HUMAN-MACHINE RELATIONSHIPS IN THE AUTOMATION INDUSTRY: ROBOTICS, ARTIFICIAL INTELLIGENCE AND AUTOMATION APPLICATIONS

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ABSTRACT

The interaction of robotics and artificial intelligence (AI) has profoundly impacted the automation industry. Integration of advanced technology to automation processes opens up new opportunities to achieve levels of quality and productivity not previously feasible. Automated processes are transforming more adjustable and smart systems, utilizing the capabilities of AI and intelligent robots to boost efficiency or reduce costs. AI-enabled robots also provide a safe working environment for operators while assisting people in processing massive amounts of data and making real-time decisions. This research aims to identify and explore these emerging phenomenon trends through a conceptual framework combining human and machine relations. While certain operations may be automated, applying new technology to activities will also enable the creation of new jobs, allowing flexibility for human operators to concentrate on creative problem solutions. Five propositions provide direction for research in this field, including (1) the continuing role of humans, (2) the enhancement of job-related skills, (3) the impacted labor market, (4) the effects on mental health, and (5) the role of trust. The study also provides managerial and research implications.

Keywords: *Robotics, Artificial Intelligence, Cobot, Automation, Internet of Things.*

INTRODUCTION

"Not Fired, Just Not Hired" was the caption of Time magazine's "The Automation Jobless" story (Time, 1961). Over the past two centuries, there have been regular predictions that new technology and automation will cause a significant loss of middle-class jobs (Autor, 2015). According to the World Economic Forum, technology will generate at least 12 million more employment by 2025 than it will eliminate, indicating that automation will ultimately benefit society (Nunes, 2021). Advances in robotics and AI can automate a wide range of human activities and dramatically reshape how people live and work in the coming decades (Smith and Anderson, 2017). Though much of today's automation occurs behind the scenes, technology is becoming more visible in people's daily lives. Everyday activities may soon use more technology than ever before. Automation impacts our lives daily through machine learning, AI, and robots, often without our awareness (Hughes Network Systems, 2018).

In a process known as "creative destruction," the emergence of robots has increased productivity, economic growth, and the creation of new employment in industries that do not yet exist. According to estimates, a 1% increase in the number of robots per worker in the industrial sector results in a 0.1% gain in production for the entire workforce (Cooper, 2017). A new era of automation is beginning due to advancements in robotics and AI, which enable machines to perform as well as or better than humans in various tasks, including those requiring cognitive ability. According to McKinsey Global Institute analysis of more than 2,000 labor activities spanning 800 jobs, over half of the tasks for which individuals are paid about $16 trillion in salaries in the world economy have the capacity to be replaced by automation by adopting existing proven technologies (Chui et al., 2017). In contrast, the Global Gross Domestic Product (GDP) was around 81 trillion in 2017 (World Bank, 2022).

Integrating automation and business systems, which focuses on aligning all activities to the customer perspective, accelerates leveraging new digital technologies to improve efficiency and competitive position (Lydon, 2020). Innovations in the automation industry, driven by new technology like AI, are transforming how businesses manage repetitive tasks (Hecks, 2021). Now, automation involves a wide range of technologies - from complex machines like robot arms to relatively computer software that automates tasks such as data entry and processing by AI. The new technology that almost every business can take advantage of recent innovations is built for heavy industry and general business use. Technology is primarily a tool with no value if it does not align with strategy or improve operations as a whole (Deloitte Insights, 2020), so by using technological advancements, the factories need to be outfitted with smart sensors, embedded software, and robots that gather and analyze data to enable better decision making.

Working conditions and lifestyles have been significantly altered by modern industrial technology. The step into production technology, utterly different from the past, is called the industrial revolution. Fundamental changes such as the invention of machines and the adoption of factory systems in how people conducted business all played key parts in how the Industrial Revolution developed and influenced people's lives for generations to come (Ultius, 2013). The first revolution began with vast coal extraction and the major creation of the steam engine, which generated a new energy source. At the same time, the increase in steel demand, chemical synthesis, and communication systems like the telegraph and telephone were critical factors in the second industrial revolution. In the second half of the 20th century, people witnessed the third industrial revolution developing in the era of high levels of automation due to computers, robots, and programmable logic controllers (Institute of Entrepreneurship Development, 2019). The Internet of Things, cyber-physical systems, and information and communication technologies have all contributed to the fourth industrial revolution, which is now taking place in the 21st century. (David et al.,2022). From a commercial standpoint, the fourth industrial revolution's objective is to be able to mass-produce individualized items at low cost. To achieve this goal, it is required to redesign the manufacturing processes and increase factory productivity and efficiency by automation (Bonnaud et al., 2019).

