

Exploring the Revolution on Jobs and Its Overall Challenges in the Field of Engineering and Technology with Statistical Aspects



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Abstract: Technology has been developing instantaneously since the beginning of the 19th century from the inventions of light bulb by Thomas Edison to the space shuttle by NASA (National Aeronautics and Space Administration). Technology contributes to the GDP growth, transforms work force, enhances business innovation and creates jobs. Rapid development of technology has created many newer industries and professions for instance, Facebook created worldwide 182,000 jobs (World Economic Forum, 2016) and it is expected information technology sector will grow by 22 percent by 2020 (World Economic Forum, 2013). Nevertheless, technology is creating many employments; it is also replacing many other jobs with technological breakthrough (Arntz, Gregory & Zierahn, 2016). The study of this paper is to identify the technology challenges and its implication to the future job market, economy as well as human resources practices. The paper also suggests means of addressing the areas and recommendations for future research in this area.

Index Terms: Engineering, Jobs, Organization, Revolution, Technology.

I. INTRODUCTION

Minimum wages in most countries are increasing continuously in order to substantiate the increasing costs of living. In United States the federal minimum wages has been stagnant since year 2009 at \$7.25 however, minimum wage tends to vary at state level ranging from \$8.25 to \$11.00 (U.S. Bureau of Labor Statistics). Figure 1 below illustrates the increase in minimum wage in US economy (by federal) from 1950 to 2007 with relative to today's dollars comparison [1]. The empirical studies show that the increase in minimum wage tended decrease employment among teenage workers (Brown, Gilroy, & Kohen, 1982). Nevertheless, the increase in the minimum wage reduces employment opportunities for less skilled workers (Neumark & William, 2008). Figure 2 illustrates the percentage of population who exited the labor force due the reasons like retirement, disability, continue schooling, family responsibility, self-employment, job displacement due to technology augmentations, discouragement, retrenchment and others.

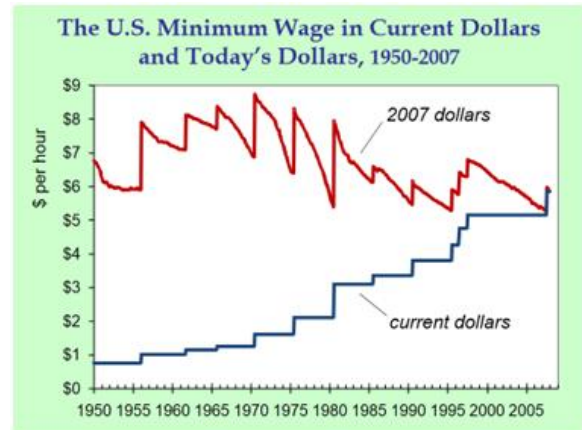


Fig 1 : U.S. Minimum Wage Rate (by Federal) from the year 1950 -2007 (Source: U.S. Bureau of Labor Statistics).



Fig 2 : Percentage of employed who exited the labor force, January 1991 – December 2016 (Source: U.S. Bureau of Labor Statistics Note: Shaded area represents recessions).

As a result, organizations are keen seeking alternatives methods of maximizing their operations by minimizing the use of manpower [2]. Technology is replaced with the human touch International Federal Robotics (IFR) estimates in 2013 that the global demand for machines sold for domestic and personal use grew 28 % to \$1.7 billion (Coffey, Valerie, 2015). It is impossible to predict how this newer technology will impact our jobs and minimum wage in future; nonetheless as the debate unfolds, most likely that organizations will use this technology advancement to their advantage in order to produce goods and services at low prices and high quality [3].

Today many organizations adopts technology namely Industry 4.0, Artificial Intelligence (AI), Automation, Machine Learning and the main five sectors that make technology as a priority are media and entertainment, finance and banking, healthcare, education and tech industry [4].

