IGF Internet Governance Forum
Dynamic Coalition on Internet & Jobs

SUSTAIN-ABLE AUTOMATION

as

SDG#18

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Foreword

On 14th November 2018, during the closing session at the Internet Governance Forum (IGF), Paris, I mentioned that we will have to address 'proliferation of technology,' 'productivity,' and 'profits,' keeping 'people' at the core (https://tinyurl.com/IGF-Paris). I also stressed the importance of addressing the issue of job loss with increasing automation. For nations with high GDP and a few million population, a 6–7% displacement (job loss) would be possible to handle, but just think of a country like India and China with 1.4+ billion people! Since then, I have worked on the idea of what I call 'Sustainable Automation.' When the world is increasingly dependent on technology, we should not indiscriminate but be discreet about when and where to adopt technology.

Whenever new technology arrives, we are skeptical. However, if we look at the global economy, with the passing of every decade, the divide between the rich and the poor is widening; the rich are becoming richer, and the poor are becoming poorer. Will technology aggravate this divide and turn the world more 'unequal,' or will it enable more job creation and enhance people's standard of living?

As technology and automation sweep across sectors, we need to evaluate their net impact. Given that this is a complex topic, I have worked with my team to look at this issue from three macro-level perspectives: countries, sectors, and professions. We have tried to do our best to touch on key aspects, but I must state that this is a preliminary paper to trigger a wider debate on this important topic. We are not making a judgment call here but will await a more detailed study on this topic, within and outside the IGF community, to trigger a deeper dive into every dimension of automation and its net impact on jobs and reduction of the economic divide.

Our recommendations towards the end are based on our limited analysis, and we will continue to engage with interested stakeholders to take this study to the next level. I hope to lead a discussion and announce a major project in this area at the 17th IGF 2022 in Ethiopia. This project will look at a model in which the internet and internet-based technologies can make every individual economically independent.

I look forward to working with you.

With best wishes and warm regards,

Dr. Rajendra Pratap Gupta
Chairman
Dynamic Coalition on Internet & Jobs (DC-Jobs)
Internet Governance Forum
Twitter @rajendragupta

Introduction

Automation is the process of using different technologies, machines, and tools to acquire outcomes with minimal human interference (techopedia, 2022). Technology has infiltrated every corner of our lives. It not only has changed the traditional way of operating but also has the ability to perform tasks performed by human beings. Automation is gaining importance because of its ability to

- **Increase productivity**
- **Introduce more efficiency**
- **Increase accuracy**
- **Provide more safety across sectors beyond manufacturing (service sector)**

Despite the benefits of automation, concerns over the high levels of unemployment are rising, thus impacting the rate of employment and the economy. The demand for low-skilled labor has reduced.

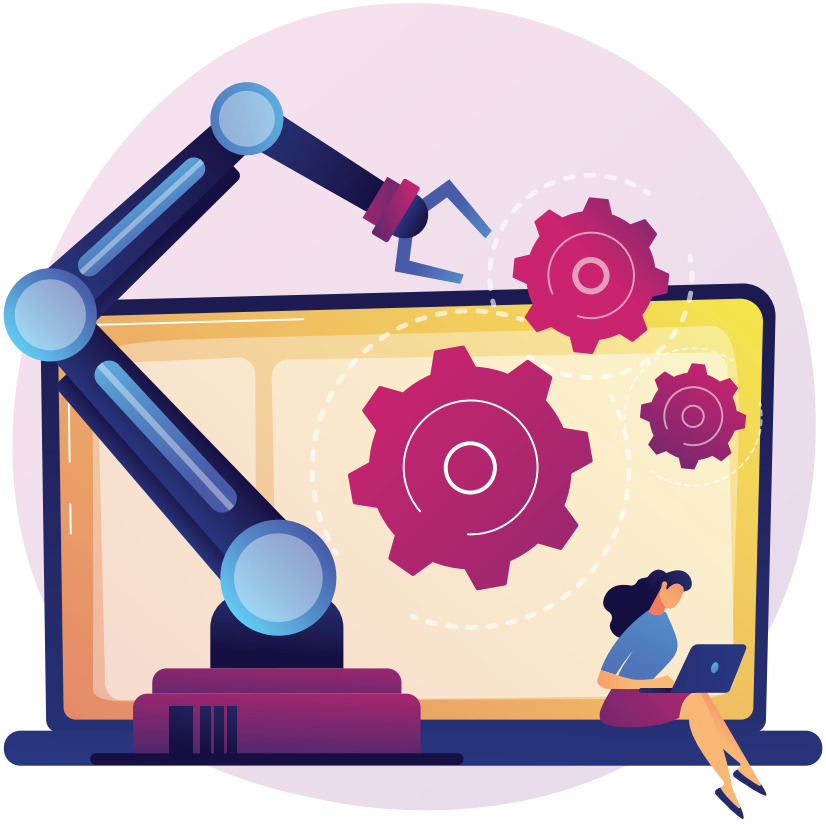
If we look at reports, the future of jobs in the age of automation is unclear. According to a PricewaterhouseCoopers (PWC) report, automation will displace 7 million jobs in 2037 while creating 7.2 million jobs. McKinsey's report states that about 400 million people in 46 countries will lose their jobs by 2030 due to automation (McKinsey & Company, 2018).

The MIT Technology Review Report states that automation will steal more jobs than it creates. Companies are implementing Artificial Intelligence (AI) to improve customer satisfaction, while it will also lead to the loss of some roles and restructuring of others (Rayome, 2019).

According to the Brundtland commission 1983, economic development at the cost of ecological health and social equity did not lead to long-lasting prosperity.

Sustainability is a holistic approach that considers ecological, social, and economic dimensions, recognizing that all must be considered together to find lasting prosperity. **Dr. Rajendra Pratap Gupta** coined the term '**Sustainable Automation,**' and according to him, '**We must consider profits and proliferation of technology keeping people at the center; it is about three Ps – People, Proliferation of Technology, and Profits. Sustainable automation is a framework to deploy automation, keeping people's welfare as the overarching goal, where technology is deployed for and with people, and not for completely replacing man with the machine. It is about intergenerational and intra-generational planning with regard to the adoption of technology. De-humanizing a work place is against the ethos of work!**'

In this report, we have talked about the pros and cons of automation. This is a complex and emerging topic, so we have attempted to do our best possible with the limited time and resources, and the disjointed data available. To give a bird's eye view of the emerging situation post-automation, we have looked at a few countries and the manner in which automation is affecting these countries and the quantum of preparation of these countries to use automation for their benefit. We have also analyzed the impact of automation on various sectors and professions. Towards the end, we have presented a few relevant case studies and the effect of automation on them. Finally, we draw our viewpoint and some recommendations based on the assessment from countries, sectors, and professions.



Countries

Brazil

Most countries in Latin America have struggled to adopt automation within their economies, but a few of them such as Mexico, Brazil, and Argentina have embraced it and continue to do so. Brazil is the world's largest exporter of soya, sugarcane, and beef, which have higher chances of automation in the future (Consultancy.lat, 2018). Brazil is also the fourth largest textile producer in the world. 'Brazil produces around 3.1 billion apparel items each year, largely based on its strong position in cotton, and there is a tremendous interest in new textile technologies that can enhance productivity. There are also over 100 textile schools and colleges, which illustrate the opportunities perceived in the industry's future ', says Technology/Machinery Automation for Brazil, Secretary General Therese Premier-Andersson. (Innovation in Textiles Brazil, 2022).

Brazil is predominantly covered with forest (59.4% of total land area) and hence forms an important market for TEXO AB, a leading manufacturer of weaving machines for the production of paper machine clothing (World Bank Data, 2020) . Brazil is also investing in industrial technology to pave the way for economic growth. For example in 2019, Brazil's National Service for Industrial Training (SENA-SP) launched a partnership with Nokia to implement its portfolio of technology and connectivity solutions at Sena-Sp's Lab (Nokia Press Release, 2019).

A crisis in job creation and retention already seems to be looming. If we want to get a sense of what automation can do to this developing country, it is important to consider that 58.1 % of the country's jobs could be automated in the next 10 to 20 years , while 55.1 % of the country's formal jobs could be replaced by machines. Additionally, the informal sector of Brazil faces a higher risk of automation. Approximately, 62% of the country's informal jobs may disappear due to automation over the next two decades (Ottoni, Oliveira, Estrela, Santos, & Barreira, 2022)

Developing countries such as Brazil need a detailed sectoral and profession-wise assessment to understand in detail the impact of automation. Prima-facie, the picture does not seem rosy post-automation.

United States

In the United States, 78.74% of the people are employed in the service sector, 19.91% in the manufacturing sector, and just about 1.36% in the agricultural sector, and there has not been much difference in the proportion of people employed in the three sectors since 2010.

However, when we talk about the GDP, the majority of it is generated through the industry sector and the services sector has a smaller contribution to the GDP. Hence, we conclude that although more GDP is generated in the industry sector, it

employs fewer people, which means it is more automated. On the other hand, when we talk about the service sector, it seems to employ a larger proportion of people but generates lower GDP. This could be because the potential of the population is not being used to the fullest.

The capitalist and profit-centric investors in the US will move faster towards automation, the real impact of which will be felt over the next decade or so. The displacement of jobs due to automation in the US or for that matter in any developed country will most likely be the highest.

India

'India is at that point where desire, pressure, politics, inclination, and consumer demand are all pushing us in the direction of increased automation. There are examples of technology implementation in India, which are probably much better adopted and commercially deployed than what you might see in developed countries such as Japan or North America' says Rajen Vagadia, vice president and president, Qualcomm India and SAARC. Automation provides solutions to many sectors with huge monetary benefits. One example of its use in the medical industry is the work that could happen in genome sequencing. The first genome project took ten years and cost billions of dollars. Now, with Netapp and NVIDIA technology, the same job has been reduced to hours, without compromising on security or accuracy. If we were to compare the level of automation achieved by Indian firms across sectors, India does not lag behind advanced economies, especially in sectors such as finance. The second leading industry is healthcare and its use of AI in predictive analytics and diagnostics. The third area witnessing growth is the creation of AI-powered robots. These robots will not only help reduce customer service costs but also improve the customer experience (Rana, 2020).

Having said that, although India will be greatly impacted by automation, is it prepared well enough to handle automation? Or will automation cause unemployment in routine tasks in India? India is heavily dependent on agriculture and manufacturing, employing (approximately) more than 60% of the population. We can observe that although most people are employed in agriculture, their contribution to the GDP is low (Fig 1 & Fig 2). The economic survey report for 2021–22 claims that agriculture will continue to occupy a critical position in the state's economy despite the growth of the industrial sector. This phenomenon is primarily because of the rural population, which constitutes about 80% of the total in India, which heavily relies on routine unskilled work in sectors such as agriculture, construction, and manufacturing (Express News Service, 2022). The latest Periodic Labor Force Survey report shows a sharp increase in employment in agriculture from 42.5% of total employment in 2018–2019 to 45.6% in 2019–20 (Sharma, 2021). Such a large shift of labor in favor of agriculture cannot be voluntary. It is a sign of a labor market emergency where non-agricultural sectors are unable to provide employment, and the workforce is forced to shift to agriculture. This puts the Indian workforce at a high risk of automation as the traditional agriculture methods will not be sufficient to feed the growing world population, and if technology automates the agriculture sector, it would lead

to job losses. Similarly, India's mining sector has the second highest risk of the impact of automation after Bangladesh. The sector's vulnerability to automation stems from its relatively low skill requirements, high degree of routine and manual tasks, and the use of direct physical activity to operate machinery.

