القمة العالمية للحكومات WORLD GOVERNMENT SUMMIT

In Collaboration With

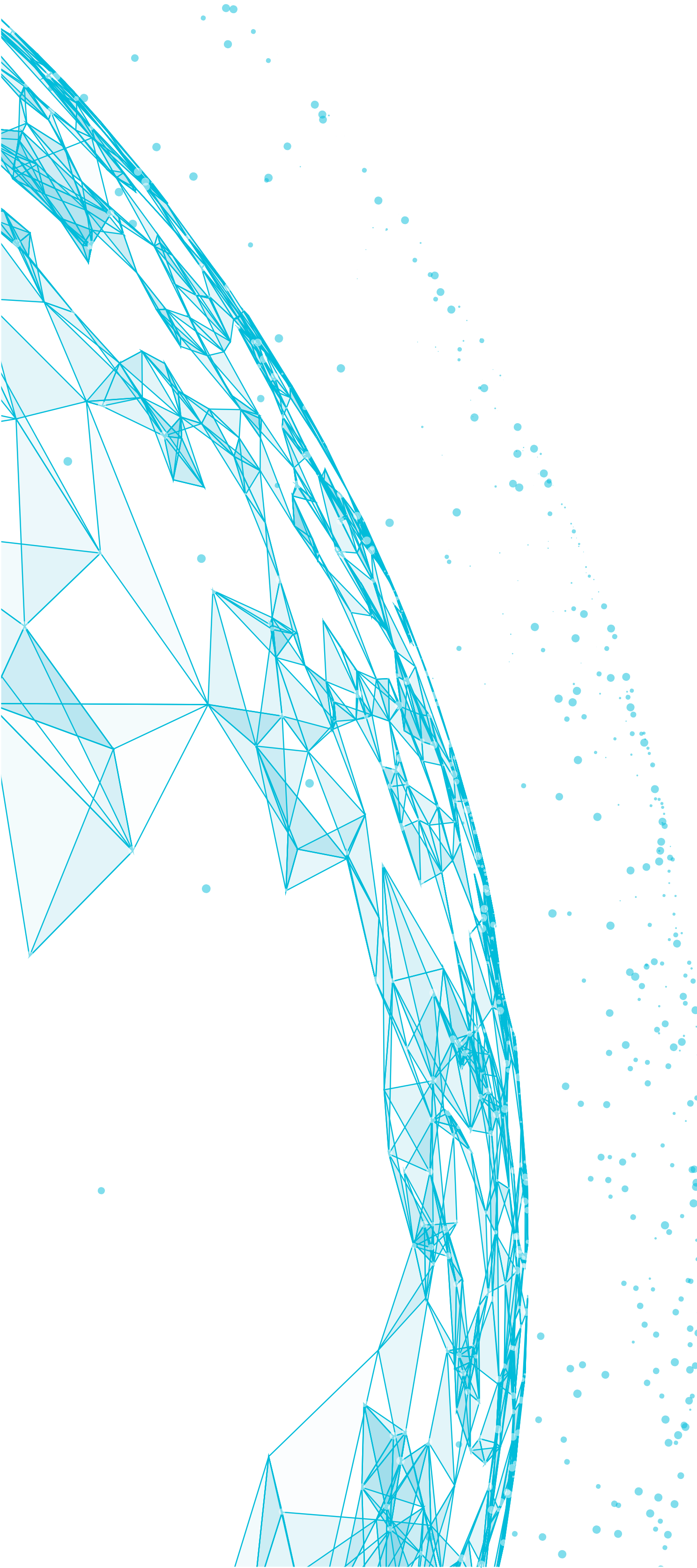
McKinsey&Company

THE FUTURE OF JOBS IN THE MIDDLE EAST

January 2018

Authors:
Jan Peter aus dem Moore
Vinay Chandran
Jorg Schubert

WORLD GOVERNMENT SUMMIT



القمة العالمية للحكومات WORLD GOVERNMENT SUMMIT

The World Government Summit is a global platform dedicated to shaping the future of government worldwide. Each year, the Summit sets the agenda for the next generation of governments with a focus on how they can harness innovation and technology to solve universal challenges facing humanity.

The World Government Summit is a knowledge exchange center at the intersection of government, futurism, technology, and innovation. It functions as a thought leadership platform and networking hub for policymakers, experts and pioneers in human development.

The Summit is a gateway to the future as it functions as the stage for analysis of future trends, concerns, and opportunities facing humanity. It is also an arena to showcase innovations, best practice, and smart solutions to inspire creativity to tackle these future challenges.

INDEX

TOPICS

1. EXECUTIVE SUMMARY

As the world enters the age of the 4th industrial revolution marked by the accelerating innovation and adoption of ever more sophisticated automation technologies, the future of work has re-emerged as a fundamental question among policy-makers, business leaders, workers, and the broader public around the globe.

Most of the existing research and reports have focused on the impact of automation in advanced, industrial countries, e.g. the OECD member states.[1] In this report, we instead focus on scenarios for the future evolution of jobs and workforce automation[2] in the Middle East by building and extending on recent and ongoing research on the "Future of Work" by the McKinsey Global Institute (MGI).[3]

Our analysis comprises six countries in the Middle East – Bahrain, Egypt, Kuwait, Oman, Saudi Arabia, and the United Arab Emirates. Together, these six focus countries represent a population of more than **147 million people** and a combined gross domestic product (GDP) of more than **1.5 trillion USD** as of 2016. Our eight key findings and insights are:

1. In the 6 Middle East countries, 45 percent of the existing work activities in the labor market are automatable today based on currently demonstrated technology. This average is slightly below the global average of 50 percent, and there is only relative small variation within the 6 countries (with Saudi Arabia and Oman having a slightly lower share of automatable current activities at 41 percent, and Egypt a higher share of 48 percent).

2. The automation potential translates into massive economic value and opportunities at stake: in all 6 Middle Eastern countries in our sample combined, $366.6 billion in wage incomes and 20.8 million FTEs are

[1] See e.g. Carl Benedikt Frey and Michael A. Osborne, "The future of employment: How susceptible are jobs to computerisation?", Oxford Martin School, September 17, 2013; ibid, "Technology at Work v2.0: The future is not what it used to be", Citibank, January 2016; World Economic Forum, "The future of jobs: Employment, skills, and workforce strategy for the fourth Industrial Revolution", January 2016; Melanie Arntz, Terry Gregory, and Ulrich Zierahn, "The risk of automation for jobs in OECD countries: A comparative analysis", OECD Social, Employment and Migration working paper number 189, OECD, May 2016; Holger Bonin, Terry Gregory, and Ulrich Zierahn, "Übertragung der Studie von Frey/Osborne: (2013) auf Deutschland", Forschungsbericht 455, Bundesministerium für Arbeit und Soziales, April 14, 2015; Jeremy Bowles, "The computerisation of European jobs", Bruegel, July 24, 2014.

[2] In line with the previous MGI research, our definition of automation includes robotics (machines that perform physical activities) and artificial intelligence (software algorithms that perform calculations and cognitive activities). Companies may adopt these technologies for reasons other than labor cost savings, such as improved quality, efficiency, or scale, although worker displacement could still be a consequence. For a glossary of automation technologies and techniques see the technical appendix of the January 2017 McKinsey Global Institute Report.

[3] James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst (2017), "Harnessing automation for a future that works", McKinsey Global Institute Report, January 2017; James Manyika, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko and Saurabh Sanghvi "Jobs Lost, Jobs Gained: Workforce Transitions in the a time of Automation", McKinsey Global Institute Report, December 2017.

associated with activities which are already technically automatable today.

3. The technical automation potential varies substantially across industries: whereas sectors intensive in routine tasks like manufacturing, transportation and warehousing, as well as the information sector exhibit technical automation potential in the region larger than 50 percent, sectors which are more dependent on human interaction, creative, and non-routine activities and services like arts, entertainment and recreation, healthcare and education display below average automation potential of 29 to 37 percent.

4. The potential threat of displacement by automation technology is most acute for current workers and employees with low to medium levels of education and experience. The average technical automation potential for the workforce with high school or some professional experience is 55 percent, whereas for staff with "less than high school" it is 50 percent. The challenge is that in the 6 countries in our sample, almost 57% of the currently employed workforce fall into these two categories. A higher education degree or equivalent levels of professional experience are still the best guarantee to secure a job in the future labor market – the average automation potential drops to ~22 percent for employees holding a bachelor or graduate degree.

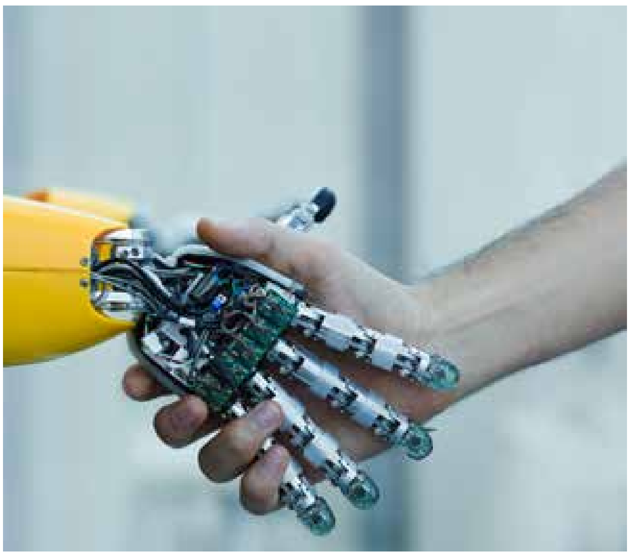
5. The proportion of work actually displaced by 2030 will likely be lower, because of technical, economic, and social factors that affect adoption. For the 6 countries in the sample, the projected adoption of technical automation based on these factors could be anywhere between 3 to 45 percent by 2030 – which for some countries like the

UAE, Bahrain, and Kuwait is higher than the projected global average of 32 percent in the earliest scenario.

6. A closer look at the potential impact for the UAE reveals that particularly in the dual labor markets of the Gulf countries, policymakers already face today a major strategic choice how to organize the future of work. In the UAE, we estimate that based on the segmentation of work activities by sector, occupation and education, more than 93 percent of the labor-saving technical automation potential applies to jobs currently held by expat workers. Local invention and the rapid adoption of automation technology especially in sectors with historically low labor productivity, or scarcity of skilled local talent, could be a major contributor to economic growth and new globally competitive future jobs. Such a new equilibrium requires an integrated governance and policy framework of targeted sector and technology investments, skill-based visa admission systems, as well as training and education programs.

7. We estimate that in the medium- to long-term, the associated labor productivity increases can also be an engine for growth and new job creation like in previous innovation cycles. Automation is estimated to add between 0.3 to 2.2 percent in compound annual productivity growth to the world economy by 2030. In addition, the balance between productivity improvement and labor substitution effects vary widely across sectors based on their automation potential. Interestingly, the gains in some sectors/ functions (e.g. oil and gas, consumer marketing) which play a major role in the young, and resource-rich economies of the Middle East far outstrip the labor substitution effects.

8. In general, workers of the future will spend more time on tasks requiring social & emotional skills and logical reasoning, and less time on tasks requiring repeated motor skills and structured information gathering and processing. Based on the historical evidence and case examples, automation technology could create net new jobs, most of them outside the technology sector itself. New types of "middle jobs" could arise with strong human-machine interaction straddling between domains.



2. WORK IN THE NEW AGE OF AUTOMATION

The world of work is at a major inflection point. As the economist Andrew McAfee predicted in 2013, "in the world that we are creating very quickly, we are going to see more and more things that look like science fiction, and fewer and fewer things that look like jobs".[4] Over the last five years, the hallmarks of this new age of automation (or the "Second Machine Age", as McAfee and his co-author and fellow economist Erik Brynjolfsson named it in their book of the same title[5]), have started to become increasingly clear.

First, the technical frontier of activities that machines can perform better than humans is expanding rapidly, and starting to affect all workplaces. A few years ago, most tasks that got automated by robots and computers were still considered simple and routine, while more complex cognitive and challenging tasks were assumed to still require human coordination and intelligence for quite some time. But in the age of artificial intelligence, humanoid robotics, quantum computing and similar advances, technology is quickly evolving to perform not only simple repetitive tasks, but increasingly can take over more complex work activities that many employees would consider attractive and interesting parts of their own job. A great example of what such 'science fiction' can look like is the breakthrough which Google's Deepmind AI team introduced with its "AlphaGo Zero" program in October 2017: while the first version that beat the reigning world champion in the complex game of Go in March 2016 still had to train on thousands of games played by human players, the new "Zero" version learnt the game entirely by playing against itself – and then went on to beat the previous version by a record of 100 games to 0.[6]

A second feature of the new age is that the pace of automation is accelerating due to the exponential nature of the underlying technologies. The "AlphaGo Zero" example also illustrates this. In many cases, the spread of one type of automation technology increases the gains from and the speed of the adoption of the next one. The futurist Ray Kurzweil identified such positive, evolutionary feedback loops as a key feature of his "law of accelerating returns". This lead him to conclude that if the pace of technological progress continues to accelerate and spirals out of control, the so-called "singularity" could be near within this century, a paradigm shift in human-machine interaction.[7] But even without necessarily

4 Andrew McAfee, "What will future jobs look like?", TED2013 at Longbeach (27 February 2013), available at: https://www.ted.com/talks/andrew_mcafee_what_will_future_jobs_look_like.

