AL HABTOOR RESEARCH CENTRE

RESTORING BALANCE

IMPACTS OF AUTOMATION ON THE

UAE

LABOUR FORCE

Economics & Energy Programme

Restoring Balance
Impacts of Automation on the UAE Labour Force

AL HABTOOR RESEARCH CENTRE
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ABSTRACT

According to the McKinsey Global Institute report between 400 million and 800 million people worldwide could be displaced by automation and need to find new occupations by 2030, with 75 million to 375 million of those affected need to move to another new jobs and learn new skills.

Over the last two decades, there has been a surge in interest in automation and digital technologies, as well as their implications for our societies. Several writers have calculated experimentally the impact of automation technologies on employment and people by examining technology adoption at the business or industry level in previous years and related this to labour market outcomes, but their conclusions have been mixed. Some studies find that automation technologies positively impact employment, while others show that they have a negative impact.

Our study examined the impact of automation on the United Arab Emirates (UAE) in terms of demographics, employment and economic sectors by implementing several scenarios of automation. These scenarios revealed that, in most cases, automation will positively impact UAE in terms of some macroeconomic indicators, and will lead to its economic growth and stability. Finally, we provided some recommendations that will enhance and facilitate the transition to automation in the UAE.

INTRODUCTION

Automation refers to the use of technology to perform tasks that are typically carried out by humans. It has been a driving force behind many of the technical achievements of the last century, and its use has grown dramatically in recent years. Automation can take numerous forms, including the employment of robotics, artificial intelligence, and other digital technologies. Over the last two decades, there has been a surge in interest in automation and digital technologies, as well as their implications for our societies. The invention of new technologies, and the increasing accessibility to some of them, has led to questions about their impact on various elements of productive structures once they are adopted; on the one hand, the impact is on production processes and the restructuring of GVCs, while on the other related hand, the focus has shifted towards quantitative and qualitative effects on work organization and, more broadly, working conditions.[1] Continuous improvements in technology have enabled the automation of a

1- Anzolin G. (2021), Automation and its Employment Effects: A Literature Review of Automotive and Garment Sectors, Seville: European Commission, 2021, p.7.

growing number of tasks. As a result, there is widespread anxiety that new technology will eliminate a substantial number of jobs and cause technological unemployment.[2]

In what is now commonly referred to as the fourth industrial revolution, technological improvements in recent years have created a large amount of uncertainty among the workforce. While advances in technology development have generated excitement, there is still concern among employees about the possibility of job displacement due to technological unemployment. Numerous discussions and forums have investigated the possibility of technology replacing humans in the workplace. The current rate of innovation is higher than at any other moment in history, and businesses and academia are devoting significant resources to predicting the possible impact on organizations and labour.[3]

Indeed, automation has the potential to provide major benefits such as greater efficiency, productivity, and accuracy. Automation can also help to cut expenses by eliminating the need for manual work and reducing the possibility of errors. Furthermore, automation can improve product and service quality by maintaining consistency and decreasing variability.[4]

However, the adoption of automation also has the potential to disrupt the workforce, as some jobs may be automated and others may change as a result of the adoption of automation. Businesses and organizations must carefully assess the potential workforce consequences and establish methods to assist affected personnel, such as training and retraining programs and the development of new skills and knowledge. According to the McKinsey Global Institute report between 400 million and 800 million people worldwide could be displaced by automation and need to find new occupations by 2030, with 75 million to 375 million of those affected need to move to another new jobs and learn new skills.[5]

As a result, the adoption of automation poses a number of ethical and social challenges, such as the possible influence on employment, wages, and resource allocation. It is critical for businesses and policymakers to recognize these concerns and develop solutions. Overall, automation adoption is a complicated and necessitates careful

2- OECD. (2019). Determinants and impact of automation: An analysis of robots' adoption in OECD countries, OECD digital economy papers No.277, p.6.

3- Abdulla, M. (2019). Adoption of job automation technologies in the fourth industrial revolution: A managerial perspective, Gordon Institute of Business Science, University of Pretoria, p.2.

4- Manyika, J., et al. (2017). A future that works: automation, employment, and productivity. McKinsey Global Institute.

5- McKinsey Global Institute. (2017). Jobs lost, jobs gained: Workforce transitions in a time of automation, p.11.

planning and analysis of the potential consequences on the labour, business, and the larger community. It has the potential to provide considerable benefits, but it is critical to properly manage the adoption process to ensure that these benefits are achieved in a fair and sustainable manner.

As such, our study will start by examining the effect of automation on employment in both developing and developed countries. Then, we will analyse the impact of automation on the UAE as it represents a unique model since it's neither a developed nor a standard developing country since there are several differences between the UAE and developing countries. Its unusual position between industrialized and developing countries makes the implications of automation distinctive, as the country's labour market primarily depends on immigration. It is therefore believed that nationals will be affected less severely than in the majority of developing countries. In addition, the country's robust financial resources enable it to absorb the expense of automation, unlike developing countries. After analysing the impact of automation on employment in the UAE, we will elaborate on scenarios regarding the adoption of automation in the UAE, and we will provide some recommendations for the automation transition in the UAE.

Methodology

In our research, we will be utilizing a combination of quantitative and statistical methodologies to identify the impact of automation on the labour force. We will be gathering a wide range of data which will be analysed using statistical techniques. By using these methods, we will examine the relationship between automation and the labour force and identify patterns and trends. Also, we will use quantitative methods such as econometric models to estimate the effect of automation on labour market outcomes such as jobs, wages, and the population structure of the UAE. Through this approach, we will provide future scenarios of the impact of automation on the labour force in UAE.

LITERATURE REVIEW

For many years, automation has been a recurring theme in public debate. English textile workers protested the introduction of textile machines as early as the nineteenth century. The fear that technological progress would result in mass unemployment acquired prominence during the twentieth century and is a hot topic today, both in policy debate and academic inquiry.[6] Rapid breakthroughs in artificial intelligence, machine learning, and robotics have appeared poised to change the world of work over the last decade. The COVID-19 pandemic has only drove speculation about automation's transformational potential. The virus has no effect on technology that substitute for human work, which offer corporations the opportunity for huge cost savings. Are workers being displaced by automation technology, pushing society increasingly closer to a world of enormous technological unemployment?[7]

Several writers have calculated experimentally the impact of automation technologies on employment and people by examining technology adoption at the business or industry level in previous years and related this to labour market outcomes, but their conclusions have been mixed. Some studies find that automation technologies positively impact employment, while others show that they have a negative impact.[8]

Indeed, the literature is divided on the effect of automation on employment; some studies claim that automation will result in job losses, the destruction of complete jobs, and an increase in the unemployment rate; others believe that, along with job losses, there will be room for new jobs, resulting in increased productivity and employment. On the other hand, some suggest that automation will only affect routine low-skilled jobs that robots can undertake and that non-routine high-skilled jobs will not be affected, and the demand for it will increase.

In our study, we looked at 150 studies and reports that examine the effects of automation on employment and their relation to employment, whether it is positive, negative or neutral in both developed and developing countries. All these studies will appear in (**Appendix 1**).

6- Autor, H. (2015). Why Are There Still So Many Jobs? The History and Future of Workplace Automation, Journal of Economic Perspectives, 29 (3) 3–30 p.3.

7- Georgieff, A., & Milanez, A. (2021). What happened to jobs at high risk of automation? p.8.

8- Acemoglu, D. and Restrepo, P. (2020). Robots and jobs: Evidence from US labor markets, Journal of Political Economy- Volume 128 (6).

Automation Affects Employment Negatively and will Destroy Complete Occupations

The first and one of the most famous contributions is Frey and Osborne, who forecasted a high number of job losses. They estimate the degree of automation of various occupations, assuming that automation will occur and that when it does, the corresponding jobs will be destroyed. To evaluate this, they used a novel methodology to estimate the likelihood of computerization for 702 detailed jobs.

They analysed the projected implications of future computerization on labour market outcomes based on these estimations, with the primary goal of examining the number of jobs at risk and the relationship between an occupation's probability of computerization, salaries, and educational attainment. According to their estimations, over 47% of total employment in the United States (U.S.) is classified as high-risk, and the majority of transportation and logistics workers, as well as the majority of office and administrative support workers and labour in production occupations, are at risk.[9]

Similarly, a number of studies in different countries has found a negative impact of automation on employment and it will lead to job destructions. For example, in the U.S., one of the many studies conducted found that automation will destroy 9,108,900 jobs.[10] Likewise, a study in Europe found that 9% of the jobs in 21 Organisation for Economic Cooperation and Development (OECD) countries are at highly susceptible to automation.[11] Also, a study in Canada found that 2 million employees could lose their jobs by 2030,[12] and in Ireland, a study revealed that two out of every five jobs are likely to be substantially impacted by automation.[13] In Germany, a study demonstrates that each robot destroys two manufacturing jobs, but it is counterbalanced by the effect of robots on the rest of the economy.

The overall effect is thus neutral.[14] A study conducted in European Union countries found that one additional robot per thousand workers reduces the employment rate by 0.16-0.20 percentage points.[15]

9- Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? Technological forecasting and social change, 114, 254-280, p.268.