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While the technological advancement promises a surreal future, job loss due to technology replacement also inevitable. Proponents for technology advancements already suggest that the progression in technology only replace semi and unskilled jobs, however it will herald a new era of innovative jobs [5]. While there are pro and cons in the adoption of technology and most compelling reasons for companies to shift towards Industry 4.0 and automation of processes are to increase productivity, minimize human errors, optimize productions costs and mainly to focus on repetitive task improvement efficiency [6].

II. LITERATURE SURVEY

A. Current Job Trends

Securing management and executive talent is an important topic in today's contemporary business community, though a century later it may no longer being a dominant paradigm [7]. Topics such management development, career planning, succession planning, and etc. Once, roots of contemporary practices turn out to be obsolete with the changing technology. There are numerous human resources that already have been replaced by technologies which focus on productivity and cost reduction. In an article written by Jeremy Rifkin, 2005 indicated that European politicians often blame outsourcing for the disappearance of jobs indeed in reality the work is not going to China but going to robots.

The street vendors an integral part of urban economics who sell everything from fresh vegetables to prepared food are being substituted by vending machine a coin-actuated machine. Street vendors initially not only provide jobs and source of income for their households but also for porters, security guards, transport operators, storage providers, and others (Informal Economy Monitoring Study (IEMS) which eventually diminishing in developed economies [8]. The earliest idea of vending machine came from Alexandria 215 BC which dispensed holy water when the coin was deposited (Higuchi, 2007). The commercialization of vending machines only took place in 1880 used to dispense postcards and later evolved to soda in cup and canned soda. In 1972, the first glass vending machines for snack has been introduced. Despite studies indicate snacks sold by vending machines were high in sugar, fat and saturated fat (Park, & Papadaki, 2016), regardless it has remained popular among consumers.

Another industry that rapidly inspired by technology is automobile sector. Today self-driving or autonomous cars are being tested by auto companies such as Tesla, Ford, Toyota and Mercedes Benz and has become a reality in both the US and other developed economies [9]. It is estimated that about 4 million jobs of drivers in transportation industry are at stake affected by self-driving cars and these jobs ranges from taxi driver, truck driver to bus drivers (Arinze, Ndubizu, & Sylla, 2016). The application of integrated systems in automobile manufacturing also has replaced the human need. Conventional routine of assembling car is scrapped and supplanted since automotive assembly workers are often exposed to some or all of the major ergonomic risk factors for musculoskeletal disorders (MSD) including: heavy loads, awkward postures, repetitive motions, and environmental exposures [10].

Another classic example of describing technological changes to human resource in earlier days can be seen in the bowling arena where bowling pinsetter machine is invented to

rearrange the pins after each strike. Traditionally in US, child and teenage labor are used gearing bowling alleys (Fig 3) and later when the abolition of child labor came into effect in 1904 (Child Labor, 2014), bowling arenas started to adopt mechanical pinsetters. These mechanical pinsetters are more efficient, less time consuming and more cost effective.



Fig 3 Child Labor in America 1908- 1912. Lewis W. Hine
(Source: <http://www.historyplace.com/unitedstates/childlabor/hine-bowling.htm>)

B. Future Job Trends

As this trend continues, in future many more jobs will be replaced by machines. In future, it is possible for a humanoid robot to replace human teacher even though causes disruption to the educational landscape and loss is no of jobs relating to teaching roles (Bosede & Adrian, 2018). Some research is already ongoing where Nao and Pepper robot teachers from Softbank Robotics are introduced to students at early childhood schools in Singapore (Crowe, 2016). These as to prepare students get to use to the idea of robots being their teachers in future. This program has also shown success in initial research stage with autistic children with high level of engagement compare to the traditional approach (Crowe, 2016). The scope of distance learning combined with e-learning education also has created new opportunities for students globally (Sehra, Maghu, & Bhardawaj, 2014). The use of e-learning provides flexibility, economical and environmental status for students and to diverge from traditional 'brick and mortar' schools with teacher to modern education. In many countries the exchange of sexual services for money is legal; however soliciting for prostitution in public is illegal (Davis, 2006). Prostitution often subject to human trafficking and a recent survey shows that in India alone, there are an estimated of 1.2 million children involved in prostitution (Biswajit, 2009). Prostitution despite of the ban in 116 countries continues to exist. It contributes to crime rate and as for this reason, there are a number of countries which have legalized prostitution in order to extend some degree of legal protection from discrimination and crime in particular (Weitzer, 2008). Soon these jobs can be also replaced by androids to prevent crime, sexually transmitted diseases and exploitation of human. Artificial intelligence able to stimulate all most of the human expressions and emotions and also the technology exist for making robot skin feel human. There is already concern by the sex workers worldwide about possibility of them becoming technologically obsolete in future (David Levy, 2007).