5 Erik Brynjolfsson and Andrew McAfee, The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. W. W. Norton & Company, 2014.

6 See "AlphaGo Zero: Learning from scratch" (available at: https://deepmind.com/blog/alphago-zero-learning-scratch/), and David Silver et al, "Mastering the game of Go without human knowledge", Nature 550, 354–359 (19 October 2017).

7 See Ray Kurzweil, "The Law of Accelerating Returns" (available at: http://www.kurzweilai.net/the-law-of-accelerating-returns), "The Singularity Is Near: When Humans Transcend Biology". New York: Viking, 2005.

agreeing to such a far-reaching utopian vision, the evidence on the exponential nature of technological progress is increasing.[8]

Thirdly, the resulting economic and societal disruptions and adjustment challenges are becoming more visible and prominent, leading to a new rise of "automation anxiety" that is polarizing the public debate between technology optimists vs. pessimists.[9] Recent surveys done with U.S. workers provide ambiguous results, with in some cases "26% say their jobs will be eliminated within the next 20 years due to new technology"[10], whereas others find that "some 59% [of Americans] are optimistic that coming technological and scientific changes will make life in the future better, while 30% think these changes will lead to a future in which people are worse off than they are today".[11] Many researchers and observers argue that fears of technological unemployment, the potential dehumanization of work, or other far-reaching moral implications are indeed not new and at least in the short-run likely overstated, and have also marked previous episodes of rapid technological change in the last 200 years ever since the start of the Industrial Revolution.[12] David Autor, the MIT labor economist who originated the now broadly adopted "task approach" to study the interaction between human labor and technology in modern labor markets, argues that there will always be limits to the efficient unbundling of tasks: even if technology will substitute for an increasing share, workers will keep a comparative advantage in the required complementary tasks.[13] He thus expects that "a significant stratum of middle-skill jobs combining specific vocational skills with foundational middle-skills levels of literacy, numeracy, adaptability, problem solving, and common sense will persist in coming decades".[14]

As one of the defining issues of our time, McKinsey & Company and the McKinsey Global Institute (MGI) have a longstanding interest of contributing to the debate on the future of work. In the first of two recent reports in 2017, MGI estimated that "overall, 50 percent of the activities that people are paid to do in the global economy have the potential to be automated by adapting

[8] See, e.g., Béla Nagy, J. Doyne Farmer, Quan M. Bui, and Jessika E. Trancik, "Statistical Basis for Predicting Technological Progress," PLOS ONE 8(2): e52669, 2013. In their analysis, the authors show that the well-known exponential "Wright's law" and "Moore's Law" best match the data on the evolution of cost and production of 62 technologies against many alternatives.

[9] See e.g. The Economist (2016), "Automation and anxiety – the impact on jobs", Special report, 25 June 2016.

[10] Frank Newport (2017), "One in Four Workers say Technology will eliminate their job", Gallup May 17, 2017.

[11] Pew Research Center (2014), "U.S. Views of Technology and the Future – Science in the next 50 years", April 17, 2014.

[12] See, e.g., Joel Mokyr, Chris Vickers, and Nicolas L. Ziebarth (2015), "The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?" Journal of Economic Perspectives, 29(3): 31-50; Gretchen Gavett, "Today's Automation Anxiety was Alive and Well in 1960", Harvard Business Review 08 February 2016; Irving Wladawsky-Berger, "As Automation Anxiety Grows, Remember We've Been Here Before", 1 September 2017 (available at: https://blogs.wsj.com/cio/2017/09/01/as-automation-anxiety-grows-remember-weve-been-here-before).

[13] See David H. Autor (2015), "Why Are There Still So Many Jobs? The History and Future of Workplace Automation." Journal of Economic Perspectives, 29(3): 3-30; and David H. Autor (2015), "Paradox of Abundance: Automation Anxiety Returns", in: Performance and Progress: Essays on Capitalism, Business, and Society: Oxford University Press.

[14] Ibid. Autor cautions that this prediction rests on the assumption that "human capital investment must be at the heart of any long-term strategy for producing skills that are complemented by rather than substituted for by technological change".

currently demonstrated technology".[15] In line with the discussion above, the report also highlighted that "while less than 5 percent of all occupations can be automated entirely using demonstrated technologies, about 60 percent of all occupations have at least 30 percent of constituent activities that could be automated. More occupations will change than will be automated away."[16] Building on this work, McKinsey Global Institute's latest report published in December 2017, "Jobs lost, jobs gained: Workforce transitions in a time of automation" assesses the number and types of jobs that might be created under different scenarios through 2030 and compares that to the jobs that could be lost to automation for a sample of 6 focus countries (including China, Germany, India, Japan, Mexico, and the United States). The key finding of this new research is that while there may be enough work to maintain full employment to 2030 under most scenarios in the focus countries, the transitions will be very challenging—matching or even exceeding the scale of shifts out of agriculture and manufacturing we have seen in the past.[17]

□ □ □

Our previous analyses of workforce automation for the global economy (based on 46 countries that comprise almost 90 percent of global GDP) also highlighted the wide variations both in the technical automation potential and the potential speed of adoption between countries. This insight motivates our research in this report to shed further light on how these forces will play out in the Middle East. Similar to their global peers, countries in the region vary both in their current sectoral makeup, in other words, the distribution of workers between economic sectors, as well as the occupational organization between different job titles within sectors. The divergent starting points do have immediate implications for the estimated technical automation potential in the respective economies. In addition, and maybe more importantly, many governments in the region are making ambitious and bold moves to shift the model of their countries from resource- to knowledge-driven economies, with the potential to accelerate the speed of adoption given the influence of the public sector and government policy on regional labor markets. Finally, recognizing the fact that most countries in the region still operate in a dual labor market with strong segmentation between the type of work done by local nationals versus expats raises the question how such a model will evolve and adapt to the global forces of workforce automation and technological progress.

[15] James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst (2017), „Harnessing automation for a future that works", McKinsey Global Institute Report, January 2017.

[16] Ibid.

[17] James Manyika, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko and Saurabh Sanghvi „Jobs Lost, Jobs Gained: Workforce Transitions in the a time of Automation", McKinsey Global Institute Report, December 2017.

3. SIZING THE POTENTIAL FOR WORKFORCE AUTOMATION IN THE MIDDLE EAST

In our analysis, we focus on 6 countries in the Middle East: Bahrain, Egypt, Kuwait, Oman, Saudi Arabia, and the United Arab Emirates. Together, these six countries represent a population of 147 million people, and a gross domestic product (GDP) of more than 1.5 trillion USD as of 2016.[18] Some of our previous research on the status and potential of the digital economy already highlighted the major spread that exists within these countries with respect to their starting point in adopting new technologies: based on their 2015 scores in the McKinsey Country Digitization Index, the UAE as the leading country in the sample scored 50 percentage points higher than Egypt as the least digitally advanced country in 2015. For the digitization in the business sector – which arguably is most relevant for the outlook on workforce automation, the spread was even more pronounced with the UAE reaching a more than four times higher digitization index score than Egypt.[19]

To gauge the potential for workforce automation in the Middle East, we built on our global MGI automation model which uses the state of technology in respect to 18 performance capabilities to estimate the technical automation potential of more than 2,000 work activities from more than 800 occupations, and then extended this analysis to our six Middle East focus countries (see the Technical appendix for details). It is important to note that when we discuss automation potential in this section, we refer to the technical potential for automation by adapting technologies that have already been demonstrated. As the technology becomes more advanced, that potential will also evolve. While this section focuses on the potential impact of technologies that have been developed today, we will address in a later section the question about the speed with which the technological capabilities are likely to improve and be adopted in the workplace.

[18] Worldbank Databank, World Development Indicators (2017), accessed November 2017.

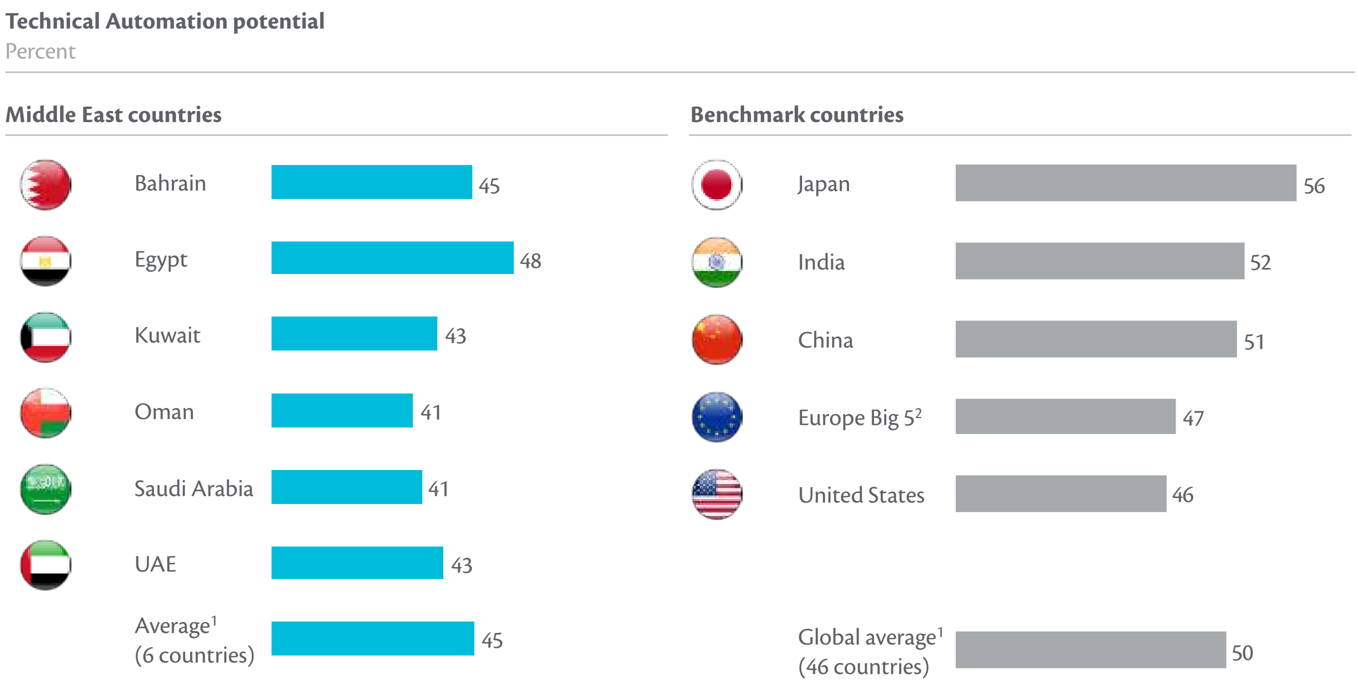
[19] See Tarek Elmasry, Enrico Benni, Jigar Patel, and Jan Peter aus dem Moore (2016), "Digital Middle East – Transforming the region into a leading digital economy", Digital McKinsey, October 2016.

The technical automation potential in the six Middle East countries is only slightly below the global average and benchmarks of advanced industries. We estimate that 45 percent of the existing work activities in the labor markets of the six Middle East focus countries are automatable today based on currently demonstrated technology. This is only slightly below the estimated global average of 50 percent (Exhibit 1). Notably, Egypt displays the highest potential share at 48 percent, whereas Saudi Arabia and Oman have a lower share of automatable current activities at 41 percent in this sample. Overall, the regional average is at similar levels as the US at 46 percent or the "Big 5" European countries (France, Germany, Italy, Spain, and the United Kingdom).