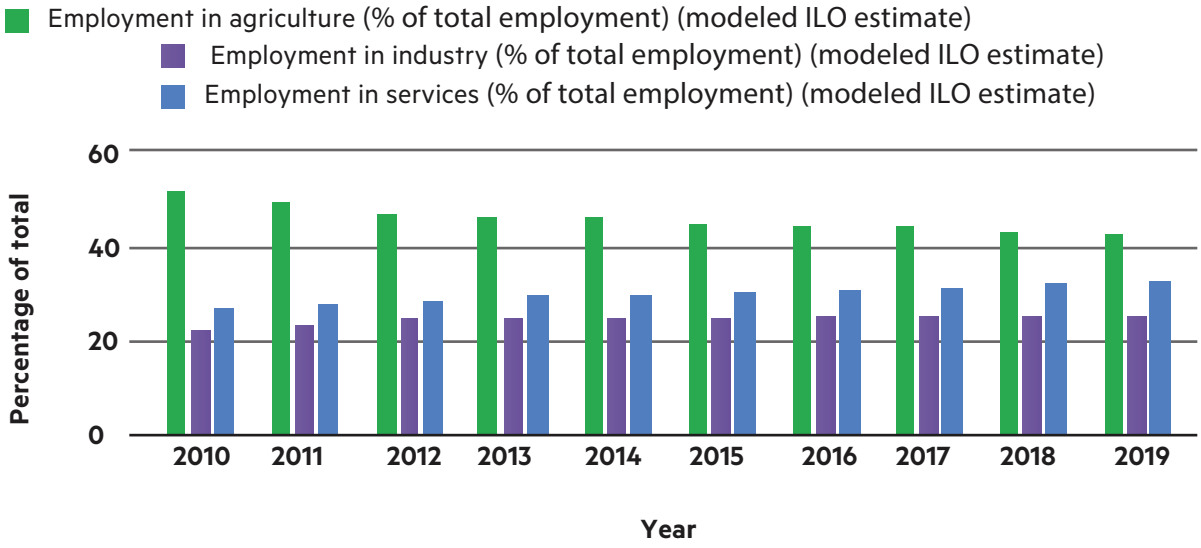


Fig 1. India's employment in Agriculture, Industry, and Services (% of total employment)

Source : World Bank

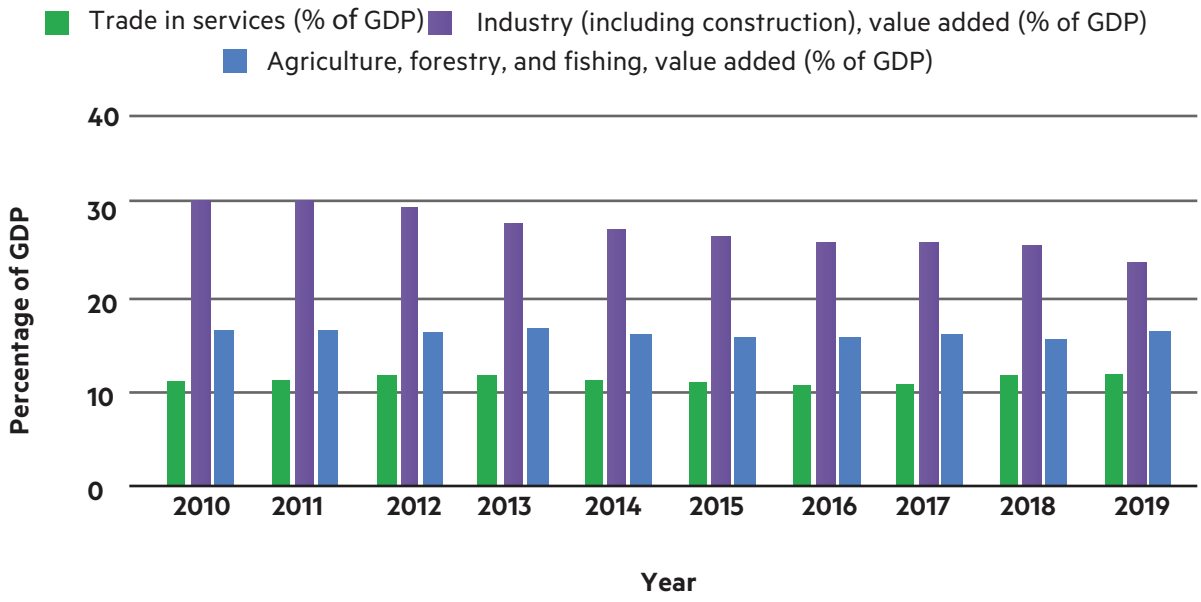


Fig 2: India's GDP % from Agriculture, Industry, and Services

Source : World Bank

A report by Business Today, says that digital change and automation are driving enormous productivity gains in the world of work, helping to improve living standards around the world. However, significant adjustment costs can also be associated with automation, and these costs are often felt by workers least able to transition successfully into new roles (S, 2021).

"LMICs like India with a large unskilled population base will have to 'skillfully' lift 100s of millions to middle class before talking of automation. In the current economic scenario, India cannot afford Universal Basic Income (UBI). So, for India, the right thing to do is to make 'Sustainable Automation' the overarching theme of 'Digital India."

– **Dr. Rajendra Pratap Gupta**

China

China is an upper-middle-income country with the world's largest population. Employment in agriculture was reported as 24.73% in 2020 (Trading Economics, 2020). China's employment declined from 82% to 31% between 1962 and 2013. The elimination of workers out of low productivity is the reason for China's progress and eventually becoming a high-income economy. Results indicate that about 24% of the share of employment in agriculture will decline by 2020 (Felipe, Dacuycuy, & Lanzafame, 2014)

China has successfully produced one-fourth of the world's grain and fed one-fifth of the world's total population with less than 10% of the world's arable land.

The employment rate in agriculture has declined from 36.7% in 2010 to 25.1% in 2019. However, the employment rate in services has increased from 34.1 % in 2010 to 47.4% in 2019.

"For China, automation across sectors is a foregone conclusion, and this will bring to the fore the question of job loss with automation. Large countries have much to lose when it comes to deploying automation. The impact of deploying automation needs to be studied in far greater detail at the sectoral level."

– **Dr. Rajendra Pratap Gupta**

Singapore

Singapore boasts of the world's highest robot density (Robot density is the number of operational industrial robots relative to the number of workers, says Milton Guerry, President of the International Federation of Robotics) with 918 robots per 10,000 human workers. It ranks as one of the nations most prepared for automation. It has a highly skilled workforce with 11.5 years, on average, of schooling. Its Skills Future program also supports lifelong learning by providing people of all ages the resources to attain mastery of skills. Additionally, it scores highly on the proportion of the population covered by social protection measures. This displays a mature social welfare system to support workers who might be disadvantaged (Deloitte, 2021). As we know, the biggest challenges that countries face because of which automation becomes a bane for the country are the large shift in the type of roles that require a more skilled workforce, and unpreparedness leads to unemployment. However, Singapore is able

to reap the benefits because of its investment in education, which allows for a smooth transition (Raj, 2021).

According to the Department of Statistics Singapore, about 70% of the GDP is generated by the service sector whereas about 25% is by the manufacturing sector (Statistics of Singapore, 2021). Singapore's workforce is highly skilled, meaning they perform functions that are more difficult to automate and are more likely to be supplemented by new technology than be displaced. In fact, more than 60% of workers in Singapore's manufacturing sector are classified as highly skilled, and it is a share that is still growing. Another unique feature of Singapore's labor market is the large, volatile foreign workforce that is heavily employed in occupations vulnerable to future automation. About 70% of the country's 1.4 million foreign workers hold a "work permit" visa, indicating employment in lower-wage labor-intensive occupations. If the government faces domestic pressure to further tighten quotas for foreign workers, robots could fill the void in several areas. However, the number of Singaporean resident workers employed in low- to-medium skilled service sector jobs has not decreased over the years, and these workers are increasingly vulnerable to automation as the capabilities of robots expand. SMEs and the large retail and food and drink sectors could be particularly vulnerable. If automation is to be carried out at a rapid pace, this cohort will need sustained government support to facilitate the transition. Thus, the government could enjoy an increase in productivity coming from robots while at the same time dampening the negative impact of job displacement (Lambert & Jung, 2020). It is too early to conclude, but it will take a few years to see how this small nation finds a way to address employment with automation.

South Korea

South Korea has emerged as a leading manufacturer through its research and development and advanced technologies. Few countries in the world embrace automation like South Korea. According to the International Federation of Robotics, South Korea was the country with the second-highest robot density. South Korea had 868 robots deployed per 10,000 people in 2019 (International Federation of Robotics, 2021). Companies have strong incentives for automation. To tackle the problems of rising labor costs and to compete in the global market, Korean companies strive to take advantage of automation in their manufacturing sectors. According to the Boston Consulting Group, Korea is introducing robots in manufacturing sectors about four times faster than the global average. Every year, the government spends hundreds of millions of dollars on efforts to modernize and automate its sectors. Last year, the government and Samsung Electronics Co. collaborated to establish a 100 billion fund to aid 2,500 businesses in converting to ‘smart factories’ (Kim, 2019). Such a focus on automation is because of the decline in the working-age population in Korea, and to increase productivity and maintain living standards is very vital. “Humans will likely coexist with robots. Currently, in the automated market, more than 80% are robots in factories,” said

Kwon Young-sun, an engineer at Gaitech Korea.

However, with the benefits of automation, we can't overlook the fact that with the rising automation, the problem of unemployment and shortage of jobs is also increasing, thereby impacting the economy. Though advanced technology is expected to boost the economy, at the same time, it impacts the labor market due to the fast-aging population. Some say that South Korea's aging population is not prepared for the future, and due to the low fertility rate, it creates immense pressure on graduates in a shrinking jobs market. The manufacturing sector has been losing jobs for years. Reports in 2019 from LG Economic Research Institute found that almost 3 million workers in manufacturing face a "high risk" of layoffs.

The robot revolution is more than just reshaping factories. Services, which employ around 70% of the nation's workforce, are also being automated. As an example, Lotteria, South Korea's top hamburger chain, uses digital kiosks in more than half of its restaurants. As younger people can familiarize themselves easily with digital kiosks, the elderly or technologically challenged people are facing difficulty in Seoul. Seoul has issued a guide and standards for digital kiosk operators so that elderly people unfamiliar with digital devices can easily use digital ordering machines. The standards will include large fonts and simpler screen layouts to increase the readability of kiosk menus (Sae-jin, 2022). The city government said it would develop unmanned terminals that can be conveniently used by digitally vulnerable and illiterate people in banks and cinemas in cooperation with private companies by the end of 2022 (Yonhap News, 2022).

South Korea's unemployment rate reached a 20-year high equating to 5.4% in January 2021, its highest in more than two decades. Just after a year, in February, job growth increased to a nearly 22-year high, i.e., the unemployment rate dropped to 2.7% (Roh, 2022). This might give us a positive impression, but if we look through a closer lens, the addition was mostly in the healthcare services and the social sector to cater to the aftermath of the pandemic while jobs in retail, wholesale, and manufacturing continued to shrink.

Many large Korean companies that employ a large share of the Korean workforce are likely to adopt automation because of its advantage, making the employees more vulnerable to potential job loss due to automation. Between 1995–2010, the productivity of Korean manufacturing companies with more than 300 employees increased by an average of 9.3% a year, but their workforce shrank by 2% every year during the same period.

According to the Drivers and Disrupters report, South Korea ranks amongst the countries most exposed to the risk of automation (Orlik, Johnson , & Tanzi, 2019)

To conclude, we can say that although Korea is fast in embracing automation and is quickly adopting to maintain productivity growth with its aging population, it can threaten its low-skilled workers. Although

the government is trying to tackle this threat (for example, an initiative called learning factories which will equip about 50000 workers with skills to handle robots and automated machines by 2022), the training will take time, and the robots are coming in much sooner (Kim, 2019).

Japan

'The world's stock of robots has tripled in the last three years' (International Federation of Robotics), but this is not the most surprising aspect. The most astounding fact is that Japan contributes 45% of new ones to this every year (The Economist, 2022). Automation is the route to more productivity at a lesser cost for companies, as robots can work for 24 hours at the same pace without complaining about fatigue. The rising demand for robots all over the world is a testimony that more and more companies around the world are adopting them. Japanese manufacturers are in a strong position to take advantage of the current scenario as they are among 5 of the top 10 global producers of robots and factory automation systems and have an estimated 30% share worldwide (Hennessy Funds, 2021). Japan leads in robot production and is one of the most robot-integrated economies in the world. The coming wave of automation promises new possibilities for replacing labor in non-manufacturing. Small and medium-sized companies are incorporating automation. For example, the PARO Therapeutic (Interactive robot developed by The National Institute of Advanced Industrial Science and Technology) has developed an advanced interactive robot that functions as a social companion for seniors, specifically designed to stimulate patients with dementia, Alzheimer's disease, and other cognitive impairments . The robot is designed as a pet-friendly seal that responds to the owner's voice and interactions. Data has shown that this unique approach is effective in both the therapy of loneliness and the treatment of dementia. Japanese retail and restaurants have installed touch-screen order terminals. Japan's progress in automation is likely to move at a faster pace than any other country because of its shrinking population due to which productivity has declined, and robots can be saviors in such an economy.

But the downside is that the country's low birth rate and rising life expectancy have reduced the number of people in the working-age population, and hence the key to Japan's growth is not only to hire workers but also to get work done through automation. The McKinsey Global Institute (MGI) estimates that Japan will need a 2.5-fold increase in productivity growth over the next decade simply to maintain its recent GDP growth rate (Horii & Yasuaki, 2020). However, Japan is taking all the steps in the right direction. Under Prime Minister Kishada's initiative, 'Digital Garden city nation,' the goal is to make the 5G network available to 99% of the population by 2030 (Jiji, 2022).

"For countries like Japan, automation is a choiceless option. We need to move from indiscriminate to discreet adoption of automation."

- Dr. Rajendra Pratap Gupta

"We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come—namely, technological unemployment. This means unemployment due to our discovery of means of economizing the use of labor outrunning the pace at which we can find new uses for labor. But this is only a temporary phase of maladjustment. All this means in the long run that mankind is solving its economic problem"

- John Maynard Keynes (Economic Possibilities for our Grandchildren, 1930)

"The increase of technical efficiency has been taking place faster than we can deal with the problem of labor absorption."