The purpose of this research is to explore the emerging automation industry and the relationships created between humans and machines. Specifically, this paper will propose a conceptual framework emphasizing the crossovers among robotics, AI, and automation. It will

use an interaction pyramid to address and highlight human interactions with crossover points by mentioning significant aspects of the human function, while a Venn diagram will describe recent applications in the automation industry. The study will further identify newly generated tasks and how they impact human attitudes and social inequality while creating gender and wage gaps.

LITERATURE REVIEW

The Oxford Dictionary defines automation as using machines to do work that was previously done by people. International Society of Automation (ISA) defines automation as "the creation and application of technology to monitor and control the production and delivery of products and services" (International Society of Automation, 2017). Automation is pre-programmed, a self-running system that performs specific tasks and precisely follows human instructions without making its own conclusions. At the same time, it allows people to monitor asset and production performance and simplify workflows by eliminating human process inefficiencies and delays to maintain lean, efficient, and productive operations (Foster, 2022). Automation not only comes with favorable effect costs, time, and production advantages but also can help decrease or eliminate three of the five primary causes of workplace accidents: contact with hazardous items, heavy lifting, and repetitive stress injuries, and lead to lowering the frequency of occupational injuries in manufacturing by up to 72%. (Universal Robot, 2019).

Although robotics and automation have many common elements, many possible distinctions exist. Robotics is concerned with systems that include sensors and actuators that function independently or semi-autonomously in collaboration with people (Goldberg, 2012). Robots are mainly used when tasks are either too complex for humans to perform well (e.g., the movement of heavy parts on an assembly line and other physical tasks), extremely repetitive, or both (Martin, 2021). Although robots offer many kinds of advantages to manufacturers, such as longer working hours, being able to work in dangerous conditions, and higher levels of accuracy and performance than employees, they threaten employees by taking over their jobs. According to Cooper's report (2017), each new industrial robot installed in the manufacturing sector since 2004 has displaced an average of 1.6 employees.

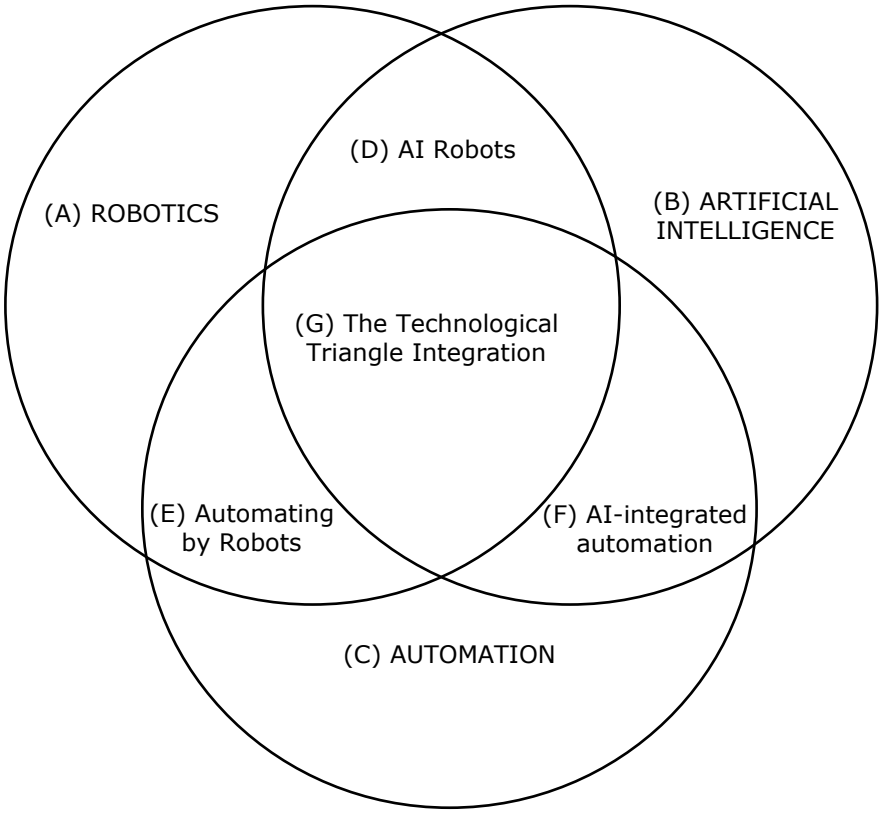
AI has a powerful displacement effect by replacing workers in tasks that they previously performed. It also assists specialists in analyzing conditions and arriving at a decision based on the learning from experience and information it acquires (Acemoglu and Restrepo, 2018). AI not only improves the effectiveness, speed, and precision of human efforts (Statistical Analysis System Institute, 2020) in cognitive tasks such as decision-making, problem-solving, memory, attention, and judgment but also enhances workplace safety by offering an automated approach to monitoring and mitigating injuries before they happen (Balakreshnan et al., 2020). A certain number of workplace injuries occur because workers do not wear Personal Protective Equipment (PPE). The cameras powered by AI can quickly spot workers wearing PPE such as safety glasses, ear protectors, gloves, and hard hats.