10- Solon, O. (2017). Robots will eliminate 6% of all US jobs by 2021, report says.

11- Arntz, M., et al. (2016). The risk of automation for jobs in OECD countries: A comparative analysis, OECD Social, Employment and Migration Working Papers, No. 189, OECD Publishing, Paris, p.8.

12- Canada. Department of Finance. Advisory Council on Economic Growth. (2017). Learning nation: equipping Canada's workforce with skills for the future.

13- Doyle, E., Jacobs, L., & Unit, E. P. (2018). Automation and occupations: a comparative analysis of the impact of automation on occupations in Ireland. Irish Government Economic and Evaluation Service, Technical Paper, Dublin.

14- Dauth, W. et al. (2017). German robots-the impact of industrial robots on workers.

15- Chiacchio, F., et al. (2018). The impact of industrial robots on EU employment and wages: A local labour market approach (No. 2018/02). Bruegel working paper.

The risks of job automation in developing countries are found to vary across countries. It is estimated to range from 55% in Uzbekistan to 85% in Ethiopia. In emerging economies, the risk of automation is estimated to be relatively high with 77% of jobs in China and 69% in India found to be at risk.[16] Also, in Brazil, a study found that automation will negatively affect 60% of the employment force,[17] and in Mexico, a study estimated that 65 percent of total employment is at high risk of being automated, and 57% of employment in the formal sector is at high risk of being displaced by automation technologies.[18]

Another interesting contribution is presented by Carbonero et al. where they explore whether the rise in robotization leads to re-shoring, i.e. the fact that firms in developed countries may find it more profitable to bring production back home after having it previously off-shored to low-cost from emerging economies. They find that robots have led to a drop in global employment of 1.3% between 2005 and 2014 in 15 sectors and 41 countries. The impact is rather small in developed countries, -0.5%, but much more pronounced in emerging countries with about 14%. These estimates are based on an instrumental variable approach in which an index of technological progress of robots has been used to identify their ability to perform different tasks, and to isolate the structural demand for automation from cyclical effects. They find that robotization in developed countries has a detrimental impact on employment in emerging countries, providing the first evidence of cross-country effects via robot-driven re-shoring.[19]

Automation will only Affect Certain Tasks

On the opposite to what Frey and Osborne adopted to estimate the impact of automation on the occupation level that will lead to the automation of complete jobs, Autor et al. adopted an approach based on the task level which takes into account the task content of jobs and how it varies across jobs belonging to the same occupation, between and within countries.

It looks at jobs as a collection of tasks, some of which might be automated while others may not, it classifies tasks between routine vs. non-routine and manual vs. cognitive tasks. Routine tasks are those that can be decomposed into easily repeating components, and manual tasks are those that need physical work as opposed to cognitive activities, which require cerebral exertion.[20]

16- Ramaswamy, K.V. (2018). Technological Change, Automation and Employment: A Short Review of Theory and Evidence, "Technological Change, Automation and Employment: A Short Review of Theory and Evidence," International Review of Business and Economics: Vol. 2: Iss. 2, Article 1, p.3.

17- Lima, Y., et al. (2021). Exploring the future impact of automation in Brazil. Employee Relations: The International Journal.

18- Cebreros, A., et al. (2020). Automation technologies and employment at risk: The case of mexico (No. 2020-04). Working Papers, p.34.

19- Carbonero, et al. (2018) Robots worldwide: The impact of automation on employment and trade, Working Papers, No. 36, ILO Publishing, p.11.

20- Górka, et al. (2017). Tasks and skills in European labour markets, Background Paper for the world bank report growing united: Upgrading Europe's convergence machine, p.3.

This paradigm implies that computers tend to replace employees in routine jobs that adhere to well-defined rule-based procedures. In contrast, they supplement workers executing more complicated abstract tasks, such as problem-solving and complex communication activities.[21] The more routine a job involves the more likely it is to be fully automated because technologies tend to go for routine types of activities.[22] Due to the complementarity between computers and abstract tasks in production and the complementarity between goods and services in consumption, computerization can also explain the recent increase in low-skill service jobs, as higher incomes increase the demand for such services and manual non-routine tasks, which are prevalent in service occupations, cannot be substituted by computers.[23]

The influence of automation on highly- and low-skilled workers is a second method. Low-skilled workers are those that perform straightforward, process-driven jobs at an entry-level without much abstract thought. High-skilled workers are individuals who perform complex activities that demand experience, knowledge, abstract thinking, and autonomy.[24]

According to a study by Arntz, Gregory, and Zierahn, where they classified the jobs at risk of automation by education level and found that less-educated workers (those with less than a high school degree) are more likely to be replaced by automation than highly-educated (those with a bachelor degree) ones.[25]

Consequently, high-skilled workers are complementary to the technological development process, whereas low-skilled individuals tend likely to be replaced as demand shifts in favour of more educated workers. Some forms of automation will be skill-biased, increasing the productivity of high-skill people while reducing the demand for lower-skill and routine-intensive jobs, such as file clerks or assembly-line workers. Other forms of automation have had a disproportionate impact on middle-skilled workers.[26]

As a result, many employees will continue to work alongside machines as more and more tasks will be automated. Different activities, occupations, and skills will

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21- Autor, D., et al. (2003). The skill content of recent technological change: An empirical exploration. The Quarterly Journal of Economics, 118(4), 1279-1333.

22- Goos, M., et al. (2014). Explaining Job Polarization: Routine-Biased Technological Change and Offshoring, The American economic review, p.8.

23- Autor, David H. and David Dorn (2013) "The Growth of Low-Skill Service Jobs and the Polarization of the U.S. Labor Market," American Economic Review, 103(5): 1553–97.

24- Ramaswamy, K. V. (2018) "Technological Change, Automation and Employment: A Short Review of Theory and Evidence," International Review of Business and Economics: Vol. 2: Iss. 2, Article 1, p.2.

25- Arntz, M. et al. (2016), "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis", OECD Social, Employment and Migration Working Papers, No. 189, OECD Publishing, Paris, p. 10.

26- Manyika, J., et al. (2017). Harnessing automation for a future that works. McKinsey Global Institute, 2-4, p.2.

experience varying rates and degrees of automation, which will have varying effects on employees. Predictable physical activities, especially widespread in manufacturing and retail trade, as well as data collection and processing, which are activities that occur across the full range of industries, talents, and pay, are more likely to be automated sooner.[27]

Further, a study conducted by the OECD on 38 occupations in 21 countries confirms the task approach measure and found that automation has worsened employment prospects for some workers. The occupations that saw employment declines include: skilled agricultural workers; clerical support workers; skilled forestry, fishing and hunting workers; handicraft and printing workers; and metal and machinery workers. These declines are even more striking given that they occur against a backdrop of rising employment across countries.[28]

Despite the fact that low-educated individuals were significantly more likely to work in high-risk occupations at the beginning of the period, the average employment rate of low-educated workers in OECD countries has not been negatively impacted by these developments more than that of other education groups. This is due to the fact that the fall in job opportunities for these workers has been complemented by a decline in the number of low-educated workers as part of the general upskilling of the workforce. In the period between 2012 and 2019, the proportion of low-educated workers in the six riskiest jobs increased by 5.9 percentage points on average across countries.[29] Several studies have confirmed that approach of the distinction of the effect of automation on routine and no routine tasks, and low and high-skilled workers. On one hand, we can mention the examples of Norway,[30] the United Kingdom (UK),[31] Denmark,[32] and France.[33] On the other hand, developing countries have higher levels of predicted automation risk compared to developed economies. Countries range in their level of highly automatable jobs from the lowest being Yunnan –a Chinese province of 50 million inhabitants –with 5% to the highest of Ghana and Sri Lanka with 42% and 43%, respectively. Also, occupations containing relatively more routine tasks are more likely to be automated, while workers with a higher level of education reduce their risks.[34]

27- Acemoglu, D. & Autor, D. (2010b). Skills, Tasks and Technologies: Implications for Employment and Earnings. National Bureau of Economic Research, Inc, NBER Working Papers, 4.

28- Georgieff, A., & Milanez, A. (2021). What happened to jobs at high risk of automation? p.12.

29- Ibid.

30- Akerman, A., et al. (2015). The skill complementarity of broadband internet. The Quarterly Journal of Economics, 130(4), 1781-1824.

31- Lacity, M.,et al. (2015). Robotic process automation at Telefonica O2.

32- Humlum, A. (2019). Robot adoption and labor market dynamics. Princeton University.

33- Acemoglu, D., et al. (2020). Competing with Robots: Firm-Level Evidence from France. AEA Papers and Proceedings, 110, 383-88.

34- Egana del Sol, Pablo (2020): The Future of Work in Developing Economies: What can we learn from the South? GLO Discussion Paper, No. 483, Global Labor Organization (GLO), Essen.