- John Maynard Keynes (Economic Possibilities for our Grandchildren, 1930)

Automation & Jobs

Several studies have been conducted to empirically study the impact of automation on jobs. According to Brynjolfsson and McAfee, technological innovation is increasing at a growing rate, with more sophisticated software technologies disrupting labor markets by reducing workers' comparative advantage over robots (Berstein & Raman, 2015). They mention that automation is penetrating the non-routine tasks, e.g., driverless cars that were once assumed to be insusceptible to automation. Frey and Osborne analyzed 702 different occupations based on their susceptibility to automation. They concluded that 47% of the US labor force is at risk of susceptibility in the next two decades (Frey & Osborne, 2013). This fact is depicted in the figure below. However, McKinsey calculated the same share to be 45% with an altered methodology. Taking several variables in their estimation, the "fine arts," "originality, "negotiation," "persuasion," "social perceptiveness," and "assisting and caring for others," variables, all exhibit relatively high values in the low-risk category. By contrast, "manual dexterity," "finger dexterity," and "cramped workspace" variables take relatively low values.

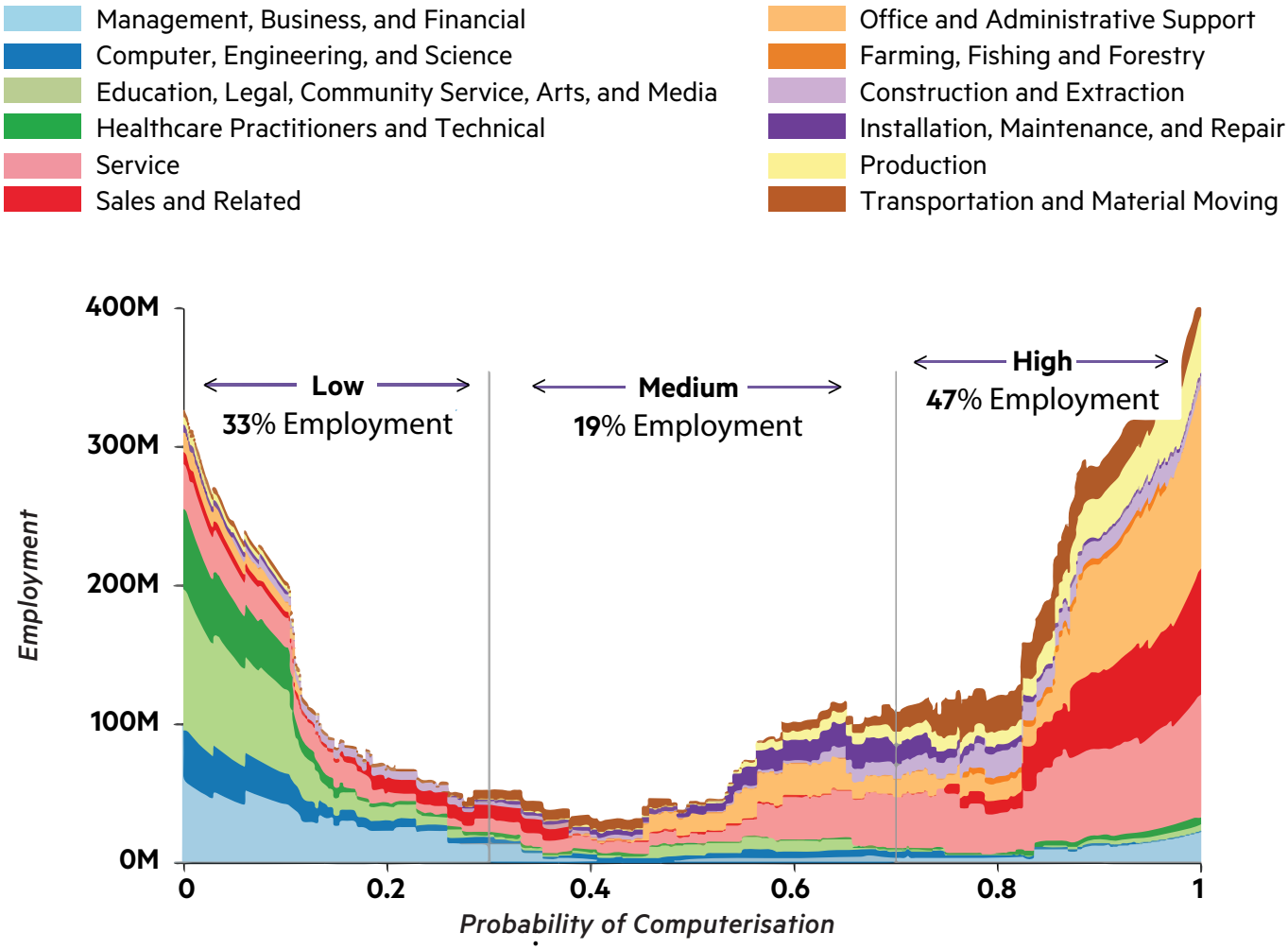


Fig 3. The Future of Employment How Susceptible are Jobs to Computerization?
Source - Frey and Osborne (2013), University of Oxford

A report by McKinsey analyzed jobless recovery after recessions that were just not limited to the increased rates of layoffs during the recession but the average increase in frictional unemployment. They further concluded that Okun's law has failed in the modern era (Manyika, et al., 2011).

The Shrinking Market

Deregulation and technological change (creating barriers to entry through economies of scale and network effects) have been instrumental in the market being concentrated with only a few big firms (Grullon, 2018). Digital monopolies have emerged in the last decade, accelerated by the COVID-19 pandemic due to reduced physical involvements, necessitating the deployment of automation in the core systems. With these high-tech companies adopting anti-competitive conduct, their power to impact organizations and individuals has been expanding through the network effects. A few high techs have acquired hundreds of companies, which endows them with enormous market domination power. For instance (as of April 2021), Amazon has acquired 40 original and 71 in the new sectors businesses, for Google and Facebook it is 81 and 187 and, 28 and 77 respectively (The Washington Post, 2021). This translates into only a few high-tech gatekeepers who control most of the market, information, commerce, and news. This means that the gains are accumulated only by a few, and society gets a shrinking pie to share. This translates into an unequal distribution of income.

The concentration of the market in a few high-tech companies, declining labor empowerment, and displacement with automation keeps the workers disadvantaged. Google used contractual restrictions and exclusivity to extend its monopoly in online search from desktops to mobiles and provide default-status to Google apps. An investigation by the House Judiciary Committee in the United States highlighted Amazon's attempt to gain a monopoly and its power to affect small and medium-sized retailers (US House of Representatives, 2020). It also highlighted Google's monopoly in the search engine, 80% market share in navigation mapping, and its efforts to impede competitors' market entry and to capture the umbrella domain of the 'Internet of things' through further acquisitions. However, the rise of online market systems creates 'innovation kill zones' due to entry and investors' lack of optimism about the new entrants in the dominant markets (Kamepalli, Rajan, & Zingales, 2021).

The new age of technology will change the working landscape and endow workers with fewer powers as technology reaps huge benefits for the employer; they will be overworked and receive less pay. Automated hardware and software have now become cheaper over

the decades, requiring only the cost of an initial installation, maintenance, and upgradation as compared to expensive benefits to the human labor force. For example, the pandemic-led technological disruptions such as contactless delivery and self-checkout have already impacted traditional jobs such as cashiers, drivers, and customer services. These constitute a major proportion of the total jobs in the retail sector.

Widening Productivity and Wage Gap

Productivity indicates the net income generated in the economy per hour of work, which is to be distributed among the various inputs (labor, capital, owner, etc.). Thus, soaring productivity due to the productivity effect of automation translated to more and more income, which is however not equitably distributed. The benefits of labor's share of income have not shown much growth. Simply put, the economic returns of the productivity increase have not reached the workers but instead the corporates and business executives. For instance, the Economic Policy Institute (Mishel & Kandra, 2021) estimates that in 2020, the CEOs of the 350 largest US firms earned an average of $24.2 million – 351 times more than the typical worker. This kind of inequality worries families across the country and across the political spectrum. Most Americans think future generations will be worse off financially (Hess, 2021).

For example, the hourly compensation growth and productivity growth in the U.S economy have been similar during the period 1948–1979. Whereas the productivity-pay gap has been widening since then (1979–2018), with productivity showing growth of 69.6% and hourly compensation showing almost a fifth growth of it, i.e., 11.6% (Economic Policy Institute, 2020)

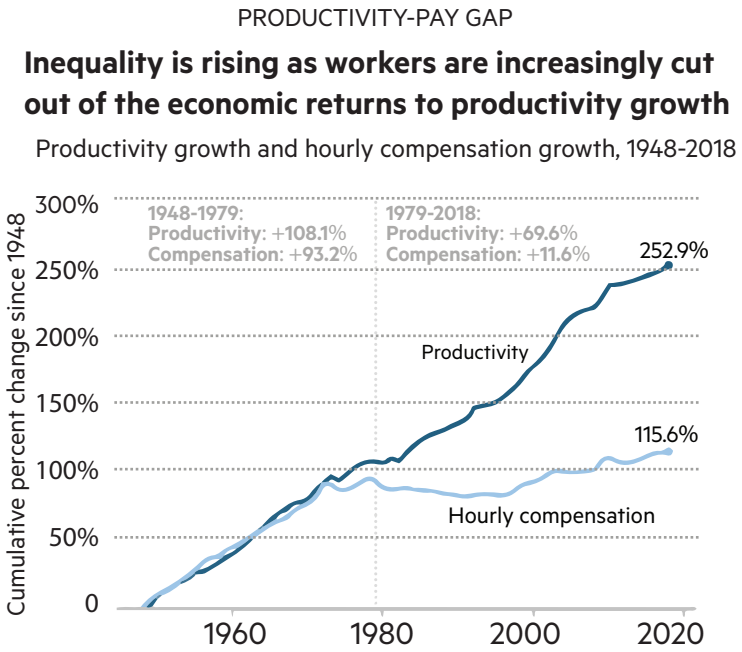


Fig 4: Productivity-Pay Gap, 2020 (Comparison of wages in the private sector in non-supervisory roles to the net productivity in the total economy)
Source : Economic Policy Institute

A detailed industry-level study (in the U. S economy) by the Bureau of Labor Statistics found 83% (of the 183) industries that had a widening productivity pay gap (an annual average growth after adjusting the Consumer Price Index deflator) (Brill, Holman, Morris, Raichoudhary, & Yosif, 2017). The sectors which showed higher productivity (mainly due to technological advancements) also showed slower growth in compensation. This productivity-pay gap has been majorly significant in the manufacturing and retail trade with the information and related industries showing the largest gap.

The labor share of income, i.e., the proportion of revenues going to labor apart from the other inputs, has also been declining. Automation reduces the bargaining power of labor, as they become easily substitutable by robots. The steady decline in the cost of AI deployment adds to their comparative advantage over the human labor force. For example, the following table depicts labor's share in income in the information sector in the U.S economy.

Table 1: Declining labor share of income among industries in the Information sector (1987 & 2015)

Information industry	Decline in labor share of income (percentage points)
Software publishers	23
Wireless Communication carriers	16
Wired Communication Carriers	10
Cable and other subscription programs	6
Motion pictures and television broadcasting	6
Radio and television broadcasting	1

Source: (U.S. Bureau of Labor Statistics, 2017)

The disempowerment of the labor force has been instrumental in the widening productivity-pay gap. As noted by Mishel et al., it has led to 3/4th of the wage gap between white and blue-collar men and 1/5th of the wage gap between high school and college graduate students from 1978 to 2011 (Freeman, 1991). In a separate study, the direct impact of the decline of unions can explain about 1/3rd of the total wage gap among men from 1973 to 2007 (Schmitt, Shierholz, & Mishel, 2013). For example, the declining US automobile industry's unionization rate relative to the overall rate from 1983 to 2020 was

simultaneously accompanied by a fall in wage advantage of the workers relative to the economy-wide wage.

