The Impact of Computerization on the Future Job Market

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ABSTRACT

The impact of technological improvement, as it has in the past, will cause dramatic changes in how the economy functions and the way humans work in the future. This paper reviews history and existing literature to predict how technology and computerization will affect society, jobs, and the current workforce. There are three main sections elaborating on the research explored for this review. The first describes the future economy, while the other two rationalize the replacement, reinvention, and creation of jobs as a result of technological development and innovation. This literature review concludes that workers within every sector of the economy will be significantly impacted by computerization and emerging technology including mass automation, unmanned vehicles, and artificial intelligence (AI). Workers must constantly continue their education and keep up with technological change to maintain secure employment.

Keywords

Future Technology, Economy, Jobs, Employment, Automation, Computerization, Artificial Intelligence, Human-Computer Interaction, Technological Unemployment

INTRODUCTION

To understand the potential impact of the upcoming technological revolution, those of the past must be recognized. With each revolution, both small and large, many significant aspects of the sociological and economical reactions have been the same. The literature shows that most people are skeptical about new technology at first. When they are finally introduced to it, many show fear, anxiety, and excitement. That excitement can be positive or negative. When the learning curve is breached, users can accept and embrace the new technology. However, the innovations never stop, so this cycle never ends. It restarts when those who have accepted the technology find shortcomings and proceed to solve for them with newer, innovative technology.

One of the most common examples used to describe this cycle is the Luddite movement of the early 19th century. The Luddites were textile industry workers known for destroying machinery invented to make weaving more efficient. The idea of these machines was met with skepticism. After they were officially introduced, the machines were confronted with extreme fear, anxiety, and excitement in the form of violence. The workers saw that these machines would replace them in their current jobs. This did happen, but it is clear now that more jobs were created than were eliminated.

The upcoming technological revolution will produce drastic improvements in computerization including automation, artificial intelligence (AI), and human-computer interaction. The mass implementation of this technology into the workplace will have considerable consequences for jobs and today's economy. This paper evaluates the effects new technology will have on the low-, middle-, and high-skill sectors of jobs.

The first section explains Arthur's (2011) theory of "the second economy," major emerging technology, and introduces the effects it could have on society. The following two sections explore the jobs that could be replaced, reinvented, and created. This review also outlines literature that supports those predictions and proactive measures that the workers affected can take to avoid technological unemployment.

1. NEW TECHNOLOGY AND THE ECONOMY

The changes society is about to encounter with digital technology are going to be much more drastic than have historically been seen. The technological revolutions of the past caused large-scale reactions, both positive and negative. However, the mass introduction of automation and computers that can think for themselves is going to change the way humanity operates more than the spinning machine and the printing press ever did.

Arthur (2011) acknowledged the seriousness of the approaching change in a publication supporting his theory of "the second economy." He explains the second economy as an entity that runs parallel to our physical economy, but it is entirely sustained by computers and their networks. Every job that has become automated fits into the second economy along with every process and facet of business that is conducted exclusively by computers. Arthur uses the airline ticketing process and the freight shipping process as examples. Years ago, every part of those processes was physically enabled by a human. Now, airports have computers to check-in passengers. Those computers communicate "underground" with a vast amount of networks to autonomously confirm travel details, identity, and security. Freight shipments are now digitally handled through a radio frequency identification (RFID) portal that does everything including receiving, tracking, and dispatching. Similar transactions in the second economy are completed without any human input on the business side. This removes those previously existing jobs from the physical economy. Arthur predicts that the second, digital economy will be the same size as our physical economy in twenty years.

The technology allowing the existence of the second economy is improving everyday. Software allowing automation is constantly progressing and creating more efficient workflows while removing the need for many human-operated positions. Unmanned aerial vehicles (UAVs, drones) are also beginning to more heavily infiltrate the workplace, but many still require a human controller. The use of drones has become so popular that the government is currently working on new laws to determine airspace regulations for these vehicles. A report produced by the Association for Unmanned Vehicle Systems International (2013)

indicates that in the 11 years following mass implementation, more than 100,000 jobs will be created and that the jobs eliminated by drones will have a net zero effect on the economy. However, this report does not seem to consider the incorporation of artificial intelligence.