Automation Effects will vary Across Sectors and will Create New Jobs

According to Vermeulen et al. who studied the effects of automation on types of sectors and developments of occupations, over time. Subsequently, they analysed the anticipated changes in employment within and across the various types of sectors, which they divided into the applying sectors, the tertiary sectors, and the producing sectors, using expert projections of employment in various (groups) of occupations over the next decade. According to their estimations, the automatability of occupations in the applying sectors is minimal, and employment changes to the "creating" sectors (particularly engineering, software, and scientific services) are significant. Existing and emerging occupations are experiencing strong job growth in "creating" sectors, as well as in the complementing facilitating, and inhibiting sectors.[35]

In addition, they provided an array of occupations mentioned as job creators of the future (e.g., big data and information systems, service robots, and an array of applications thereof). Moreover, they observed that growth in quaternary sectors (sectors such as leisure and travelling, sport and lifestyle, entertainment, arts, and culture), and possibly personal/health care, luxury goods sectors, etc., is outpacing the average growth in disposable income, which they expect to remain high not only in the producing and complementary sectors but also for upskilled jobs in the applying sectors.[36]

Indeed, this theory is confirmed by a study conducted in Europe and finds that there is nothing to suggest that the digital revolution so far has reduced overall demand for jobs. Instead, most job growth has taken place in technologically stagnant sectors of the economy, including health care, government and personal services.[37] Furthermore, another study in Europe also showed that the number of high-education jobs such as managers, engineers and health professionals is growing.[38]

The spread of digital technologies has had widespread effects on labour markets throughout the OECD. The introduction of new technologies has dramatically transformed the labour composition across sectors, occupations, and tasks. The reduction of manufacturing employment and the relocation of workers to the service sector can be partially explained by the automation of manufacturing occupations and

35- Vermeulen, B., et al. (2018) "The Impact of Automation on Employment: Just the Usual Structural Change?" Sustainability 10(5).

36- Ibid.

37- Berger, T., & Frey, C. B. (2016). Structural transformation in the OECD: Digitalisation, deindustrialization and the future of work, OECD Social, Employment and Migration Working Papers, No. 193, OECD Publishing, Paris, p.43.

38- Darvas, Z., & Wolff, G. B. (2016). An anatomy of inclusive growth in Europe. Bruegel Blueprint Series 26, October 2016.

the emergence of wholly new service industries, such as video and audio streaming and web design.[39]

In fact, according to a study conducted in the U.K., automation might influence up to 30% of U.K. jobs by early 2030, affecting a variety of worker types and industries. In 2030, roughly 45% of manufacturing occupations and 52% of transportation and storage jobs could be automated.[40]

Moreover, while digital technologies have rendered many jobs obsolete –including those of bookkeepers, data entry keyers, and typists– they have also generated positions such as software engineers and database administrators. Digital technologies have also drastically impacted the task composition of jobs: while the conventional activities of a bank teller have been mostly supplanted by ATMs, a bank teller's job now includes numerous additional client relationship management tasks.[41] Another are where autonomous technologies constitute both a promise and a threat for employment are self-driving vehicles. When commercially practical, self-driving cars will provide a more convenient, flexible, and secure form of transportation. Moreover, they pose a threat to the employment of drivers with few recognized qualifications, especially many immigrants from less-developed countries.[42]

According to a second study, certain automation technologies may actually reduce labor demand due to their substantial displacement effects with small productivity improvements (especially when substituted workers were cheap to begin with and the automated technology is only marginally better than them). Second, due of the displacement effect, we should not anticipate that automation would result in salary growth proportional to productivity growth.

In the past, high pay increases and steady labour shares were the result of other technological innovations that created new jobs for labour and counterbalanced the impact of automation on the task content of production. Certain technologies shifted labour from automated activities, while others reintroduced workers to new tasks.[43]

39- Berger, T., & Frey, C. B. (2016). Structural transformation in the OECD: Digitalisation, deindustrialization and the future of work, OECD Social, Employment and Migration Working Papers, No. 193, OECD Publishing, Paris, p.25.

40- PWC. (2018). Will robots really steal our jobs? An international analysis of the potential long term impact of automation, p.18.

41- Berger, T., & Frey, C. B. (2016). Structural transformation in the OECD: Digitalisation, deindustrialisation and the future of work, OECD Social, Employment and Migration Working Papers, No. 193, OECD Publishing, Paris, p.43.

42- Graetz, G. & Michaels, G. (2018). Robots at work. Review of Economics and Statistics, 100, 753-768.

43- Acemoglu, D. & Restrepo, P. (2019). Automation and New Tasks: How Technology Displaces and Reinstates Labor. Journal of Economic Perspectives, 33, 3-30, p.5.

In regard to developing countries, studies also demonstrated that automation will affect some sectors negatively, for example in India, robotics can displace 80% labour employed in the Indian garment sector.[44] While in England and Wales, automation in the transportation manufacturing industry resulted in a loss of 21,000 total jobs.[45]

Last, in terms of job creation, the World Economic Forum's Future of Jobs report maps the jobs and skills of the future and tracks the rate of change based on polls of global company executives and human resource strategists. The analysis showed that the workforce is automating faster than anticipated, displacing 85 million jobs in the next five years and that by 2025, the adoption of technology by businesses will revolutionize tasks, occupations, and skills.

In five years, companies will distribute work nearly equally between humans and machines. Similarly, the paper indicates that as the economy and labour markets adapt, new positions will arise throughout the care economy in technology disciplines,such as artificial intelligence (AI) and in content production careers, such as social media management and content writing.

The growing need for green economy occupations, roles at the forefront of the data and AI economy, and new positions in engineering, cloud computing, and product development are reflected in the emergence of new professions.[46] Indeed, the report made a list of jobs that will be in high demand and the ones that will shrink in the next five years,[47] as follows:

44- Vashisht, P., & Rani, N. (2020). Automation and the future of garment sector jobs in India. The Indian Journal of Labour Economics, 63(2), 225-246.

45- Prashar, A. (2018). Evaluating the impact of automation on labour markets in England and Wales (Doctoral dissertation, University of Oxford).

46- Zahidi, S. (2020). The jobs of tomorrow: Some jobs will disappear and others will emerge as the world faces a dual disruption, World Economic Forum, p.26.

47- Ibid, p.27.

Table 1 – Variation in the Demand for some Jobs in the next Five Years According to the World Economic Forum Report

Increasing Demand	Decreasing Demand
Data analysts and scientists	Data entry clerks
AI and machine learning specialists	Administrative and executive secretaries
Big data specialists	Accounting, bookkeeping, and payroll clerks
Digital marketing and strategy specialists	Accountants and auditors
Process automation specialists	Assembly and factory workers
Business development professionals	Business services and administration managers
Digital transformation specialists	Client information and customer services workers
Information security analysts	General and operations managers
Software and applications developers	Mechanics and machinery repairers
Internet of things specialists	Material-recording and stock-keeping clerks
Project managers	Financial analysts
Business services and administration managers	Postal services clerks
Database and network professionals	Sales reps and wholesale and manufacturing
Robotics engineers	Scientific products
Strategic advisors	Relationship managers
Management and organization analysts	Bank tellers and related clerks
FinTech engineers	Door-to-door sales, news, and street vendors
Mechanics and machinery repairers	Electronics and telecoms installers and repairers
Organizational development specialists	Human resources specialists
Risk management specialists	Training and development specialists

Automation will not Destroy Jobs and will Enhance Productivity

A study presented two perspectives regarding the effects of automation on the business level, the first of which sees automation as largely destroying jobs, even if this may ultimately lead to the development of new jobs that take advantage of the lower equilibrium wage caused by job destruction.

A second view emphasizes the productivity effect of automation as the primary direct effect: automating firms become more productive, which enables them to lower their quality-adjusted prices and increase demand for their products; the resulting increase in market size translates into increased employment by these firms. Overall, automation is therefore not a threat to jobs. By upgrading the production process, automation makes businesses more competitive, enabling them to gain new markets and, in a globalized world, hire more workers.[48]

In addition, an OECD report held the same view and lacked support for net employment loss at the national level. Over the preceding decade, employment increased in every country, and countries that faced a greater overall automation risk in 2012 did not experience slower job growth in the ensuing years (2012 to 2019). In fact, countries where occupations faced higher automation risk back in 2012 experienced higher occupational employment growth over the years that followed.

This is consistent with a narrative in which automation contributes to positive employment growth via productivity growth: advances in labour productivity led to reduced pricing on consumer products, and lower prices boosted consumer demand, which increased employment levels (even if the amount of labour per unit has declined). Productivity growth may be observed in occupations and sectors where automating technologies are adopted, as well as in other occupations and sectors through spillover effects.[49]

Moreover, a study analysed the relationship between industrial robots and economic outcomes across much of the developed world using a panel of industries in 17 countries from 1993-2007. The study found that increased use of industrial robots is associated with increases in labour productivity, and that the contribution of increased use of robots to productivity growth is substantial, and that it comes to 0.36 percentage points, accounting for 15% of the aggregate economy-wide productivity growth using conservative estimates. The observed pattern is strong to including various controls,

48- Aghion et al. (2021). The direct and indirect effects of automation on employment: A survey of the recent Literature, p.18.

