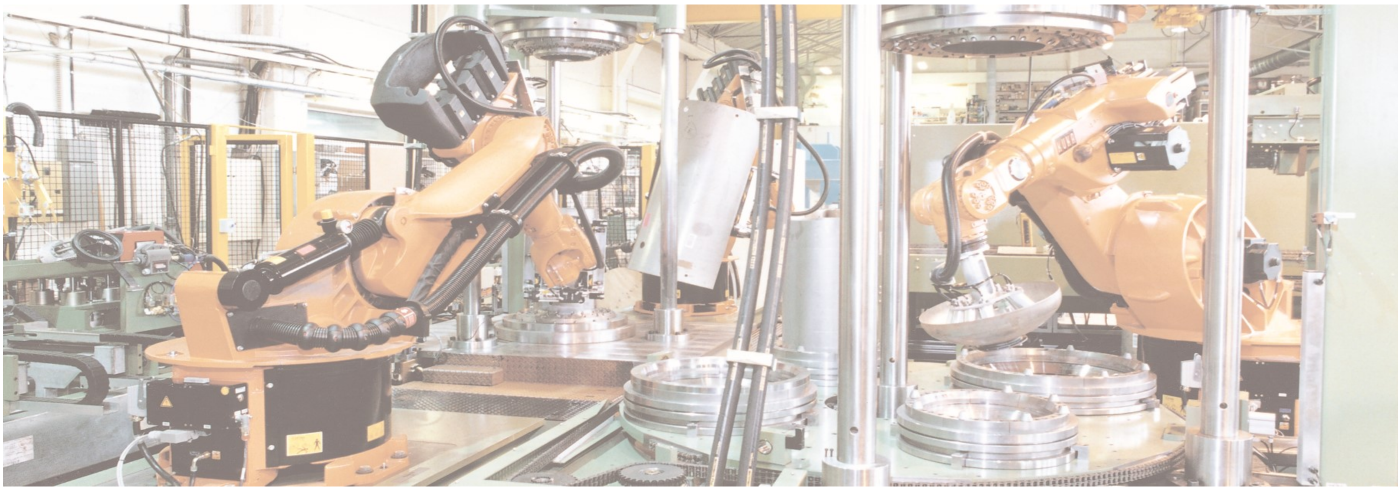

The Impact of Automation on Manufacturing

1. Summary

Some of the challenges facing business today include shortage of labour, declining unemployment rates and high staff turnover. The impact of these trends can be expected to intensify in the future with the global trend of population aging. Here we share a perspective showing how automation can address these challenges.

There is a perception that with automation and robotics come job losses. Here we consider this along with new job creation. The debate is not whether automation has a positive or negative impact on jobs; the debate is the magnitude of the impact of automation on jobs.

In a well-designed automated solution there will be benefits of productivity and yield improvements. These topics are well researched and here we provide several case-studies.

The impact of automation on health and safety on a macro level is not as well studied as its impact on jobs or productivity but in some industries the incident rates have been decreasing as automation has been increasing. Furthermore, automation allows staff to be removed from high hazard work environments.

For the benefits of automation to be realised however, the work place needs to adapt.   There is agreement among some scholars and stakeholders that a smooth adoption of more automation calls for:

- Investing in R&D and human capital such as highly skilled mechanics, engineers, and big data personnel
- Redesigning workflow and workspace to facilitate human-machine collaboration
- Actively setting and implementing digital safety standards including data security, privacy, and malicious use etc.

Published March 2019

By Scott Technology Ltd

2. Introduction

Labour shortage, high staff turnover, and work related accidents/injuries are some of the issues the manufacturing sectors face. Some regions (e.g., Europe, North America, and Japan) and industries (e.g., meat processers and fruit growers) are more affected than others. As a result, automation is being increasingly used in the production process.

This white paper summarises the results of recent research on a macro level, and provides some examples of real word applications and effects of automation. The aim is to inform on the labour force challenges we face, the benefits of automation as a solution, and the required steps companies may take to smoothly transition towards greater automation.

This paper deals with the current labour force situation and population aging estimations (Section 3), the impact of automation on jobs (Section 4), on productivity and profitability (Section 5), on yield and quality (Section 6), on workers' health and safety (Section 7) and the steps required for a frictionless transition to automation (Section 8).

3. Labour shortage, high staff turnover and population aging

An increase in population and material demand has led to a shortage of labour, with a workforce that can no longer keep up with consumption. Some regions and industries are worse affected than others.