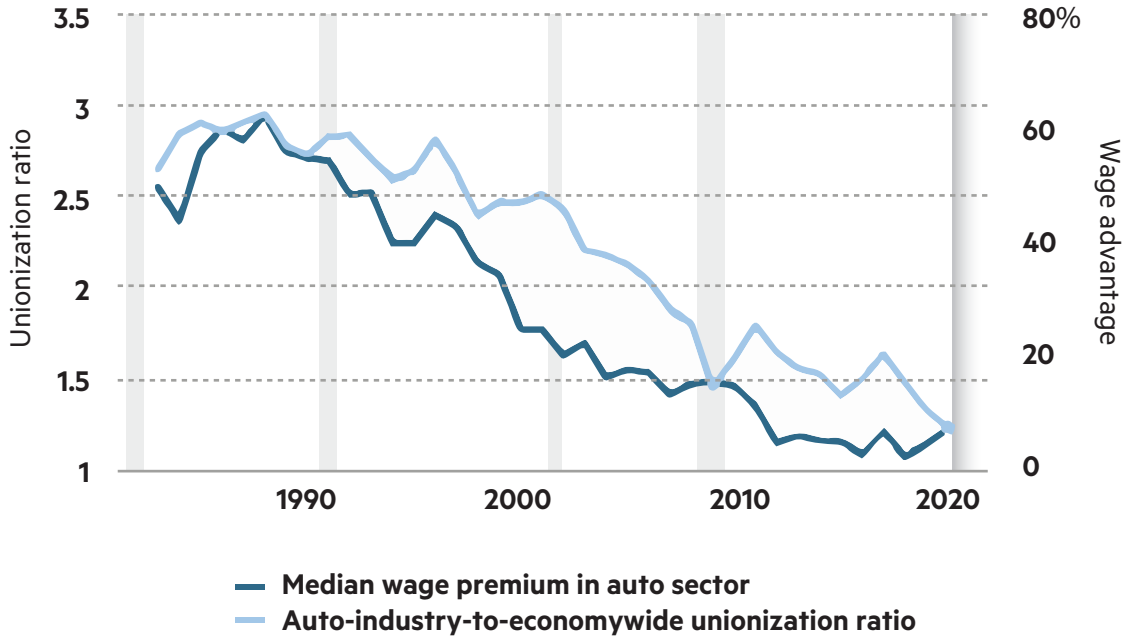


Fig 5. Ratio of auto industry unionization rate to economywide unionization rate, and percent pay advantage for the median autoworker over the median worker econo-my-wide, 1983–2022

Source: EPI analysis of BLS Current Population Survey (CPS) Outgoing Rotation Group (ORG) 1983–2020 microdata

As we can conclude, one of the most significant disadvantages of automation is that the benefits accrue to a few high-tech companies at the expense of small and medium-sized businesses. To better understand the issue, we will examine the present net worth of the five most valuable tech corporations in the world, as well as the data on their employee count. On the other hand, we will collect data from the World Economic Outlook Database, IMF, and sum up the GDP of countries that equate to the net worth of these companies and the combined population of these comparable countries. This evaluation is bound to pres-ent shocking revelations and thought-provoking conclusions.

S.No.	Country Name (IMF)	GDP, current prices 2021 (In $ Billions)	Population 2021 (Thousands)	GDP Per Capita (2021)
1	United States	22997.5	3,31,893.74	69231.4
2	China, People's Republic of	17458.036	14,12,360.00	12358.797
3	Japan	4937.422	1,25,681.59	39339.836
4	Germany	4225.924	83,129.29	50794.947
5	United Kingdom	3187.626	67,326.57	47202.581
6	India	3177.922	13,93,409.03	2282.97
7	France	2935.488	67,499.34	44852.597
8	Italy	2101.276	59,066.22	35472.831
9	Canada	1990.762	38,246.11	52078.515
10	Korea, Republic of	1798.544	51,744.88	34801.086
11	Russian Federation	1775.548	1,43,446.06	12198.213
12	Australia	1633.29	25,739.26	63529.289
13	Brazil	1608.08	2,13,993.44	7563.562
14	Iran	1426.3	85,028.76	16783.815
15	Spain	1426.224	47,326.69	30089.517
16	Mexico	1294.829	1,30,262.22	10039.576
17	Indonesia	1186.067	2,76,361.79	4356.56
18	Netherlands	1018.684	17,533.40	58292.397
19	Saudi Arabia	833.541	35,340.68	23507.276
20	Switzerland	812.552	8,697.72	93719.959
21	Turkey	806.804	85,042.74	9527.683
22	Taiwan Province of China	789.505	No Data	33775.172
23	Poland	674.127	37,781.02	17815.192
24	Sweden	627.438	10,415.81	60028.543
25	Belgium	599.989	11,587.88	51875.037
26	Thailand	513.165	69,950.84	7336.086
27	Ireland	498.891	5,028.23	99013.377
28	Argentina	488.605	45,808.75	10658.458
29	Norway	482.437	5,408.32	89089.978
30	Israel	481.591	9,364.00	51416.022
31	Austria	477.4	8,956.28	53367.54
32	Nigeria	441.541	2,11,400.70	2088.644
33	South Africa	418.02	60,042.00	6950.433
34	United Arab Emirates	409.967	9,991.08	42883.686
35	Egypt	402.838	1,04,258.33	3925.834
36	Singapore	396.992	5,453.57	72794.906

37	Denmark	395.71	5,856.73	67758.08
38	Philippines	393.612	1,11,046.91	3571.798
39	Malaysia	372.754	32,776.19	11399.123
40	Hong Kong SAR	368.137	7,413.10	49727.395
41	Vietnam	366.201	98,168.83	3724.543
42	Bangladesh	357.099	1,66,303.49	2147.274
43	Pakistan	347.743	2,25,199.93	1562.258
44	Chile	316.864	19,212.36	16069.808
45	Colombia	314.268	51,265.84	6156.137
46	Finland	298.868	5,541.70	54007.746
47	Romania	283.476	19,115.15	14667.089
48	Czech Republic	282.641	10,703.45	26410.645
49	Portugal	250.053	10,299.42	24264.394
50	New Zealand	247.685	5,122.60	48424.147
51	Peru	224.725	33,359.42	6643.005
52	Greece	216.384	10,664.57	20255.859
53	Iraq	209.507	41,179.35	5088.115
54	Ukraine	198.316	43,814.58	4827.952
55	Kazakhstan	190.814	19,002.59	9976.904
56	Hungary	184.577	9,709.89	18968.393
57	Qatar	179.571	2,930.52	68581.039
58	Algeria	164.564	44,616.63	3701.204
59	Kuwait	135.352	4,328.55	28578.756
60	Morocco	131.465	37,344.79	3620.319
61	Slovak Republic	114.947	5,447.25	21053.42
62	Kenya	109.797	54,985.70	2204.724
63	Puerto Rico	106.669	3,263.58	34173.252
64	Ecuador	106.166	17,888.47	5978.915
65	Ethiopia	99.269	1,17,876.23	995.67
66	Dominican Republic	94.714	10,953.71	8986.176
67	Luxembourg	86.768	639.07	136701.396
68	Guatemala	85.715	17,109.75	4673.632
69	Oman	83.656	5,223.38	18298.718
70	Sri Lanka	82.472	22,156.00	3742.678
71	Bulgaria	80.327	6,899.13	11683.877
72	Ghana	76.359	31,732.13	2440.962
73	Angola	74.495	33,933.61	2330.722
74	Tanzania	70.281	61,498.44	1176.648
75	Côte d'Ivoire	69.753	27,053.63	2521.904

76	Uzbekistan	69.202	34,915.10	2002.438
77	Belarus	68.208	9,340.31	7295.015
78	Croatia	67.838	3,899.00	16817.843
79	Lithuania	65.479	2,795.32	23472.866
80	Myanmar	65.16	54,806.01	1216.811
81	Costa Rica	64.276	5,139.05	12408.353
82	Panama	63.605	4,381.58	14664.31
83	Turkmenistan	63.428	6,117.93	10310.535
84	Serbia	63.068	6,844.08	9178.152
85	Slovenia	61.567	2,107.01	29192.852
86	Uruguay	59.368	3,485.15	16756.344
87	Congo, Dem. Rep. of the	57.09	92,377.99	608.952
88	Azerbaijan	54.622	10,145.21	5397.928
89	Venezuela	46.501	28,704.95	1685.657
90	Tunisia	46.479	11,935.76	3867.296
91	Jordan	45.354	10,269.02	4416.632
92	Cameroon	45.049	27,224.26	1654.723
93	Uganda	42.48	47,123.53	1000.462
94	Bolivia	39.756	11,832.94	3369.143
95	Latvia	38.965	1,883.16	20581.122
96	Bahrain	38.869	1,748.30	26135.777
97	Paraguay	38.287	7,219.64	5206.983
98	Estonia	36.287	3,213.97	27282.088
99	Sudan	35.151	44,909.35	772.567
100	Nepal	34.52	29,674.92	1163.995
101	Zimbabwe	32.568	15,092.17	2102.18
102	Libya	32.352	6,958.54	4821.508
103	Macao SAR	29.905	658.39	43771.842
104	El Salvador	28.326	6,518.50	4345.436
105	Honduras	28.221	10,062.99	2789.583
106	Senegal	27.64	17,196.31	1606.604
107	Cyprus	27.639	1,215.59	30846.478
108	Papua New Guinea	26.937	9,119.00	3004.987
109	Cambodia	26.187	16,946.45	1653.767
110	Iceland	25.459	372.3	69033.314
111	Bosnia and Herzegovina	22.419	3,263.46	6440.382
112	Yemen	22.018	30,490.64	712.305

113	Trinidad and Tobago	21.385	1,403.37	15201.114
114	Haiti	21.017	11,541.68	1765.242
115	Zambia	20.753	18,920.66	1066.671
116	Brunei Darussalam	19.915	441.53	44808.56
117	Mali	19.188	20,855.72	919.942
118	Gabon	19.161	2,278.83	8975.816
119	Burkina Faso	19.095	21,497.10	887.282
120	Georgia	18.696	3,708.61	5014.158
121	Lao P.D.R.	18.552	7,379.36	2514.027
122	Albania	18.314	2,811.67	6374.786
123	Botswana	17.804	2,397.24	7416.674
124	West Bank and Gaza	17.775	4,922.75	3400.475
125	Guinea	17.611	13,497.24	1230.132
126	Benin	17.455	12,451.03	1397.826
127	Malta	17.201	516.87	33329.118
128	Mozambique	16.104	32,163.04	500.7
129	Jamaica	15.141	2,973.46	5525.304
130	Mongolia	15.098	3,329.28	4417.601
131	Niger	14.959	25,130.81	595.235
132	Nicaragua	14.25	6,702.38	2177.478
133	Madagascar	14.184	28,427.33	501.615
134	Armenia	13.928	2,968.13	4701.403
135	North Macedonia	13.889	2,065.09	6713.668
136	Moldova	13.672	2,573.93	5284.908
137	Congo, Republic of	12.848	5,657.02	2677.272
138	Equatorial Guinea	12.701	1,449.89	8745.189
139	Namibia	12.346	2,587.34	4842.229
140	Malawi	12.176	19,647.68	567
141	Chad	11.795	16,914.99	697.339
142	Rwanda	11.131	13,276.52	859.052
143	Bahamas, The	11.126	396.91	28579.308
144	Mauritius	11.078	1,266.06	8744.34
145	Mauritania	9.13	4,775.11	2153.329
146	Kosovo	9.039	1,806.28	5031.045
147	Kyrgyz Republic	8.538	6,694.20	1282.979
148	Tajikistan	8.474	9,749.63	877.575
149	Togo	8.418	8,478.24	991.51
150	Guyana	7.612	790.33	9643.596

151	Somalia	7.39	16,359.50	486.53
152	Montenegro	5.813	620.17	9350.227
153	South Sudan, Republic of	5.167	11,381.38	364.39
154	Maldives	5.07	543.62	13189.636
155	Barbados	4.871	287.71	16875.092
156	Eswatini	4.681	1,172.37	4109.397
157	Fiji	4.657	902.9	5147.19
158	Sierra Leone	4.239	8,141.34	520.503
159	Djibouti	3.589	1,002.20	3580.751
160	Liberia	3.483	5,180.21	723.785
161	Andorra	3.33	77.35	41873.06
162	Burundi	3.329	12,255.43	272.144
163	Aruba	3.023	107.19	27118.433
164	Suriname	2.854	591.8	4680.561
165	Central African Republic	2.583	4,919.99	525.046
166	Lesotho	2.464	2,159.07	1180.51
167	Bhutan	2.397	779.9	3184.785
168	Timor-Leste	2.362	1,343.88	1757.704
169	Eritrea	2.271	3,213.97	630.572
170	Gambia, The	2.025	2,486.94	812.482
171	Cabo Verde	1.947	561.9	3455.468
172	Belize	1.797	404.92	4176.521
173	Saint Lucia	1.776	184.4	9754.734
174	San Marino	1.712	34.01	50458.193
175	Guinea -Bissau	1.629	2,015.49	878.334
176	Solomon Islands	1.611	704	2303.005
177	Seychelles	1.464	99.2	14931.131
178	Antigua and Barbuda	1.459	98.73	14684.798
179	Comoros	1.295	888.46	1405.723
180	Grenada	1.115	113.02	9856.433
181	Saint Kitts and Nevis	0.95	53.55	16467.439
182	Vanuatu	0.95	314.46	3045.425
183	Saint Vincent and the Grenadines	0.873	111.27	7876.979
184	Samoa	0.788	200.14	3947.203
185	Dominica	0.567	72.17	7690.55

186	São Tomé and Príncipe	0.52	223.36	2330.677
187	Tonga	0.501	106.76	5002.499
188	Micronesia, Fed. States of	0.407	116.25	3880.489
189	Marshall Islands	0.248	59.62	4463.23
190	Palau	0.215	18.17	12187.164
191	Kiribati	0.207	121.39	1705.808
192	Nauru	0.133	10.87	10139.069
193	Tuvalu	0.063	11.93	5833.978
194	Afghanistan	No data	39,835.43	No data
195	Lebanon	No data	6,769.15	No data
196	Syria	No data	18,275.70	No data

Table 2: Comparison of countries' GDP at current prices, GDP per capita, and total population

Source: GDP, Current Prices (International Monetary Fund), Population, Total (The World Bank) and GDP per Capita, current prices (International Monetary Fund)

Rank	Company	Market Value (in $ Billions)	Total GDP of countries* (in $ Billions)	Employee Count of the company (End of FY 2021)	Sum of the population of respective countries
1	Apple	2640.32	196 TO 71 (2670.879)	154000	1277000000
2	Microsoft	2054.37	70 TO 53 (2198.211)	181000	507310000
3	Google	1581.72	52 TO 47 (1504.964)	156500	115570000
4	Amazon	1468.4	46 TO 42 (1634.842)	1608000	496867000
5	Facebook	537	41 to 40 (766.366)	71970	106588000

Table3: Comparison of employee count and market value of Top 5 tech companies with total population and GDP of countries (grouped according to IMF ranking. Refer Table 2)

* To calculate total GDP, countries (starting from the bottom) mentioned in Table 2 are considered. For example, 196 is the serial number of the country Syria.