New automation technology has been developed for businesses to benefit from the latest industry innovations (Hecks, 2021). The automation industry jumped into a new stage powered by AI and robots. Recent integrations to this process brought fresh breath to automation, such as

machine learning, predictive maintenance, and product quality increased by robots. The application areas of the three sectors are briefly illustrated individually and in combination in terms of specific overlapping regions (Figure 1).

Robotics (A) integrates science, technology, and engineering, which involves robot construction, operation, and design. Robots are automated machines that can do specific activities quickly and precisely with little or no human assistance (Helfric, 2022). Robots have various levels of independence. Some are capable of working totally independently of human inference, while others require ongoing guidance to finish the task. Industrial robots, service robots, and cobots are the main application areas of robotics (Hickman et al., 2022).

FIGURE 1 -
ROBOTICS, AI AND AUTOMATION APPLICATIONS IN AUTOMATION INDUSTRY



Artificial Intelligence (B) is the software that gives computers the capacity to carry out tasks often performed by human minds, such as perception, judgment, learning, and problem-solving (Jorge et al., 2020). Several forms of AI include analytical, functional, interactive, textual, and visual skills (Sarker, 2022). AI can be used to improve an application's intelligence

and functionality. AI has enormous potential to serve humans, such as analyzing more and deeper data, achieving incredible accuracy, and having progressive learning algorithms. AI skills such as understanding, decision-making, risk alerting, and investigation are in great demand across all industries, such as health, banking, public sector, and manufacturing (Statistical Analysis System Institute, 2020).

Automation (C) consists of many components, such as software, devices, and machines built to perform or control tasks with human interactions or fully autonomously. Automation uses technology to minimize the human effort required to achieve specific tasks by replacing or reducing labor. The fundamental principle here is that the work is still being accomplished but with less or no human effort as input (Mckay, 2019). The main application areas are continuous batch operations such as oil refining, manufacturing, and chemical industries, which require non-stop supervision and control. (Hickman et al., 2022).

Aside from regular robots, **AI robots** (D) have particular self-analyzing skills, which AI software embeds in robot systems by learning from their environment and experience. They can behave autonomously without human assistance, and onboard processing technology assists them in analyzing information and making an accurate judgment, whether that option is to move to avoid an oncoming obstacle, pick, or select accurately (Hickman et al., 2022). Integrating AI and robotics has enabled businesses to move beyond automation and use their robots to tackle increasingly complicated and high-level jobs in construction, security, customer service, and health care.

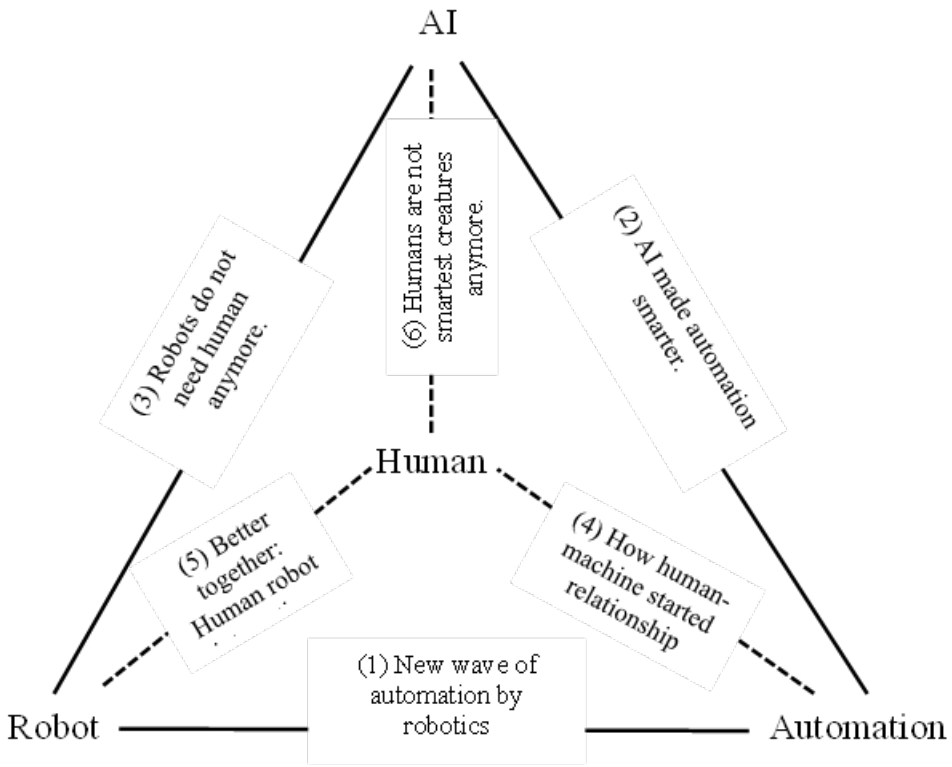
The combination of robotics and automation (E) is one of the most significant recent developments in the automation industry. The processes are automated using robotic arms and cobots that execute pre-programmed, repetitive activities safely and error-freely (Hecks et al., 2021). There are generally two primary applications for robotics integration into the automation industry: industrial robotics and collaborative robotics. Industrial robots are used as multi-axis robotic arms for material cutting, handling, assembling, and painting. In contrast, collaborative robots involve deploying robots and other automation technologies alongside employees to execute tasks.

