The Awe of Automation and Robotics

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Abstract: *In recent years, automation and robotics have become a popular topic that has been discussed and researched by many people. By evaluating the existing information and data, some authors and researchers believe that automation and robotics have brought many benefits and advancements to various industries. However, there are also some that held different opinions. Therefore, the aim of this secondary research paper is to find out and discuss both the positive and negative impacts experienced as a result of automation and robotics in various industries. This research paper is completed through the existing data found in journals, books, news and websites. Hence, it will be limited to certain industries only. The result of this paper shows that more positive impacts are being identified in adopting automation and robotics compared to the negative ones in the investigated industries. However, some issues that arise due to automation and robotics have to be solved or reduced before they become a bigger problem.*

Keywords: automation, robotics, positive impacts, negative impacts, unemployment

1. Introduction

The advance in technology has created strong momentum in operations management. Undoubtedly, this new era of transformation would affect and change the current approaches, processes, models and systems in various industries (Liu, Zhuand Seuring, 2020). By studying the existing information and data, some of the authors and researchers proposed that automation and robotics have brought many benefits and advancements to various industries and organizations. However, there are also other authors and researchers that held different opinions, which argue that automation and robotics have created negative impacts in various aspects. Thus, the objective of this paper is to identify and discuss both the positive and negative impacts experienced as a result of automation and robotics by various industries and organizations.

This paper will be divided into four parts, which include the literature review, discussion, conclusion as well as recommendations. Since there are various industries and organizations that have developed and adopted automation and robotics in their operations, this paper will thus focus on the Manufacturing Industry (MI), Construction Industry (CI), Restaurant Industry (RI) and include a few organizations in particular industries as examples. Therefore, more of the focus of this research paper will be placed on the automation and robotics that are related to the MI, CI and RI. According to Denepudi (2018), the term 'automation' was made up in 1946 as a word to describe the increased use of automatic devices in mechanized manufacturing lines in the automobile industry. While the terms 'robot' and 'robotics' has been introduced earlier compared to automation. The term 'robot' was first introduced in 1920. This term was derived from the Czech word 'robota', which carries the meaning of 'forced labour' or 'heavy work'. Then the word 'robotics' appeared in a novel for the first time in 1942 (Gasparetto and Scalera, 2019). Based on the brief history of automation and robotics, it is not difficult to find out that people are finding ways to exploit the available technology to be used in operation to get certain benefits since many years ago. Hence, this paper will further discuss whether the adoption of automation and robotics has improved the working process and achieved the desired objectives.

2. Literature Review

The presence of automation and robotics has revolutionized the operations of various industries in just a few decades (Gasparetto and Scalera, 2019). Without a doubt, automation and robotics have a crucial role to play in operations (Mohammed and Abdullah, 2019). As a way of analyzing the impacts of automation and robotics, the literature review of this research paper will touch on the benefits and problems brought by automation and robotics.

2.1 Definition of Automation and Robotics

Automation can be defined as a technology that can carry out tasks that were previously done by humans. The introduction of automation is to enhance everyday business processes so that the workers can spend more time on their actual work instead of on the processes that support the work (Mohamad, Natrah and Ahmad, 2019). While robotics is a machine that is able to perform physical tasks semi-autonomously or autonomously after being programmed by a computer (Ben-Ari and Mondada, 2018). In short, the concept of automation and robotics is to build devices that can perform heavy and repetitive tasks to reduce the burden on people (Gasparetto and Scalera, 2019).

2.2 Adoption of Automation and Robotics

As it is known to all, the adoption rate of automation and robotics is increasing year to year. The global automation and robotics market is predicted to grow by more than 10% a year and reach $21.3 billion by 2026 (Edwards, 2022; Research and Markets, 2021). Due to the wake of Industrial 4.0, 59% of the manufacturers have started to use at least some form of automation and robotics. This makes the MI become the highest rate of adoption of automation and robotics (Bourne, 2020; The ASEAN Post, 2019). The key driver for increased automation and robotics might be due to the government pushing for a minimum wage increase (Research and Markets, 2021). The increasing workforce demand and pressure have pushed the need to consider various automation and robotics in operations (Farah and Shahin, 2018). Obviously, there are also some other reasons for organizations to adopt automation and robotics,

including increasing productivity, cost reduction, improving the quality of products and services and others which will be further discussed below.