Sources: (*Statista, 2022*) *and* (*World Bank Data*)

Table 3 tries to sum up that a mere five companies' market value is actually equal to the sum of the GDP of 157 countries. In simpler terms, the income generated by 157 countries equals the income generated by just five companies across the world. This kind of difference is bound to concentrate wealth in a few hands. To comment further on it, we compare the number of employees employed in these companies to the sum total of the population of countries whose GDP total is equal to the company's market value. This shows that out of the total population of these countries, the benefits of these companies to the economy are accruing to a few only.

(Dwoskin, 2020) writes that while the global pandemic brought destruction and downfall of medium- and small-sized businesses and the whole economy came to a standstill, tech giants such as Amazon, Facebook, Google, and Apple made huge profits. They came as saviors at a time when the entire country was in lockdown, and their big pockets helped them endure the miseries that came with the pandemic. The situation that the pandemic created escalated sales for these tech giants. As more people were restricted to their houses, they resorted to shopping online to fulfill their demands. Demand for laptops and cloud-based services grew as more and more people worked from home (Murphy & Contreras, 2022). In fact, global e-commerce sales are expected to reach $7.5 trillion by 2025. The sky is the limit for these companies. These tech companies manage to grow

even in these hard times (Swant, 2020), and as they grow, the gap between the populations will widen in terms of incomes.

However, the rise of these big giants could easily drag us toward the next financial crisis. This might seem like an abrupt statement as these companies have brought progress for not only themselves but also the economy too. However, as quoted by management guru Peter Drucker- "In every major economic downtown in US history, the 'villains' have been the 'heroes' during the preceding boom" (Faroohar, 2019). This could be because of the fact that these Tech-Giants are expanding at the cost of many small companies and stealing everyone's meals (Klebnikov, 2021). Another factor that could be a disadvantage for smaller and midsized businesses is the huge investments required to adopt these new technologies. For example, in 2021, AI analytics company 'Unsupervised' published a survey of 520 small- and mid-sized business (SMB) owners in the US that found that 48% still consider AI too expensive. Forty percent said their businesses lacked the staff expertise to use them. This also results in these baby companies having to resort to overburdening themselves with debts because tech companies push the costs down to such an extent (How automation is helping companies big and small, 2022). The author states that it could have a crippling effect on these companies and the economy. It is no coincidence that a smaller and smaller group of wealthy people and businesses control the majority of the world's wealth and keep it out of the hands of national governments by employing financial gizmos such as tax offshore and buy-backs. This is probably a major factor in our economy's lack of startups, decreased employment growth, declining demand, and other unsettling tendencies.

The policymakers will have to choose between a small number of large companies and a large number of small companies. The first choice goes against the fundamentals of a strong economy.

- Dr. Rajendra Pratap Gupta

Application of Automation Across Sectors

Agriculture

According to a report by the United Nations, the world population is expected to rise to 9.7 billion by 2050 (United Nations, 2019), and the UN Food and Agriculture Organization predicts that worldwide food production needs to increase by 70% to be able to feed the estimated population of 2050. Traditional farming methods will not be sufficient to achieve this ever-increasing demand of the predicted population. Organizations are working on robotics innovation for self-reliant tractors, robotic harvesters, automated watering, and seeding robots. Although these technologies are new, a large number of agricultural firms are adopting these in their processes (Ku, 2022).

However, agriculture is an important factor for economic growth as it can account for approximately 25% of the GDP in some least developed countries of the world. In such a scenario, automation can pose a threat if technological advancements happen, but people are not taken into consideration, and there is extreme poverty among the people employed in the rural sector. However, if inclusive growth is put at the center of economic growth, it can reap benefits for both the country and its population as a whole. For example, In China, 'Better water-use efficiency on 44,000 hectares of farmland and new technologies have improved soil conditions and boosted the production of rice by 12% and maize by 9%. More than 29,000 farmers' cooperatives report higher incomes and increased climate resilience (The World Bank , 2022).

Employment in Agriculture

Food is the basic essential that we need for our survival. As countries develop, technology improves, which typically leads to fewer people working in agriculture.

Poverty is mostly accumulated in rural areas but because of employment opportunities, agriculture remained at the center of discussion for reducing poverty and contributing to economic development (The World Bank, 2022). Increasingly, activities are associated with input supply, food processing, food services, etc. which altogether make up the agri-food system. The Agrifood Systems remains the major employer (Dolislager, et al., 2020), where the majority of the jobs are off farms and involve input supply, processing, and services; new digital technologies provide a substitute for domestic labor. Automation is also gaining importance in the field of food, agriculture, and farming.

In the 20th century, in the USA, 30 million (3 crore) people were engaged in agriculture but in the 21st century, due to mechanization, 89% of the agricultural production is done by nearly 3 lakh people (Gupta, 2020). *Employment in agriculture* (*% of total employment; modeled ILO estimate*) *in the United States was reported at just 1.312% in 2020* (Trading Economics, 2022). This clearly points towards a shift of population employed in agriculture

to other sectors. For example, the largest work provider, i.e., the employment in agriculture in India, is shrinking at the hands of the service and manufacturing sectors. There is a positive shift in the workforce from agriculture to the service sector. People are finding more job opportunities in the non-agricultural sector due to easier access to credit and infrastructure in rural India (Gupta P. , 2019).

There are numerous reasons for agricultural diversification (This practice refers to changes in cropping patterns or indulging in non-farming activities such as poultry farming or animal-husbandry by farmers which aids them in increasing productivity and hence their income). Some of them are the Seasonal nature of employment, Decline in productivity due to poor irrigation, Technological challenges, etc. We can see in the infographics below the countries such as Canada, the USA, Brazil, and China even with very few people employed in agriculture have been able to achieve extremely high productivity through automation. (We can see from the graph that Canada has 0–2.5% of its population employed in agriculture, but agricultural value added per worker falls between $70000–$90000.) Russia, South Africa, Brazil, and Australia have achieved high productivity through automation too. On the other side, some countries have more people employed in agriculture, but the productivity is very low. These include Somalia, the Central African Republic, the Democratic Republic of Congo, Chad, Cameroon, Zambia, etc. Countries such as Myanmar, India, Nepal, Vietnam, and Afghanistan also have a large number of people employed in agriculture, and their productivity is also not that much. Countries need to focus on selectively using automation to increase productivity and value addition for agriculture to offset the net job loss due to automation, and this needs detailed planning and careful execution.

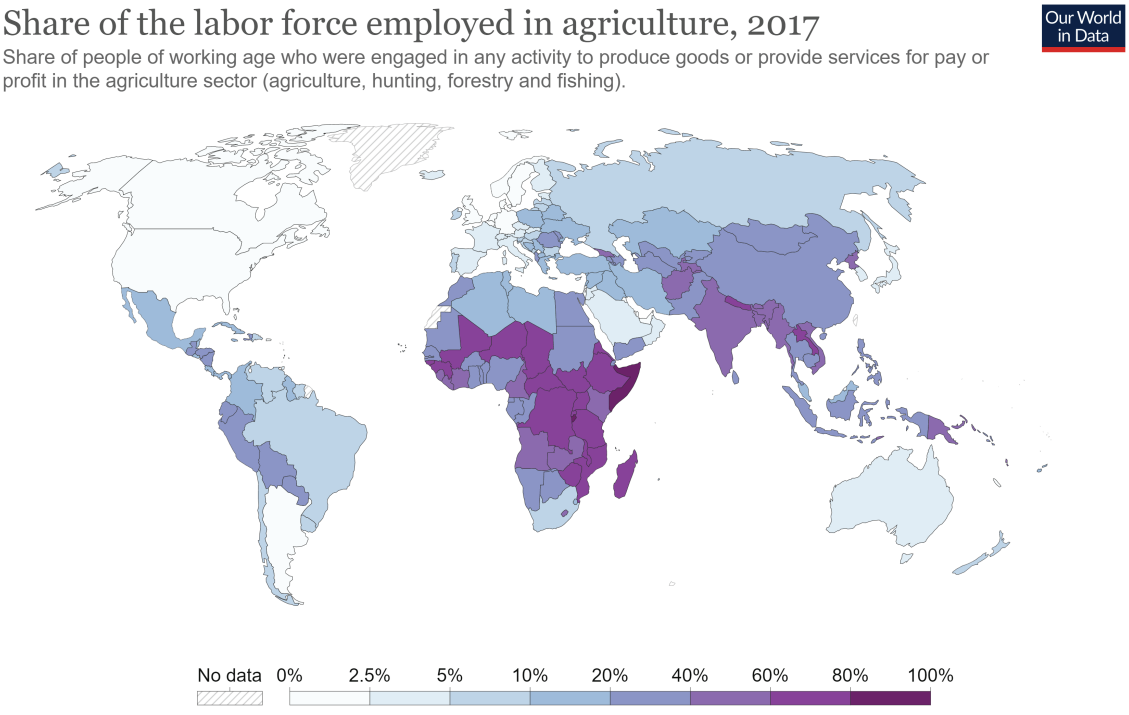


Fig 6. Share of the labor force employed in agriculture, 2017

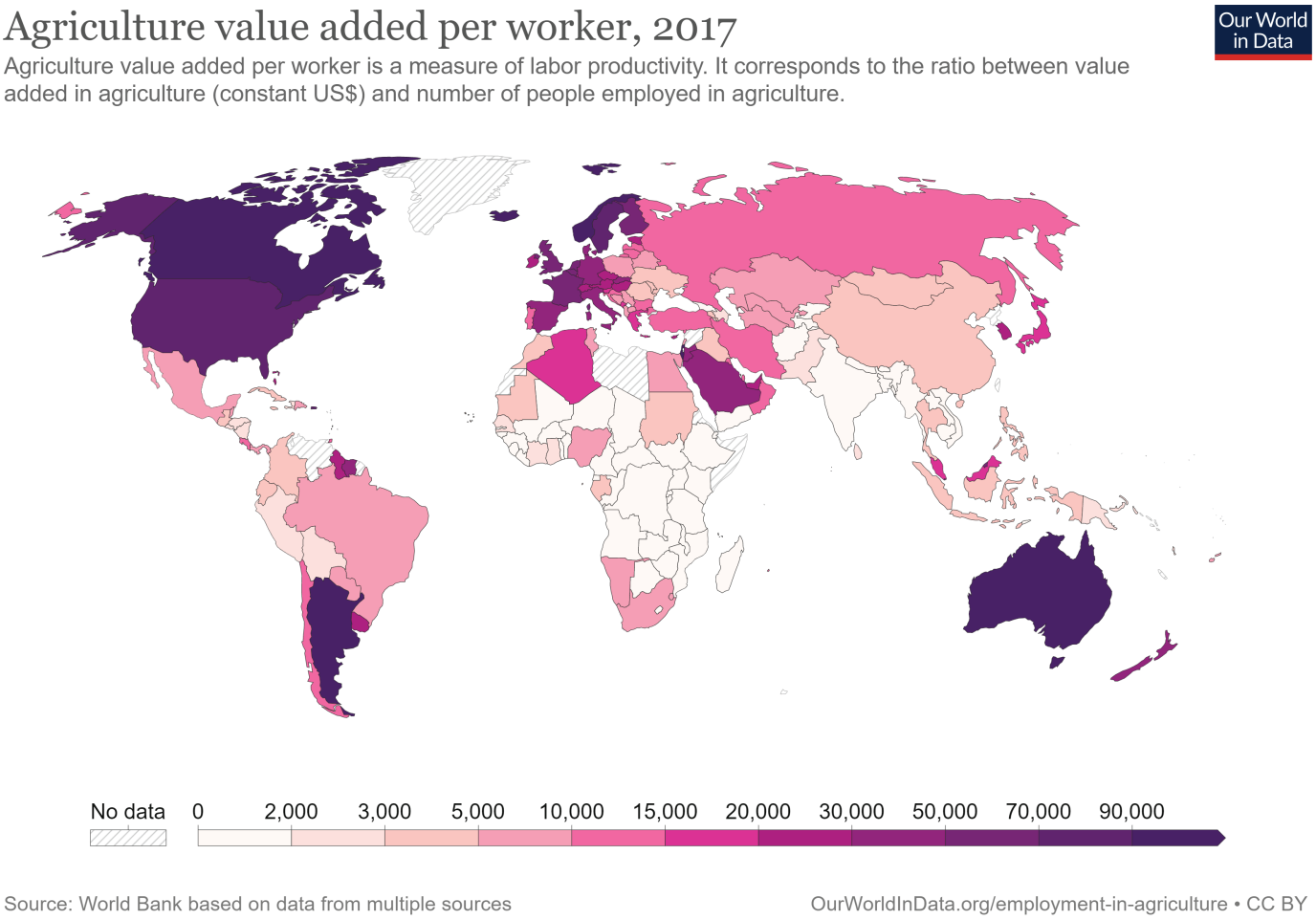


Fig 7. Agriculture value added per worker, 2017

Manufacturing

Manufacturing plays an important role in a country's economy. The share of manufacturing is an important GDP indicator. Manufacturing helps emerging and developing countries in their economic growth (Banerjee, 2020). The advantage of automation lies in producing high volumes in less time with safety and less human error. On the other hand, its disadvantage is more pollution and often high cost in the beginning. Some predictions say that out of 60% of all occupations, 30% of the tasks will be automated.