49- Georgieff, A., & Milanez, A. (2021). What happened to jobs at high risk of automation? p.9.

for country trends, and for changes in the composition of labour and in other capital inputs. They also find that robot densification is associated with increases in total factor productivity, earnings, and reductions in output prices[50]. Likewise, a McKinsey report estimated that automation could raise productivity growth globally by 0.8% to 1.4% annually.[51]

Industrial robots represented for approximately 2.3% of the capital assets in robot-using businesses in 2007, and their utilization was quite limited even in the examined developed economies. There is every reason to anticipate that robots will continue to boost labour productivity if their quality-adjusted prices continue to fall at a rate equal to that observed over the previous few decades and as new applications are found. Recently, the development of robots has been increasingly directed towards services. Medical robots, manufacturing logistic systems, and unmanned aerial vehicles, sometimes referred to as "drones" are areas that are witnessing a particularly rapid expansion.[52]

In Europe, a study similarly revealed a positive correlation between recent robot adoption and total employment across a wide range of specifications. From 1995 to 2015, their findings indicate that one additional robot is correlated with 5 (+/–2) additional workers. In relative terms, the result can be understood as one additional robot per 1000 workers being correlated with an increase of 1.3 (+/–0.2%) in total employment.[53]

In addition, another study conducted in Europe, through data from the European Manufacturing Survey across 3000 firms in six EU countries and Switzerland for the year 2012, finds neutral effect on employment and positive effect on productivity.[54]

In a recent comprehensive study that looked at what happened to jobs at risk of automation over the past decade and across 21 OECD countries. Even though they find no evidence of net overall job loss at the country level, they demonstrate that employment growth has been significantly lower in jobs at high risk of automation compared to jobs at low risk.[55]

50- Graetz, G. & Michaels, G. (2018). Robots at work. Review of Economics and Statistics, 100, 753-768.

51- McKinsey Global Institute. (2019). Driving impact at scale from automation and AI, p.7.

52- International Federation of Robotics. (2012). World Robotics Industrial Robots 2012, p.19.

53- Klenert, D., et al. (2020). Do robots really destroy jobs? Evidence from Europe, p.30.

54- Jäger, A. et al. (2016). Analysis of the Impact of robotic systems on employment in the European Union - Update.

55- Georgieff and Milanez (2021).

In the context of developing countries, studies conducted in China[56] and Indonesia[57] found that automation will have a positive impact on employment and will lead to employment growth, while studies in South Africa[58] and Chile[59] found that automation will have no impact on employment, and in Mexico[60] it will result in higher earnings.

After exploring the impact of automation on employment and concluding that automation will affect some sectors that are more susceptible to automation than others. For example, jobs that involve routine tasks or tasks that can be easily defined and codified are more likely to be automated. This includes jobs in manufacturing, data entry, and some types of customer service. Other sectors that may be affected by automation include transportation, retail, and finance. We will now analyse the effect of automation on employment in UAE.

56- Qin, X., et al. (2022). Automation, firm employment and skill upgrading: firm-level evidence from China. Industry and Innovation, 29(9), 1075-1107.

57- Calì, M., & Presidente, G. (2021). Automation and manufacturing performance in a developing country.

58- Parschau, C., & Hauge, J. (2020). Is automation stealing manufacturing jobs? Evidence from South Africa's apparel industry. Geoforum, 115, 120-131

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ANALYSIS

From the previous literature review, it is clear that automation has a mixed impact on various economic sectors and a varied impact on different countries among developed and developing. Due to its hybrid qualities between developing and developed countries, it is hard to anticipate the impact of automation on the UAE. Hence, we will start by analysing the demographics of UAE since it has a special composition, then we will shed the light on labour market distribution in UAE across different economic sectors, and we will elaborate on a number of automation scenarios varying between full and partial automation scenarios.

Demographics and Employment

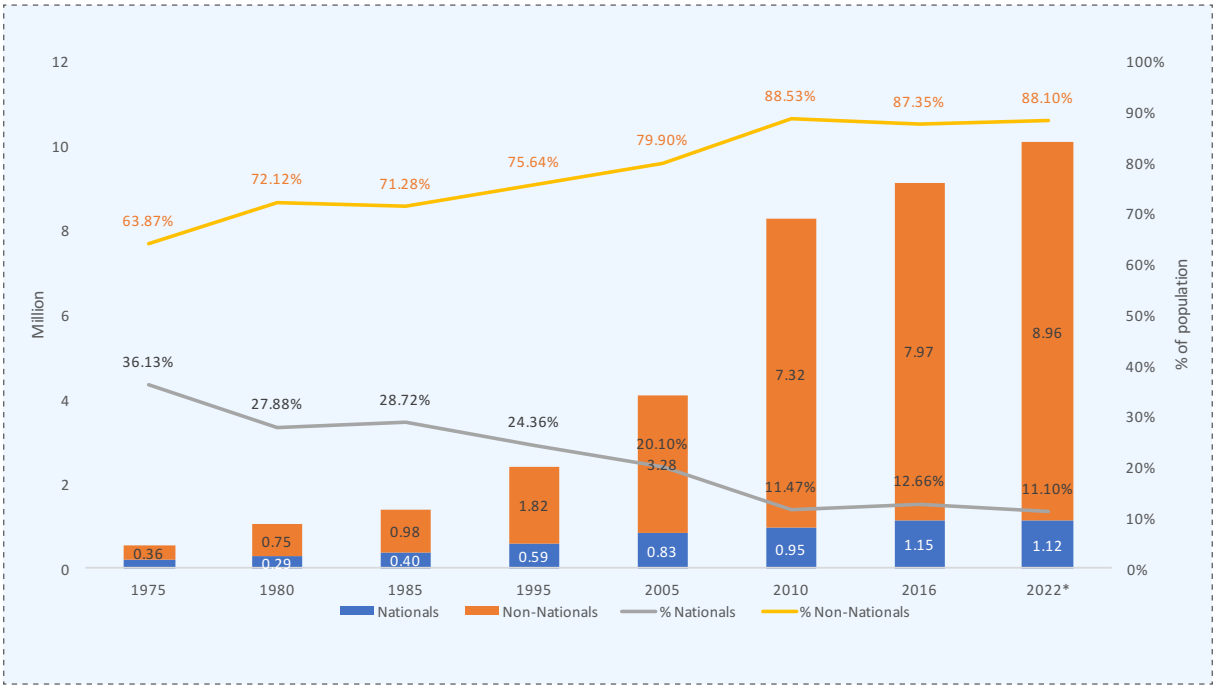
The UAE's economy relies heavily on immigrants. As a result, their cost is quite expensive, so we will examine the demographic situation in the UAE, the distribution of the labour force across economic sectors, and the influence of automation on these sectors to determine the number of jobs that automation will displace. Finally, we will

define the holistic impact of the automation displacement and replacement on some specific macroeconomic indicators, which are jobs, wages, economic sectors, changes in demographic structure, and remittances outflow.

Demographics

Immigrants account for most of the UAE's population due to their role as the economy's primary growth driver. Furthermore, the UAE's rapid economic development, over the past three decades, has accelerated their dependence to the point where their growth rates are double to those of nationals; the following figure shows the distribution of the UAE's population:

Figure 1 - UAE Nationals and Non-nationals as a Percentage of Total Population



Source: UAE Federal Competitiveness and Statistics Authority, 2022 United Nations estimates

The figure shows that from 1975 to 2022, the number of expatriates climbed from 360 thousand to around 8 million, while the number of nationals increased from 200 thousand to 1.2 million during the same period. As a result, the percentage of expatriates in 2022 exceeded 88% of the total population, according to the United Nations.

The majority of these expatriates reside with their families; in the Emirate of Dubai[61] -the largest in terms of population of about more than 30%of the total population or 3.4 million in 2020, approximately 70% are males, whether citizens or not, is married, while 71.5% of its female population is married, for a total of 70.8% of the state's population, The following table provides some notable figures:

Table 2 - Population and some Vital Statistics in Dubai

	2020	2021
Total Population	**3.4 million**	**3.5 million**
Emirati	0.3 million	0.3 million
Non-Emirati	3.1 million	3.2 million
Marital Status	**100%**	**100%**
Single	27.3%	27.2%
Married	70.7%	70.8%
Average Size of Households	**4.3 person**	**4.3 person**

Source: Dubai Statistics Centre

The table demonstrates that in 70% of the cases, Dubai needs the support of four individuals per job opening, hence increasing consumption and decreasing production rates for the population due to high dependency rates.

Employment and Economic Sectors

When it comes to the employment dissemination at the UAE national level, 68% of the workforce includes individuals between the ages of 29 and 40. More than 50% of the workforce comprises individuals with a degree less than a bachelor's degree, indicating that their profession involves physical exertion. The following table shows the percentage of distribution of the labour force by education:

61- In our analysis, we use Dubai data because there are no detailed recent data available on the UAE. Moreover, Dubai is the largest Emirate in terms of GDP and population, as it amounts to more than one-third of the country.