2.3 The Positive Impacts of Automation and Robotics

Generally speaking, automation and robotics have impacted the operations of various industries in a positive way. The majority of research indicates that automation and robotics increase the productivity of the MI, CI and RI (Jamshed, Zeashan and Azfar, 2017; Seo and Lee, 2021; Bogue, 2018; Farah and Shahin, 2018; Anas and Yudi, 2017; Hickman *et al.,* 2022; Au-Yong-Oliveira *et al.,* 2019). The main reason would be automation and robotics can be programmed to work 24/7 for continuous production, in contrast, human workers are unable to achieve this (Acieta, 2022). The efficiency of operations in some organizations has proved that automation and robotics are playing a significant role in **increasing productivity**, which also directly increases the organizations' market competitiveness (Jamshed, Zeashan and Azfar, 2017; Farah and Shahin, 2018).

Besides, a number of research have proved that the adoption of automation and robotics would directly **reduce operation costs**, especially labour costs (Pan *et al.,* 2018; Jang and Lee, 2020; Sain, Singh, and Kaur, 2020). The utilization of automation and robotics can replace human labour which directly reduces expenses and machines and robots are possible to perform the task of 3 to 5 people depending on the task given (Pan *et al.,* 2018; Productivity Inc., 2022). As mentioned above, the minimum wage for labour is increasing; hence, adopting technologies will be the best solution to save costs (The Restaurant Times, 2021).

Furthermore, some studies mentioned that automation and robotics are able to **improve the quality of products and services** (Zheng *et al.,* 2018; Mohamad, Natrah and Ahmad, 2019; Kumar, Balasubramanian and Raj, 2016; Albert *et al.,* 2019; Research and Markets, 2021; Hickman *et al.,* 2022). This is because automation and robotics are able to carry out tasks with less or without human errors. By eliminating human errors, waste reduction such as waste in materials and time can also be achieved (Manuel *et al*., 2019; Albert *et al.,* 2019; Mohamad, Natrah and Ahmad, 2019; Jamwal *et al.,* 2021; Hickman *et al.,* 2022; Au-Yong-Oliveira *et al.,* 2019).

In addition, organizations aim to **improve workplace safety** for workers particularly those in high-risk industries such as the MI and CI through automation and robotics (Pan *et al.,* 2018; Kumar, Balasubramanian and Raj, 2016). On the other hand, due to the outbreak of COVID-19, providing services without contact are in the spotlight as the safety of workers and customers is the main concern for restaurants. This trend widespread the use of service robots in restaurants to reduce the probability of workers and customers getting infected (Jang and Lee, 2020; Wang and Wang, 2021). However, research conducted based on the **Technology Acceptance Model** (TAM) has indicated that customers have concerns and trust issues about the service robots as the adoption is yet to be widely commercialized (Seo and Lee, 2021), which will be further discussed below.

Last but not least, **hygiene** is an important element in food manufacturing because poor hygiene practices would increase the level of bacteria and germs in the food (Giammanco *et al.,* 2011). Therefore, adopting automation and robotics in certain processes is the way to ensure the foods produced are untouched by a human during processing to prevent the transmission of bacteria and germs. The devices used in food manufacturing will be washed regularly with pressurized hot water and industrial detergents to ensure the food produced is safe for consumption (Jamshed, Zeashan and Azfar, 2017).

2.4 The Negative Impacts of Automation and Robotics

Without a doubt, automation and robotics are accomplishing the above-mentioned benefits. Even so, it brought together some problems that cannot be ignored. Worker displacement or in other words, **unemployment** is the main problem often associated with automation and robotics (Wajcman, 2017; Seo and Lee, 2021; Lima *et al.,* 2021; Au-Yong-Oliveira *et al.,* 2019). Throughout history, the advancement of automation and robotics did not cause unemployment in the long run although it caused some disruptions to the labour market. However, some technological unemployment thesis mentioned that the current revolution is different from the previous ones and has caused an increase in unemployment (Lima *et al.,* 2021). This can be proven as the advancement of automation and robotics are replacing more and more jobs that were previously done by people. Hence, the probability of technological unemployment is fairly high (Au-Yong-Oliveira *et al.,* 2019).

Furthermore, the **high initial costs** to adopt automation and robotics could be a challenge for organizations (Delgado *et al.,* 2019; Mohammed and Abdullah, 2019; Duong *et al.,* 2020). Thus, there are some organizations that hesitate to plunge into fully automated processes due to limitations in financial resources (Kumar and Gupta, 2019). On the other hand, organizations expect that the high initial adoption costs would have a quick return; in fact, some of the organizations are struggling with low returns (Delgado *et al.,* 2019).