Merging automation with AI capabilities to improve process outcomes creates **AI-integrated automation** (F). This combination is trained and requires less human effort to impact the process while it provides cognitive input to individuals, augmenting their analytical powers, and does not require professional guidance (Jorge et al., 2020). Predictability and consistency, facts-based decision-making, and operational efficiency are significant advantages of this automation. The combination of AI and automation contributes to the business in many application areas, such as brand management, software testing and development, customer service, and handling batch operations (Sarmah, 2019).

The intersection of AI, robotics, and automation forms **the technological triangle (G) integration**. This integration optimizes workflow operations by enhancing efficiency, lowering risks, and providing superior quality products at a reduced cost by using AI robots (IBM Cloud Education, 2021). AI not only contributes to the integration by embedding in robotic systems but also by effectively redesigning entire automated processes and providing access to major control components.

Entry of AI and robots into the automation industry generated new approaches, increased flexibility, and expanded opportunities. New waves of mechanization also changed humans' role in this process. Robotics and cognitive machines capture the tasks that humans previously performed. With the advent of the new era of automation, the Robot-Automation-AI model needs another dimension: the Human. Managers and technology developers must consider the emerging relationships among all four dimensions. The critical aspects of human-machine relationships are illustrated in Figure 2. These aspects are briefly explained below.

FIGURE 2
HUMAN AND MACHINE RELATIONSHIPS IN THE AUTOMATION INDUSTRY



(1) New wave of automation by robotics. Robots brought new breaths to the automation industry, such as boosting productivity and cutting labor costs (Tilley, 2017). While building automation systems, robots' capabilities should be taken into account. According to Tilley (2017), a successful automation strategy requires good decisions to automate activities at each level, from simple programmable logic controllers to highly sophisticated robots.

(2) AI made automation smarter. Automation systems become safer, less faulty, and more operative. Thanks to AI applications in control systems, based on data and program systems, it can diagnose, control, and predict outcomes (Bryan, 1997). Safety issues have become necessary for manufacturers by integrating the Internet of Things (IoT) into automation systems (Dawson, 2018). When constructing a line of defense against hackers in manufacturing,

AI may be a helpful tool for recognizing and learning patterns continuously for any deviations (Amit et al., 2019).

(3) Robots do not need humans anymore. Due to self-learning, robots keep improving to handle their assigned processes better. Robots controlled by AI can learn from their surroundings and past experiences and expand their capabilities based on that information. AI-based robots are not only used in hazardous environments such as chemical and radioactive factory mining, which are dangerous for human workers, but also in designing and producing goods according to customers' desires (Helfric, 2022).

(4) How human-machine relationship started. Initially, people began to automate tasks to decrease manpower requirements, reduce the cost of operation, and monitor the whole process. Supervisory Control and Data Acquisition systems were built to control and monitor spot devices, measure, and be aware of all kinds of alarms (Li et al., 2017). Thanks to these types of systems, operators could determine the cause of issues, prevent loss of production, and achieve product quality.

(5) Better together: Human-robot interactions. The increased use of human-robot collaboration in manufacturing means enhanced safety, reliability, and more streamlined processes. To execute manufacturing operations on work parts, such as pick-and-place, assembling, screwing, or inspection, humans, and robots may share a workspace depending on the scenarios. There is no doubt that while building the manufacturing processes, kinds of collaborations such as independent, supportive, or sequential scenarios should be considered (El Zaatari et al., 2019).

(6) Humans are not the smartest creatures anymore. AI compensates for humans' weaknesses and limitations by enhancing precision, accuracy, and attention to their efforts (Kazutoshi, 2018). AI helps humans by creating a safer workplace and analyzing big data in manufacturing. As Jorge et al. (2020) mentioned, AI has the potential to analyze massive volumes of complicated manufacturing data such as operation, environmental, measurement, and process data. By quickly analyzing large amounts of data, humans can expand their vision of the manufacturing process by forecasting possible faults and improving quality and productivity.

Without a doubt, machines will eventually be able to complete all necessary activities without the assistance of humans. According to a report by McKinsey (Manyika et al., 2016), 59% of all industrial tasks, including product packing, material loading on machinery for production, welding, and equipment maintenance, can be automated. Management of people and functions requiring experience in planning, creativity, or judgment are examples of less automatable activities. Empathy and contextual understanding skills are generally tough to automate because machines cannot interpret emotions reliably well. Emotional intelligence is necessary for many professions, including those requiring critical thinking, inventive problem-solving, flexibility, and cognitive judgment. (Trompert, 2021).