According to (Fortune Business Insights, 2022), the worldwide commercial automation marketplace size is projected to reach USD 395.09 billion in 2029 at a CAGR of 9.8% during the forecast period [2022–2029]. Let us consider how various industries are impacted by automation within the manufacturing industry-

Construction

The Construction Industry institute defines construction technology as "the collection of innovative tools, machinery, modifications, software, etc. used during the construction phase of a project that enables advancement in field construction methods including semi-automated and automated construction equipment" (Jones, 2020).

The construction industry is one of the major sources of employment and is mostly labor-intensive. It is considered one of the main industries contributing to China's economic development with a 9% GDP. Though it has been a huge economic contributor, the industry experienced low productivity. The use of automation in construction is comparatively low, but the industry is gradually adapting to automation.

One example of automation being applied to the construction industry is 3D printing, which is widely used because it is cheaper, reduces material waste, improves safety, relies less on human resources, etc. 3D printing will replace construction activities in terms of labor requirements (Hossain, 2020).

Automobile

Auto manufacturers are encouraging automation to make it more cost-efficient by using technology instead of human workers, which would save companies' expenses. The innovation of the first moving assembly line on December 1, 1913, by Henry Ford reduced the time to build a car from 12 hrs to one hour and 33 minutes. The assembly line meant that Ford no longer needed craftsmen and instead could hire low-skilled workers (New York Daily, 2013).

The technologies used in manufacturing are computer-driven software that requires humans to handle them, but these jobs are very different from those before. Eventually, this will lead to robots replacing humans in jobs (Parker, 2016).

Companies like Kia, based in Korea, known for using robots in their manufacturing, claim an increase in productivity of nearly about 200% from automation. There are 1000 robots and less than 1000 people in an assembly line. On the other hand, a company like Mercedes hired humans to replace robots as they believed that humans offer much more adaptability and flexibility than robots do. It can be said that future work will be collaborative between humans and robots (McKeon, 2018). Tesla, the world's largest electric vehicle maker, has been known for developing cars that are not only environmentally friendly but also superior to fossil-fuel ones. In 2017, however, Musk tried to automate its assembly lines too. In California, hundreds of industrial robots were being used for manufacturing in place of humans, which led to large losses for the company in

the form of missed targets, cash setbacks, financial losses, and high employee turnover. Musk finally admitted that their company had gone way overboard with automation and readopted old assembly line practices. Even after all the losses, he predicted that automation was the future and that he aimed to strike a balance to achieve productivity and drive down costs.

Transportation

Automated traffic control system

Automated traffic systems will enable less road traffic, accidents, and also proper parking by using different wireless sensor networks and surveillance cameras, and Internet of Things (IoT) may take away the jobs of traffic police and valets.

Started in 2013, this project has been embraced by three countries, i.e., Netherlands, Germany, and Austria. If proven successful, it may encourage other European countries to adopt the same policy.

The objective of this scanning study was to find existing intelligent transportation systems (ITS) applications deployed in other countries, which could be effective in mitigating safety problems in the United States.

The objective of this scanning team was to focus on 11 areas where technology deployments would improve safety on the nation's highway system (Automatic Intelligent Traffic Control System).

Travel agents

Before the wide use of the Internet, many people worked as travel agents to help find, arrange, and book the best deal for traveling. Today, with the Internet and computers, we can do this without a travel agent.

Driverless Cars

Driverless cars are the result of the innovation of autonomous technology, which will change the way mobility is perceived. Autonomous vehicles will eliminate the profession of drivers (Nikitas, 2021). For example, Nissan launched the "Seamless Autonomous Mobility (SAM)" system developed in collaboration with NASA to realize fully autonomous mobility.
It combines in-vehicle artificial intelligence (AI) with remote human support to help autonomous driverless vehicles decide in unpredictable situations such as road obstacles. It also collects all vehicle information in the cloud and builds in-vehicle AI knowledge. This technology will enable millions of autonomous vehicles to drive safely and smoothly on the road sooner with human support.

Mining

Mining is a large industry as it is of global importance. Most companies are willing to automate a large sector to minimize mining-related injuries and enhance productivity and efficiency along with safety. The changes will lead to the loss of jobs, especially affecting semi-skilled and low-skilled employees (Amin, 2018).

The mining industry may lose more than half of its jobs to automation in the next decade due to the deployment of equipment such as self-driving trucks, automated loaders, automated drilling, etc. The most affected will be the less skilled miners, drivers, and maintainers. Driverless technologies will lead to a 15% to 20% increase in output and a 10% to 15% decrease in fuel consumption (Thibodeau, 2016).

Countries such as India, Pakistan, Bangladesh, Myanmar, Indonesia, and the Philippines have a large proportion of their rural population employed in the mining sector, and as mining gets automated, these countries are at huge risk, as workers will be displaced (Deloitte, 2021).

Textile

Stitching/sewing plays an important role in garment manufacturing, and around 60 to 65% constitute that sector, and hence there is a possibility of this sector getting automated and displacing these workers. Automated assembly lines may replace 15–16 workers per assembly line.

Fabric spreaders, cutters, ironmasters, and packers constitute 15% of total garment sector employment. A CNC spreader and cutter (computer-run equipment that uses laser beams to form custom shapes) is expected to eliminate 40 to 50% of jobs in the next five years (Vashisht, 2019).

Automation in the textile industry can help increase productivity by multiples at a much lower cost. Not only that, it ensures a safe working environment for the workers employed because every step of the process, especially the spinning, weaving, and dyeing is dangerous for workers, but automation uses machines for these steps and ensures safer working conditions (Textile Blog, 2021). Automation is most commonly used in the sewing sector and has also begun in-product development and manufacturing processes such as 3D patterns, AutoCAD, and Auto-Cutter. High-tech sensor machines and barcode readers are also used in various factories. Therefore, there is no doubt that the industry will undergo major changes over the next decade.

Below is a chart that represents the probability of various segments being automated within the textile sector.

Jobs in the Garment Sector	Share in Employment	Nature of Task Performed	Education	New Technology	Probability of Automation	
					Next 5 years	10 to 15 years
Managers & professional	2.5	Cognitive	College	None	NA	NA
Clerks	1.5	Routine Cognitive	Senior Secondary	None	NA	NA
Fabric Spreaders and Cutters	8	Routine	Primary and Below	CNC Spreaders & Cutters	High	High
Tailors/Sewing Machine Operators	65	Routine	Primary and Below	Sewbot	Nil	Very Low
Iron Masters	5	Routine	Primary and Below	Automatic Knitwear Finisher (Ironing Robot)	Low	High
Quality controllers	8	Cognitive	High School	None	Nil	Nil
Packers	2	Routine	Primary and Below	Folding Robots	Nil	Very Low
Other Support Staff	8	Manual Physical	Primary and Below	None	NA	NA

Table 4: Probability of automation in the Indian garment sector
Source: (Vashisht & Rani, Automation and the Future of Garment Sector Jobs in India, 2020)

Household Chores and Automation

According to research, 90% of household tasks from dusting, doing the laundry, and cleaning dishes would be the work of robots in the next two decades. The innovations supposed to hit the market in the next 10 to 20 years for household chores are all "house robots." Multi-functioned small drones would also be common in the 2030s, which might be used for cleaning, dusting, watering, and security. AI butlers would be responsible for everyday routines such as paying bills, managing subscriptions, and shopping.

Virtual chefs would provide recipe books and video tutorials to make cooking easier (Sanghvi, et al., 2017).

Numerous gadgets will make our life easier, but at the same time, they will impact our physical health by making us physically inactive, which will lead to non-communicable diseases (Tech Times, 2019).

Services

Retail

Retailing has a high technical potential for automation in which 53% of the activities are estimated to become automated. Activities such as packaging and maintaining records of

sales and product information and other data collection activities are fast becoming technology driven.

Margin pressure in the retail industry has made automation their requirement. Retailers use automation to support and bolster margins. The decline in physical and manual skills will increase technological skills. This decline can create a gap in skills and will require retailers to either hire new workers or reskill current work (Sanghvi, et al., 2017).

Because of growing consumer demand, retailers are fulfilling their demand through online orders. Therefore, unless retailers have good control over the fulfillment of demands, they will not sustain themselves in the long run and will be out of business, which will displace more workers. Robotics warehouses in the retail industry may displace order pickers (**Baird, 2018**), and this replacement has already started and will pick up pace going forward.

E-commerce has eased online shopping, starting from searching to delivery of products at our doorsteps. Of the shoppers, 87% prefer it for its speedy and efficient delivery. While e-commerce was associated with a decrease in jobs, it actually created 178,000 new jobs over the span of 15 years to meet the need of hundreds of workers who can handle everything right from web design to logistics.

Due to e-commerce, the turnover of physical stores has declined. Suffering from pricing, to survive in the market, they have to sell their products at a low price without any profit margins and also offer heavy discounts (Dahiya, 2017).

With COVID-19, people were left with no other option but to move to online purchases, and this move will impact mom-and-pop stores. We will witness a reduction in the number of retail stores and retail jobs in the times ahead.

Logistics

The logistics industry encourages automation because of its productivity, efficiency, and accuracy. Logistics workers are concerned that their jobs might be automated. Since 2014, Amazon has not only deployed 30,000 robots in its warehouse facilities but also hired 50,000 staff in logistics operations. Automation will also create new job roles for highly skilled logistic technicians who can handle highly sophisticated automated systems. The US Bureau of Labor Statics says that jobs will increase by 4.8% between 2014 to 2024 in handling and transporting materials (OTTO Motors, 2019).

Two professions in logistics, i.e., truck drivers and warehouses have high chances of being displaced. Around 429k warehouse workers may be replaced by robots (Mabe, 2017).

Education and Training

Our basic methods of education have not changed much over the centuries. A small number of students gathers in one physical space, and the teacher delivers direct lessons, each roughly the same length, from a fairly rigid curriculum. The teacher is the 'sage on the stage.' One size must fit all and what is not understood in class must be explored in a separate study or not at all. There is no tailor-made arrangement for those who want to learn at a faster or slower pace. However, with the advent of technology, this is changing. For example, at Rocketship Education, a network of nine charter schools in California, students spend three-quarters of their day with the teacher in the classroom and the remaining quarter using an online platform in the "Learning Lab" (Blended Learning, 2022). In this lab, the software draws on individual performance data to adapt what is taught – content, approach, and pace – according to the specific needs and abilities of each student. If one individual requires special attention, the system will notify the teacher (New Classroom, 2021). A similar approach is used in New Classroom schools in New York, Book of Matches Learning schools in Detroit (Match Book Learning, 2022), and Ednovate schools in Los Angeles (Ednovate, 2022).

These schools use what is known as "adaptive" or "personalized" learning systems. At least, seventy companies now provide these systems: Knewton, Reasoning Mind, and DreamBox are some of the most well-known platforms (Newsman, 2013). There are also different types of online educational networks such as Edmodo, the so-called 'Facebook for schools,' with 48 million users (Edmodo, 2022). They are specifically tailored to support communities of teachers, students, and parents. There are media platforms such as Edudemic, Edutopia, and ShareMyLesson in which people share materials (blogs, videos, and lesson plans) about what works in the classroom (Edudemic, 2022) (Edutopia, 2022) (Share My Lesson, 2022). "Learning management systems" and "virtual learning environments" such as Moodle with 65 million users and BrightSpace with over 15 million users help teachers organize their work, teach, distribute materials, and interact with students outside of the classroom (Moodle, 2022) (Bright Space, 2022). Other online platforms provide educational content. Khan Academy, for example, is a free online collection of 5,500 instructional videos (viewed 450 million times), providing 100,000 practice problems (solved 2 billion times) (Khan Academy, 2022) with 10 million unique visitors each month in 2014 – a seventy-fold increase since 2010 (SRI Education, 2014). It has a higher effective attendance than the total primary and secondary school population of England (Department of Education , 2013). TED, a collection of online lectures (more or less eighteen minutes in length) of thoughtful people on a wide variety of topics, reached its billionth at the end of 2012, while TED-Ed is a platform that helps create lessons based on their videos (Staff, 2012). YouTube- EDU, the part of the video hosting platform that is allocated for educational content alone, contains more than 700,000 "high-quality" educational videos (Google, 2015).