Machines using AI have been conceptualized for years and some forms of it have finally been released. AI is currently experienced most frequently in gaming, but it will likely be seen on a much larger scale in the near future. Software is being developed for things much more complicated like self-driving cars, service robots, and drones.

Kim et al., (2006) provided research to create service robots for the elderly. The robots are designed to perform housekeeping, yard maintenance, and security. The researchers formulated an argument that an industry-standard development system would be an effective way to design these robots. The outcome of their research was the COMET (Concurrent Object Modeling and Architectural Design) method. Their goal is to implement this method in UML (Unified Modeling Language)-based service robot software. It could prevent flaws and inconsistencies in software innovations.

The ability of robots to work with humans introduces the element of human-computer interaction. A time may come when many of our human coworkers will be replaced by robots. While that occurrence seems plausible in some cases, in others workers doubt that they could ever be replaced. One argument is that robots will never reach the same cognitive ability as a human for reasoning and understanding emotions. Although robots might not be able to achieve the same level of empathy and understanding as a human, it is highly possible that they could reach a level high enough to participate in most business settings. Researchers have provided plans for the cognitive architectures of artificially intelligent computers (Johal, Pellier, Adam, Fiorino, & Pesty, 2015). These plans outline the science behind human emotion and find ways to cognize them with a machine. Today, several of these machines have been created successfully with few flaws. They use voice, touch, and facial expressions to detect emotions and attempt to respond accordingly.

With all of this new technology and its influence on the workplace and the economy, the sociological effects must be addressed. Humans are creating all of these innovations, so it is society's duty to take responsibility for the positive and negative outcomes. When technology is in the wrong hands, it can cause vast and serious damage. Dodig-Crnkovic (2015) conducted a study in two Swedish universities, which involved teaching professional ethics and sustainable development courses to two classes of engineering students. The findings contained positive social results demonstrated by engineers who completed the course. Those engineers were more likely to consider the impact that innovations would have on humanity in their development process, which could lead to the prevention of many potentially catastrophic effects on society.

As the time approaches when computers could be able to think and work for themselves, it is important that the technology designers consider the social impact when developing artificial intelligence. Incorporating ethics classes into the educational system and addressing technological innovations could help to ensure that computerization does not have a negative impact on the existence of humans.

Considering the rate technology changes today, current and future workers can never afford to abandon education. Society is making a major switch from education-optional to education-required to survive in the current and future economy. Those that cannot or refuse to keep up with the changes will be subjected to "technological unemployment," or unemployment caused by technology updates within the workplace. A 2014 study evaluated the effects of different types of higher education on a resume submission for employment (Deming, Yuchtman, Abulafi, Goldin, & Katz, 2014). By submitting thousands of fake resumes to various employers, the researchers were able to determine that applications showing a college education from a public institution had the most successful callback rates. Contrary from the past, it will likely become exceedingly difficult to acquire or maintain a job without a higher education.

However, today's system of higher education needs to become more flexible and more available (Jen, Kaur, De Heus, & Dillahunt, 2014). In many cases, course material should be adjusted each semester to accommodate change in technology and digital trends (Ernst, 2011). Ernst concluded that making updates to the course curriculum for Computer Organization and Design at the University of Wisconsin had a positive effect on a student's ability to understand and use future digital platforms.

It is extremely difficult to keep up with dynamic technology. Gallivan (2004) analyzed the psychology behind a professional's ability to adapt to the rapid changes in technology. The researchers surveyed IT professionals and evaluated them and their experience in the workplace based on their gender, tolerance of ambiguity, and openness to experience. The study found that the two personality traits did have an effect on satisfaction in the workplace and ability to cope with change. The results of the gender study varied between employers. A worker's personality and ability to keep up with change can have an impact on the likelihood that they will be subjected to technological unemployment.