Last but not least, it is no denial that the adoption of automation and robotics would **increase the safety of workers** to some extent, at the same time, however, it contains risks of hazards especially human-robot collaboration (Galin and Meshcheryakov, 2019). Collaborative robots (Cobots) that shared physical space with humans to do some automated and manual processes have resulted in highly complex safety cases (Gleirscher *et al.,* 2022). Therefore, strictly following some regulated security and protective measures which have been stated in ISO 10218 and ISO 15066are necessary when composing human-robot collaboration. Also, a **Hazard and Operability Analysis** (HAZOP) needs to be conducted to identify potential hazards and operability problems (Gleirscher *et al.,* 2022; Chemweno, Pintelon, and Decre, 2020).

3. Discussion

3.1 Human versus Automation and Robotics

3.1.1 Productivity

Currently, the biggest and most challenging task faced by organizations is productivity. The low efficiency of workers is one of the significant factors that push the adoption of automation and robotics (Sreekumar, Chhabra, and Yadav, 2018). Take the world's largest food and beverage manufacturer, **Nestlé** as an example; the adoption of robots has boosted the plant's productivity by 53% (Asea Brown Boveri Ltd., 2021). Similar to the CI, the adoption rate of **drone technology** has grown by 239% in 2018 as it has a productivity level of up to 94.48% compared to traditional techniques and human workers (Mahajan, 2021). Other than drones, a **3-D printer** is also currently emerging in the CI. It is a machine that can build buildings such as houses by depositing material layer by layer (Cherdo, 2022). Griffiths (2014) mentioned a Chinese Organization, **WinSun** has used four huge 3-D printers to build ten bungalows within a day and part of the materials are recycled construction waste which also creates a positive impact on the environment. Furthermore, in a related study, the application of technology in the RI is also proven to be effective. **Service robots** are starting to be used in restaurants such as cooking and delivering food and beverage. Adopting service robots can reduce the waiting time, for instance, a restaurant in Boston, **Spyce** with a robotic kitchen can get the food served to customers in three minutes or less (Seo and Lee, 2021). This short waiting time achieved by Spyce by adopting available technology has a stark contrast to the fast-food restaurant. A study found that the average waiting time for fast-food restaurants would be 5.42 minutes which is longer compared to Spyce. The waiting time would reduce customer satisfaction where some customers have expressed dissatisfaction as 5 minutes to get fast food served is considered long (Mathias, Hera, and Erwin, 2012; Johanudin et al., 2018).

3.1.2 Cost Reduction

As discussed above, the government is pushing for a minimum wage increase (Research and Markets, 2021). This has been proven by studying the existing data, the basic wage in Malaysia is on an upward trend (Trading Economics, 2021). What is noteworthy is that the basic wage in Malaysia is announced to be adjusted from RM1, 200 to RM1, 500 which will come into effect in May (Thomas, 2022). More importantly, machines and robots are different from human workers, they are able to work 24 hours per day and perform the task of 3 to 5 people depending on the task given (Acieta, 2022; Pan et al., 2018; Productivity Inc., 2022). This can be proven by the factory of **Tesla** located in California, which is operating for 24 hours to hit the production goal but it needs 3 work shifts to run the factory smoothly (Hyatt, 2018). However, machines and robots used in the factory can work around the clock without ceasing and do not demand a raise. Therefore, adopting automation and robotics would be more cost-effective for organizations (Mohammed and Rumaiya, 2014).

Besides, based on the investigation, in some highly labour-intensive industries such as the RI, the percentage of labour costs is sometimes reported to be 75% of total sales (The Restaurant Times, 2021). Hence, adopting a service robot is the only choice to reduce operating expenses. For example, **NALE-The Nasi Lemak Company** located in Shah Alam has adopted service robots to reduce costs and at the same time serve food contactless during the pandemic (Husna, 2021).

3.1.3 Improve the Quality of Products and Services

According to Kujawinska and Vogt (2015), the error rate of visual quality control would only range between 3% to 10% in simple control tasks and under the best condition. However, the error rate would increase to 20% to 30% under the suboptimal condition and due to other factors, such as lightning, work time and stress level. Based on research, the accuracy of the quality inspection is range from 95% to 98.6% by using machine vision technology. Hence, an **automated smart quality inspection robot** should be used for quality inspection and control, especially in manufacturing processes such as food production due to the demand for food quality and safety (Lu, Xu, and Wang, 2020; Guo et al., 2020). This automated smart quality inspection robot is also widely used in automobile manufacturing to inspect and control the quality of large objects (Asif, 2017). By eliminating human errors, waste reduction can be achieved. Take automobile manufacturing as an example, each car contains around 100 components that are made of different materials, this increases the possibility for human errors and lets defects go unnoticed during production. The defective materials need to be either discarded or repurposed before continuing to be used in production. Therefore, if small defects are not noticed and continue to be in production, they would become large defects which increase the waste of material and directly increase costs to the organization (Naber, 2022).