These online platforms are deployed in different ways. Students often use platforms to catch up on these out of class. Some teachers draw on them as teaching material and teach in the traditional way (SRI Education, 2014). Others use teaching materials in different ways, for example, by 'flipping' the classroom, so that students watch routine lectures on these platforms at home and do their homework in class (TED Talk, 2011). Parents use them for "home education" in which the children are educated at home, rather than in a traditional school, a practice that spread sharply in the United States, doubling the percentage of the total school-age population between 1999 and 2012. It is therefore not surprising that Larry Summers, former chairman White House Council of Economic Advisers and former president of Harvard said that "the next quarter century will see more changes in higher education than the last three combined," (Summers, 2012) and that Sir Michael Barber, an ex-Downing Street Advisor foresees changes in education in his report named- 'An Avalanche is Coming' (Donnelly, Rizvi, & Barber, 2013). Below is a table that depicts the bright future of Ed-Tech all over the world.

Company	Country	Cluster	Unicorn Year	Valuation
BYJU's	India	Tutoring	2017	$22B
Yuanfudao	China	Tutoring	2017	$15.5B
Zuoyebang	China	Tutoring	2018	$10B
BetterUp	United States	Corporate Learning	2021	$4.7B
VIPKid	China	Language	2016	$4.5B

Table 5: Top 5 Global EdTech Unicorns
Source: Halon IQ

"Education will move outside the four walls of the schools in this decade. Conventional Degree-based education for theoretical subjects has no future, and for those who go for it."

- Dr. Rajendra Pratap Gupta,
Member,
National Education Policy Committee, Government of India.

Healthcare

In the healthcare industry, automation has already impacted scheduling appointments, data entries, and the manually performed task of transferring data from one system to another. On the other hand, the value-added work cannot be replaced (Chow, 2021).

Healthcare uses drones as a means of transport for their speed of up to 36 km/h and can be used even in cloudy conditions. Drones can carry a load of less than 2 kg (Konert, 2019).

Robotic surgeries are getting common, and patient portals are making way for better patient engagement. During COVID-19, the use of digital consultations has gone up drastically. With Digital Therapeutics, the treatment of chronic diseases will also increasingly depend on technology.

Chatbots in healthcare can reduce hospital visits, decreasing hospital admissions, as well as reduce wait and consultation times, that too without visiting a doctor (Kalinin, 2020).

Chatbots scored 81% compared to an average human doctor's score of 72% for a representative test of the membership of the Royal College of General Practitioners (MRCGP) exam (Gupta R. P., Digital Health- Truly Tanformational, 2021). Over time, robots and automation will overtake doctors in the medical field.

Pharmacy

The proliferation of online pharmacies will move at a faster pace than it ever happened earlier. In the case of pharmacy, automation can be used for storing, labeling, administering, and filling. Automated pharmacy has benefits such as speed, accuracy, security, productivity, medical waste reduction, etc. AI is growing rapidly in the field of pharmacy, such as providing automated robot pharmacies to deliver their services more efficiently with accuracy. If AI continues to make such changes, it would be difficult for pharmacists to adapt to all those new changes, resulting in their having to find themselves new jobs.

Professions and Automation

While we have seen how automation will impact countries and sectors, it is also important to see how automation will impact various professions.

By the mid-2030s, one-third of all jobs could face the risk of automation (PwC). The sector of the workforce most likely to be disrupted will be those with low educational attainment. On the other side, according to many estimates, more jobs will be created than lost through automation in the next few years. According to the World Economic Forum's Future of Jobs Report 2020, AI is expected to eliminate 85million jobs by 2025 and create 97million new jobs (Handley, 2020).

Professions are undergoing a paradigm shift, and these also include creative professionals, which was earlier considered to be exclusively a domain requiring a high level of cognition and emotional quotient but somehow, all this is also moving to the domain of automation. The challenge facing world leaders and policymakers in the wake of COVID-19 will be to ensure that people are not overlooked or replaced by machines in the rush for economic growth.

Media workers and Entertainers

The common creative industry response to automation is complacency, a notion that you cannot automate creativity, but this is coming across as untrue, and tons of examples prove this.

1) China launched its first female news anchor Xin Xiaomeng and also introduced a male AI presenter Qiu Hao who can move naturally, gesture, speak, express facially, etc. (Loeffler, 2019)**.**

2) A South Korean broadcaster has introduced an AI news anchor capable of working 24x7.

A study revealed that more than 85 million jobs in media will be lost in the next five years due to automation (Steger, 2019)**.**

Digital transformation has impacted almost every industry and every walk of life by bringing about a major transformation in recent years. The entertainment industry is no exception.

In fact, changes in the industry have happened so quickly and are so obvious that it looks completely different from twenty years ago. This is great news for people who love to watch movies, series, shows, and other such video content. We have changed over time

and now we live in a world of digital technology. It has changed how we used or experienced entertainment.

Today we have Amazon Prime, Netflix, Hulu, and many other video service providers, and we can watch whatever we want. We have a whole new world of entertainment and a wide range of options to watch through mobile devices without the need to travel to a theatre. Animated movies do business and compete with star-casted movies. Therefore, the challenge of automation is real in the world of entertainment.

Managers and Executives

AI will not replace managers, but managers using AI will replace the managers that do not.

Technologies deliver data and responses instantly. Production managers should be updated with new skills to supervise the machines. Maintenance management is also getting automated so that each item can be shipped on a live tracking basis. Automated management can also track the items selling faster. The transition future requires employees to be trained for working with machines and collaborative algorithms.

Architects, Building engineers, & Construction workers

When we look at how technology has affected the profession, we realize that many decades ago architects started each project afresh with a blank sheet of paper and a set of hand tools (circles, T-squares, pencils, etc.) and created designs for each client. The advent of "computer-aided design" (CAD) changed this process. Desktop design software such as AutoCAD, Revit, and CATIA replaced traditional tools, and digital designs replaced hand-drawn designs (Scheer, 2014). New technologies also bring new possibilities: 3D simulations can be navigated and explored, deconstructed and folded back, turned upside down and zoomed in on. In short, there can be endless experiments with different shapes and structures. There are more complex uses of CAD systems, collectively called "computational design." These approaches are responsible for curves and bubbles – “blobitecture” – seen in some contemporary buildings; for example, the Beijing National Stadium (the "Nest") or London City Hall. Similarly, the advent of "computer-aided engineering" (CAE) has transformed the work of structural engineers.

Any fixed distinction between design and construction seems to be blurred by new technologies. The robots are equipped with “almost every imaginable tool' to help assemble the buildings (Hack, 2014). For example, in the United Kingdom, the "Seed Cathedral,” the top pavilion at the World Expo 2010 in Shanghai, could not be built without robotics.

These examples are just a glimpse of the expanding horizons of automation for the construction sector. How many job losses or additions it will lead to, we have no clue.

Doctors, Physician Assistants, Pharmacists, Nurses, & Health Aides

Traditionally, when people felt unwell, they felt the need to visit doctors and get a diagnosis. However, platforms such as National Health Services Choices and WebMD are becoming a replacement for these visits as they help provide guidance not only on symptoms but also on treatment.

According to (Doctors' consultations 2014/1, 2014) in the United States, the number of unique visits (190 million) on these websites is more than all the doctors. Powerful computerized offline diagnostic systems such as using algorithms to scan mammograms increased the accuracy in detecting breast cancer (Steiner, 2012).

Similarly, at Medtronic (global producer of medical devices and therapies), the design of insulin delivery pumps is getting automated and based on sensor data as dosing of insulin no longer requires any manual intervention of an expert.

When we talk about automation in the jobs of pharmacists, we have an example from the University of California, San Francisco's pharmacy, where there is a single robot that has completed approximately more than 2 million prescriptions without error. On the other hand, US human pharmacists commit an error 1% of the time (Steiner, 2012).

The TUG robot (autonomous mobile robots specifically made for hospitals by Pittsburgh-based company, Aethon) is used to deliver and supply everything from linen to medicines in hospitals across the United States(140 hospitals), and they make 50000 deliveries a week, thus taking over the jobs of nurses (Aethon, 2015).

Even distance between a patient and doctor can no longer stop the doctor from treating the patient. For example, using telesurgery with the help of advanced robotics, a team of US surgeons was able to remove the bile sac of a French woman over 6,000 km across the Atlantic Ocean (IRCAD, 2001).

There is a similar example from the National Health Service in Airedale, West Yorkshire, UK, where telepresence was used to avoid the hospitalization of 50% of prison inmates (Neville, 2014). Google has also joined forces with Novartis, a European drug maker, to develop smart contact lenses to monitor blood sugar levels in lieu of pricking fingers to do so (Scott, 2014). Increased computing power means that certain areas that were previously thought of theoretically but not actually possible are now thriving. An example of this is genomics, a science that scans the DNA of patients to personalize their treatment and predict future diseases (Hayden, 2014).

Hence, technology is definitely transforming the health sector, and many professionals now delivering care will get replaced with technology solutions.

Lawyers, Judges, Auditors, and Financial Specialists

Lawyers and Judges

For future lawyers, the author of '*Tomorrow's Lawyers-An Introduction to Your Future*' predicts that the legal environment will change so much in the coming two decades that it has not changed in the last two centuries (Susskind, 2013). Moreover, technology will play a central role in the transformation of the law profession. One key category of the system, which will automate, is the creation of legal documents. These "document building systems" – built with tools like *ContractExpress and Exari* (Thomas Reuters, 2022) can generate high-quality documents after simple interactive work consultation with users. Originally, they only served to help lawyers. Now similar systems are becoming available online for laymen users (Epoq, 2022). Other document services are also available – for example, *Dokracie*, which organizes open collections of legal agreements, (Thomas Reuters, 2022) and *Shake*, an app that helps create legal handheld device contracts (Shake Law, 2022); legal help is also available online. Legislation and case law are accessible freely in many jurisdictions. Major court appeals are also being launched. One option is a virtual court (Susskind, 2013). It is already being used for vulnerable witnesses to provide evidence or for preliminary hearings in criminal proceedings. In these cases, it is the conventional layout of the courtroom in which they include lawyers, parties, or witnesses – via video link. In China, for example, millions of legal cases are now being decided by "*internet courts*" that do not require citizens to appear in court. A "*smart court*" includes non-human judges powered by artificial intelligence, or AI. People seeking legal action can register their cases online. They can then participate in a digital court hearing. The system offers users the ability to communicate and receive court decisions via text message or via major messaging services. China's first internet court was established in the eastern city of Hangzhou in 2017 (Lynn, 2019).

The largest bank in the Russian Federation, Sberbank uses AI to make more than 1/3rd of their loan decisions, and they predict it will increase to 70% in less than five years. 'Robot Lawyers' have replaced 3000 employees in the bank's legal team, and the back office team was expected to be cut by more than 98% from 59000 to 1000 by 2021 (Gupta R. P., Your Degree is Not Enough, 2020).

Auditors and Finance Specialists

When we talk about tax and audit work that used to be done by professionals, in recent years, an option for personal taxation has appeared – online tax preparation computer software. Some familiar systems in the United States are TurboTax, H&R Block at Home, and TaxAct (TurboTax, 2022). Using these apps, individuals answer a set of simple questions about their financial affairs and automatically, the software compiles their returns. There is no need for a human expert. In the United States, in 2014, nearly 48 million people prepared their own returns online without a tax professional using tax preparation software – either commercial systems, such as those mentioned above, or free

software provided by the tax office (from basic forms that help with calculations to more sophisticated systems) (IRS, 2014) In the past, accountants were also needed by individuals and small businesses as they helped track their cash-flow, process invoices, record expenses and so on. A growing number of computerized online accounting software is now available for many of these tasks. Some of the better-known systems are QuickBooks, Xero, and Kashflow (Quickbook, 2022) (Xero, 2022) (Kashflow, 2022) There are tax authorities in Chile, Mexico, Argentina, and other countries replacing traditional, easily falsified paper invoices with mandatory online ones "electronic invoices," which must be submitted to the tax authorities immediately after the transaction (Economist, 2014). As many tax tasks are computerized, the day-to-day work of tax professionals is changing. Own tax teams, management consulting, software developers, and business intelligence providers are increasingly interested in leadership tax work. In response, traditional tax practices focus less on tax compliance work (preparation and submission of returns) and implementation of higher taxes work planning (for example, where to locate headquarters or where to live, reduce tax liability) and work with tax transactions (for example tax advice). Councils are becoming more proactive rather than reactive. For example, Deloitte provides expats abroad with computerized advice on where they can and cannot travel to minimize their tax based on GPS data from their mobiles.