The usage of robotic sex workers is an initiative to move the industry from what the author consider to be ‘dark ages’ to a more controlled environment and it is predicted that sex workers replacement with robots will become common in many European countries that legalize prostitution especially in Britain by 2035 (Sean Martin, 2016).

Other areas which we can expect to see changes in near future will be in terms of health screening based on the adaptation of fictional Hollywoodmovies such as Hero 6, Elysium, etc, which set taboo. It is also possible to develop healthcare robots that help humans to screen their physical condition on the spot without doctor’s assistance [12]. According to a study by Johns Hopkins University, it is found that many patients die due to the results of misdiagnosis. In US, the study claims that more than 250,000 people die every year due to medical errors (Marshall & Olga, 2016). Vigorous data collections and analysis is important as to reduce misdiagnosis. Thus, data pooling could be done through active patient checkups, testing, diagnosis, prescription, behavior modification and etc. Nevertheless, the process itself is time consuming and it is not easy for the doctor to comprehend the information accurately. Eventually, it is stated that the computers will replace and replicate 80 percent of the doctor’s task and further amplify their capabilities by assisting them in critical decision makings. According to the studies carried by Bates, Leape, et. al., 1998 the adoption of the information technology by physicians able to reduce serious medication errors by 55% [11]. This shift to technology in healthcare services is crucial for hospitals to avoid errors and provide basic care for those people who cannot afford health care services.

Bureau of Labor Statistics of U.S. Department of Labor predicted between years 2014 - 2024, employment on 217 occupations is projected to decline (BLS, Dec 2015). Besides, Wall St. identified 18 jobs that will shed more than more than 300,000 jobs due largely to advances in technology from 2014 to 2024 (Evan & Samuel, 2016). John Maynard Keynes revelation the fear of ‘technological unemployment’ and called it as ‘new disease’ since its ability to effectively substitute human labour (The Economist, 2014).

Organizations are constantly experimenting with new technologies, ideas and business models that require flexibility and over time the discoveries of newer technology becomes best practices which as a result eliminates manpower. For example although Just in Time (JIT) can be traced back to Henry Ford (Figure 4a), however the origins of JIT as a management strategy traces back to Toyota Company. With JIT, Toyota introduced ‘autonomation’, automating production system and reducing human intervention (Figure 4b) in 1952 through the practices of Kanban. Today, many organizations such as Hewlett Packard, McDonalds and others applies this concept [13].

Fig (a)



Fig (b)



Fig 4 (a) Henry Ford Assembly Line,
Fig 4 (b) Toyota Assembly Line

(Source:

<https://corporate.ford.com/articles/history/100-years-moving-assembly-line.html>

<https://scottamx.com/2017/10/05/toyota-production-philosophy-automation/>).

