cost of labor definition*. Investopedia. https://www.investopedia.com/terms/c/cost-of-labor.asp

EuroDev. "Social Security Tax Rates for Employers in Europe." EuroDev Blog, 27 Mar. 2023, blog.eurodev.com/social-security-tax-rates-employers-europe.

Kabir, U. (2022, December 13). 15 biggest AI companies in the world. Yahoo! Finance. https://finance.yahoo.com/news/15-biggest-ai-companies-world-140230064.html

Harris, K., Kimson, A., & Schwedel, A. (2018, February 7). *Labor 2030: The collision of demographics, automation and inequality*. Bain . https://www.bain.com/insights/labor-2030-the-collision-of-demographics-automation-and-inequality/

Corpuz, E. (2016, November 11). *UN Report: Robots will replace two-thirds of all workers in the developing world*. Futurism. https://futurism.com/un-report-robots-will-replace-two-thirds-of-all-workers-in-the-developing-world
C. W. M. Naastepad & Christopher Houghton Budd (2019) Preventing Technological Unemployment by Widening our Understanding of Capital and Progress: Making Robots Work for Us, Ethics and Social Welfare, 13:2, 115-132, DOI: 10.1080/17496535.2018.1512641

Davies, K. (2023, March 3). *Unemployment rate in Germany 2023*. Statista. https://www.statista.com/statistics/227005/unemployment-rate-in-germany/

"World Economic Outlook Database." IMF, 7 Apr. 2023, www.imf.org/en/Publications/WEO/weo-database/2023/April.

OECD. (2023, May). *Unemployment rates, OECD - Updated: May 2023 - OECD*. Unemployment Rates, OECD - Updated: May 2023. https://www.oecd.org/sdd/labour-stats/unemployment-rates-oecd-updated-may-2023.htm

"South Korea Research and Development Expenditure - Data, Chart." TheGlobalEconomy.Com, www.theglobaleconomy.com/South-Korea/Research_and_development/.

Yoon , S. (2022, January 31). *This is how South Korea can become a Global Innovation Hub*. World Economic Forum. https://www.weforum.org/agenda/2022/01/startups-in-south-korea-are-thriving-this-is-why/

David Autor and Brendan Price. (2013). "The Changing Task Composition of the US Labor Market," Massachusetts Institute of Technology, https://economics.mit.edu/files/11600.

Baker, B., & Choi, Y. (2017). *The Impact of Automation on Business and Employment in South Korea*. The IUP Journal of Supply Chain Management,.

"These are the EU countries with the largest economies." World Economic Forum. (n.d.). https://www.weforum.org/agenda/2023/02/eu-countries-largest-economies-energy-gdp/

Ranjan, A. (2022, September 22). *Germany's €30Bn start-up strategy: Everything you need to know*. Start Up Energy Transition. https://www.startup-energy-transition.com/germany-startup-strategy/

Cho, Y. (2020, February 7). *How is Korea preparing for the jobs of the future and what can we learn from them?*. World Bank Blogs.

https://blogs.worldbank.org/eastasiapacific/how-korea-preparing-jobs-future-and-what-can-we-learn-them

Borowiec , S. (2022, June 6). Fearing lawsuits, factories rush to replace humans with robots in South Korea. Rest of World. https://restofworld.org/2022/korea-factories-replace-humans-with-robots/

Maout, T. (2021, February 26). Does automation increase productivity? 7 data-backed findings - make. https://www.make.com/en/blog/does-automation-increase-productivity

Froymovich, R. (2019, May 21). *Productivity depends on people - workflowTM*. ServiceNow. https://www.servicenow.com/workflow/employee-engagement/business-process-automation-employee-productivity.html

Manyika, J., Chui, M., Miremadi, M., Bughin, J., George, K., Wilmott, P., & Dewhurst, M. (2017). *A future that works: Automation, employment, and Productivity*. McKinsey Global Institutte.

Manyika, J., Chui, M., & George, K. (2017, February 6). *25% of Ceos' time is spent on tasks machines could do*. Harvard Business Review. https://hbr.org/2017/02/25-percent-of-ceos-time-is-spent-on-tasks-machines-could-do

Jung, S. (2023, April 21). The future of work in South Korea. Seoulz. https://www.seoulz.com/the-future-of-work-in-south-korea/

Yoo, C. (2023, March 15). Older workers pull South Korea jobless rate down to record low. Reuters. https://www.reuters.com/world/asia-pacific/south-korea-feb-unemployment-rate-eases-match-record-low-2023-03-14/

Hess, R. (2023, May 25). *How will AI Automation Affect Career and technical education? (opinion)*. Education Week. https://www.edweek.org/technology/opinion-how-will-ai-automation-affect-career-and-technical-education/2023/05
Max-Planck-Gesellschaft. (n.d.). How do Germans tick? - max planck institute for biology of ageing. https://www.age.mpg.de/fileadmin/media/career/international_Office/How_do_Germans_tick.pdf

Chomanski, B. Massive Technological Unemployment Without Redistribution: A Case for Cautious Optimism. Sci. Eng. Ethics 2019, 25, 1389–1407

Walsh, T. Expert and Non-Expert Opinion About Technological Unemployment. Int. J. Autom. Comput. 2018, 15, 637–642.

Vedarthan, Deepak. "Consulting Chronicles: The Human Business Model." LinkedIn, www.linkedin.com/pulse/consulting-chronicles-human-business-model-deepak-vedarthan.

Kim, T.W.; Scheller-Wolf, A. Technological Unemployment, Meaning in Life, Purpose of Business, and the Future of Stakeholders. J. Bus. Ethics 2019, 160, 319–337.

Gueorguiev, N., & Nakatani, R. (2021, November 18). *Sharing the gains of automation: The role of fiscal policy*. IMF. https://www.imf.org/en/Blogs/Articles/2021/11/18/sharing-the-gains-of-automation-the-role-of-fiscal-policy

Caton, N., Ko, Y., & Kim, H. (2022, October 23). *South Korea*. Growing Older. https://globalreportingprogram.org/growing-older/south-korea/

"Employment of Older People in Germany and the EU Markedly up in the Last 10 Years." Federal Statistical Office, 19 Jan. 2023, www.destatis.de/EN/Press/2023/01/PE23_N003_13.html#:~:text=More%20and%20more%20older%20people,from%2047%25%20to%2060%25.

Kyei, W. (2022, November 23). *Korean government agencies that support startups*. Seoulz. https://www.seoulz.com/korean-government-agencies-that-support-startups/

BMWK - Federal Ministry for Economics Affairs and Climate Action. (n.d.). Our energy transition for an energy supply that is secure, clean, and affordable. BMWK. https://www.bmwk.de/Redaktion/EN/Dossier/energy-transition.html

Jacky Liang, Ben Ramanauskas & Andrey Kurenkov, *Job Loss Due to AI — How Bad Is It Going to Be?*, Skynet Today (Feb. 4, 2019), https://www.skynettoday.com/editorials/ai-automation-job-loss

Stettner, Andrew, et al. "Mounting a Response to Technological Unemployment." The Century Foundation, 26 Apr. 2018, tcf.org/content/report/mounting-response-technological-unemployment/.

Park, K. (2023, May 26). *Profitability over growth: 5 investors explain their mantra for South Korean startups*. TechCrunch. https://techcrunch.com/2023/05/25/south-korea-investor-survey/