Table 3 - Distribution of the Labour Force by Education

Less than a Bachelor's Degree		Bachelor's Degree or Higher	
Illiterate	3.4%	Bachelor or Equivalent	33.1%
Read & write	5.9%	Higher Diploma	1.1%
Primary	9.9%	Masters or Equivalent	10.1%
Lower Secondary (Preparatory)	11.5%	Doctoral or Equivalent	1.0%
Upper Secondary (Secondary)	16.5%	Not Stated	0.3%
Post-Secondary non-Tertiary	3.3%		
Short-Cycle Tertiary Education	4.0%		
Total	**54.4%**		**45.6%**

Source: UAE Federal Competitiveness and Statistics Authority

As explored in the table, the percentage of individuals holding a degree less than a bachelor's degree is higher than the ones holding a bachelor's degree. This means that the individuals holding a degree less than a bachelor's degree which are known as the low-skilled and generally perform routine tasks that are identified as being easily automatable as they are simple and can be achieved by robots.

In terms of distribution of employees in the economic sectors, the dissemination of Dubai's labour force. The results reveal that 56% of the nationals are concentrated in public administration and defence jobs, 6.7% in financial services and insurance, and 5.8% in retail. In comparison, 27% of immigrants are concentrated in the construction sector, 16.3% in the retail industry, 9% in manufacturing, 6.4% in agriculture, and 6.4% in the services sector, which are sectors at high risk of automation.

Table 4 - Distribution of Individuals Employed for 15 years and over by Nationality and Sector

Economic Sector	Nationals	Non-Nationals
Agriculture, forestry, and fishing	0.3	0
Mining and quarrying	1	0.3
Manufacturing	2.2	9
Electricity, gas, steam, and air conditioning supply	3.9	0.3
Water supply; sewerage, waste management and remediation activities	0	0.1
Construction	0.7	27.2
Wholesale and retail trade; repair of motor vehicles and motorcycles	5.8	16.3
Transportation and storage	6.7	6.4
Accommodation and food service activities	0.6	5.4
Information and communication	1.8	2.9
Financial and insurance activities	6.5	2.9
Real estate activities	2.4	3.9
Professional, scientific, and technical activities	1.8	5.1
Administrative and support service activities	2.8	8.3
Public administration and defence; compulsory social security	56	1.6
Education	2.3	2
Human health and social work activities	4	1.5
Arts, entertainment, and recreation	1	0.9
Other service activities	0.1	0.6
Activities of households as employers	0	5.2
Activities of extraterritorial organisations and bodies	0.1	0.1

Source: Dubai Statistics Centre

We can see that each analysed economic sector mostly dominated by non-nationals has more potential to be automated as we will illustrate in the following section.

Automation and Employment

In 2017, a study by McKinsey and Oxford Economics, updated on November 14th 2022, evaluated the impact of automation in 54 countries, representing 78% of the global labour market, to determine the proportion of time spent on activities with the technological capacity to be automated by applying currently demonstrated technology. Concerning the UAE, the study found that there are 1.9 million automatable jobs, most of which are dominated by expatriates, especially in agriculture, construction, retail trade and manufacturing; the following table shows the top ten sectors affected by automation and its automation potential:

Table 5 – UAE's Top Ten Most Automatable Sectors

Economic Sector	Total Workers in the Sector (Thousands)	Percentage of Automation	Number of Replacable Workers (Thousands)	Global Automation Potential
Agriculture, forestry, and hunt	734.2	50%	368.9	50%
Construction	716.7	45%	320.6	45%
Retail trade	589.6	47%	277	54%
Manufacturing	564.4	58%	326.5	64%
Administrative and support	564.4	35.5%	96.6	41%
Educational services	185.7	29%	53.1	34%
Transportation and warehousing	180.7	58%	104	60%
Accommodation and food service	155.2	64%	99	66%
Wholesale trade	112.9	43%	49	50%
Healthcare and social assistance	94.6	35%	33	38%

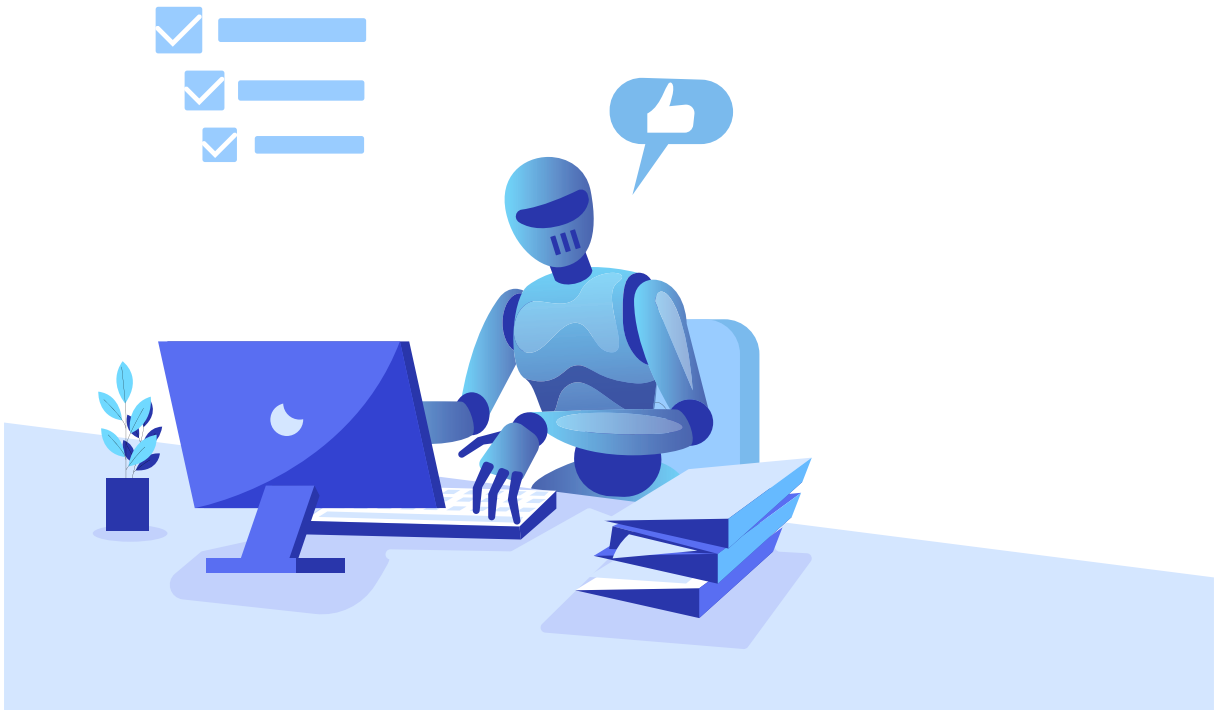
Source: McKinsey Global Institute

The table shows that the sectors dominated by migrants and dependent on physical work are at high risk of automation, especially construction, manufacturing, wholesale and retail trade, and agriculture. Hence, it is necessary to elaborate on some automation scenarios to see their impact on these different sectors.

Automation Scenarios

In order to observe the automation impact on UAE, we elaborated on four scenarios that varies between full and partial automation. Additionally, to evaluate the impact of automation on employment in the UAE, we rely on two factors: the impact on jobs and wages which will influence the remittances outflows of the UAE.

Automation and Jobs



The following table describes the four scenarios derived from was calculated by McKinsey study concerning the percentage of automation that the UAE may accomplish by 2030 in the top ten identified economic sectors, which in terms of jobs accounts for 1.7 million, which is equivalent to 90% of automatable jobs in the country.

Table 6 - Four Scenarios of Automation in UAE's Main Economic Sectors

Economic Sector	Total Jobs in the Sector (Thousands)	Full Automation Potential	Scenarios (Thousands)			
			100%	60%	40%	20%
Agriculture, forestry, and hunt	734.2	50%	368.9	221.34	147.56	73.78
Construction	716.7	45%	320.6	192.36	128.24	64.12
Retail trade	589.6	47%	277	166.2	110.8	55.4
Manufacturing	564.4	58%	326.5	195.9	130.6	65.3
Administrative and support	564.4	35.5%	96.6	57.96	38.64	19.32
Educational services	185.7	29%	53.1	31.86	21.24	10.62
Transportation and warehousing	180.7	58%	104	62.4	41.6	20.8
Accommodation and food service	155.2	64%	99	59.4	39.6	19.8
Wholesale trade	112.9	43%	49	29.4	19.6	9.8
Healthcare and social assistance	94.6	35%	33	19.8	13.2	6.6
Total	**3898.4**		**1727.7**	**1036.6**	**691.1**	**345.5**

The table shows that there are four scenarios of automation in the country as follows:

- The first scenario estimates that if the country realises its full automation potential by 2030, it will eliminate 1.7 million jobs across the ten sectors.

- The second scenario assumes that if the country reaches 60% of its automation potential by 2030, it will eradicate 1 million jobs.
- The third scenario forecasts that if the country reaches 40% of its automation potential by 2030, it will lead to the loss of 691 thousand jobs.
- The last scenario supposes that if the country reaches 20% of its automation potential by 2030, it will eliminate 345 thousand jobs.