III. CONSTRAINTS AND CONTRIBUTION OF TECHNOLOGY TO HUMAN GROWTH AND ECONOMY

The discovery of technology, the use of labour are outrunning the pace at which we cannot find new uses for labour (John Maynard Keynes.) Since technology advancing virtually in every sector globally and promises a surreal future, prediction of job losses due to human replacement is also inevitable. The consequences of the technology to future of humans are as follows:

- (i) Workers will need to replace their skills with state of skills that incorporates technology to thrive in the workplace of the future. Over the past 15 years, automation has displaced workers and accelerated the shift in workforce skills. According to the landmark 2017 studies, in USA alone, automation process has replaced around 5.6 workers, **and** reduced the percentage of the total population employed by 0.34% and also reduced wages by 0.5%. Besides, the demand for high tech skilled jobs were continuously growing and the demand for physical and manual labour are keep declining. Within the 14-year period of time, the number of industrial robots has quadrupled and between 360,000 and 670,000 jobs were removed (Sattens, 2017).
- (ii) Likelihood to change occupations based on the job demand. According to a research done by McKinsey, 2018, 3% of the global workforce need to change their occupation category by year 2030. This shift could take place among moving from one occupation to another or moving sectors

The study in England and Wales suggest that since 1871, technology has created new demand and newer jobs. Figure 5 shows the switch in the workforce from blue color jobs ‘muscle power’ to professional jobs in England and Wales. Furthermore it is argued that, technology also eliminates hard, dangerous and dull jobs.

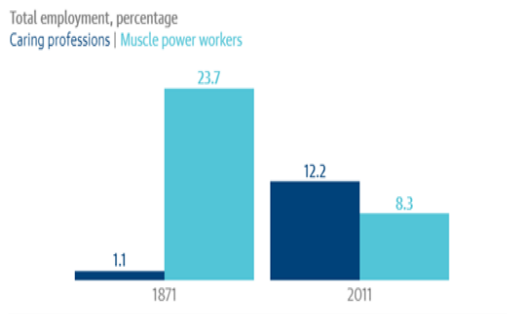


Fig 5 : Labor Switching from 1871 to 2011 (Source: England and Wales Labour Force Survey).

Note: ‘Muscle power’ workers include cleaners, domestic servants, laborers and miners. ‘Caring professions’ includes health care and teaching professional and care home workers.

(iii) McKinsey, 2018 research also suggest that professional occupations can decline due to Artificial Intelligence (AI). Monotonous jobs can be replicated by the machines easily, therefore, professionals need to equip themselves with higher cognitive skills such as creativity, critical thinking and complex information processing skills. Skilled professionals are required to oversee, coordinate and manage complex AI in empowering them to perform better.

(iv) Change in the ergonomics of the workplace and workflows due to more people require to work alongside with the machines. The introduction of AI robots allows the workplace, workflow and workspaces to evolve in order to enable human and machines to work together. For instance, the introduction of AI robots to help teach English in Japanese classroom has created much anticipation among the teachers and the students as to share the common classroom space. The Japanese Education Ministry has allocated around 250 million yen to incorporate the AI robots in classrooms in improving Japanese students weak oral and written English. In this case, AI robots are placed as rather a facilitator in helping to augment the productivity growth of English teacher than as replacement.

(v) The introduction of the technology likely to impose pressure on the average wages in advanced economies. High-wage jobs will grow significantly, especially for medical, technological and professional field. Technology also creates newer jobs and higher wages however expected a large portion of jobs such as teachers, nursing aides and others typically to have lower wages (McKinsey, 2018).

(vi) Equitable income distribution will become a problem with technological advancement. Technology eliminating middle class jobs and widening income inequality (Besse, J., 2015). “The risk is that automation could exacerbate wage polarization, income inequality, and the lack of income advancement that has characterized the past decade across advanced economies, stoking social, and political tensions” (McKinsey, 2018).

IV. TECHNOLOGY CONTRIBUTION TO THE ECONOMY

Technology are transforming businesses and contributing to economic growth. The existence of technology over decades are already adding value to various products, services and organizations. Technology is used across in every sector and industry starting from aligning internal processes to personalize product recommendations to finding anomalies in the production process flow. Technology also used by professional services from facilitating their services to identify fraudulent activities and many more. Technology not only limited to knowledge transfer however it also includes AI advances such as techniques that addresses estimation, clustering problems, and others which assist decision making process. An analysis conducted by McKinsey, 2018 found that several hundred AI use the “most advanced deep learning techniques deploying artificial neural networks could account for as much as \$3.5 trillion to \$5.8 trillion in annual value, or 40 percent of the value created by all analytics techniques”.