Exhibit 1

THE TECHNICAL AUTOMATION POTENTIAL IN THE MIDDLE EAST COUNTRIES IS SIMILAR TO GLOBAL AVERAGES, WITH NOTABLE VARIATIONS BETWEEN COUNTRIES

Potential impact due to automation based on adoption of currently demonstrated technology



1 weighted average based on FTE employment in 2016
2 France, Germany, Italy, Spain, and the United Kingdom
NOTE: Numbers may not sum due to rounding

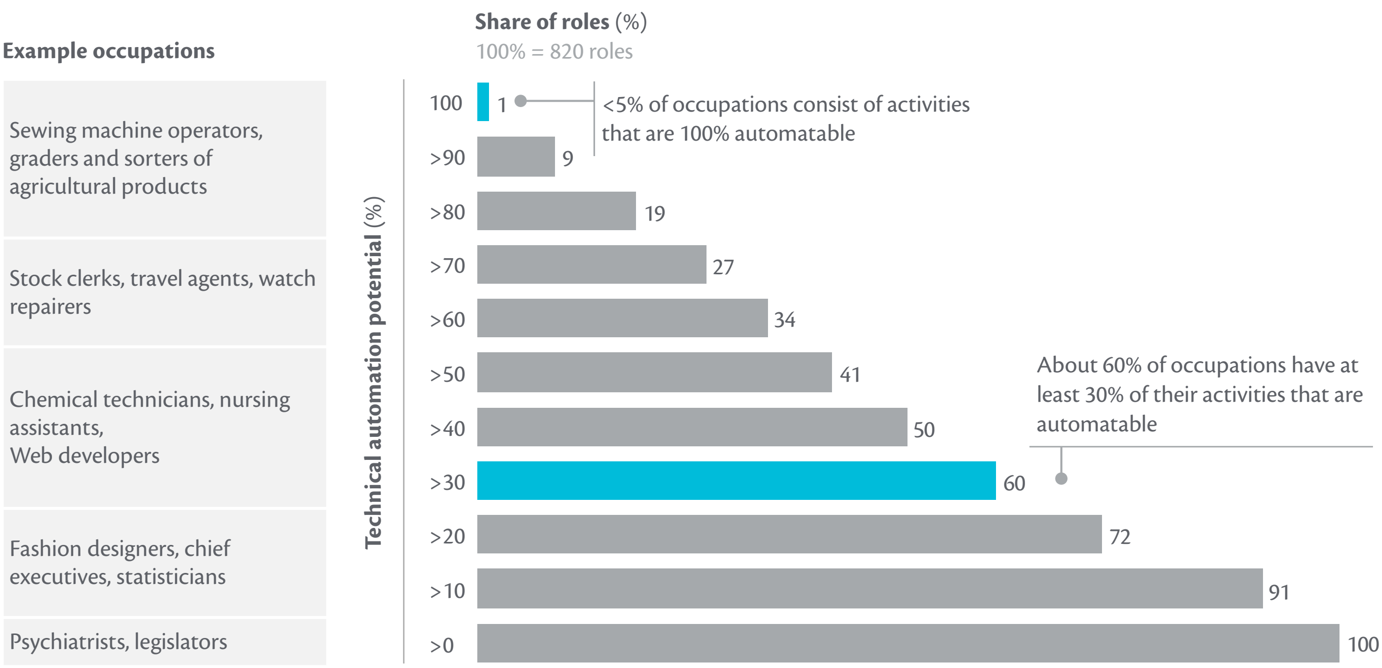
SOURCE: Oxford Economic Forecasts; Emsi database; US Bureau of Labor Statistics; McKinsey Global Institute analysis

Only a small percentage of occupations can be fully automated by adapting current technologies, but some work activities of almost all occupations could be automated. The similarity of the global and regional results reflect that our model predicts that less than 5 percent of occupations can be fully automated, while about 60 percent of occupations have at least 30 percent of activities that can technically be automated (Exhibit 2). Specifically, occupations that are fully automatable include those high in routine tasks like machine operators or sorters of agricultural products, whereas occupations requiring higher shares of creative, complex and human interaction activities like fashion designers or psychiatrists, are much less susceptible even to partial automation today.

Exhibit 2

WHILE FEW OCCUPATIONS ARE FULLY AUTOMATABLE, 60 PERCENT OF ALL OCCUPATIONS HAVE AT LEAST 30 PERCENT TECHNICALLY AUTOMATABLE ACTIVITIES

Automation potential based on demonstrated technology of occupation titles in 6 Middle East countries (cumulative)[1]



1 We define automation potential according to the work activities that can be automated by adapting currently demonstrated technology.

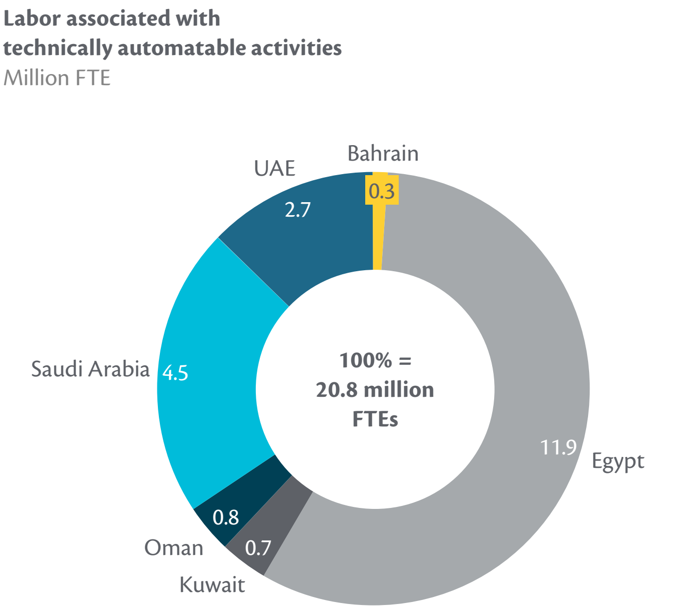
SOURCE: US Bureau of Labor Statistics; McKinsey Global Institute analysis

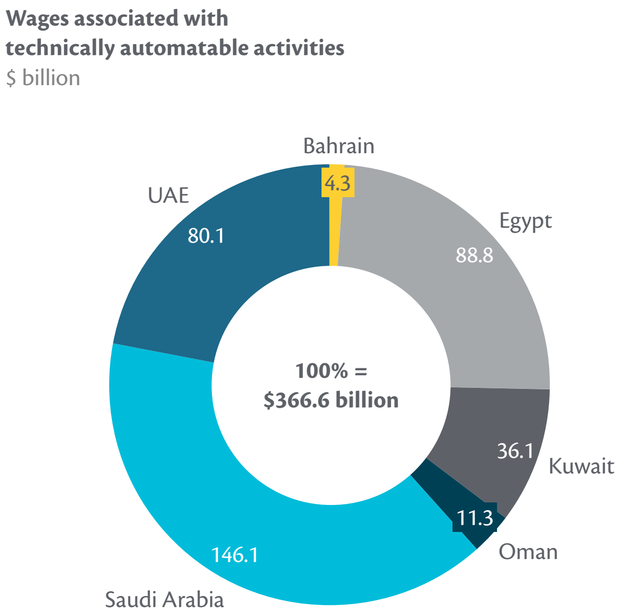
The automation potential translates into massive economic value and opportunities at stake. In all six Middle Eastern countries in our sample combined, $366.6 billion in wage incomes and 20.8 million FTEs are associated with activities which are already technically automatable today (Exhibit 3). The relative labor force size and current wage levels are the major factors how this economic value is distributed among the countries: while Egypt with almost 12 million FTEs currently employed in automatable work activities tops the list in terms of the labor share, the economic value at stake is highest for Saudi Arabia in the region, reflecting its higher average wage structure.

Exhibit 3

IN THE MIDDLE EAST, 20.8 MILLION FTES AND $366.6 BILLION IN WAGES ARE ASSOCIATED WITH ACTIVITIES WHICH ARE ALREADY AUTOMATABLE TODAY

Potential impact due to automation, adapting currently demonstrated technology (6 countries)





NOTE: Numbers may not sum due to rounding.

SOURCE: Oxford Economic Forecasts; Emsi database; US Bureau of Labor Statistics; McKinsey Global Institute analysis

4. MORE OR LESS POLARIZING? VARIATIONS BY INDUSTRY AND TYPE OF EMPLOYMENT

The variations in technical automation potential between the countries in our sample might seem surprisingly small considering their different starting points in terms of sectoral and occupational make-up. Indeed, our focus on the technical potential thus far also acts as an "equalizer", as it rests on the assumption in the model that all countries have the same access to the currently available automation technology. This might be more realistic than it sounds, keeping in mind that many technologies are increasingly digital rather than physical, and at least some evidence that the speed of diffusion and adoption of new technology in the globalized economy has increased and become more pervasive.[20] Before we discuss this restriction further in the next section, we first explore the variation in technical automation potential within countries from the perspective of sectors and job types.

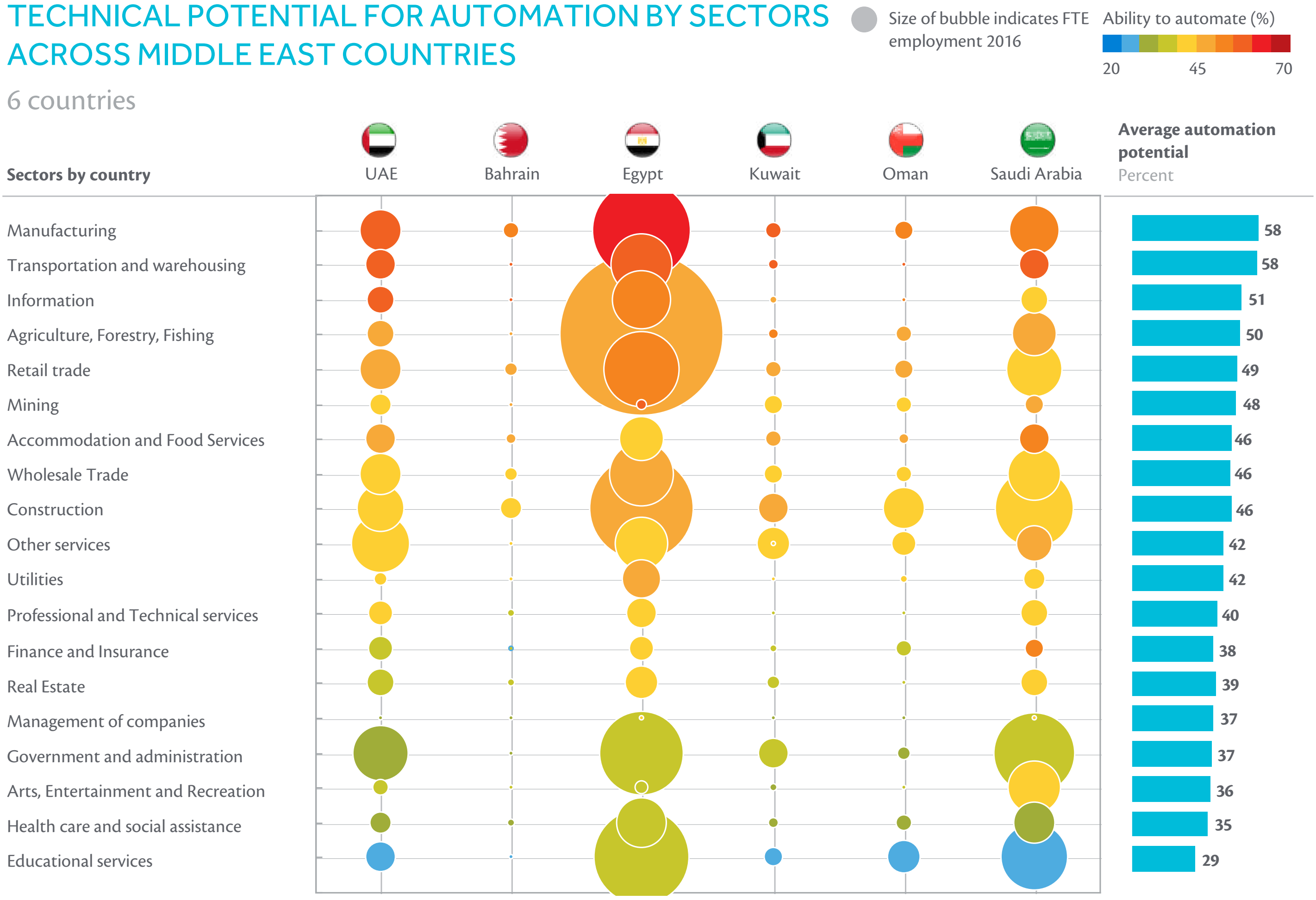
The degree of automation potential varies substantially across industries, raising doubts about the future proof-ness of some sector job creation plans. Sectors intensive in routine tasks like manufacturing, transportation and warehousing, as well as the information sector exhibit technical automation potential in the region larger than 50 percent, while sectors which are more dependent on human interaction, creative, and non-routine activities and services like arts, entertainment and recreation, healthcare and education display below average automation potential of 29 to 37 percent (Exhibit 4). This variation helps illustrate the fact that a much higher share of the automation potential in the region is concentrated in Egypt compared to some of the Gulf economies, driven by its larger absolute and relative workforce footprint for example in manufacturing, or agriculture. A second look at this sectorial breakdown highlights why the current evolution of automation technology can be perceived as a threat to previous and ongoing efforts in the region to create future employment opportunities in sectors that historically have been engines of relatively stable and well-paid jobs: sectors like manufacturing, logistics, information, and retail trade all display above average automation potential around 50 percent or above. This at least raises some questions how "future proof" supposed opportunities for net new job creation in some of the regional development plans are, especially if they are informed only by benchmarks driven by the evolution of other countries in the past, or extrapolations of historical growth rates.