Automation and Wages

After exploring the impact of automation adoption scenarios on jobs, the following table presents the four possibilities generated in terms of wages based on the previous automation scenarios that the UAE may achieve by 2030 in the top ten economic sectors:

Table 7 - Four Scenarios of Automation in the UAE's Main Wages and Economic Sectors

Economic Sector	Total Wages in the Sector (USD Billions)	Full Automation Potential	Scenarios (USD Billions)			
			100%	60%	40%	20%
Agriculture, forestry, and hunt	26	50%	12.2	7.3	4.9	2.4
Construction	44.3	45%	15.9	9.5	6.4	3.2
Retail trade	39.3	47%	15.4	9.2	6.2	3.1
Manufacturing	30.3	50%	13	7.8	5.2	2.6
Administrative and support	15.3	35.5%	4.7	2.8	1.9	0.9
Educational services	10.8	29%	2.8	1.7	1.1	0.6
Transportation and warehousing	11.3	58%	5.6	3.4	2.2	1.1
Accommodation and food service	4.8	64%	2.5	1.5	1	0.5
Wholesale trade	8.4	43%	2.8	1.7	1.1	0.6
Healthcare and social assistance	8.2	35%	2.5	1.5	1	0.5
Total	**198.7**		**77.4**	**46.4**	**31**	**15.5**

The table shows that there are four scenarios in the country:

- The first scenario estimates that if the country realises its full automation potential by 2030, the country will save 38% of the wages it pays, which represents USD 77.4 billion of the USD 198.7 billion that the country pays in the present time.
- The second scenario assumes that if the country reaches 60% of its automation potential by 2030, the country will save 23% of the wages, which represents USD 46.4 billion of the USD 198.7 billion that the country pays in the present time.
- The third scenario forecasts that if the country reaches 40% of its automation potential by 2030, the country will save 15.5% which represents USD 30.9 billion of the USD 198.7 billion that the country pays in the present time.
- The last scenario supposes if that the country reaches 20% of its automation potential by 2030, the country will save 7.7% which represents 15.4 billion the USD 198.7 billion that the country pays in the present time.

Impact on Population

As previously explained, the ten sectors are mostly occupied by non-citizens, so the impact is felt more by them. On the other hand, the loss of a job will prevent their recruitment in the first place, along with their families, which will be directly reflected in the demographics, which have become non-national. Citizens make up the majority, as stated above.

The impact of automation on the population can be evaluated by estimating the number of jobs lost owing to automation, then estimating the percentage of non-citizens among them, and then calculating the final population size based on the average dependency rate. Our scenarios will be built upon the following estimations:

- Percentage of eliminated jobs: 88% non-nationals, considering their percentage of the total population.
- Percentage of married non-nationals: 70%.
- The average size of the non-nationals household is three persons.

Our four scenarios will be as follows:

Table 8 – Impacts on Population

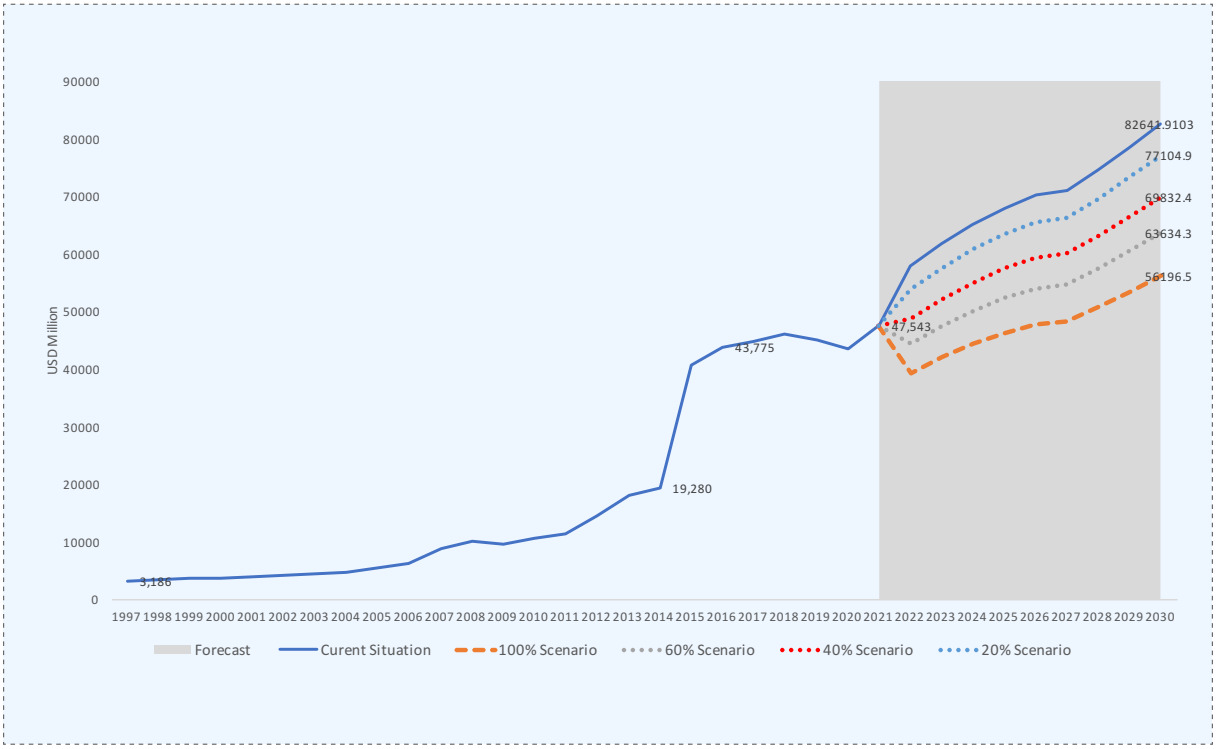
Scenario	Eliminated Jobs (A)	Non-nationals Eliminated Jobs (B=A *0.88)	Single Non-nationals (C= B*0.30)	Married Non-nationals (D= C-B)	Households of Married (E= D*3)	Total Number of Lost Population (F= E+C)
100% Automation	1727.7	1520.4	456.1	1064.3	3192.8	3648.9
60% Automation	1036.6	912.2	273.7	638.6	1915.7	2189.3
40% Automation	691.1	608.2	182.4	425.7	1277.1	1459.6
20% Automation	345.5	304.1	91.2	212.9	638.6	729.8

The table shows that in the first scenario estimates that by 2030 UAE will lose 3.6 million of its non-national population, which goes down to 729.8 in the case of only 20% automation.

Impact on Remittances

Using the two previous estimations, we can predict the impact of automation on remittances, which will drop due to the loss of both employment and wages; the graph below represents a 10-year prediction of remittances under our four scenarios.

Figure 2 - Effects of Automation of the Four Scenarios on Remittances



The graph demonstrates that remittances grew rapidly from USD 3.1 billion to USD 47.5 billion between 1997 and 2021; if nothing changes, they may reach USD 82.6 billion by 2030. However, remittances will only reach USD 56.1 billion if the full automation scenario is achieved by 2030, and USD 77.1 billion in case the 20% automation potential scenario is achieved.

RESULTS

Automation will change the nature of the workforce, as some jobs will be eliminated or replaced by machines. This will lead to a shift towards more highly skilled and technical jobs and an increased demand for workers with expertise in programming and data analysis. Hence, it will affect immigration to the UAE as follows:

- We found that the ratio of nationals to non-nationals reduced from 36:63 in 1975 to 11:88 in 2022.
- 70% of non-nationals are married, and the average of their families is 4.3 persons.
- More than 54% of the UAE workforce has a degree lower than a bachelor's degree, which indicates that their profession is at high risk of automation.
- 56% of nationals are concentrated in public administration and the defence sector, 6.7% in financial services and insurance, and 5.8% in retail.
- 27% of immigrants are concentrated in the construction sector, 16.3% in the retail industry, 9% in manufacturing, 6.4% in agriculture, and 6.4% in the services sector.
- Non-nationals are concentrated in sectors at high risk of automation. In addition, there are 1.9 million jobs at high risk of automation, most of which are dominated by non-nationals, especially in agriculture, construction, retail trade and manufacturing.
- Our four scenarios forecast that automation will eliminate around 1.7 million jobs in the full automation scenario which will cause a loss of USD 77.4 billion in terms of wages.
- In the case of the 20% automation scenario, it will likely eliminate 345 thousand jobs and USD 15.4 billion in terms of wages.
- In the case of elimination of 1.7 million jobs, the country will lose a minimum of 3.6 million of its non-national population, which goes down to approximately 730 thousand in the case of eliminating 345 thousand jobs.
- In the full automation scenario, remittances of non-nationals will increase from USD 47.5 billion in 2021 to only USD 56.1 billion by 2030, while under the 20% automation scenario it will hit USD 77.1 billion.
- In the scenario of full automation, the UAE might save up to USD 201 billion in remittances by 2030, and in the case of the 20% automation scenario, the savings might reach USD 42 billion by 2030.