Globally, using data from the World Bank, Fig. 1 (right) shows that between 1991 and 2017,

- The growth rate of the labour force is generally decreasing for all country groups,
- In general, the unemployment rates are lower post 2000, and
- High income countries have experienced a negative annual unemployment rate of change since 2010.

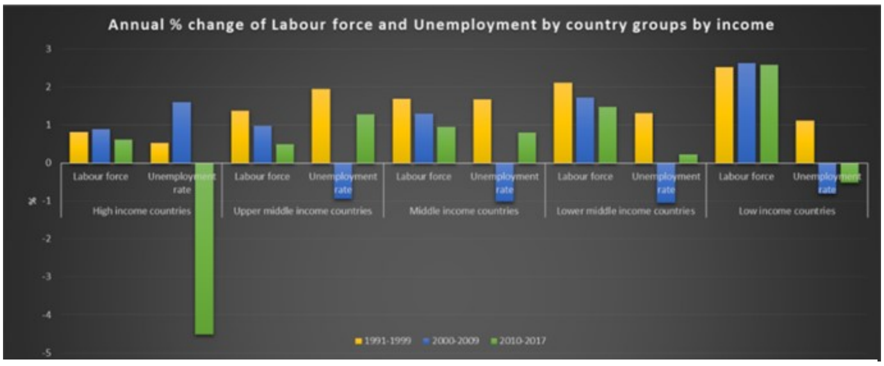

Figure 1. Annual % change of labour force and unemployment by country groups
Source: this study, using data from the World Bank

The combination of declining unemployment rates in a declining labour market presents a serious challenge. When there is limited labour, competition for staff will increase and in certain industries high staff turnover is becoming the norm. In the U.S. meat and poultry processing industry, for example, labour turnover has increased from an historical 1-1.5% per week to 2-2.5% in recent years. The cost of replacement could add up to 4% of total processing cost, which is equivalent to hundreds of millions of profit loss (McCracken, 2018).

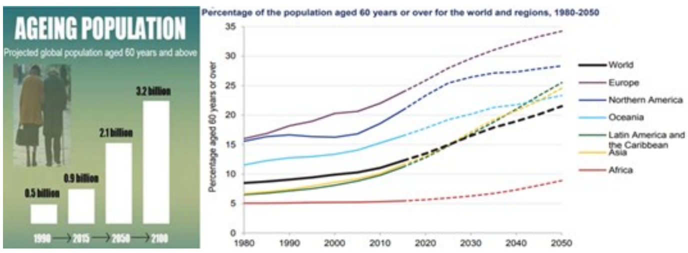

Figure 2. Population estimation of 60 years or over Worldwide.
Source: UN (2015, 2017)

This shortage in labour and high staff turnover will almost certainly intensify in the future due to population aging.

According to the UN (2015, 2017), '*the number of 60 years + people is expected to more than double by 2050 and to more than triple by 2100, rising from 962 million globally in 2017 to 2.1 billion in 2050 and 3.2 billion in 2100. Globally, population aged 60 or over is growing faster than all younger age groups*' (Fig. 2 LHS).

Population aging is particularly concerning for developed regions. In Europe, approximately 25% of the population were over 60 years old in 2015, this number will increase to nearly 35% in 2050. Worldwide, approximately 12% of all people are over 60 years old in 2015, this number will increase to 21% in 2050 (Fig. 2 RHS).

4. Jobs

Job loss seems to be the first thing that comes to mind when it comes to automation and robotics; yet job creation is also an aspect brought by the same technology.

Autor (2015) commented that *'(a)utomation does indeed substitute for labor—as it is typically intended to do … journalists and even expert commentators tend to overstate the extent of machine substitution for human labor and ignore the strong complementarities between automation and labor that increase productivity, raise earnings, and augment demand for labor'*.