[20] See, e.g. OECD (2008), "Global Economic Prospects – Technology Diffusion in the Developing World", The World Bank; Washington DC. For example, the speed of mobile phones adoption across the globe seems to have benefitted both from increasing foreign direct investment and increased migration of skilled workers. See Thomas Lebesmuehlbacher (2016), "Globalization and Technology Diffusion: The Case of Mobile Phones", available at: http://dx.doi.org/10.2139/ssrn.2756005 However, our own recent MGI research concludes that while diffusion is faster than it was for technologies introduced in the early 20th century, there is no evidence that technological adoption has accelerated over the last 60 years, when measured in percentages (McKinsey Global Institute, December 2017).

Exhibit 4

TECHNICAL POTENTIAL FOR AUTOMATION BY SECTORS ACROSS MIDDLE EAST COUNTRIES

6 countries



SOURCE: US Bureau of Labor Statistics; McKinsey Global Institute analysis

The notion that many sectors are becoming quickly less labor-intensive is often described as "premature deindustrialization". Specifically, the economist Dani Rodrik recently has shown for manufacturing that even many low-wage emerging economies might have already experienced peak employment in the sector, and now see its absolute and relative employment contribution already decline.[21]

Currently demonstrated automation technology mostly affects work activities performed by employees with low to medium levels of education and experience. As the flip-side of the sectoral breakdown, the distribution of the technical automation potential by education and experience levels is even more dispersed. For the workforce with high school or some professional experience,

[21] Dani Rodrik (2016), "Premature deindustrialization," Journal of Economic Growth, volume 21, number 1, 2016.

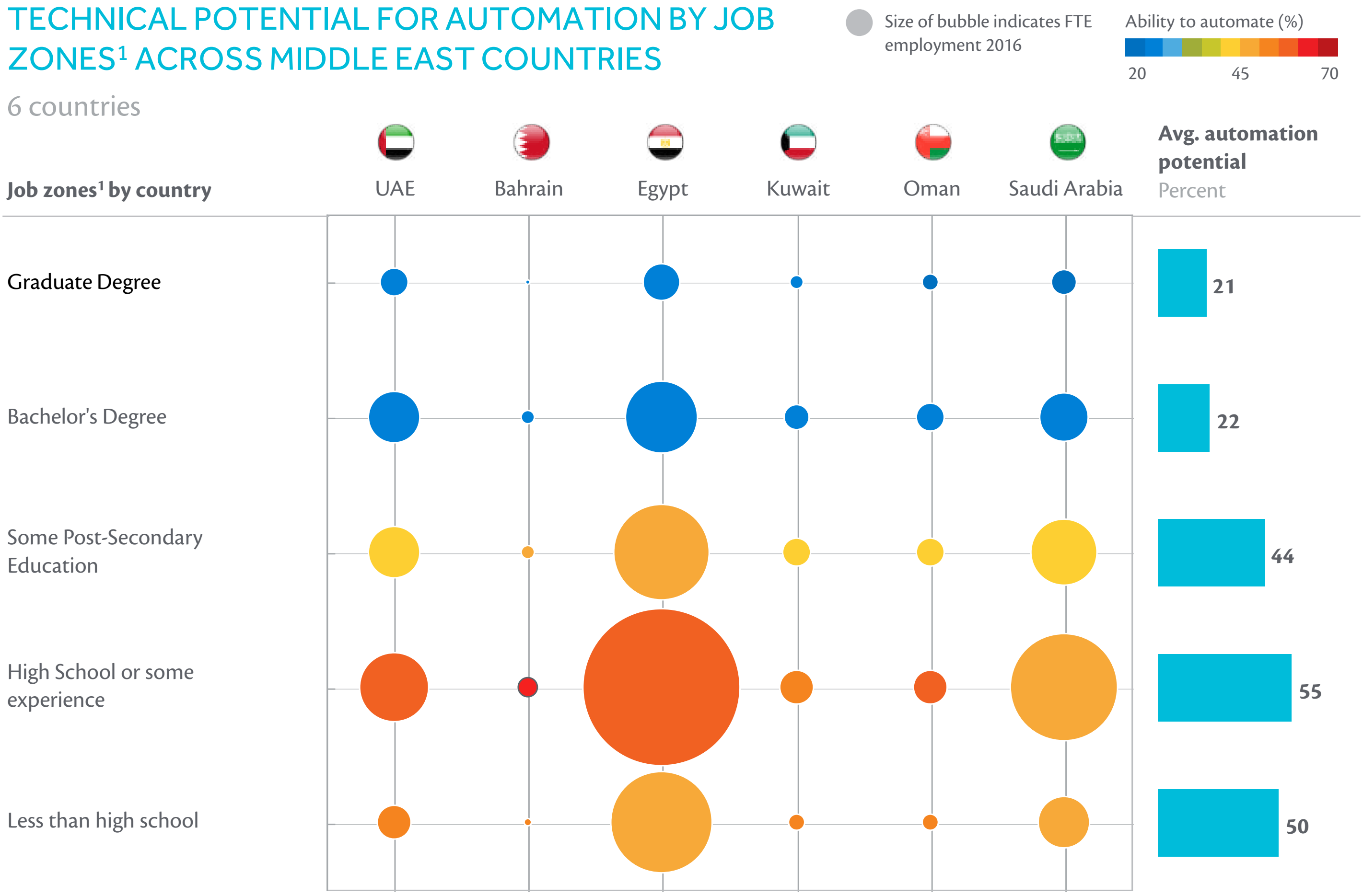
it is 55 percent, whereas for staff with "less than high school" it is 50 percent (Exhibit 5). In the 6 countries in our sample, almost 57% of the currently employed workforce fall into these two categories. A higher education degree or equivalent levels of professional experience still seem like the best guarantee to secure employment in the future labor market – the average automation potential drops to ~22 percent for employees holding a bachelor or graduate degree. This evidence reflects some skill bias of the technical change, which means that on average, occupations with higher wages and skill requirements have lower automation potential.[22]

The question whether this skill bias in favor of high-skilled employees will continue to persist, accelerate, or potentially even reverse with the next set of emerging technologies over the coming decades is an open debate among economists. For example,

Exhibit 5

TECHNICAL POTENTIAL FOR AUTOMATION BY JOB ZONES¹ ACROSS MIDDLE EAST COUNTRIES

6 countries



1 Job zones are based primarily on education required, adjusted for experience required
SOURCE: US Bureau of Labor Statistics; McKinsey Global Institute analysis

[22] See David H. Autor, Frank Levy, and Richard J. Murnane, "The skill content of recent technological change: An empirical explanation," Quarterly Journal of Economics, November 2003, and Daron Acemoglu and David H. Autor, "Skills, tasks, and technologies: Implications for employment and earnings," in Handbook of Labor Economics, volume 4B, David Card and Orley Ashenfelter, eds., Elsevier, 2011.

Erik Brynjolfsson and Andrew McAfee argue that in the "Second Machine Age" the trends towards technologies that favor high-skilled employees and a more unequal "superstar economy" will continue unabated.

On the other hand, their fellow MIT economist Daron Acemoglu has also produced theoretical and empirical evidence that the skill bias and resulting employment and wage equality under certain conditions could stabilize or even reverse. His approach assumes that the future direction of research towards automation and the creation of new tasks is endogenous and dynamic, or in other words, responding to the economic incentives created by automation itself over time.[23] In a novel paper, he also highlights other economic constraints that could negatively affect the transformation and productive use of automation, e.g. a mismatch between the skill requirements of new technologies, and the possibility that new automation technology is being introduced at an excessive rate.[24]

[23] See Daron Acemoglu and Pascual Restrepo (2016), "The Race Between Machine and Man: Implications of Technology for Growth, Factor Shares and Employment", NBER Working Paper No. 22252;

[24] Daron Acemoglu and Pascual Restrepo (2018), "Artificial Intelligence, Automation and Work", MIT Economics Working Paper 14641.

5. MORE THAN TECHNOLOGY - DRIVERS OF ADOPTION OF WORKFORCE AUTOMATION

Technological change including the invention and spread of automation in the form of artificial intelligence, neural networks and new forms of robotics and automated products and services is not a static force, but rather an evolutionary process that is never finished. In this section, we hence open the aperture of our framework to discuss the pace and extent of automation of work activities in the future. Building on the MGI research for the global economy, we also present potential scenarios illustrating how the automation of existing work activities could evolve in our six Middle East focus countries.

Our MGI model is based on 5 broad factors that shape the future automation scenarios. They include technical feasibility, the cost of developing and deploying solutions, labor market dynamics, economic benefits, and social and regulatory acceptance. For the ease of understanding, we briefly discuss and summarize these concepts here[25]:

- **Technical feasibility** comprises both the availability of suitable technologies building on basic scientific research, as well as the required level of performance and maturity to be embedded in work processes beyond a pure lab environment.
- **The cost of developing and deploying solutions** reflects the fact that companies do have to invest in the development and deployment of new automation solutions. Even while such costs in the age of reusable open source software, cloud services, and access to new labor pools around the world have dramatically decreased for many (software) technologies, companies still pay for the implementation and transformation compared to the status quo, and hence will run a business case to determine if such investments are worth making.
- **Labor market dynamics** affect both the potential benefits of automation in the form of the net gains from the substitution or replacement of existing workers or employment of workers with adjusted tasks. The projected adjustments of wage-sums are hence a key determinant, which in turn depend on the respective supply and demand of employees with the required skill profiles.
- **Economic benefits** are not just relevant in the form of potential labor or production cost savings, but also include benefits from increased quality and efficiency.
- **Regulatory and social acceptance** recognizes the fact that even in the case of clear technical and economic advantages, organizational change, policy choices, and

[25] For a more detailed exposition of the concepts and assumption modelling framework, please refer to Chapter 4 of the MGI report "Harnessing automation for a future that works", published in January 2017.

acceptance to stakeholders can easily uphold or delay the adoption of new technologies.

The MGI model framework synthesizes the effects of these five factors into four timing stages. It estimates when automation technologies will reach each level of performance across 18 capabilities, the time required to integrate these capabilities into solutions tailored for specific activities, when economic feasibility makes automation attractive, and the time required for adoption and deployment (Exhibit 6). We modeled scenarios incorporating these stages for each individual activity in every occupation for all sectors across 46 countries that account for about 80 percent of the world's workforce.

Each of the four stages affects the overall pace of automation reflected in the model. Technical feasibility accounts for much of the variance in our modeled scenarios, but economic feasibility is also a significant factor, especially in the earliest scenario, where the modeling suggests it could hold up adoption and deployment for eight to nine years for some activities.

Exhibit 6

FIVE FACTORS AFFECT THE PACE AND EXTENT OF AUTOMATION; WE MODEL USING FOUR STAGES

Key factor	Technical feasibility		Cost of developing and deploying	Labor market dynamics	Economic benefits	Regulatory and social acceptance
Impact on pace and extent of automation	For an activity to be automated, every capability utilized for that activity must reach the required level of performance	Capabilities need to be integrated to form solutions	Costs associated with developing as well as deploying different solutions determine the pace of reaching economic feasibility	Economic feasibility of automation will depend on comparison with cost of human labor, affected by supply and demand dynamics	In addition to labor cost savings, automation could bring more benefits to employers, including increased quality and efficiency and decreased error rate	Adoption of automation shaped by pace of organizational change, policy choices, and acceptance to stakeholders

Stage	Technical automation potential	Solution development	Economic feasibility	Adoption
How we model it	▪ Estimate the technology progression timeline for each capability through interviews and surveys with industry and academic experts	▪ Estimate solution development times for activities based on required capabilities and historical development timelines	▪ Assume adoption begins when automation cost for an activity is at parity with labor cost ▪ Compare labor wage and solution cost — Occupation- and country-specific wages and their evolution — Solution-specific costs and their reduction	▪ Model an S-shaped adoption curve based on historical technology adoption rates

NOTE: Economic benefits affect both when adoption will begin and its pace. For determining economic feasibility, we assume that decision-makers discount the uncertain benefits of initial labor cost savings by roughly the same amount as they believe the also uncertain non-labor cost-related benefits will be captured.