Cobots, or computer-controlled robotic devices, are technologies developed that can enable complicated and flexible production processes with human assistance (El Zaatari et al., 2019). The strength and endurance of robots are combined with the adaptability and decision-making of human participants in human-robot interaction (Djuric et al., 2016). Humans naturally use a combination of body language and hand gestures, voice commands, and visual interfaces to

contribute to this interaction. Cobots have become more intelligent and highly skilled by working alongside humans than their predecessors.

Compared to people, AI-driven applications have a faster execution speed, greater operational capacity, and exactness while being profoundly large in dreary and monotonous positions. However, the human role has not disappeared in AI-powered automation systems yet. According to Cuomo (2021), "IBM keeps the human impact of automation at the core of every strategy." World Robotics reports in 2021 by the International Federation of Robotics that 3 million robots are working globally (Guerry et al., 2021). In contrast, roughly two-thirds of the workforce is employed in tasks that may potentially be automated with the application of recently developed technology (Manyika et al., 2017). Although Industry 4.0 impacted manufacturing by creating smart factories, human workers dominate the manufacturing labor force, performing more than 72% of factory tasks (Hu et al., 2018). At every level of the production process, automation will lead to improved processes. However, it is still crucial that human involvement is required to react, decide how data should be used for optimal efficiency, and handle problems as they arise.

P_1: Humans continue to play essential roles in the era of automation with their emotional intelligence, cognitive judgment, and mental adaptability, although technological innovations impact the role of humans in the automation industry by changing workplaces or reshaping their tasks.

According to Acemoglu and Restrepo (2018), there is a balance among automation, eliminating people's jobs and labor demand by creating new tasks. Hence, the human workforce that performs physical tasks and analyzes data to increase productivity and quality decreases. In contrast, new jobs generate modern labor demand, like trainers to train using machines, operators to control semi-autonomous robots, and supporters to repair, calibrate, or fix automated machines. As Foster (2022) mentioned, the potential unemployment threat to humans because of automation may transform essential opportunities for improving workers' career paths.

Undoubtedly, new types of jobs affected workers' skill demand while increasing social and cognitive skills and decreasing physical and manual skills. According to Schwabe and Castellacci's estimation (2020), if the automation industry's impact on the labor market increases, workers' skills will reshape according to new technology opportunities. Higher-skilled employees benefit from automation, whereas low-skilled individuals who cannot adapt to the latest industry's outcomes will suffer. McKinsey Global Institute (2018) showed that the number of employees who work as machine feeders or packaging machine operators, which need physical and manual skills, could decrease twice while occupations demanding cognitive and emotional skills will grow with Industry 4.0 disrupting production functions in factories (Bughin et al., 2018).

Professionals in the labor market need to update their abilities promptly throughout their jobs to keep up with changing circumstances (Norton, 2017). Due to the "Skill Revolution," simultaneously, businesses are ramping up their requirement so that their human workforce can undertake new and complex functions with new types of tasks generated (Foster, 2019). Humans

need to focus not only on improving their skills to carry out the functions or activities that cannot be automated or done by robots but also on interacting with automation and gaining the new skills required for machine integration. Regarding skill types in manufacturing and production, the workforce analysis shows that old-fashioned physical and manual abilities will be replaced by managing machines, high learnability, and complex problem-solving skills (Manpower Group, 2019).

P_2: The new wave of the automation industry forces employees to enhance their job-related skills to meet the requirements of businesses to perform newly generated tasks.

While advanced improvements in the automation industry stimulate economic growth, generate opportunities, and raise the standard of living, they may also pose or solve severe issues for individuals and communities, such as growing inequality and job displacement (Mckay et al., 2019). New automation trends create opportunities for high-skilled workers with advanced technical, academic, and interpersonal skills, negatively impacting low-skilled individuals by paying less or threatening job loss. Due to job polarization by automation, employment opportunities and wages between (un)skilled individuals are impacted significantly (Schwabe and Castellacci, 2020). Latest automation technologies will lead to job loss in repetitive task occupations such as assembly line or switchboard operators because of being automated tasks, whereas it may have a more favorable impact on highly skilled people by raising labor demand, earnings, and attractiveness of their activities.

Potential threats have been explained by Acemoglu and Restrepo (2018) that taking away humans' job via automating task lead to the decomposition of wages, the slow adaptation of labor demand, and even decreased profitability gained from automation. By receiving the financial benefits from automation, high-skilled and educated people work in high-wage positions due to high demand from the labor market, whereas the employees who execute the tasks that could be automated or done by robots are low-paid. Furthermore, the occupations requiring low skill are the most risky because these positions consist of repetitive and automatable tasks with more automation potential.