PwC (2018) noted that *'… new technologies … will create many new jobs. Some of these new jobs will relate directly to these new technologies, but most will just result from the general boost to productivity, incomes and wealth that these technologies will bring. As these additional incomes are spent, this will generate additional demand for labour and so new jobs, as such technologies have done throughout history…'*

Predicted Jobs Automation Will Create and Destroy

When	Where	Jobs Destroyed	Jobs Created	Predictor
2016	worldwide		900,000 to 1,500,000	Metra Martech
2018	US jobs	13,852,530*	3,078,340*	Forrester
2020	worldwide		1,000,000-2,000,000	Metra Martech
2020	worldwide	1,800,000	2,300,000	Gartner
2020	sampling of 15 countries	7,100,000	2,000,000	World Economic Forum (WEF)
2021	worldwide		1,900,000-3,500,000	The International Federation of Robotics
2021	US jobs	9,108,900*		Forrester
2022	worldwide	1,000,000,000		Thomas Frey
2025	US jobs	24,186,240*	13,604,760*	Forrester
2025	US jobs	3,400,000		ScienceAlert
2027	US jobs	24,700,000	14,900,000	Forrester
2030	worldwide	2,000,000,000		Thomas Frey
2030	worldwide	400,000,000-800,000,000	555,000,000-890,000,000	McKinsey
2030	US jobs	58,164,320*		PWC
2035	US jobs	80,000,000		Bank of England
2035	UK jobs	15,000,000		Bank of England
No Date	US jobs	13,594,320*		OECD
No Date	UK jobs	13,700,000		IPPR

Table 1. Examples of job estimation by different sources
Source: Winick (2018)

The debate here is not whether automation has a positive or negative impact on jobs; the debate here is the magnitude of the impact of automation on jobs. This lack of clarity is captured in Winick (2018), which summarised a small part of job loss/creation estimation studies (Table 1). The author noted that '*…these predictions are made by dozens of global experts in economics and technology, no one seems to be on the same page. There is really only one meaningful conclusion: we have no idea how many jobs will actually be lost to the march of technological progress.*'

For example, on the job loss front, Thomas Frey (2012) suggested that 2 billion jobs worldwide could be automated by 2030, while McKinsey reported (2017b) the number should be 400 million to 800 and Graetz and Michaels (2015) suggested that there is no relationship between the use of robots and manufacturing job loss for the studied countries between 1996 and 2012.

Similarly, predictions on the number of jobs created worldwide through automation differ significantly. The estimated range differs from 2 million jobs (Martech, 2013 and Gartner, 2017) to U.S. 555-890 million (McKinsey, 2017b). PWC (2018) suggested that '*the net long term effect on employment in advanced economies like the US and the EU may be broadly neutral …*'

According to IFR (2017), the automotive industry in the U.S. had accumulated an additional 52,000 units of the operational industrial robots between 2010 and 2016. During the same period, 260,600 jobs were added in the sector. Similarly, in the German automotive industry, which is renowned for its robot density (300 per 10,000 workers[1]), 72,313 jobs were added between 2010 and 2016 (data from EUROSTAT[2], 2018).

[1]https://www.forbes.com/sites/niallmccarthy/2018/04/25/the-countries-with-the-highest-density-of-robot-workers-infographic/#40beeab01853

[2]Eurostat is the statistical office of the European Union.

5. Productivity and Profitability

The productivity-boost effect of automation is well supported by research.

Graetz and Michaels (2015) studied the impact of robotics on productivity using macroeconomic research. Using panel data from 14 industries in 17 countries between 1993 and 2007, the study found that the use of robots raised countries' average GDP growth rates by about 0.37 percentage points and productivity growth by about 0.36 percentage points respectively. These figures represents 12% of total GDP growth and 18% of labour productivity growth for the 17 countries over that time period.

Ceber (2017) studied the impact of automation on economic development (GDP per capita and labour productivity) in 23 OECD countries between 1993 and 2015. The study found '*a positive association between robotics density and labour productivity; … a one-unit increase in robotics density growth is associated with a 0.04% increase in labour productivity*'. And, '*… a positive relationship between robotics automation and economic development … a 1% increase robotics investment is associated with a long-run increase in GDP per capita of 0.03%.*'

McKinsey Global Institute (2017a) estimated that '*automation could raise productivity growth globally by 0.8 to 1.4 percent annually*'. Berg, Buffie, and Zanna (2018) suggested that '*… even a small increase in the level of robot productivity can increase output enormously if the robots and humans are sufficiently close substitutes…*'

According to Gollschewski (Rio Tinto's Pilbara Mines Managing director) (Fig. 3), the mine sites equipped with autonomous trucks and drills out-performed the manned sites for the investigated period; and the level of performance of the automated sites were improving with time.