RECOMMENDATIONS

After analysing the impact of automation adoption on employment in the UAE on jobs and economic sectors, we observed that the automation will mostly have a positive impact on the UAE. Therefore, we will provide some recommendations and policy interventions to help the policymakers with the automation adoption and transition:

Automation Tax

- The government can introduce an "automation tax" to help those unemployed due to automation, computerization, and robotization. This means that each time the government adopts a robot at the workplace, it needs to assess the damage it will cause to workers and calculate the tax based on that damage to compensate each worker who lost their job.
- This will be a kind of compensation in the form of a monthly salary to help those who lost their job due to the automation process. In addition, taxation of automation technology can reduce the substitution rate and provide educational institutes to keep pace in reskilling the unemployed.

An Income Redistribution System

- The government can implement a system to redistribute income through a universal adjustment benefit to support displaced workers.
- This system means that the government will invest more in policies that actively connect workers to jobs and will pay them an amount of money regularly to help them maintain a decent life and avoid poverty in case they get displaced and lose their jobs because of automation. Also, this system will help workers support themselves financially while job searching or training.

Transition through Universal Basic Income

- The government can increase the transition's dynamic efficiency. This is accomplished by various strategies, such as smoothing out frictional–technological unemployment, supporting the formation of new businesses, and assuring the inclusion of the (low-skilled) unemployed by facilitating and stimulating the upgrading of skills.

- The structural shift of the economy could be aided and facilitated by teaching the personnel being replaced in the old sectors to find work in the new sectors emerging, as opposed to limiting substitution in the sectors being automated and merely compensating those being replaced.
- To achieve this goal, policy measures must ensure that employees are upskilled (within the application sector) and obtain training for new skills (also inside new sectors) at the same rate that they are laid off due to substitution.
- Ultimately, the universal basic income may increase the dynamic efficiency of a structural transition because it enables people to pursue entrepreneurship (which contributes directly and indirectly to employment), and unleashes creativity, the benefits of which accrue not only to the tertiary sectors but also to the innovativeness of the traditional sectors, etc.

Foster Collaboration Between Humans and Machines

- Automation can be most effective when it is used in conjunction with human expertise and judgment. The government needs to foster the collaboration between humans and machines and consider how they can work together most effectively.
- Companies need to pay special attention to those workers who are most at risk of being replaced by automation by providing them with free requalification and retraining programs, they can also introduce work sharing and reduced working hours to keep some of the displaced human employees.

Better Communication with Employees

- Automation can be a source of concern for employees, and it is important to communicate clearly with them about the changes that are taking place. This should include an explanation of the rationale behind the implementation of automation, the anticipated benefits and repercussions, and any help offered to affected employees.
- Managers must keep their employees informed about strategic decisions and intentions for investment in robots, artificial intelligence, and automation technologies, and include them in the decision-making process, since employees

must be prepared for their professional future in the current organization. Employees should support the decisions about the deployment of automation; otherwise, they may sabotage its effective and efficient implementation.

- Meetings might be arranged between organisations already employing automation to share information on how to engage with employees who are at risk of being replaced. Additionally, organisations could enrich job roles with duties that are more difficult to automate and more valuable to human workers, thereby indirectly reducing employees' fear of losing their employment to automation technologies.
- They must emphasize the positive effects of automation on removing operational bottlenecks and freeing up more time for human employees to focus on revenue-generating activities.

Better Education System

- Policymakers must invest in education to train human employees to work in a robotic society where most goods and services are at high risk of automation.
- Investing in training and development programs to prepare the workforce for upcoming changes is essential. Based on the scenarios elaborated, remittances will provide around 45 to 200 billion USD; this money can be used to invest in education and training to train the employees and meet the requirements they need for the new jobs that will emerge.

Clear Automation Guidelines

- Automation can be most successful when it is integrated into established processes and protocols.
- Establish clear guidelines for the use of automation in order to ensure that it is used effectively and efficiently. In addition, there should be a monitoring and evaluation process of the impact of automation in order to identify any issues or challenges that may arise.
- This should include an evaluation of the impact on productivity, efficiency, and costs, as well as the impact on the workforce.

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APPENDIX

No	Title	Year	Author	No	Title	Year	Author
1	The Impact of Automation on Employment: Just the Usual Structural Change?	2018	Vermeulen	81	Humans Wanted: How Canadian Youth can Thrive in the Age of Disruption	2018	Royal Bank of Canada
2	Robots Worldwide: The Impact of Automation on Employment and Trade	2020	Carbonero	82	The Probability of Automation in England: 2011 and 2017	2019	White
3	Technological Change, Automation and Employment: A Short Review of Theory and Evidence	2018	Ramaswamy	83	The Future of Jobs Report 2018	2018	World Economic Forum
4	Small Cities Face Greater Impact from Automation	2018	Frank	84	Risk and Readiness: The Impact of Automation on Provincial Labour Markets	2018	Wyonch
5	Automation and Jobs: When Technology Boosts Employment.	2019	Bessen	85	What Are the Labor and Product Market Effects of Automation?	2020	Aghion
6	A Short-run View of What Computers Do: Evidence from a UK Tax Incentive	2017	Gaggl	86	Robotic Process Automation and its Impact on Accounting	2019	Jędrzejka
7	The Skill Complementarity of Broadband Internet	2015	Akerman	87	Socioeconomic Impact of Automation on Horticulture Production Firms in the Northern Gulf of Mexico Region	2008	Posadas
8	Benign Effects of Automation: New Evidence from Patent Texts	2018	Mann	88	The History of Technological Anxiety and the Future of Economic Growth: Is this Time Different?	2015	Mokyr
9	How Computer Automation Affects Occupations: Technology, Jobs, and Skills	2016	Bessen	89	Are Robots Taking our Jobs?	2017	Borland
10	Artificial Intelligence as Augmenting Automation: Implications for Employment	2021	Tschang	90	Automation and Artificial Intelligence: How Machines are Affecting People and Places	2019	Muro

11	The Impact of Robotics and Automation on Working Conditions and Employment	2018	Pham	**91**	Automation in the Public Sector: Efficiency at the Expense of Equity?	2019	Borry
12	The Future of Employment: How Susceptible are Jobs to Computerisation?	2017	Frey	**92**	At the Discretion of Rogue Agents: How Automation Improves Women's Outcomes in Unemployment Insurance	2009	Wenger
13	The Rise of the Robots: Technology and the Threat of Mass Unemployment Martin Ford	2015	Ford	**93**	Computerization and Occupational Change: Assessing the Impact of Automation on Racial and Gender Employment Densities	2022	Mason
14	Every Study we could find on what Automation will do to Jobs, in One Chart	2018	Winick	**94**	Impact of Automation on Accounting Profession and Employability: A Qualitative Assessment from Lebanon	2019	Rkein
15	Automation and the Future of Employment: Implications for India	2018	Islam	**95**	Disruption in the Apparel Industry? Automation, Employment and Reshoring	2021	Barcia
16	Automation: A Guide for Policymakers	2020	Bessen	**96**	Automation Technologies: Long-term Effects for Spanish Industrial Firms	2020	Camina
17	Testing the Employment Impact of Automation, Robots and AI: A survey and some Methodological Issues	2019	Barbieri	**97**	The Impact of Automation on Inequality Across Europe	2020	Kaltenberg
18	Automation of Employment in the Presence of Industry 4.0: The Case of Mexico	2022	Ramos	**98**	Is Automation Labor-Displacing in the Developing Countries, Too? Robots, Polarization, and Jobs	2019	Maloney

19	Harnessing Automation for a Future that Works	2017	Manyika	**99**	The Automation of Jobs: A Threat for Employment or a Source of New Entrepreneurial Opportunities?	2017	Sorgner
20	Exploring the Future Impact of Automation in Brazil	2021	Lima	**100**	Automation and Occupations: a Comparative Analysis of the Impact of Automation on Occupations in Ireland	2018	Doyle
21	The Talented Mr. Robot: The Impact of Automation on Canada's Workforce	2016	Lamb	**101**	Economic Impacts of Mechanization or Automation on Horticulture Production Firms Sales, Employment, and Workers' Earnings, Safety, and Retention	2012	Posadas
22	Automation in the Future of Public Sector Employment: The Case of Brazilian Federal Government	2021	Adamczyk	**102**	Automation and the Future of Garment Sector Jobs in India	2020	Vashisht
23	Perceptions about the Impact of Automation in the Workplace	2020	Dodel	**103**	Automation in Latin America: Are Women at Higher Risk of Losing Their Jobs?.	2022	Egana-delSol
24	The Impact of Automation on Tourism and Hospitality Jobs	2020	Ivanov	**104**	The Employment-Impact of Automation in Canada	2015	McLean
25	What is the Impact of Automation on Employment	2019	Aghion	**105**	The Impact of Automation on Employment in Manufacturing Industry: A Case of Coca Cola company in Tanzania	2020	Goodluck
26	The Impact of Automation and Artificial Intelligence on Worker Well-being	2021	Nazareno	**106**	Automation, Creativity, and the Future of Work in Europe: A Comparison Between the Old and New Member States with a Special focus on Hungary	2020	Makó