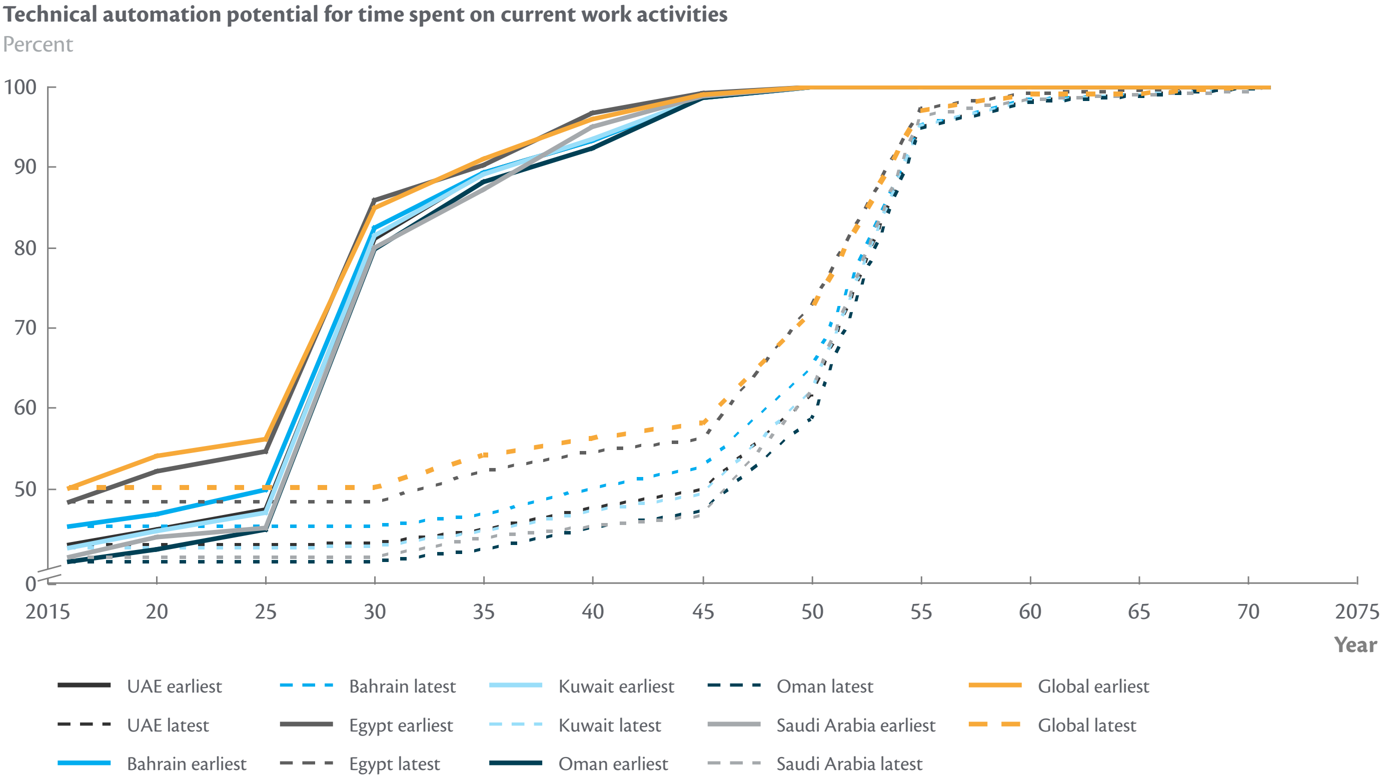
SOURCE: McKinsey Global Institute analysis

Our previous global research highlighted that automation will be a global force that affects all countries, whether they are emerging economies or advanced ones. In the earliest scenario we modeled, automation could account for more than 50 percent of working hours in two-thirds of countries within just 20 years, by 2036. In the latest scenario we modeled, more than half of all countries will have 50 percent automation or more within 50 years, by 2066. Moreover, adoption of automation could be faster initially in advanced economies than emerging ones because of wage levels and integration solution costs. On the other hand, sectors where software solutions to integrate automation technologies will be required, the pace of automation across emerging and advanced economies could be similar. In some sectors like finance, real estate, rental and leasing activities, wage distributions that are already more aligned globally could also drive more synchronous adoption patterns. Adoption could also be accelerated because of policy measures, increased competition, a lack of legacy systems that could be a brake on automation implementation, and a high degree of technological literacy.

Exhibit 7A

THE TECHNICAL AUTOMATION POTENTIAL IS LIKELY EVOLVING SIMILARLY ACROSS COUNTRIES, BUT WITH SUBSTANTIAL UNCERTAINTY BETWEEN AN EARLIEST VS. LATEST SCENARIO...

Scenarios for evolution of technical automation potential



SOURCE: McKinsey Global Institute analysis

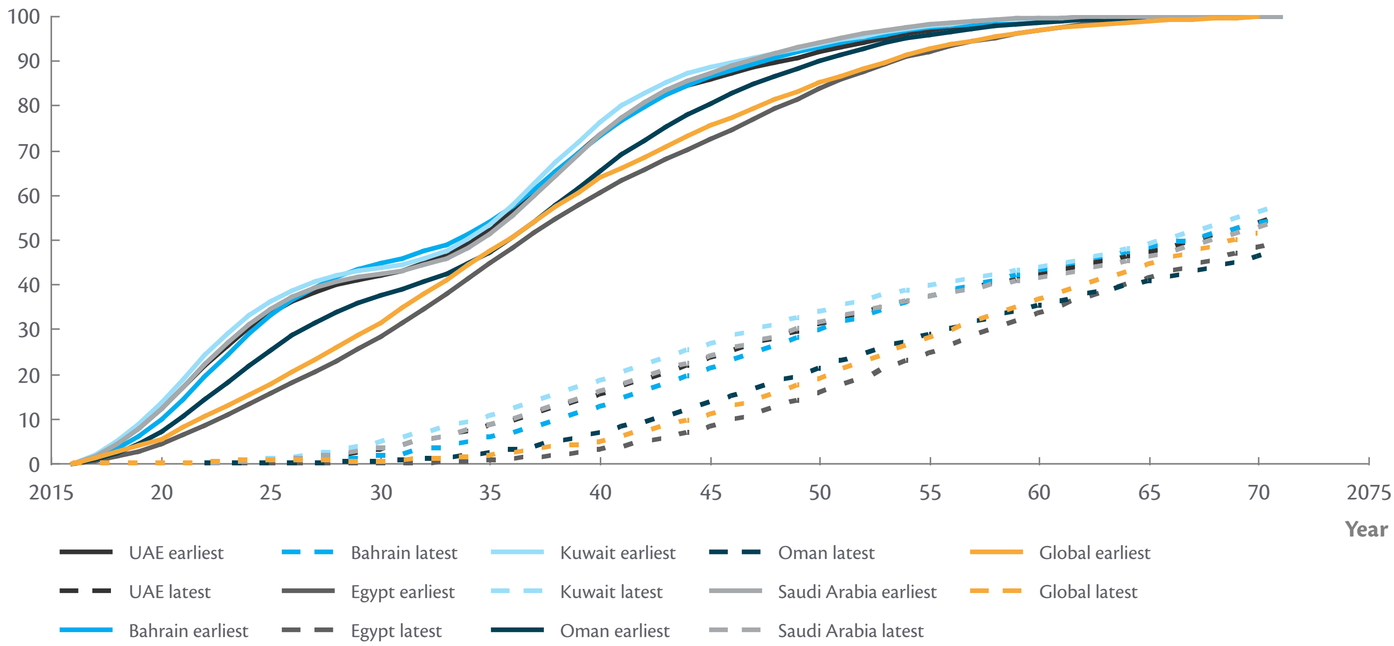
Exhibit 7B

...WHICH IS EVEN FURTHER AMPLIFIED BETWEEN THE EARLIEST VS. LATEST ADOPTION SCENARIOS FOR AUTOMATION TECHNOLOGY

Scenarios for evolution of adoption of automation potential

Adopted automation potential for time spent on current work activities

Percent



SOURCE: McKinsey Global Institute analysis

The Middle East countries could witness increases and convergence in technical automation potential of current work activities up to around 80 percent until 2030, but actual adoption is likely to be much slower. Exhibit 7A and 7B illustrate the potential model dynamics for the six Middle East countries in our sample. For all countries, the wide spread between the solid lines (representing the earliest technological feasibility/ adoption scenarios) and the dashed lines (representing the latest scenarios) highlight the significant uncertainty around the future evolution – the data should hence be interpreted with caution and more inform the rough potential directions rather than exact predictions. Interestingly, in the earliest scenarios, the technical potential and adoption across countries seem to converge more quickly, whereas in the latest scenarios the variation between countries is more sustained. And consistent with the previous results above, the technical automation potential for Egypt is starting from the highest baseline, and most rapidly increasing in the first 15 years (partially even overtaking the global average) – see Exhibit 7A. However, the projected actual adoption for Egypt is the slowest compared to the other countries in the sample (see the bottom panel in Exhibit 7B).

6. AUTOMATION IN A DUAL LABOR MARKET CONTEXT

When considering potential future pathways for workplace automation in the Middle East, it is important to take regional idiosyncrasies into account. All regional economies (albeit to varying levels) still display features of a dual labor market that is split between higher-paid jobs for locals, mainly in the public sector, and lower-paid expat workers, predominantly employed in the private sector.[26] This structure has been a major impediment in the past for the strategic efforts undertaken by many governments in the region to raise the employment of nationals in the private sector.[27]

In the dual labor markets of the Middle East, workforce automation based on currently demonstrated technology is primarily affecting expat workers. We extended our analysis from section 5 to capture the distribution between local nationals and expat employees. Due to data limitations and for the sake of simplicity, we focus in this section on the UAE. But given the similar economic structure and strong links between automation potential and the sector, occupational, and skill makeup, we expect the results to represent at least directionally also the situation and outlook for the other Gulf countries.

For the UAE, more than 60% of the automation potential is concentrated in 6 out of the 19 sectors in our sample; these include other services[28], administrative and support and government, manufacturing, construction, and retail trade as well as wholesale trade (Exhibit 8). It also highlights that 90% of the technical automation potential based on currently demonstrated technologies apply to work activities currently performed by expats. The only notable sector with a sizable technical automation potential for local nationals is unsurprisingly the government sector.

[26] The concept of "dual labor markets" was originally introduced for the US labor market in the 1970s. It characterizes a division based on institutional factors between a "primary" labor market of more stable, high-paying jobs compared to the "secondary" labor market of short-term, unstable, and often low-skilled and low-paid jobs (see Michael Reich, David M. Gordon, and Richard C. Edwards (1973), "Dual Labor Markets – A Theory of Labor Market Segmentation", American Economic Review 63:2 (May 1973), pp. 359-365). In the context of the Gulf economies, it refers more loosely to the broader segmentations between employment of local nationals vs. expat workers along the public-private sector divide, and occupational levels.