3.1.4 Safety

Sain, Singh and Kaur (2020) and Kumar, Balasubramanian and Raj (2016) stated that the absence of automation and robotics could cause poor safety standards in the MI and CI which may result in heavy injuries or death. Hence, technology that can help to improve the safety of workers has largely been introduced in the operation of particular industries. According to the United States Bureau of Labor Statistics, there are approximately 40% of eye injuries in the workplace per year and mainly from the MI and CI due to welding (American Academy of Ophthalmology, 2014). Thus, utilizing available technology that can directly reduce workers' risk is essential. For example, **welding robots** are required to ensure a high level of safety and improve working conditions (Oke et al., 2019). Besides, **material handling robots** are also being used in MI and CI as they can automate the most unsafe and tedious tasks and improves efficiency in operation (Robot Worx, 2022). Kumar, Balasubramanian and Raj (2016) mentioned that carrying heavy material manually by workers from one place to another may cause trips and falls, therefore, utilizing robots to carry loads is necessary.

On the other hand, the outbreak of COVID-19 has given impetus to the adoption of service robots in the RI to avoid services with high levels of human contact. Service robots are safer compared to human waiters during the pandemic

which also directly protects both workers and customers (Jang and Lee, 2020; Wang and Wang, 2021). Research related to service robots has been conducted by Seo and Lee (2021) using TAM to explore the reasons and analyze the decision of people on accepting or rejecting technology. Based on the result, the customers agree that service robots are useful and more of them intend to revisit robot restaurants. However, the findings also show that some customers have concern and trust issues with service robots in the RI as they are yet to be widely commercialized. The increased perceived risk of customers would directly decrease satisfaction with robot service restaurants. Thus, an effort needs to be made by restaurants to improve the trust of customers and increase their intention to revisit (Seo and Lee, 2021).

3.1.5 Hygiene

According to Farah and Shahin (2018), optimum hygiene standards are the key element that must be maintained in food manufacturing processes. Adopting automation and robotics in food manufacturing can eliminate human contact with food and decreased incidents of cross-contamination. Poor hygiene practices in the food production processes would increase the level of bacteria and germs. This can be proven by a study conducted, due to poor hygiene practices during cheese production, there is a high level of bacteria in the 50 pieces of cheese analyzed, which does not comply with the acceptability levels for **Staphylococcus aureus** and **Escherichia coli** (Giammanco et al., 2011). Staphylococcus aureus and Escherichia coli are the significant causes of food-borne disease, estimated 241, 000 cases and 70, 000 cases reported respectively each year in the United States and these infections might cause death (Kadariya, Smith, and Thapaliya, 2014; Johns Hopkins Medicine, 2022). Therefore, the application of automation and robotics in certain processes is necessary to reduce the transmission of germs and bacteria. For instance, **robotic manipulators** are encouraged to be used to reduce or eliminate the food produced being touched by humans. Other than that, **mixers and blenders** are also commonly used in food manufacturing. The advances in mixers and blenders have ensured hygiene and at the same time ensure the high quality of food produced as the machine can be programmed based on the speed of mixing and length of mixing time (Pellegrini, 2017).

3.2 Arising Issues in Automation and Robotics

3.2.1 Unemployment

With the increasing adoption rate of automation and robotics, machines and robots have taken over many tasks that were previously done by humans (Au-Yong-Oliveira et al., 2019). Lima et al. (2021) mentioned the current revolution is different from the previous ones and has caused an increase in unemployment though now the rate of technological unemployment is still not a major threat for most workers. However, the global unemployment rate is estimated to reach 24% or more in 2050 which is approximately 4 times higher compared to the global unemployment rate of 6.3% in 2021 due to the unequal distribution of work between humans and technologies (Daheim and Wintermann, 2015; Wajcman, 2017). According to Lima et al. (2021), several studies have been dedicated to estimate the impact of

automation and robotics on jobs and the result shows that there is around 85% of the workforce in Ethiopia is at high risk to be replaced by technologies, followed by Brazil (60%), Uzbekistan (55%), Switzerland (48%), the United States (47%), and Canada together with Germany (42%). From the studies, it can be concluded that the job security of a high number of people has been affected and threatened due to the revolution of automation and robotics in operations, especially semi-and low-skilled workers (Albert et al., 2019; International Labour Office, 2011).