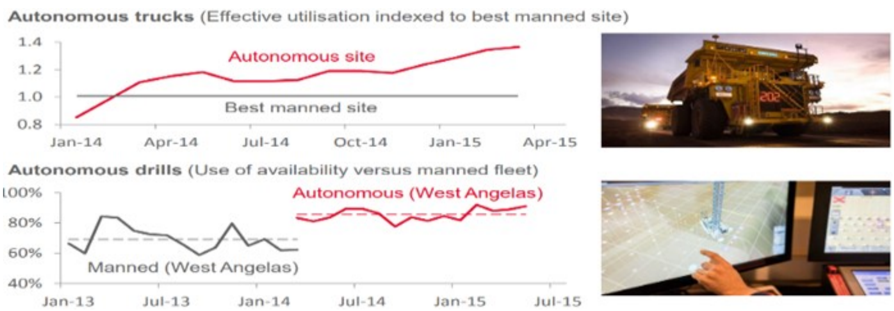

Figure 3. Rio Tinto Pilbara mine site performance, autonomous vs manned 2013-15
Source: Gollschewski (2015)

DHL (the global third-party logistics provider) suggested that, by using virtual reality and heads-up display, the staff are able to locate items faster. Their Ohio facility achieved a 10% productivity improvement during the trial period (Trebilcock, 2018).

6. Yield and quality

Yield improvement is another benefit of automation. McKinsey (2017a) suggested that the magnitude of the benefit varies substantially based on individual use case. One such example is hydroponic farms that are operated by automated systems. New Jersey based Bowery farm (Fig. 4 on the right) was suggested to be much more productive than average farmlands (Kowitt, 2018). This is because this indoor farming facility is mainly automated. Sensors control and set optimal temperature and moisture levels, leading to faster growth, more crop cycles, and higher yield per crop cycle (Fain, cited in Kowitt, 2018). Furthermore, this way of farming requires less water and no pesticides, which minimises water wastage and enhances crop flavour (Bloomberg, 2018)

In another example even small scale beef boning automation in the meat processing industry can effectively increase the amount of meat in primal cuts. Greenleaf (2009) found that these units can provide an average yield savings of approximately 0.40% (0.63 kgs)/carcass, for three different types of cattle, which was equivalent to AU $3.04/carcass on average, based on 2009 cattle prices.

Figure 4. Bowery farm
Source: Kowitt, 2018

In addition to the increased profit/carcass, the otherwise wasted meat becomes available for consumption. If the beef boning unit was used in all Australia beef processing facilities, the additional yield would have put approximately 4,510 tonnes of beef on the dinner table in 2017.

7. Health and Safety

The impact of automation on health and safety on a macro level is not as well studied as its impact on jobs or productivity. Levert and Héry (2018) presented two sides of the coin: automation might be a contributing factor to work load intensification but it can also reduce physical demands and repetitive tasks.

While the report suggested that work load intensification could be the reason for an increase in work-related incidents, this theoretical hypothesis is not well matched by real world statistics. The occupational incidence rate in the U.S. private sector (Fig. 5) and U.S. poultry industry (Fig. 6) has been falling in the past 15 years, which coincided with the intensification of automation in general.

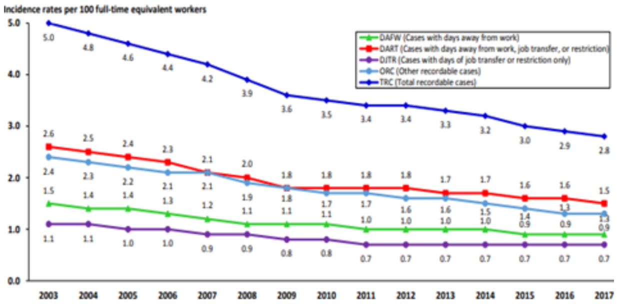

Figure 5. US occupational incidence rates, 2003-17
Source: BLS (Nov, 2018)

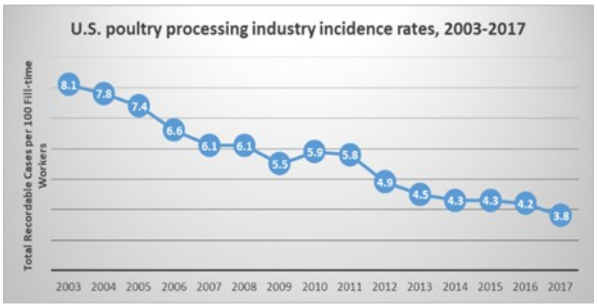

Figure 6. US Poultry industry incidence rates, 2003-17
Source: BLS Incidence rates—detailed industry level 2003-17[3]

Beyond statistics, automation systems and robotics are seen at the most hazardous work places substituting repetitive and risky tasks. Automated welding systems, fully or collaborative, minimise operators' exposure to metal fumes and ultraviolet (UV) radiation while eliminating injuries such as burns, eye damage, electric shocks, cuts, and injury to toes and fingers typically associated with manual welding.