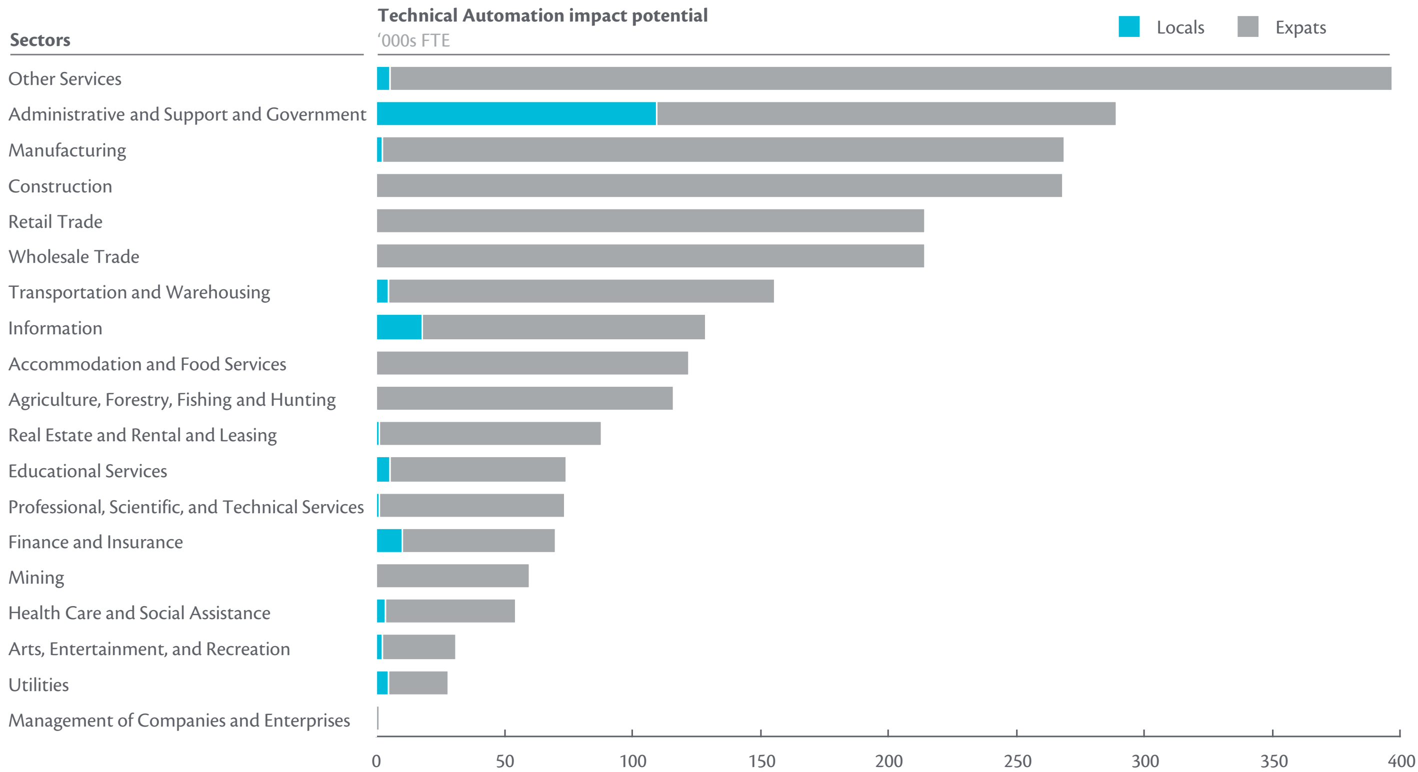
[27] For an overview, see Steffen Hertog (2012), "A comparative assessment of labor market nationalization policies in the GCC", in: Hertog, Steffen, (ed.) National employment, migration and education in the GCC. The Gulf Region: economic development and diversification, 4. Gerlach Press, Berlin, Germany; and Kasim Randeree (2012), "Workforce Nationalization in the Gulf Cooperation Council States", Georgetown University Center for International and Regional Studies.

[28] The sector classification is based on the ISIC Rev. 3 codes. "Other services" hence include sector segments S (private services not classified elsewhere, e.g. the repair of computers and personal and household goods and a variety of personal service activities), T (activities of households as employers of domestic personnel such as maids, cooks, waiters, valets, butlers, laundresses, gardeners, gatekeepers, stable-lads, chauffeurs, caretakers, governesses, babysitters, tutors, secretaries etc.), and U (activities of international organizations, activities of diplomatic and consular missions).

Exhibit 8

60% OF AUTOMATION POTENTIAL IN UAE IS CONCENTRATED IN 6 SECTORS – AND 90% OVERALL IS ASSOCIATED WITH WORK ACTIVITIES PERFORMED BY EXPATS

Potential impact due to automation, adapting currently demonstrated technology, UAE



1 Other services include NACE rev. 2 sectors 90-99 Other service activities; Activities of households as employers; activities of extraterritorial organizations and bodies
2 Classification is based on industry of employer, i.e. "Admin and Support and Government" includes e.g. IT professionals working for government organizations
3 Educational services and healthcare sector include both public and private employers
SOURCE: McKinsey Global Institute, team analysis

Automation could be the catalyst for more productive labor markets and the emergence of attractive new future jobs in key private sectors. At first sight (and in line with our previous discussion in Section 5 above), the data on the distribution of the automation potential between locals and expats might raise concerns that this could delay the adoption of new technologies, especially in the private sector: employers could simply perceive the case for automation less urgent and attractive based on the comparatively low wage levels of expat labor. We are convinced, however, that this starting point could be turned into a comparative advantage instead: the fact that there is less of a "legacy" of a workforce model that might have worked well for all stakeholders in the past, creates a window of opportunity to direct the evolution of automation technology beyond pure labor-saving technology towards the creation of more productive, and attractive future jobs.

The construction sector provides an interesting example for this. The sector is ripe for disruption, with 5 types of innovation displaying ample opportunity for boosting productivity that has not kept up with other sectors, and create economic impact and new jobs.[29] The technologies that are either already being deployed or prototyped and underpin this opportunity range from high-definition surveying and geolocation, to next generation 5D building information modelling[30], or specific use cases of the Internet of Things (IOT) and advanced analytics. In this region in particular, massive infrastructure investments and innovative government initiatives can showcase the way towards faster adoption - as with the "Office of the Future", the first fully functional, inhabited 3D printed building located in front of Emirates Towers in Dubai.[31] In fact in 2016, at least five mega infrastructure projects in Dubai have already been named among the most innovative and least wasteful in the world.[32] Similar technological advances and opportunities also apply to retail and wholesale trade, as well as logistics and transport sector that have traditionally been rich in providing jobs, but operating below their potential in terms of labor productivity.[33]

For automation to reach its full beneficial potential requires an integrated eco-system for sector policy-making and investments, coupled with an advanced skill-based visa system, and opening up of future skills and lifelong learning opportunities. Capturing the opportunities for future work in a workplace rich with automation technology and artificial intelligence requires timely, effective and efficient programs to equip workers at scale with new skills to interact with machines. In fact, the reason why automation is again sometimes perceived as a threat rather than an opportunity, might have less to do with any demonic powers of new robots and technology, but with the fear that our current education and training systems are not fit to respond to this challenge. A lack of awareness, gaps in granular data and timely signals on new skill requirements, long lead times to develop and accredit new skill development programs, as well as complex governance and collective action problems are some of the factors that hamper human efforts in winning the race with the machines. However, many countries

[29] Rajat Agarwal, Shankar Chandrasekaran, and Mukund Sridhar (2016), "Imagining construction's digital future", McKinsey & Company, June 2016.

[30] Next generation 5-D Building Information Modelling (BIM) is a five-dimensional representation of the physical and functional characteristics of any project. It considers a project's cost and schedule in addition to the standard spatial design parameters in 3-D like geometry, specifications, aesthetics, thermal, and acoustic properties.

[31] See Adam Williams (2016), "World's first 3D-printed office building completed in Dubai", New Atlas, May 25th, 2016. The article highlights that the "labor cost came in at half of what it would be for a building of similar size made using traditional methods", and the "workforce included a single staff member monitoring the printer's progress, seven people to install the building components, and 10 electricians and other specialists to handle more technical issues".

[32] Cleofe Maceda, "UAE mega projects among world's 'most innovative, least wasteful'", GulfNews, November 21, 2016.

[33] See also Section 3 of the MGI report published in January 2017 that provides 5 hypothetical case studies that suggest how automation could affect specific processes across various industry sectors and physical settings in the future: a hospital emergency department, aircraft maintenance, an oil and gas control room, a grocery store, and mortgage brokering.

are increasingly recognizing and rising to this challenge[34]: to highlight just a few examples, Canada has set-up an innovative Future skills lab approach to drive an agile and forward-looking skill development agenda.[35] In the United Kingdom, the UK Commission for Employment and Skills (UKCES) conducted a two-year long Futures program to tackle workforce development issues between 2014 and 2016, organized around five key productivity challenges, and employing innovative methods to stimulate co-creation, stakeholder engagement, collaboration, innovation, and scalability and sustainability of proposed solutions.[36] In the UAE, the government has also recently reconstituted the Education and Human Resources Council (EHRC), in order to "continue efforts to ensure the education and human resources policies are compatible with the needs of the changing labor market".[37]

□ □ □

Accelerating, scaling and replicating, and increasing regional and international cooperation and knowledge exchange between future workforce development initiatives and entities with the same agility, commitment and speed as new technology gets invented, diffused and adopted around the globe will be key to secure a future that works for everyone. In our final section, we will discuss how some of the benefits from fully realizing automation's potential could look like.

[34] For a broader overview and discussion, see also World Economic Forum (2017), "Accelerating Workforce Reskilling for the Fourth Industrial Revolution", July 2017.
[35] Advisory Council on Economic Growth (2017), "Building a highly skilled and resilient Canadian workforce through the Futureskills lab approach", February 6, 2017.
[36] UKCES (2016), "Evaluation of the UK Futures Programme: Conclusions and Guidance", Evidence Report 101, August 2016.
[37] See https://www.mofa.gov.ae/EN/MediaCenter/News/Pages/12-11-2017-UAE-Education-and-Human-Resources-Council.aspx.

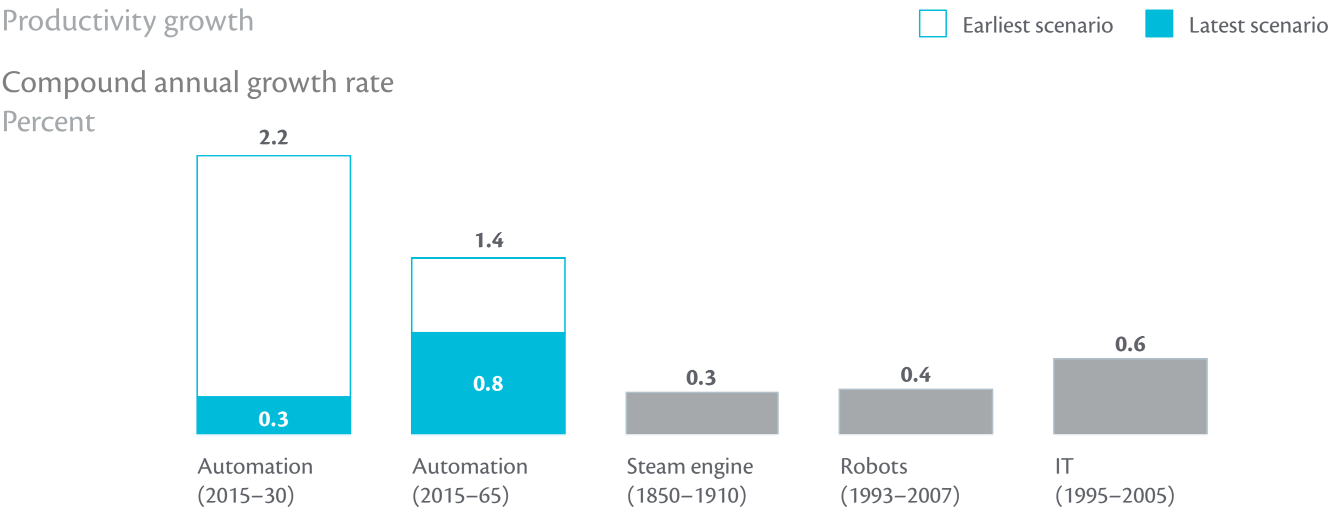
7. AUTOMATION AS AN ENGINE OF PRODUCTIVITY, ECONOMIC GROWTH AND FUTURE JOBS

The spread of automation technology is a mega-trend and game changer, and as we have highlighted throughout this report, its disruptive potential is already causing serious challenges for employers, workers, government and society around the world in the short and medium term. At the same time, it is easy to forget that based on the historical experience of previous innovation cycles, the associated labor productivity increases can also be an engine for massive economic growth and new job creation. In this final section, we hence summarize some of the evidence for this, and discuss the implications for the nature of future jobs.

Automation is estimated to add between 0.3 to 2.2 percent in compound annual productivity growth to the world economy until 2030. Our research for the global economy shows that automation technology can be an engine for productivity growth, both over the short- and medium term. Expanding the time horizon until 2065 based on the projected adoption scenarios discussed in section 5 above still equates to an average additional potential of 0.8 to 1.4 percent in compound annual productivity growth from now on (Exhibit 9).[38]

Exhibit 9

AUTOMATION OF EXISTING ACTIVITIES COULD INCREASE PRODUCTIVITY AT MAGNITUDES SIMILAR TO OTHER MAJOR TECHNOLOGIES



NOTE: We include multiple technologies in our analysis of "automation," so these technologies are not entirely comparable, but meant to provide an order of magnitude comparison.

SOURCE: Nicholas Crafts, "Steam as a general purpose technology: A growth accounting perspective," *Economic Journal*, volume 114, issue 495, April 2004; Mary O'Mahony and Marcel P. Timmer, "Output, input, and productivity measures at the industry level: The EU KLEMS database," *Economic Journal*, volume 119, issue 538, June 2009; Georg Graetz and Guy Michaels, *Robots at work*, Centre for Economic Performance discussion paper 1335, March 2015; McKinsey Global Institute analysis

[38] See the MGI report published in January 2017 for details on the growth accounting and projections. The projections rely on McKinsey & Company's proprietary Global Growth Model that provides complete time-series data for more than 150 concepts and 110 countries over 30 years. A key assumption is that human labor displaced by automation would rejoin the workforce and be as productive as it was in 2014, that is, new demand for labor will be created.