3.2.2 Investment Costs

Many authors have mentioned that there is a high cost required for organizations to adopt automation and robotics in their operations (Delgado et al., 2019; Mohammed and Abdullah, 2019; Duong et al., 2020). A study conducted has proved that the high initial capital investment ranked as the main challenge faced by organizations (Delgado et al., 2019). In 2018, a total of $55m of investment has been invested by **Nestlé** together with **XPO Logistics** to just test run prototype robotics and automation technologies in a warehouse (Churchill, 2018). Hence, adopting automation and robotics in operations needs a strong financial resource to support. It is not affordable for all organizations and this might be the reason that some organizations refused to move into fully automation and robotics in their operations (Kumar and Gupta, 2019).

3.2.3 Safety Issues

As discussed, one of the purposes for organizations to adopt automation and robotics in operations is to improve the safety of workers during work. However, some incidents that happened have proved that operating the machines and robots with a proper procedure, following strict regulated security and providing protective measures are necessary to avoid unforeseen incidents. When dangerous machinery is involved in the workplace, a small mistake can lead to serious injuries such as crushed limbs, hands, or fingers, broken bones, amputation, electrical burns, or even wrongful death (Ji, Pons and Pearse, 2018). For instance, the death of a food manufacturing worker that has fallen into a spin chiller while doing cleaning work (Yee, 2021). The incidents are reminding the organizations to ensure the safety of workers while adopting automation and robotics to gain benefits. Therefore, some specific guidelines and requirements such as **ISO 10218** and **ISO 15066** have been developed by the International Organization for Standardization to guide organizations to provide a safe workplace for the workers. In ISO 10218, guidelines and requirements for the intrinsic safe design, information and protective measures to operate industrial robots have been specified. It also describes some basic hazards related to robots and provides requirements to eliminate or alternatively reduce the risks (ISO, 2011). While in ISO 15066, the safety requirements for the working environment and collaborative industrial robot systems have been specified. It also added additional guidance and requirements on collaborative industrial robot operation stated in ISO 10218 (ISO, 2016). Besides, HAZOP, a systematic and structured way to identify potential hazards and operability problems should be conducted by organizations as a final check before starting to operate a machine or robot (Chemweno, Pintelon, and Decre, 2020; Rausand, 2011).

4. Conclusion

Undeniably, the advancement in automation and robotics have brought several benefits to operations, including improved productivity, reduced labour costs, improved quality of products and services, increased safety of workers and hygiene. However, the research also shows that automation and robotics have raised some issues, such as increasing technological unemployment, high investment and initial cost and safety issues. Although there are more positive impacts that have been identified compared to negative ones, still, some of the issues risen need to be solved or alternatively reduced. By preparing this research and the recommendations provided below, some issues that arise due to the adoption of automation and robotics could be avoided or reduced.

This secondary research paper has identified and discussed both the positive and negative impacts of automation and robotics in the operations of the MI, CI and RI. While the previous studies gathered were limited to investigating the impacts of automation and robotics in one particular industry instead of investigating it as a whole. Since a secondary research method has been used in this paper, further research can be done by distributing a survey to a few different organizations that embark on different industries to find out the specific benefits they gain from adopting automation and robotics and also the opinions regarding the risen issues due to the automation and robotics in operations.

5. Recommendations

First and foremost, **appropriate training should be provided** to ensure workers know the proper procedure to operate the machinery to avoid any unforeseen incidents. As discussed above, a small mistake would lead to serious injuries or even death when operating dangerous machinery (Ji, Pons and Pearse, 2018). More importantly, research conducted shows that the level of awareness about occupational hazards among operation workers is sometimes limited (Ayodele and Olubayo-Fatiregun, 2013). Thus, providing appropriate training for workers is an effective way to avoid or reduce accidents. When the workers are well-trained, increased hazard awareness and have a deep understanding of how the machinery is operating, the accident cases are expected to be reduced (Awodele *et al.,* 2014).

Furthermore, organizations need to **ensure that they are strictly following the guidelines and requirements** that have been mentioned above. Organizations are responsible to provide workers with a suitable and safe workplace especially operating cobots that involved human-robot collaboration. For example, environmental aspects such as noise insulation and sufficient lighting are important as they would influence the collaboration of human operators with robot systems (Chemweno, Pintelon, and Decre, 2020; Gleirscher *et al.,* 2022). Also, the organizations have to do every checking that is necessary before putting the machinery into use to prevent any accidents caused by improper functioning (Chinniah, 2015).

Lastly, organizations are **recommended not to operate fully with automation and robotics**. Automation and robotics should be adopted for necessary processes only. For example, the process that needs to run for 24 hours which is unable to be accomplished by a human worker, or in other words, needs a few alternative shifts that would increase labour costs. By taking this action, technological unemployment can be reduced and at the same time, organizations can save some labour costs by adopting available technologies to do the longest hours of work.

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