27	Managing Automation Employment, Inequality and Ethics in the Digital Age	2017	Lawrence	**107**	Automation and Manufacturing Performance in a Developing Country	2021	Calì
28	Automation and Employment: The Case of South Africa	2018	Le Roux	**108**	Is an Army of Robots Marching on Chinese Jobs?	2019	Giuntella
29	The Impact of Automation and Knowledge Workers on Employees' Outcomes: Mediating Role of Knowledge Transfer	2022	Itoe Mote	**109**	Trouble in the Making?: The Future of Manufacturing-led Development	2017	Hallward-Driemeier
30	What will the Future Bring? The Impact of Automation on Skills and (Un) employment	2019	Au-Yong-Oliveira	**110**	Service Sector Reform and Manufacturing Productivity: Evidence from Indonesia	2013	Duggan
31	Is This Time Different? A Note on Automation and Labour in the Fourth Industrial Revolution	2019	Marengo	**111**	Various Perspectives of Labor and Human Resources Challenges and Changes due to Automation and Artificial Intelligence	2019	Bayón
32	The Impact of Automation on Inequality	2018	Hong	**112**	The Vulnerability of European Regional Labour Markets to Job Automation: The Role of Agglomeration Externalities	2021	Crowley
33	Automation, Computerization and Future Employment in Singapore	2017	Fuei	**113**	Automation, Workers' Skills and Job Satisfaction	2020	Schwabe
34	Automation and Robotics in Mining: Jobs, Income and Inequality Implications	2021	Paredes	**114**	The Impact of Sustainable Transition of Automation on Employees in the Automotive Sector and the Influence of Corona Pandemic.	2020	Isac

35	Threats and Opportunities in the Digital Era: Automation Spikes and Employment Dynamics	2021	Domini	**115**	Risk and Readiness: The Impact of Automation on Provincial Labour Markets	2018	Wyonch
36	Impacts of Robotic Process Automation on Global Accounting Services	2018	Fernandez	**116**	The Rise of the Robot Reserve Army: Automation and the Future of Economic Development, Work, and Wages in Developing Countries	2018	Schlogl
37	Robots vs Humans: Collaboration or Competition?	2017	Dobson	**117**	Socially Responsible Automation: A Framework for Shaping Future	2018	Sampath
38	Planning and Scope Definition to Implement ERP	2015	de Castro	**118**	Gender, Occupational Segregation, and Automation	2019	Cortes
39	Organizational Impact of System Quality, Information Quality, and Service Quality	2010	Gorla	**119**	The Future of Employment Revisited: How Model Selection Determines Automation Forecasts	2021	Stephany
40	Robotic Process Automation at Telefonica O2	2015	Lacity	**120**	Four Fundamentals of Workplace Automation	2015	Chui
41	The Impact of Artificial Intelligence on Employment. Praise for Work in the Digital Age	2018	Petropoulos	**121**	The Impact and Opportunities of Automation in Construction	2019	Chui
42	The Skill Content of Recent Technological Change: An Empirical Exploration	2003	Autor	**122**	The Future of Work: The Impact of Automation Technologies for Employment in Northern Ireland	2019	Foster
43	Lousy and Lovely Jobs: The Rising Polarization of Work in Britain	2007	Goos	**123**	Asian Development Outlook (ADO) 2018: How Technology Affects Jobs	2018	Asian Development Bank
44	Skills, Tasks and Technologies: Implications for Employment and Earnings	2011	Acemoglu	**124**	World Development Report 2016: Digital Dividends	2016	World Bank Group
45	An Anatomy of Inclusive Growth in Europe	2016	Darvas	**125**	The Rise of Technology and Impact on Skills	2019	Ra

46	Is Automation Labor-displacing? Productivity Growth, Employment, and the Labor Share	2018	Autor	**126**	Automation, Job Characteristics and Job Insecurity	2019	Coupe
47	Is Automation Stealing Manufacturing Jobs? Evidence from South Africa's Apparel Industry	2020	Parschau	**127**	Can Pandemic-induced Job Uncertainty Stimulate Automation?	2020	Leduc
48	The Impact of Automation on Business and Employment in South Korea	2017	Choi	**128**	The Impact of Industrial Robots on EU Employment and Wages: A Local Labour Market Approach	2018	Chiacchio
49	What Key Competencies are Needed in the Digital Age? The Impact of Automation on Employees, Companies and Education	2017	Zobrist	**129**	Robots at Work: Review of Economics and Statistics	2018	Graetz
50	The Direct and Indirect Effects of Automation on Employment: A Survey of the Recent Literature	2021	Aghion	**130**	Robots and Jobs: Evidence from US Labor Markets	2020	Acemoglu
51	Skill-biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles	2002	Card	**131**	German Robots: The Impact of Industrial Robots on Workers	2017	Dauth
52	The Growth of Low-skill Service Jobs and the Polarization of the US Labor Market	2013	David	**132**	Robots and Firms	2021	Koch
53	The Trend is the Cycle: Job Polarization and Jobless Recoveries	2012	Jaimovich	**133**	The Employment Consequences of Robots: Firm-level Evidence	2020	Dixon
54	Technical Change and Automation of Routine Tasks: Evidence from Local Labour Markets in France	2017	Charnoz	**134**	What Happens to Workers at Firms that Automate	2019	Bessen

55	Who is Afraid of Machines?	2019	Blanas	**135**	Evaluating the Impact of Automation on Labour Markets in England and Wales	2018	Prashar
56	Robot Adoption and Labor Market Dynamics	2019	Humlum	**136**	Determinants of Automation Risk in the EU Labour Market: A Skills Needs Approach	2018	Pouliakas
57	Robot Imports and Firm-Level Outcomes	2020	Bonfiglioli	**137**	Occupational Mobility and Automation: A Data-driven Network Model	2021	del Rio-Chanona
58	Competing with Robots: Firm-Level Evidence from France	2020	Acemoglu	**138**	Positive Impact of Industrial Robots on Employment	2013	Gorle
59	Does Automation in Rich Countries Hurt Developing Ones?: Evidence from the US and Mexico	2019	Artuc	**139**	Predictions 2018: Automation Alters the Global Workforce	2018	Fed
60	Future Shock? The Impact of Automation on Canada's Labour Market	2017	Oschinski	**140**	The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution	2016	World Economic Forum
61	What Happened to Jobs at High Risk of Automation?	2021	Georgieff	**141**	China Overtakes USA in Robot Density	2022	The International Federation of Robotics
62	The Impact of Automation on Employment and its Social Implications: Evidence from Chile	2021	Katz	**142**	Robots will Eliminate 6% of all US jobs by 2021, Report Says	2017	Solon
63	Automation, Labor Productivity and Employment – A Cross Country Comparison	2011	Kromann	**143**	2 Billion Jobs to Disappear by 2030	2021	Frey
64	Is Technology Widening the Gender Gap? Automation and the Future of Female Employment	2019	Brussevich	**144**	Marketing: Robots, AI will Replace 7% of US Jobs by 2025.	2016	Forrester

65	Automation, COVID-19, and Labor Markets	2021	Petropoulos	**145**	Unsettling New Statistics Reveal Just How Quickly Robots Can Replace Human Workers	2017	McRae
66	The Race Between Man and Machine: Implications of Technology for Growth, Factor Shares, and Employment	2018	Acemoglu	**146**	The Future of Jobs, 2027: Working Side by Side with Robots	2017	Forrester
67	Automation Technologies and Employment at Risk: The Case of Mexico	2020	Cebreros	**147**	Jobs Lost, Jobs Gained: What the Future of Work will mean for Jobs, Skills, and Wages	2022	Manyika
68	The Impact of Digitalization and Automation on Horticultural Employees – A Systematic Literature Review and Field Study	2022	Sam	**148**	Will Robots Steal our Jobs? The Potential Impact of Automation on the UK and other Major Economies	2017	Berriman
69	Automation, Firm Employment and Skill Upgrading: Firm-level Evidence from China	2022	Qin	**149**	Labour's Share	2015	Andy
70	Automation, Unemployment, and the Role of Labor Market Training	2021	Schmidpeter	**150**	Automation and New Tasks: How Technology Displaces and Reinstates Labor	2019	Acemoglu
71	Learning Nation: Equipping Canada's Workforce with Skills for the Future	2017	Department of Finance of Canada				
72	The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis	2016	Arntz				
73	The Future of Skills: Employment in 2030	2017	Bakhshi				
74	Structural Transformation in the OECD: Digitalisation, Deindustrialization and the Future of Work	2016	Berger				

75	What is the Future of Work?	2016	Breene				
76	The Future of Work: Final Report	2018	Dharmaratne				
77	The Future of Work: A Literature Review	2018	Balliester				
78	Will Robots Really Steal our Jobs?	2018	Hawksworth				
79	Automation and a Changing Economy, Part I: The Case for Action	2019	McKay				
80	The Future of Work: Five Game Changers	2019	Policy Horizons Canada				

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