Our estimates of the potential productivity boost from automation over the next 50 years are substantial, but in line with the historical average compound productivity growth rate of 1.8 percent over the last 50 years.[39] They are however of an order of magnitude similar to other technologies in the past two centuries – like the introduction of the steam engine, or robots in manufacturing and information technology as illustrated in Exhibit 9 – and especially, when taking into account that per our definition, automation encompasses multiple base technologies with myriads of use cases across industries.

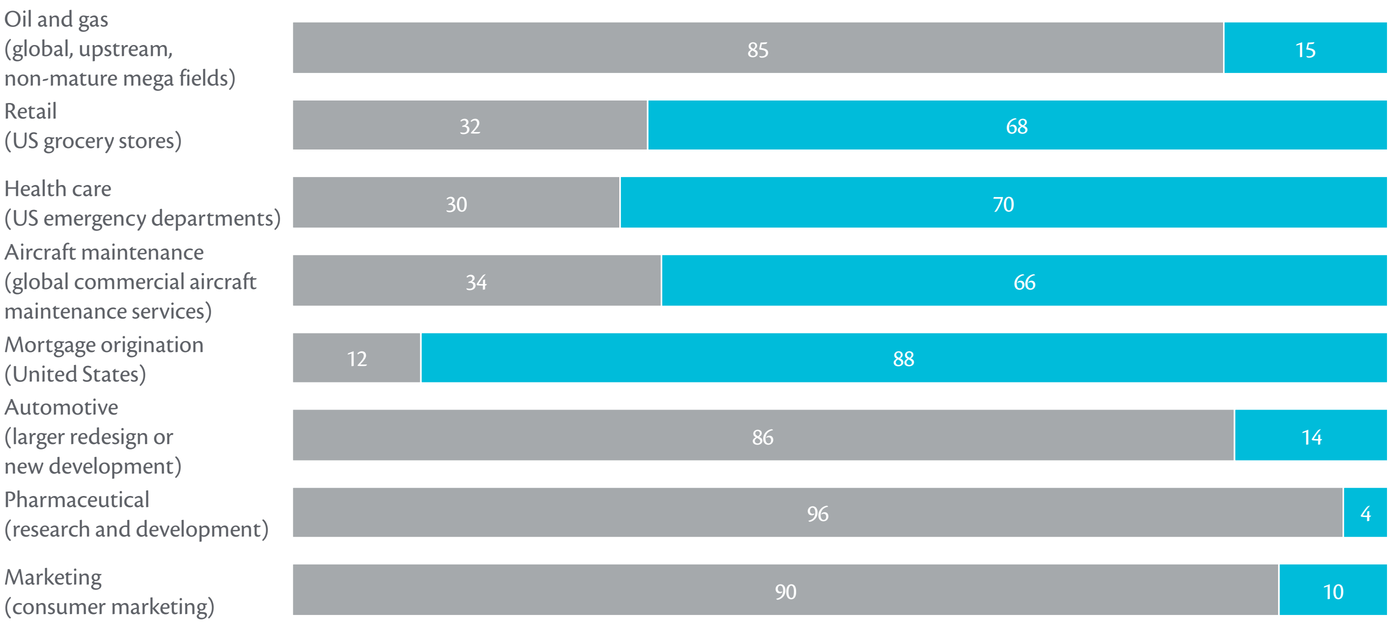
Automation will provide manifold gains in productivity beyond pure labor substitution. Based on our experience of advising on the deployment of current automation technologies and case studies across sectors, we observe and estimate that the labor substitution effect in some industries will be far outweighed by other performance gains, e.g. by reducing waste or wait/idle times in production, lowering defects and maintenance cost, improving speed to market for new products, or raising revenue per customer (Exhibit 10). Interestingly, such gains are estimated to play a major role especially

Exhibit 10

AUTOMATION IMPROVES CORPORATE PERFORMANCE IN WAYS BEYOND SIMPLE LABOR SUBSTITUTION

Relative weight of performance gains vs. labor substitution
Percent

Performance gains | Labor substitution



SOURCE: McKinsey Global Institute analysis

[39] James Manyika, Jonathan Woetzel, Richard Dobbs, Jaana Remes, Eric Labaye, and Andrew Jordan (2015), "Global growth: Can productivity save the day in an aging world?", McKinsey Global Institute, January 2015.

for some of the current sector strongholds of the demographically young and resource-rich economies in the Middle East, like in the oil & gas industry, or consumer marketing.

If the historical patterns of job destruction and provides some lessons for the future, automation technology could create net new jobs, most of them outside the technology sector itself. As part of our recent MGI research, we also conducted case studies for two technologies in the United States—personal computers and automobiles— to estimate the net impact on job growth. The net impact of both technologies was highly positive, creating new jobs that made up 10 percent of total employment over four decades.[40] The growth of computers has generated significant employment: in the United States, the estimates are that computers have enabled the net creation of 15.8 million jobs since 1970 (Exhibit 11). In addition, the analyses revealed that "only about 1 percent of net new jobs came directly from the computer manufacturing industry and only 3 percent came from supplier industries", while "over 75

Exhibit 11

TECHNOLOGY DRIVES THE CREATION OF MANY MORE JOBS THAN IT DESTROYS OVER TIME, MAINLY OUTSIDE THE INDUSTRY ITSELF

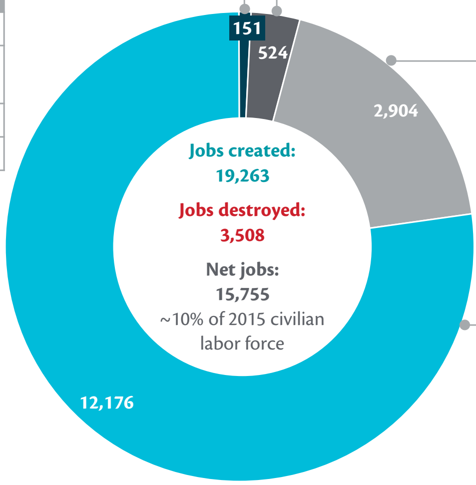
Example: Personal computers

Total US jobs created and destroyed by personal computers (examples listed are not comprehensive)

Thousand jobs

Indirect Computer suppliers, 1970–2015	
▲ Managers	42
▲ Semiconductor manufacturing occupations	31
▲ Printed circuit assembly occupations	26
▼ Typewriter indirect occupations	-79

Direct Computer equipment manufacturing, 1970–2015	
▲ Assorted managers and administrators	31
▲ Computer software developers (in-industry equipment)	27
▲ Computer scientists	18
▼ Office machine manufacturers (typewriters)	-61



Enabled Computer software and service industries, 1970–2015	
▲ Software developers (software and apps)	768
▲ Computer scientists	686
▲ Managers	416
▼ Typewriter repair	-32

Utilizers Computer-utilizing industries, 1980–2015	
▲ Customer service reps	3,205
▲ Computer scientists (not in computer industry)	1.873
▲ Stock and inventory clerks	1,517
▼ Bookkeepers and auditing clerks	-881
▼ Secretaries	-823
▼ Typists	-562

SOURCE: IPUMS; Moody's; IMPLAN; US Bureau of Labor Statistics; FRED; McKinsey Global Institute analysis

[40] James Manyika, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko and Saurabh Sanghvi "Jobs Lost, Jobs Gained: Workforce Transitions in the a time of Automation", McKinsey Global Institute Report, December 2017.

percent of net employment generated has been in occupations that use computers."[41]

The question whether a similar pattern will recur for the future of jobs in the age of automation is open to wide speculation. The increasing complexity and specialization required to make advances in automation technology might point towards strong concentration effects when it comes to the actual invention and creation of new technologies, especially in the age of digital platform economics, dominated by few global technology players with seemingly unsurmountable resources of talent and funding.

At the same time, automation technologies do rapidly continue to become more accessible to more people based on their digital nature, and the power of open source protocols, networks, public cloud infrastructure and crowdsourced funding. The fact that many major sectors still are only at the starting point of their disruption should provide ample opportunities for new "creators" and entrepreneurs around the globe, as traditional sector boundaries are blurring, too.[42]

New types of "middle jobs" could arise with strong human-machine interaction straddling between domains. The insight that in the case of personal computers, the largest employment growth happened in the category of "utilizers" might be even more informative what future jobs the age of automation will create and require. Some of our previous research highlighted that most organizations adopting new automation technology, and in particular advanced analytics and AI, are not in need of large cadres of deep subject matter experts like data scientists, but even more critically require so-called "translators", or in other words, specialists who can analyze, distill, and clearly communicate information of the greatest potential value.[43] Their specific profile is that they can bridge between different domains within an organization based on complimentary skill sets. In a similar vein, a recent global study into new categories of jobs driven by AI and businesses identified "trainers", "explainers", and "sustainers" as three new categories required at scale to unlock productivity and business growth opportunities. Notably, some of the new jobs in these categories are assumed not to require a college degree or advanced skills, upending the notion that only high-skilled jobs could survive.[44,45]

More broadly, Nobel-prize winning economist Christopher Pissarides and MGI Director Jacques Bughin summarized in a recent op-ed

[41] Ibid.

[42] Venkat Atluri, Miklos Dietz, and Nicolaus Henke (2017), "Competing in a world of sectors without borders", McKinsey Quarterly July 2017.

[43] Matt Ariker, Peter Breuer, and Tim McGuire, "How to get the most from big data", McKinsey & Company, December 2014.

[44] H. James Wilson, Paul R. Daugherty, and Nicola Morini-Bianzino (2017), "The Jobs That Artificial Intelligence Will Create", MIT Sloan Management Review, Summer 2017.

[45] This is consistent with a conjecture by David Autor that "many of the middle-skill jobs that persist in the future will combine routine technical tasks with the set of nonroutine tasks in which workers hold comparative advantage: interpersonal interaction, flexibility, adaptability, and problem solving." See Autor (2015a).

article five imperatives that policy-makers and business leaders should embrace to manage the transition into the New Age of Automation[46]:

1. **"Embrace AI and automation without hesitation"** – as attempts to slow down the speed of technological progress would likely be futile and counterproductive in a globalized competitive economy.
2. **"Equip workers with the right skills"** – including more, and more timely investments into the human skills that complement new automation technology.
3. **"Focus on augmented-labor opportunities"** – increasing opportunities for creation of new jobs from the implementation and customization of new technologies.
4. **"Innovate and capitalize on new market opportunities at the same pace that human tasks are being replaced"** – take advantage of technological disruption to build new competitive advantages in reconfigured global value chains.
5. **"Reinvest AI-driven productivity gains in as many economic sectors as possible"** – create incentives that gains are reinvested into the local and regional communities most affected by the transition in oder to boost demand for new labor.

□ □ □

The advent of the new age of automation is marked by many uncertainties. While the potential for the substitution of human labor is rapidly expanding, new opportunities arise for the creation of future jobs based on potential gains in productivity and performance across industries – both globally, and in the Middle East. More awareness and research will be required to further inform the emerging complex dynamics, especially given the large potential variation between and within countries. Government, businesses and society in the fast-developing nations of the Middle East should take special notice of the ensuing policy choices, and chart their own course quickly. The stakes are high, as the boon of workforce automation could not just lie in overcoming some of the long-standing issues of labor market segmentation, but also in unlocking new sources of innovation and growth in an economy that combines man and machines in new ways.

[46] Christopher Pissarides and Jacques Bughin (2018), "Embracing the New Age of Automation", Project Syndicate, 16 January 2018, available at: https://www.project-syndicate.org/commentary/automation-jobs-policy-imperatives-by-christopher-pissarides-and-jacques-bughin-2018-01.