Income polarization by automation will likely tend to change educational requirements because higher degrees of education will likely be required for a more significant percentage of employment in the future. While skill requirements for jobs increase globally, the necessity of advanced degrees for the labor market will increase, and at the same time, occupations with lower educational requirements will decline (Manyika et al., 2017). In considering unequal educational opportunities for everyone, wage polarization may increase in the professions affected by automation.

Regarding gender, the new automation age impacts labor markets unequally by creating opportunities and threats. According to McKinsey Global Institute research, women may, on average, lose their jobs to automation less frequently than males, and given their current employment status, they may also be marginally more likely to fill openings for new positions (Madgavkar et al., 2019a). Automation can potentially cover the gender gap in the workplace by

creating new jobs. According to Harvard Business Review, they estimate that women will be able to be hired to newly generated positions more than men by 2030 due to removing sharply divided gender lines in occupations and sectors by automation (Madgavkar et al., 2019b).

> *P_3: Recent automation technologies impacting the labor market and nature of employment as follows:*
> *P_{3a}: They create more high-skill jobs than low-skill ones by disrupting occupation balance and adapting to future employment needs and educational requirements.*
> *P_{3b}: They accelerate income inequality by widening the wage gap based on humans' current job-related skills.*
> *P_{3c}: They close the gender gap by expanding gender-specific opportunities while impacting gender-based occupations.*

After the latest automation technologies take out repetitive, dull, mundane tasks at employees' workplaces, the jobs that require creativity, innovation, and emotional skills were left to humans. Darino et al. (2019) believe that employees have more control over their daily lives and a higher sense of authority and mission over their efforts, so this process increases their motivation. As automation reduces the workload of humans, it gives employees more time to concentrate on unique and creative activities. According to Smartsheet's automation impact in the workplace report (2017), wasted time is reduced, and human error is eliminated. Automation also leads to more exciting and valuable tasks by focusing on a curious and highly valuable part of employees' jobs.

Depending on psychological and social aspects, automation may contribute to alleviating workplace stress by taking pressure off workers and reducing the possibility of human errors (Wani et al., 2018). Employees are alerted and made clearly aware of their duties due to the automated process, allowing them to work in a more comfortable environment. Furthermore, workers' stress at the workplace is positively impacted due to more challenging tasks getting easier, such as managing machines or tools being easy to use by humans and operating or collaborating with robots. According to Nazareno and Schiff (2021), the workforce becomes more manageable due to making jobs more straightforward through automation, leading to stress being down.

AI's advent into the automation industry also demonstrated its influence on people's mental health. According to Lie and Wei (2022), when implementing AI-powered automation in manufacturing, a reduction is witnessed in workers' psychological depression. Due to the developed workplace automation, such as reducing workloads, boosting work efficiency, and providing a safe environment for workers, employees' well-being and mental health are positively impacted (Li and Wei, 2022). However, in terms of human-robot collaboration, Lu et al. (2022) mentioned that workers may feel more stressed because of low safety awareness, which is associated with humans' mental health while showing possible methods for assessing mental stress and safety awareness during robot collaboration.

P_4: Automation has mixed impacts on workers' mental health and could increase motivation at the workplace by eliminating or reshaping the work activities of humans.

One of the crucial aspects in the automation industry is trusting machines by humans from the quality, precision, judgment, and fairness perspectives. Humans' confidence level and willingness to act according to suggestions, orders, and decisions made by automation or AI show trust in machines (Hancock et al., 2011). Hoff and Masooda (2015) evaluate human-automation trust from three perspectives. Those include executing task performance by automation, operator understanding while using automation, and establishing the designer's purpose for an automated system. Trust issues are especially crucial in Safety Instrumented Systems used in hazardous processes and help avoid accidents and consequent losses because a designer's carelessness while building an automation system or operator error can be costly for the entire process in emergency cases. Explaining the system's range of applications and purposes to the end-user clearly and simply and eliminating design errors and unforeseen variances help to increase trustworthiness between humans and automation (Lee and See, 2004).

Trust became more vital after integrating AI into the automation industry because decisions are no longer made within pre-programming rules but are made according to the learning process based on experience and feedback (Glikson and Woolley, 2020). Humans have not discovered the full potential of AI in the automation industry yet, and there are still unpredictable matters. AI-based robots are more capable of learning than humans, so the automation sector's future may be unexpected for individuals. The unpredictability of AI is explained by Yampolskiy (2020) that even though we know the system's end goals, we cannot accurately and consistently forecast the precise steps an intelligent system will take to accomplish its goals. If AI's entry data may be improper or unfair, then automation outcomes will be impacted negatively by corrupted robots' responses and behaviors. Although 100% safe AI will always be a pipe dream due to AI's unpredictable nature, we can still work toward safer AI since we can foresee some aspects of the AI we create (Yampolskiy, 2020).