Another real world example is the use of cobots by German chainsaw maker STIHL in their cut-off production. According to IFR (2018a), Cobots were introduced to STIHL's cut-off machine inspection and packaging line because the lifting of a unit (weighs around 10 kg) by human operators had proven to be a considerable burden. During inspection, cobots remove the cut-off machine from a suspended conveyor, carry out the shake test, and keep it suspended until a final visual inspection is completed (Fig. 7 on the right); the packing line staff were involved from the outset interacting with the cobots for final inspection. Not only did the cobots help reduce the physical strain on human operators, it made the process more efficient.

Figure 7. Cobots holding STIHL cut-off machine for operators to inspect
Source: IFR (2018a)

Another example is Saint Gobain, a French specialist glass maker, who use a collaborative robot to polish glass. They reported that the cobots not only freed operators from the constant vibration of polishing, but they also reduced production time by one third (IFR, 2018b).

8. The Transition towards Production Automation

There is agreement among some scholars and stakeholders (e.g., Autor (2015), Bessen (2016); PwC (2016); IFR (2017), McCracken (2018), and McKinsey (2018)) that the smooth transition towards automation need to be coordinated amongst governments, industries, and companies.

Summarising from cited experts, a governments' role in this transition is to provide fit-for-purpose education systems to prepare and retrain the work force, creating dynamic labour market search/match plate forms and implement policies to allow the adoption of automation. While companies are suggested to:

- Invest in R&D and human capital such as highly skilled mechanics, engineers, and big data personnel
- Redesign workflow and workspace to facilitate human-machine collaboration
- Actively set and implement digital safety standards including data security, privacy, and malicious use.

[3] https://www.bls.gov/iif/oshsum.htm#14Summary_News_Release

9. Conclusion

Automation and robotics is here, just like steam power in the 1780s, electricity in the 1870s, and computing systems in the 1960s. The evidence supporting the argument that automation increases productivity, helps to address population aging and labour shortage, and improves work place health & safety cannot be ignored. While there might be short-term negative social impact, stopping or scaling back automation or robotics is not the answer. A company, industry or nation runs the risk of losing competitiveness altogether should the progress of automation be halted. It is therefore paramount that the collaboration between governments and industries make this transition safe and beneficial for all.

10. References

Autor D. (2015). Why Are There Still So Many Jobs? The History and Future of Workplace Automation. Journal of Economic Perspectives 29(3) PP 3–30. Retrieved from https://economics.mit.edu/files/11563

Berg A., Buffie E., and Zanna L. (2018). Should We Fear the Robot Revolution? (The Correct Answer is Yes). IMF. Retrieved from https://www.imf.org/en/Publications/WP/Issues/2018/05/21/Should-We-Fear-the-Robot-Revolution-The-Correct-Answer-is-Yes-44923

Bessen J. (2016). Computer don't kill jobs but do increase inequality. *Harvard business review*. Retrieved from https://hbr.org/2016/03/computers-dont-kill-jobs-but-do-increase-inequality

Bloombery. (2018). This High-Tech Farmer Grows Kale in a Factory. Retrieved from https://www.youtube.com/watch?v=AGcYApKfHuY

Centre for Economics and Business Research (Cebr) (2017). The impact of automation – a report for Redwood. Retrieved from https://cebr.com/wp/wp-content/uploads/2017/03/Impact_of_automation_report_23_01_2017_FINAL.pdf

Frey T. (2012) 2 Billion Jobs to Disappear by 2030. Retrieved from https://www.futuristspeaker.com/business-trends/2-billion-jobs-to-disappear-by-2030/

Gartner (2017). Gartner Says By 2020, Artificial Intelligence Will Create More Jobs Than It Eliminates
Retrieved from https://www.gartner.com/newsroom/id/3837763

Gollschewski M. (2015). Productivity improvements in a changing world, presentation. Retrieved from https://www.riotinto.com/documents/150713_AusIMM_Productivity_improvements_in_a_changing_world_MG.pdf

Graetz G. and Michaels G. (2015). CEP Discussion Paper No 1335 - Robots at Work. Centre for Economic Performance, the London School of Economics and Political Science. Retrieved from http://cep.lse.ac.uk/pubs/download/dp1335.pdf

Greenleaf Enterprise (2009). REVIEW OF SCOTT'S TECHNOLOGY MANUAL ASSIST BONING SYSTEM:
A Benefit Analysis prepared for Meat and Livestock Australia

Greenleaf Enterprise (2013). Ex-Post value proposition for automated Ovine x-ray Primal Cutting Systems.