The government is having a particularly hard time keeping up with the growth in technology. New laws, like those for UAVs, will be needed to deter malpractice in the creation and use of such powerful equipment. There have been several instances in which drones have caused turmoil in the airspace. UAV technology predates the Cold War (Shaw, 2014), and there are still no laws in place. The small issues encountered with human-operated drones will be insignificant once artificial intelligence is massively released. All national governments should be prepared.

The upcoming technological revolution and the expansion of the second economy are going to have an extensive impact on workers and today's society.

2. CANDIDATES FOR REPLACEMENT

Each job analyzed for this section falls into two of the five following categories: routine or non-routine and high-, middle-, or low-skill. David, Levy, and Murnane (2001) used job requirement data from 1960 to 1998 to predict that routine, middle- and low-skill jobs are most likely to be replaced first. The research indicated that technology will replace most jobs requiring only routine and manual skills heightening the need for potential workers to be college-educated creative thinkers. Based on past occurrences and the current capabilities of computers, this seems plausible.

Bitner, Brown, and Meuter (2000) use banking as an example to show that changes in technology and societal preferences have led

to broad computerization in the industry. Before the escalation of the internet and social networks, people enjoyed the social aspect of banking. The tellers made banking an enjoyable customer experience. In 2015, good customer service is more so affected by convenience and efficiency. Computerization has been a popular solution, which has eliminated many routine, middle-skill teller jobs in the process. There are several banks that now operate entirely online in the second economy, such as GoBank.

Several papers were published in the late 20th century detailing the loss of routine, middle-skill jobs, while there was a demand for workers in high-skill positions. Computers taking many of the middle-skill jobs forced the displaced workers into low-skill jobs, high-skill jobs, or unemployment. Most people that learned and understood the new technology remained or leveled-up into the high-skill arena. Those that did not faced unemployment or moved down into low-skill jobs. This process continues to happen today and is a major contributor to the increasing wage gap (Bresnahan, Brynjolfsson, & Hitt, 1999).

Allen (1996) conducted a study that compared jobs in the 1980s that required more technological ability and education to those that did not and provided evidence that the increasing wage gap is a result of "newly" required technology skills. The study also supported that technology replaces some workers and increases opportunity for others. Historically, middle-skill workers have suffered most from technological revolutions. This research also shows that higher education has an important impact on someone's ability to find employment. The 2015 Condition of Education report found that a college education has a significant impact on employment rates and income (Kena et al., 2015).

Jaimovich and Siu (2012) reported on the disappearance of routine jobs in the middle-skilled sector of the economy (ex. manufacturing). They argue that job polarization and jobless recoveries are related by analyzing the increase in low-skill, low-income and high-skill, high-income jobs and the reduction of jobs that fall in between. The findings show that during recessions, unemployment usually afflicts workers in routine jobs and that re-employment is a slow process.

Kristal (2013) argues that the loss of jobs is a result of capitalism and concludes that new technology benefits the employers over the employees concerning efficiency and earnings. Evidence to support this theory was found by studying data from all income sources for the working and capitalist classes.

Frey and Osborne (2013) evaluated jobs specifically on the level of education, routine labor, and cognitive labor required to perform the job to determine which are most at risk for computerization and when. The research deduced that low-skill administration, transportation, and service jobs are most likely to be replaced by computers first. Jobs that require empathy and creativity are the least susceptible to computerization. These jobs include many in the medical fields of mental health and therapy. Frey and Osborne also found that level of education and wage have a negative correlation with the likelihood of computerization. They predict that displaced low-skill workers with creative and social skills will be able to find positions in the middle-skill sector.

3. JOBS OF THE FUTURE

While the evolution of technology might eliminate some jobs, experts believe that it will reinvent and create more jobs than are lost (Smith & Anderson, 2014). As with the invention of the spinning machines in the early 19th century, innovation leads to improvement in efficiency, which opens the door for opportunity.

The jobs reinvented will be those that remain after computerization occurs in their industry sector. Those workers will be interacting with robots and artificially intelligent computers on a daily basis. This will require higher education and an understanding of the new equipment. For example, carrier aircrafts might no longer require pilots onboard. Instead, the job might call for a ground controller to pilot a carrier drone remotely. These will likely be considered middle-skill jobs that require some amount of cognitive reasoning.