8. TECHNICAL APPENDIX: ESTIMATING THE TECHNICAL AUTOMATION POTENTIAL

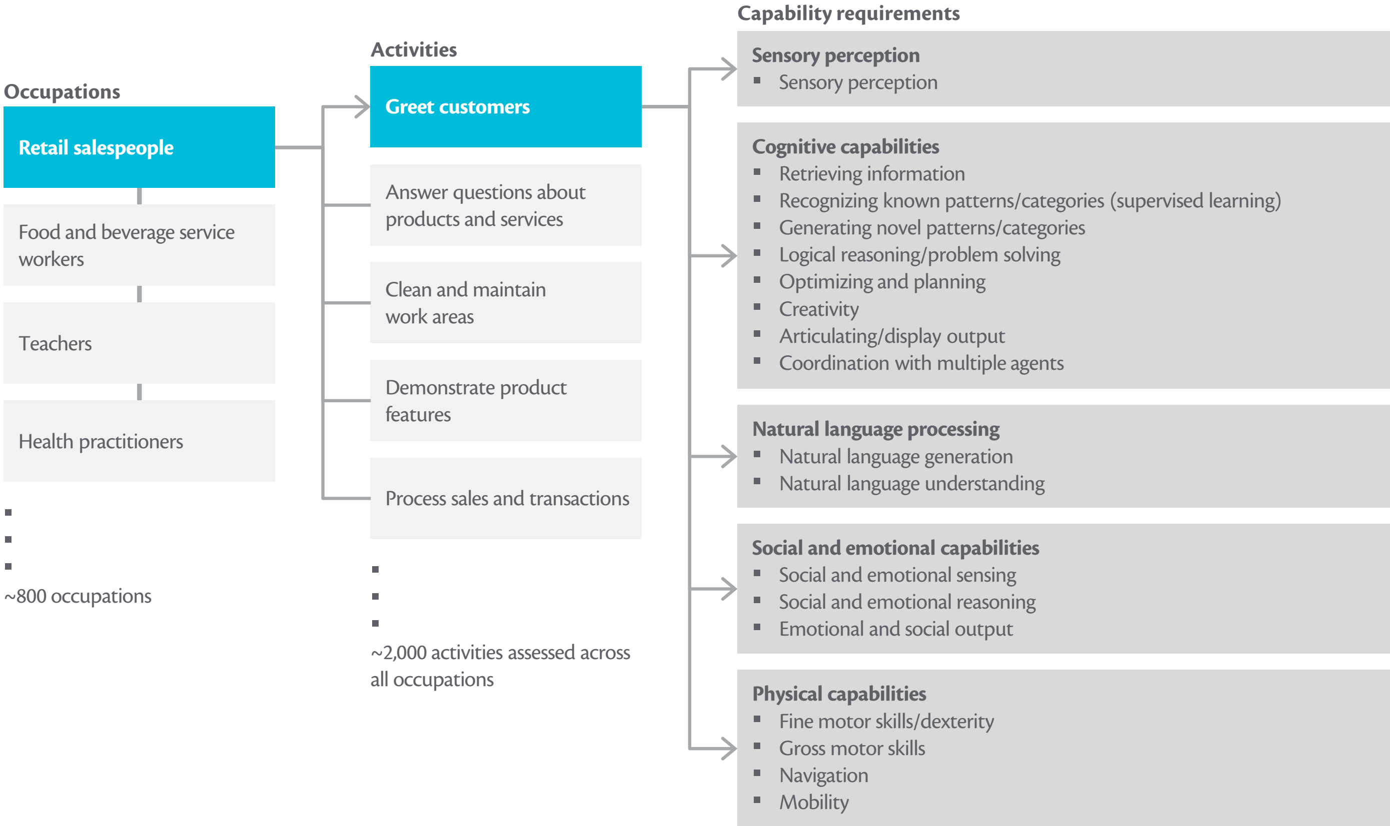
To assess the technical automation potential, we used a disaggregation of occupations into constituent activities that people are paid to do in the global workplace. Each of these activities requires some combination of 18 performance capabilities, which we list in Exhibit A1. They are in five groups: sensory perception, cognitive capabilities, natural language processing, social and emotional capabilities, and physical capabilities. We estimated the level of performance for each of these capabilities that is required to perform each work activity successfully, based on the way humans currently perform activities—that is, whether the capability is required at all, and if so, whether the required level of performance was at roughly a median human level, below median human level, or at a high human level of performance (for example, top 25th percentile). We then assessed the performance of existing technologies today based on the same criteria. This analysis enabled us to estimate the technical automation potential of more than 2,000 work activities in more than 800 occupations across the economy, based on data from the US Department of Labor. By estimating the amount of time spent on each of these work activities, we were able to estimate the automation potential of occupations in sectors across the economy, comparing them with hourly wage levels. Drawing on industry experts, we also developed scenarios for how rapidly the performance of automation technologies could improve in each of these capabilities.

The analysis we conducted for the United States provided us with a template for estimating the automation potential and creating adoption timing scenarios for 45 other economies representing about 80 percent of the global workforce, including for our six focus countries in the Middle East. For further details, please refer to the Technical Appendix of the original MGI report.[47]

[47] James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst (2017), "Harnessing automation for a future that works", McKinsey Global Institute Report, January 2017.

Exhibit A1

TO ASSESS THE TECHNICAL POTENTIAL OF AUTOMATION, WE STRUCTURE OUR ANALYSIS AROUND 2,000 DISTINCT WORK ACTIVITIES



SOURCE: McKinsey Global Institute analysis

9. BIBLIOGRAPHY

A

- Acemoglu, Daron, and David H. Autor (2011), "Skills, tasks, and technologies: Implications for employment and earnings," in Handbook of Labor Economics, volume 4B, David Card and Orley Ashenfelter, eds., Elsevier, 2011
- Acemoglu, Daron, and Pascual Restrepo (2016), "The Race Between Machine and Man: Implications of Technology for Growth, Factor Shares and Employment", NBER Working Paper No. 22252
- Acemoglu, Daron, and Pascual Restrepo (2018), "Artificial Intelligence, Automation and Work", MIT Economics Working Paper 14641
- Advisory Council on Economic Growth (2017), "Building a highly skilled and resilient Canadian workforce through the Futureskills lab approach", February 6, 2017
- Agarwal, Rajat, Shankar Chandrasekaran, and Mukund Sridhar (2016), "Imagining construction's digital future", McKinsey & Company, June 2016
- Ariker, Matt, Peter Breuer, and Tim McGuire (2014), "How to get the most from big data", McKinsey & Company, December 2014.
- Arntz, Melanie, Terry Gregory, and Ulrich Zierahn (2016), "The risk of automation for jobs in OECD countries: A comparative analysis", OECD Social, Employment and Migration working paper number 189, OECD, May 2016
- Atluri, Venkat, Miklos Dietz, and Nicolaus Henke (2017), „Competing in a world of sectors without borders", McKinsey Quarterly July 2017
- Autor, David H., Frank Levy, and Richard J. Murnane (2003), "The skill content of recent technological change: An empirical explanation," Quarterly Journal of Economics, November 2003
- Autor, David H. (2015a), "Why Are There Still So Many Jobs? The History and Future of Workplace Automation." Journal of Economic Perspectives, 29(3): 3-30
- Autor, David H. (2015b), "Paradox of Abundance: Automation Anxiety Returns", in: Performance and Progress: Essays on Capitalism, Business, and Society: Oxford University Press

B

- Bonin, Holger, Terry Gregory, and Ulrich Zierahn (2015), "Ubertragung der Studie von Frey/Osborne: (2013) auf Deutschland", Forschungsbericht 455, Bundesministerium für Arbeit und Soziales, April 14, 2015

- Bowles, Jeremy (2014), "The computerisation of European jobs", Bruegel, July 24, 2014

- Brynjolfsson, Erik, and Andrew McAfee (2014), The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. W. W. Norton & Company, 2014

E

- Elmasry, Tarek, Enrico Benni, Jigar Patel, and Jan Peter aus dem Moore (2016), "Digital Middle East – Transforming the region into a leading digital economy", Digital McKinsey, October 2016

F

- Frey, Carl Benedikt, and Michael A. Osborne (2013), "The future of employment: How susceptible are jobs to computerisation?", Oxford Martin School, September 17, 2013

- Frey, Carl Benedikt, and Michael A. Osborne (2016), "Technology at Work v2.0: The future is not what it used to be", Citibank, January 2016

G

- Gavett, Gretchen (2016), "Today's Automation Anxiety was Alive and Well in 1960", Harvard Business Review 08 February 2016

- Google Deepmind (2017), "AlphaGo Zero: Learning from scratch", available at: https://deepmind.com/blog/alphago-zero-learning-scratch/

H

- Hertog, Steffen (2012), "A comparative assessment of labor market nationalization policies in the GCC", in: Hertog, Steffen, (ed.) National employment, migration and education in the GCC. The Gulf Region: economic development and diversification, 4. Gerlach Press, Berlin, Germany

I

- IMF (2016), "Economic Diversification in Oil-Exporting Arab Countries", Presentation prepared for Annual Meeting of Arab Ministers of Finance, Bahrain, April 2016

K

- Kurzweil, Ray (2001), "The Law of Accelerating Returns", available at: http://www.kurzweilai.net/the-law-of-accelerating-returns

- Kurzweil, Ray (2005), "The Singularity Is Near: When Humans Transcend Biology". New York: Viking, 2005

L

- Lebesmuehlbacher, Thomas (2016), “Globalization and Technology Diffusion: The Case of Mobile Phones”, available at: http://dx.doi.org/10.2139/ssrn.2756005

M

- Maceda, Cleofe (2016), “UAE mega projects among world’s ‘most innovative, least wasteful’”, GulfNews, November 21, 2016
- Manyika, James, Jonathan Woetzel, Richard Dobbs, Jaana Remes, Eric Labaye, and Andrew Jordan (2015), “Global growth: Can productivity save the day in an aging world?”, McKinsey Global Institute, January 2015
- Manyika, James, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst (2017), “Harnessing automation for a future that works”, McKinsey Global Institute Report, January 2017
- Manyika, James, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko and Saurabh Sanghvi (2017), “Jobs Lost, Jobs Gained: Workforce Transitions in the a time of Automation”, McKinsey Global Institute Report, December 2017
- McAfee, Andrew (2013), “What will future jobs look like?”, TED2013 at Longbeach (27 February 2013), available at: https://www.ted.com/talks/andrew_mcafee_what_will_future_jobs_look_like
- Mokyr, Joel, Chris Vickers, and Nicolas L. Ziebarth (2015), “The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?” Journal of Economic Perspectives, 29(3): 31-50

N

- Nagy, Bela, J. Doyne Farmer, Quan M. Bui, and Jessika E. Trancik (2013), “Statistical Basis for Predicting Technological Progress,” PLOS ONE 8(2): e52669, 2013
- Newport, Frank (2017), “One in Four Workers say Technology will eliminate their job”, Gallup May 17, 2017

O

- OECD (2008), “Global Economic Prospects – Technology Diffusion in the Developing World”, The World Bank; Washington DC.

P

- Pew Research Center (2014), “U.S. Views of Technology and the Future – Science in the next 50 years”, April 17, 2014

- Pissarides, Christopher, and Jacques Bughin (2018), "Embracing the New Age of Automation", Project Syndicate, 16 January 2018, available at: https://www.project-syndicate.org/commentary/automation-jobs-policy-imperatives-by-christopher-pissarides-and-jacques-bughin-2018-01

R

- Randeree, Kasim (2012), "Workforce Nationalization in the Gulf Cooperation Council States", Georgetown University Center for International and Regional Studies
- Reich, Michael, David M. Gordon, and Richard C. Edwards (1973), "Dual Labor Markets – A Theory of Labor Market Segmentation", American Economic Review 63:2 (May 1973), pp. 359-365
- Rodrik, Dani (2016), "Premature deindustrialization," Journal of Economic Growth, volume 21, number 1, 2016

S

- Silver, David et al (2017), "Mastering the game of Go without human knowledge", Nature 550, 354–359 (19 October 2017)

T

- The Economist (2016), "Automation and anxiety – the impact on jobs", Special report, 25 June 2016

U

- UKCES (2016), "Evaluation of the UK Futures Programme: Conclusions and Guidance", Evidence Report 101, August 2016

W

- Williams, Adam (2016), "World's first 3D-printed office building completed in Dubai", New Atlas, May 25th, 2016
- Wilson, H. James, Paul R. Daugherty, and Nicola Morini-Bianzino (2017), "The Jobs That Artificial Intelligence Will Create", MIT Sloan Management Review, Summer 2017.
- Wladawsky-Berger, Irving (2017), "As Automation Anxiety Grows, Remember We've Been Here Before", 1 September 2017 (available at: https://blogs.wsj.com/cio/2017/09/01/as-automation-anxiety-grows-remember-weve-been-here-before)
- Worldbank Databank (2017), "World Development Indicators", accessed November 2017
- World Economic Forum (2016), "The future of jobs: Employment, skills, and workforce strategy for the fourth Industrial Revolution", January 2016
- World Economic Forum (2017), "Accelerating Workforce Reskilling for the Fourth Industrial Revolution", July 2017

AUTHORS

Jan Peter aus dem Moore

Associate Partner
Email: Jan_Peter_aus_dem_Moore@mckinsey.com

Vinay Chandran

Partner
Email: Vinay_Chandran@mckinsey.com

Jorg Schubert

Senior Partner
Email: Jorg_Schubert@mckinsey.com

The authors would like to thank their colleagues Gurneet Singh Dandona, Ryan Ko, and Vivian Singer for their support with the data analyses, and many helpful discussions and comments. They also are grateful to Shuaib Mohamed Moinuddin who provided expert support for the design and layout of this report.

www.worldgovernmentsummit.org