The surge of modernization has resulted in not only large organization embracing technology but also extended to small businesses. The affordability of today’s computer hardware, mobile devices and cloud-based services has enable small business to use technology in enhancing their growth and profitability margins. Besides, there are many new technology based small businesses on rise both in manufacturing and services sector. A research conducted by Brother International Corporation shows that there has been 18% increase in small business technology spending since year 2010. According to Figure 4, the Compound Annual Growth Rate (CAGR) in North America, IT spending amongst small medium size business (SMB’s) shows 4.8% from year 2011 – 2017. Spending done by these firms on hardware, software and IT services. The spending amount on technology has grown by 28.5%. The Figure 6 indicated there is a steady increase in the spending for technology from year to year.



Fig 6 North America Spending by SMBs (\$billions) 2011-2017.

The impact of technology is significant in the market economy becomes technology results in greater productivity. Productivity depends on the labor (L), physical capital (K), human capital (H), natural resources (N) and technological knowledge. Thus the production function is derived from the relationship of input and output which is $Y = AF(L, K, H, N)$ where F refers to function and A refers to the level of technology. Any improvement in technology allows more output to be produced from any combinations of inputs.

In summary technology vital to increase firm’s productivity and to contribute to the country’s economic growth. Market outcomes for some organizations also has changed over the time forexample some of the largest well known indexes such as Dow Jones Industrial Average (DJIA) and the S&P 500 has lost their value to some giant tech power houses like Apple, Google, Amazon and others whose stocks are valued much higher (Marco, 2016) due to technological vicissitudes. “Technology has an amazing power of permeate companies” (McKinsey 2018).

Organizations today spends millions of dollars on technologyfor hardware, software, data centres, networks, and staff, both internal and outsourced IT services and this spending contributes to the nation’s Gross Domestic Product (GDP). The total spending on technology accounts close to USD 6 trillion per year. “To put this number on a more illustrative perspective, if we were to consider the global technology economy a country and its yearly spending its GDP, it would be ranked as the world’s third largest economy, between the economies of China and Japan and more than twice the size of the UK economy, as shown on the Figure 7 below”:

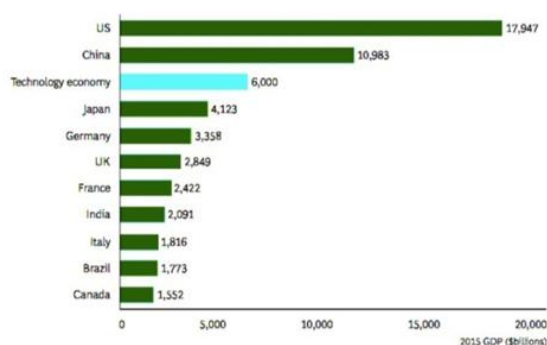


Fig 7 GP Spending on Technology

Source:<https://www.cio.com/article/3152568/leadership-management/the-growing-importance-of-the-technology-economy.html>

V. CONCLUSION

Artificial intelligence and automation face many challenges, because there is a need for massive training data and difficulties in coding an interpretation of algorithms across all the industries. Recent innovations starting to address these issue however other limitations that still persist. Explaining decisions made by machines is technically challenging because machines do subject to failure or errors which requires human touch for rectification. For example, a machine requires regular maintenance and troubleshooting for smooth operation. This requires knowledge and technical expertise form workers. Many new jobs in future are expected to be created in this area as well as field that requires data privacy, security. Besides, with the increase use of technology at workplace, organisation must address General Data Protection Regulation which offers the right for users of data collection and usage. This is a biggest challenge for any organisation today to protect the interest and privacy rights of their customers. The revolution of technology has eliminated jobs and added many more. The automotive, finance, telecommunications industries lead the technology and AI adoption. Countries such as US leading technology

investment \$23 billion, followed by Asia \$12 billion and Europe \$4 billion.

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