Greenleaf Enterprise (2014). LEAPIV lamb middle cutting, Ex-Post Review.

International Federation of Robotics (IFR). (2017) Robots benefit the US industry: 261,000 new jobs created in automotive sector alone. Retrieved from https://ifr.org/ifr-press-releases/news/robots-benefit-the-us-industry-261000-new-jobs-created-in-automotive-sector

International Federation of Robotics (IFRa). (2018). STIHL opens up new avenues with FANUC's Collaborative Robot. Retrieved from https://ifr.org/ifr-press-releases/news/stihl-opens-up-new-avenues-with-fanucs-collaborative-robot

International Federation of Robotics (IFRb). (2018). Reduce Injuries and Increase Productivity with the FT 300 Force Torque Sensor. Retrieved from https://ifr.org/ifr-press-releases/news/reduce-injuries-and-increase-productivity-with-the-ft-300-force-torque-sens

Kowitt B. (2018). This startup is building the techiest indoor farm in the world. *Fortune*. Retrieved from http://fortune.com/2018/02/28/bowery-indoor-farm-technology/

Levert C. and Héry M. (2018). Will technology improve health and safety at work? Retrieved from https://www.greeneuropeanjournal.eu/will-technology-improve-health-and-safety-at-work/

Martech M. (2013). Positive Impact of Industrial Robots on Employment. Retrieved from https://robohub.org/wp-content/uploads/2013/04/Metra_Martech_Study_on_robots_2013.pdf

McCracken C. (2018). Animal Protein's Labour Pains – Industry Bottleneck or Game-Changer? Rabobank.

McKinsey Global Institute. (2017a). A Future That Works: Automation, Employment and Productivity. Retrieved from https://www.mckinsey.com/~/media/mckinsey/featured%20insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works-Executive-summary.ashx

McKinsey Global Institute. (2017b). Jobs lost, jobs gained: Workforce transitions in a time of automation. Retrieved from https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Future%20of%20Organizations/What%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/MGI-Jobs-Lost-Jobs-Gained-Report-December-6-2017.ashx

McKinsey Global Institute. (2018). AI, Automation, and the future of work: ten things to solve for. Retrieved from https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Future%20of%20Organizations/AI%20automation%20and%20the%20future%20of%20work%20Ten%20things%20to%20solve%20for/MGI-Briefing-Note-AI-automation-and-the-future-of-work_June2018.ashx

PwC. (2016). Upskilling manufacturing: How technology is disrupting America's industrial labor force. Price Waterhouse Coopers in conjunction with the Manufacturing Institute. Retrieved from http://www.themanufacturinginstitute.org/~/media/E9F0B41DEC4F40B6AE4D74CBC794D26D/155680_2016_Manufacturing_Labor_Force_Paper_final_(2).pdf

PWC (2018). Will robots really steal our jobs? An international analysis of the potential long term impact of automation. Retrieved from https://www.pwc.co.uk/economic-services/assets/international-impact-of-automation-feb-2018.pdf

Trebilcock B. (2018). NextGen Supply Chain at DHL. Modern materials handling. Retrieved from https://www.mmh.com/article/next_gen_supply_chain_at_dhl

UN (2017). Ageing. Retrieved from http://www.un.org/en/sections/issues-depth/ageing/index.html

UN (2015). World population ageing. Retrieved from http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf

U.S. Bureau of Labor Statistics (BLS) (Nov 2018). New Release – Employer-reported workplace injuries and illnesses -2017. Retrieved from https://www.bls.gov/news.release/archives/osh_11082018.pdf

Winick E. (2018). Every study we could find on what automation will do to jobs, in one chart. MIT Technology Review. Retrieved from https://www.technologyreview.com/s/610005/every-study-we-could-find-on-what-automation-will-do-to-jobs-in-one-chart/.