Building trust is a dynamic process and depends on the performance and purpose of the AI from reliability, usability, collaboration, or interpretability perspectives (Siau and Wang, 2018). Because of an inadequate explanation, people may not always realize why an AI system makes a particular action, which may lead to doubt about the accuracy of outcomes by humans. Intelligent machines for the automation industry, frequently built on machine learning over massive data, may include inconsistencies and unjust or incorrect choices buried in the training data (Guidotti et al., 2019). Regulations need to be developed to build trustworthy AI by always being controlled by humans, using transparent data and algorithms, and avoiding unintentional bias (Joshi, 2019).

P_5: Trusting machines controlled by AI in the automation industries becomes more complicated and unsafe, while the results of processes and actions by intelligent machines have been growing less predictable and understandable by humans.

MANAGERIAL IMPLICATIONS

Businesses that currently utilize robots will probably employ them even more as the cost and complexity of automating jobs using robots decrease (Tilley, 2017). Robot installations rapidly expand because of reduced machine costs and increased demand for produced goods (Cooper, 2017). The process is accelerated because robots quickly become more capable than human labor (Cooper, 2017). The new era of automation provides significant opportunities for businesses to increase productivity using robots. Managers are expected to understand how they must utilize robots efficiently and suitably in the automation industry, such as making volume higher, defining appropriate activities to automate, and increasing profit margins. To build automation systems, robotics solutions must be applied according to businesses' long-term strategies regarding quality, cost, accuracy, and safety measures. Moreover, due to rapid changes in robotizations, managers also need to consider the easy integration with future technologies, increasing global competition, and implications for the workplace and society (Cooper, 2017).

AI-powered automation transforms employees into superhumans by effectively empowering them to utilize their talent and effort (Cuomo, 2021). Many businesses are learning about the advantages of AI and the multiple ways it may provide intelligence, boost efficiency, and discover opportunities in the automation industry. Although AI has a wide range of capabilities, its inappropriate implementation may prevent businesses from achieving their expected goals. Bringing a new level of accuracy to automation by AI, companies may analyze a lot of data while spending less time than expected to increase production systems, predict possible faults in the processes, and improve machine vision (Sarmah, 2019). Considering the unpredictability of AI in decision-making, managers need to integrate human interactions with their emotional intelligence into the cognitive processes to improve accuracy levels and understand better causes and effects.

The technological revolution in the automation industry not only provided benefits such as higher production volumes and decreased labor costs but also altered humans' role and workforce. When businesses build automated systems, they need to keep the balance between automation productivity and human efficiency. The negative impact of technology on the human workforce may lead to a decline in overall business profit. By understanding how automation affects employees, jobs, and wages, managers may assist workers in adapting to these changes and contributing to the benefits of increased productivity that new technology will bring. According to Chui et al. (2016), developing machines to understand human performance and decrease adverse effects on the workforce is a breakthrough the company needs for technological improvements. Figuring out automation from a human performance perspective, such as employees interacting with their professions and connecting individuals with technology, may inspire managers to think about executing machines efficiently.

Although human-machine collaboration is not a novel concept, how machine and human interactions are utilized together must be improved according to changing human roles by modern automation technologies. While including human factor automation systems within the latest technologies, businesses must establish collaboration scenarios between machine and

human jobs regarding communication, optimization, and safety measures (El Zaatari et al., 2019). Robots can expand people's physical reach in terms of strength, durability, and speed as a benefit of this partnership (El Zaatari et al., 2019), while employees contribute to this combination with agility, decision-making, and creativity. Regarding safety measures in human interactions with robot applications, managers must consider risk assessment and safety concepts. Movement sequences and planned collaboration space are counted as significant safety measurements to determine appropriate robot systems. Integrating robots into the automation process optimizes the task balance between humans and robots' activities, and safety requirements need to be implemented to achieve higher production and efficiency (Djuric et al., 2016).

Managers should understand how the workforce is structured inside their businesses as job-related skills evolve (Bughin et al., 2018). Companies may have trouble hiring talented workers for appropriate openings because newly hired workers leisurely adapt to the latest technology and need high training to use technology. Businesses must reevaluate and restructure their organizational structures and work methodologies to fully utilize the new technology by focusing on talented employees while redesigning business processes (Bughin et al., 2018). However, businesses must foster a learning culture, give career counseling, and provide quick, targeted upskilling opportunities to compete in the skills revolution (Manpower, 2019). Due to the technological transformation of the automation industry, managers need to balance performance skills and newly generated tasks by providing appropriate software and applications to employees, learning programs, or training to maximize productivity and efficiency.