The tax profession is said to be particularly threatened by technology.

Domestic Workers

The innovations supposed to hit the market in the next 10 to 20 years for household chores are all “house robots.” AI butlers would be responsible for everyday routines such as paying bills, managing subscriptions, and shopping. (**Refer Application of Automation across Sectors: Household chores and Automation - Page No. 34**)

Hospitality Sector and Sales professionals (Customer Service)

Hospitality Sector

The tech analyst's latest future of jobs forecast estimates that up to 12 million jobs could be lost to automation across Europe by 2040, mainly affecting workers in sectors such as retail, food services, leisure, and hospitality (O'Grady, 2022). However, the question is how will automation take away jobs in the hospitality sector. The popularity of apps has been on the rise for some time, and some are also specifically for travel, such as "Lola" and "Pana.” For example, Edwardian Hotels, London, employs an aptly named virtual host, Edward, who can take amenity requests, provide directory and review information, facilitate complaints and connect guests with an instant call-back if they need human assistance. It is designed to respond within seconds. Dutch airline KLM uses the Facebook messenger chat service to send booking confirmations, notifications, and boarding passes to passengers. This process is easily transferable to hoteliers, who can maintain a constant

dialogue with guests from booking to check-out and everything in between (Chestler, EVP, & Global Enterprise Sale & Business Development)

A survey conducted by Travelzoo concluded that about two-thirds of the people who were asked about being taken care of by machines in hotels said they were affirmative about it.

The hospitality industry has already adopted robots, for example, Marriott has *Mario* to greet guests, Hilton has *Connie*, the robot concierge, and InterContinental has *Dash* to transport items between guests. Another interesting example comes from Japan: Henn-na Hotel has more than 100 rooms and features multilingual robots (one human woman, one dinosaur) at the front desk, a robot shoulder locker service, a robot luggage carrier, and facial recognition software so you don't have to worry about carrying a key. Automation will eliminate routine and mundane jobs in the hospitality sector.

Sales Professionals

A research team at McKinsey analyzed the detailed work activities of more than 750 occupations in the United States to estimate the percentage of tasks that could be automated by adapting currently demonstrated technology. A study found that in sales and related professions, almost 50% of daily tasks can actually be automated, but they can never be fully automated (Efti, 2017).

Case Studies

Amazon Go

Retail in the united States (US) is the largest private sector employer. It employs 9.8 million people, which is 6.3% of the total US labor force (United States Census Bureau, 2020). Retail jobs all across the world are facing threats due to automation, and Amazon Go is one of the examples of how automation is fueling this threat. The rise of Amazon Go is seen as the demise of the traditional store.

Amazon Go is eliminating the jobs of cashiers and store attendants, and if the rest of the retailers follow the same concept, retail jobs may be drastically cut. Hailed as the future of retail, Amazon Go's cashless stores were arguably one of the most ambitious projects launched in the retail landscape in a long time. The Amazon Go eliminates the need for cashiers and scanner counters. The platform also generates massive amounts of data that indirectly enable further optimization of the workforce and supply chain. With this data, the system knows how many picks each warehouse worker completes per hour and exactly when items sell out. They know how much to allocate per shelf in the next planogram cycle so that the allocation lasts the whole day. This helps management optimize their planograms, supply chain, and shop floor performance.

The indirect labor savings from such a benefit is very difficult to estimate, but we estimate it at $50,000/year/shop.

One of the retailing experts described Amazon Go as a huge disruption. Some feared that Amazon Go would replace approx. 3.5 million cashiers in the United States. Although, the fascination of Amazon Go is customers' ability to enter the store, put their items into their own shopping bags, and walk out. Amazon Go has no human cashiers to interact with, as all transactions are made wirelessly through the Amazon Go app and the customers' Amazon accounts.
Amazon may create jobs, but it is difficult to make up for job losses because it needs few workers. Amazon Go is going to restructure the economy.

Automated Teller Machines (ATMs)

The introduction of automated teller machines (ATMs) meant massive technological unemployment for bank tellers (employees whose responsibilities include handling cash and other negotiable instruments) in the 1970s. Initially, everybody expected ATMs to eliminate a huge number of bank tellers. , The average bank branch initially required about 21 tellers which got reduced to 13 because of ATM machines. For banking, developing the skills to remain employable will be a challenge. On the other side, we look at the fact that this increase in the number of bank tellers will not be forever as more banking services are now available online for customers. The threat of job losses in financial markets is REAL! (Pethokoukis, 2016).

Tata Motor Pune Plant

The most remarkable thing about the Tata Harrier manufacturing plant in Pune, India, is the highest level of automation in the assembly line, which helped Harrier achieve 90% of automation (Daniels P. , 2018). The first Harrier SUV from the Pune Plant was built in a record time of just 6 months. It deployed more than 100 KUKA and ABB robots as part of a 90% automated assembly line (Daniels P. , 2018). However, one of the officials of Tata Motors stated that due to this, 1,000 to 3,000 temporary staff will lose jobs. However, the plant did not confirm the exact number of job losses. Most of the automobile industry hires staff when required and disengages them after the completion of that particular job or that particular time period (Bhalla & Agtey, 2008). The automobile industry will adopt automation given the fast-tracked technology changes and the move to electronic vehicles. The need for humans will decline over the decade, and they will be replaced by technology.

COVID and the Tech Industry

Apple - A $3 trillion corporation

While COVID-19 brought the demise of many enterprises, tech companies saw growth unlike anything before. Apple, which saw a record fiscal year with its stock nearly doubled, was one of the biggest winners in the first year of the pandemic despite store closings, supply-chain disruptions, and stressed finances for many customers. Though most revenue from Apple has been coming from its iPhones over the years, its MACs and iPads became famous amongst people because of the shift from work-from-office to work-from-home. To substantiate this point, we have statistics that prove that the MAC's sale curve was nearly flat from 2017–2019, but the boom in its sale accrued as a result of work-from-home. This increase in demand for new computers lead to Apple's $9.03 billion in Mac revenue during the September 2020 quarter, which became a new company record as families prepared for homeschooling. The company further capitalized on the rising demand by launching the new MacBook Air, MacBook Pro, and Mac mini computers.
Overall Apple completed the 2020 quarter with a revenue of $60 billion in July 2020. Apple was the first company to reach a 1 trillion dollar cap in August 2018, and it did it again by crossing the $2 trillion cap by the end of 2020. With a market value of $2 trillion, Apple has surpassed the GDP of many major developed nations, including, to mention a few, Italy, Brazil, Canada, Russia, and South Korea (Klebnikov, 2021).

When we just thought Apple could not do better than this, it achieved its remarkable feat at the start of 2022 and became a $3 trillion company in just 17 months after being a $2 trillion company, and it became the first public company in doing so. Apple's value is greater than the $2.76 trillion GDP of the United Kingdom (Smith, 2022).

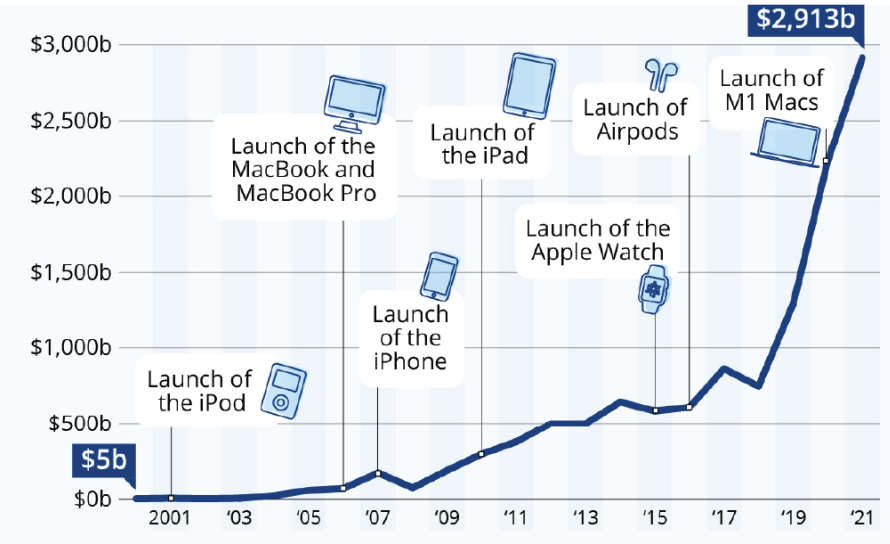


Fig 8. Apple's market capitalization at the end of 2021
Source: Statista

Conclusion & Recommendations

When we started this study, it appeared interesting, and as we conclude this study, it is appearing important for society, the economy, and individuals. There will be a churn in the way we define jobs, the way we educate, and the way we compensate.

Nations with higher GDP per capita and aging nations are better suited to adopt automation and consider the option of UBI, but for the rest, it is a twin-edged sword.

The workplace will never remain the same post-COVID. Automation will be adopted increasingly across large, medium, and small enterprises. Jobs will get created, transformed, and terminated, and that is a fact of life. Technology is unstoppable, and the only trillion-dollar companies are the tech giants, and they have the wherewithal, and they might influence and convince the policy makers to move policies favorable to them. Therefore, this is a call for bold policy makers, and out-of-box thinking for finding sustainable solutions.

There is a need to study this topic in greater detail, whether there will be a net addition or net loss of jobs. A few percent displacement of jobs can wreak havoc on families and turn it into a political issue. There will be no single model for the world. Aging nations such as Japan and countries with high incomes and low fertility rates will need automation, and similarly, other nations with high populations and low incomes or high populations and high incomes will need to tread carefully. More than that, we need to consider the following;

1) Redefine our education system, and make lifelong learning the rule.

2) Base tax structure on employment, turnover, and profits. Incentivize companies with higher manpower with tax breaks.

3) Focus on user-centered innovation when it comes to automation.

4) Re-orient and strengthen the social security system.

5) Evaluate the idea of Universal & Minimum Basic Income (UMBI).

6) Consider healthcare a social good.

7) Make the right to internet and broadband a non-negotiable social good.

8) Provide value adds for human-resource-intensive sectors such as agriculture.

9) Consider Sustainable Automation as SDG#18. If we don't do it, we will undermine all other SDGs.

'For certain scenarios like disasters or high-risk environments, the robots could replace humans, and for some stages or conditions like for seniors or elders or people with disabilities robots should assist humans but replacing humans for profits is uncalled for and that's why we need to draw a framework for Sustainable Automation. We cannot indiscriminately use robots but discreetly, yes!
We need to consider Sustainable Automation as SDG#18. If we fail to do it, we would be failing the other SDGs.'

- Dr. Rajendra Pratap Gupta

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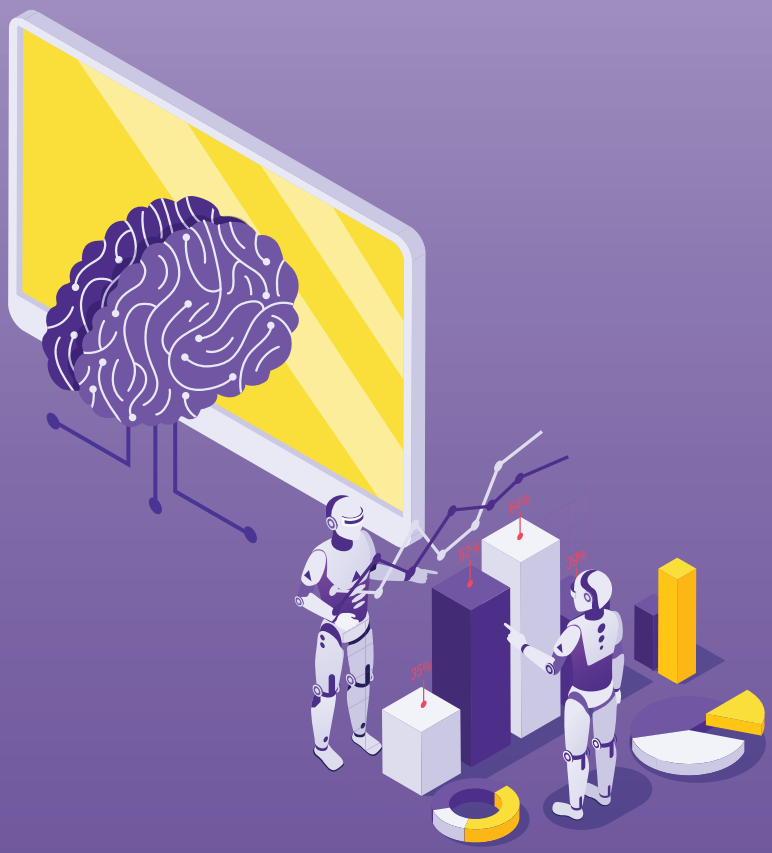

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