Beaudry, Green, and Sand (2013) conducted an analysis that indicated that the jobs created as a result of computerization will provide an oasis for workers displaced by computers. The new jobs, including computer maintenance, are likely to require more skills than cognitive ability. The research argued that the unemployment rates in 2013 were due to the fact that there was a shift in the demand for skills and cognitive abilities. It shows that after a significant technological revolution, there is an eventual need to re-employ middle-skill workers to meet demand for and materialize trending inventions. The research tracked the reversal in the demand for abilities from the year 2000 to 2011 using employment statistics and job requirements.

It is possible that these new middle- and low-skill jobs might not be stable since daily progress is made on human-computer interaction and AI. Eventually, carrier drones could be able to consciously pilot themselves and new machinery will be materialized with automation. Müller and Bostrom (2014), surveyed four groups of experts in the AI field and the findings indicated that they believe AI will reach human ability in around 25 years and that it will eventually surpass human intelligence.

However, Autor (2015) concluded that although many middle-skill jobs are susceptible to replacement, several still require enough cognitive ability that they likely will not be. These somewhat irreplaceable positions can be easily attainable, as many of them do not require an extensive amount of higher education. Additionally, it has been predicted that many of the jobs created by the upcoming technological revolution will fall into the middle-skill spectrum (Frey, 2014). This could mean that the supply of these jobs will not fall short of demand.

Another trend that will continue to reinvent the workplace is crowdsourcing. With better networking capabilities, companies are easily able to find skilled, remote, more cost-effective workers to assist in completing projects. This makes the job market much more competitive. A 2011 study justified this claim by analyzing the users on Microworkers, a crowdsourcing platform (Hoßfeld, Hirth, & Tran-Gia, 2011).

Although there is no empirical data for the future, Frey (2014) studied history, emerging technology, demographics, and trends in human interests to predict a range of jobs that could be created. He then arranged these jobs into a mix of existing and futuristic industries.

Transportation. Thought leaders are currently working on personal rapid transit systems (Frey, 2014). They are intended to operate much more efficiently than any of our current methods of transportation and will create a new sector of jobs in the transportation industry. For example, this system will need architects, station designers, and circulation engineers.

Atmospheric Water Harvesting. Progress has already been

made with technology that will extract water from the air (Kabeel, Abdulaziz, & El-Said, 2014). This could be the solution to many droughts and could also replenish the copious amounts of water used in industries like farming. When this goes global, it will open up many jobs for architects, managers, and maintenance workers (Frey, 2014).

Future Sports. With all of the digital developments, including virtual reality, new sports could be created and the existing sports improved. This would open up a realm of new positions in genetic modification, simulation, analysis, and more (Frey, 2014).

3D Printing. 3D printers already exist and are becoming more common and more affordable. They have the potential to change the world and the way business fuctions. As their popularity grows, the industry could generate many new jobs. Frey (2014) mentions manufacturers, engineers, designers, chefs, and medical professionals as examples.

All of these futuristic industries could create jobs within every sector of skilled work. They would also provide crossover opportunities for existing professionals.

CONCLUSION

This paper reviewed scholarly literature that explains why certain jobs might be replaced, reinvented, or created because of computerization in the future. The research indicates that routine jobs requiring little cognitive reasoning will be replaced first. Many of these jobs are in the middle-skill sector of work. History shows that middle-skill workers are the most likely to be subjected to unemployment after a technological revolution. It also shows that displaced workers are eventually able to find jobs again, but it is a slow process, and it is probable that they will be re-subjected to technological unemployment at a later time.

The majority of the jobs that remain and the jobs in demand will require an understanding of new technology, a higher level of education, and cognitive reasoning ability. The job market will also become more competitive. Developments in technology including automation, drones, human-computer interaction, and AI will reinvent existing jobs and create new jobs in new industries.

With unabating innovation, the cycle of job replacement, reinvention, and creation will never end. Jobs will be eliminated and created regularly impacting many people. The literature shows that the best solutions available to society are to actively continue education and stay up-to-date with new technology.

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