While businesses take advantage of automation systems, they must first adopt these applications with an awareness of how technological benefits impact employee behavior. In order to increase employee engagement and performance, which will eventually lead to improved work performance and personal well-being, businesses need to pay close attention to how employees' sentiments of competence, autonomy, and relatedness are changing due to automated tasks (Darino et al., 2019). Consequently, in terms of automating tasks, businesses need to start with dull, mundane activities at the workplace. To help employees feel less worried, managers can also convey the significant benefits of automation, such as lightening their work and taking them away from mundane tasks. Employees who fear losing their jobs may harm the corporation through internal conflicts and even willfully destroy current workplace equipment (Wani et al., 2018).

RESEARCH IMPLICATIONS

Businesses will likely be fully outfitted with these modern technologies, such as AI, machine learning, and collaborative robots, which would entirely replace traditional systems (Sarmah, 2019). Not only having smart machines and robots in the factories but also building production lines, choosing appropriate tools and equipment in automating activities, and designing the processes play an essential role in adopting new technology to automation systems in manufacturing (Cooper, 2017). Using different forms of AI and robotics applications in automation systems can be focused on specific issues, such as worker safety, cybersecurity, and

keeping up and leveraging modern technologies to improve the intelligence and capabilities of manufacturing processes (Sarker, 2022). To maximize productivity, safety, and quality, these issues must be addressed by choosing appropriate tasks to automate and enhance adopted recent technology applications. Further research could elaborate the search for new engineering designs by AI implications in manufacturing, identify key strategies for businesses, and find solutions such as more effective production lines, protection against cyberattacks, and support a healthier work environment for the challenges.

The conceptual model presented in Figure 2 illustrates human-machine relations in the new era of the automation industry by emphasizing workers' connections and interactions with each application. Future research could also shed light on new challenges in these interactions, such as supporting and getting along with each other and reshaping humans' roles according to applied new technologies. Adopting advanced technology must be easily understandable to enhance human functions and maximize interactions with appropriate guiding instructions and training. Robotics and AI integration will make the automation process more complex for humans to comprehend and utilize (Sarmah, 2019) to increase productivity and efficiency. Therefore, the matter is taken into account from machines' perspective and from humans' comprehension and utilization viewpoint. A brain-computer interface that unites people and machines can dramatically improve human capabilities and produce a "species" more potent than humans (Tencent Research Institute, 2020). Future research needs to investigate how interactions between humans and machines can be improved, and potential challenges can be minimized while implementing new technologies in the automation industry.

Integrating automation with human skills will force businesses to produce new talent strategies to help drive their growth and profitability (Manpower, 2019). The research has provided information about the importance of reshaping professional skills within the labor market to satisfy the requirements of advanced technology (Bughin et al., 2018). Further studies are needed to examine how to define skill strategies for building talent within businesses according to emerging new technology and developing people for high-growth roles (Manpower, 2019). Depending on how quickly automation and AI are used, strategies might result in structural adjustments inside the businesses and changes needed for organizational agility and adaptability (Bughin et al., 2018). Companies may benefit from educational institutions concentrating their curricula on the talents that will be in demand in the future. At the same time, industrial associations may assist them in developing more robust talent pipelines in specific industries to locate the capabilities they need (Bughin et al., 2018). Regarding business strategies, further works must include elaborated descriptions of the most effective method of assessing humans' potential and assigning individuals to the appropriate roles while adopting new technology.

When applying AI to automation, AI may be utilized to make machines smarter besides analyzing data so that it can be used as a tool for managing and evaluating humans in the workplace. Further research may provide detailed information about human well-being by gathering and examining a variety of data points by AI about a person who interacts with machines during work. Depending on humans' reactions to autonomous and smart devices, automation may strain workers and create psychological problems in the workplace (Li and Wei,

2022). AI may be created and crafted considering employees' psychological needs to lessen their workloads and enhance their physical and mental welfare (Li and Wei, 2022). Moreover, AI may evaluate mood using customized input data or emotional well-being technologies to identify whether workers require environmental encouragement or physical comfort (Croman, 2018). More research is also needed to evaluate humans' mental health, such as emotional, psychological, and social well-being, focusing on human data and examining performance based on machine productivity and efficiency.

The research could be extended to make AI transparent and eliminate its unpredictability. In terms of future research, the decisions made by AI need to be analyzed for long-term outcomes by clarifying strategy formulations by intelligent machines. Humans need to comprehend the reasons behind the automation system's behavior and if it will conform to the expectations of the system to assure the safety of a machine learning system by AI (Rudner and Toner, 2021). "As machines learn, they may develop unforeseen strategies at rates that baffle their programmers" (Yampolskiy, 2019, p.1). Although outcomes by AI in the automation industry are highly reliable, human predictability of actions and processes is declining as machines grow more intelligent. Transparency reports for the decision-making process by AI, as well as imposing specific constraints on AI systems, may aid in the development of eliminating the unpredictability of AI (Joshi, 2019). However, further research is needed while exploring constraints to intelligent machines and restraining AI functions to clarify decision processes and understand how this process would affect accuracy and performance.

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