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Examining the Impact of Autonomous Robot Integration on Efficiency, Safety and Quality Towards Industrial Revolution 4.0

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Abstract

This research investigates the impact of integrating autonomous robots into manufacturing environments, specifically at Honda Malaysia Sdn Bhd, within the framework of Industry 4.0. As industries strive for enhanced efficiency, safety, and quality, autonomous robots emerge as crucial tools that automate labor-intensive, repetitive tasks while minimizing human error. The study employs a quantitative methodology, utilizing surveys distributed to engineers, technicians, and managers to assess the effects of robotic integration. Findings reveal that the deployment of autonomous robots significantly improves production efficiency, enhances workplace safety by reducing human exposure to hazardous tasks, and ensures product quality through consistent and precise operations. The results indicate that a substantial portion of the variation in robot implementation can be explained by these independent variables. While the advantages are evident, challenges such as sensor reliability and workplace dynamics require ongoing attention to ensure optimal performance and safety. The research underscores the necessity for strategic planning in workforce adaptation, emphasizing collaboration between humans and robots to foster innovation and maintain job relevance in the evolving industrial landscape. Ultimately, this study offers valuable insights for industry practitioners seeking to leverage autonomous technology for sustainable growth and competitiveness.

1. Introduction

A robot is a mechanical device that performs physical or software tasks that are under human supervision. The term "robot" comes from the Czech word "robota," which means forced labor, and has evolved to include a variety of automatic machines with multiple functions (Moravec, 2024). Autonomous robots are advanced systems developed by humans to do work that is difficult for humans to do. Autonomous robots of this system are able to perform tasks or require little help from humans because these robots can interact with the workplace environment. Autonomous surgical robots can improve accuracy, efficiency, and execution, while offering new capabilities for difficult interventions beyond human skill (Yip & Das, 2017). In context of autonomous robot in industry 4.0, The most important aspect is to use advanced technologies like artificial intelligence, machine learning, and the Internet of Things (IoT) to optimise manufacturing and production processes. The utilization of robots in industries has been on an exponential rise since they increase productivity, efficiency, accuracy, and human safety by a substantial factor (Misra *et al.*, 2022). By incorporating one of the components of industry 4.0,

this technology can help to create a seamless and flexible production environment, eliminate human interaction, minimise mistakes, and enable large-scale customisation to suit changing market needs. Autonomous robots are rapidly being used in a variety of industries, particularly industrial autonomy, which is revolutionising how jobs are completed. The employment of this robot can boost production by executing jobs constantly, as well as eliminating mistakes and improving efficiency. This autonomous robot, controlled by sophisticated technology, can accomplish tasks with minimum human interaction. For example, autonomous robots can execute difficult activities like welding, painting, and properly assembling components. An automated robotic arm using Machine Learning and Tensorflow can efficiently perform pick and place tasks, improving efficiency and performance in industrial tasks (Rao *et al.*, 2021). The employment of autonomous robots in industry not only optimises production but also enhances safety by taking over risky and repetitive activities. Humans can also devote greater attention to activities that are easier to handle. Industrial robots can replace manual labor in various complex tasks, improving industrial automation and enhancing the service of automated production lines (Guo, 2022).

Autonomous robots are additionally helpful to quality control. This is because the autonomous robot has a sophisticated sensor system that allows it to run quality checks, spot errors and irregularities that people may overlook.industrial robot-based automated assembly system that installs RAM modules on a computer mainboard for educational purposes, helping students practice design thinking and problem-solving skills (Trung & Duong Quang Khanh, 2023). This ensures that only the finest quality items are promoted, which increases consumer happiness and reduces returns. (AI) enables robotic inspection systems to informed decision-making in quality control, identifying defects and patterns that might be imperceptible to the human eye (Priya Singh, 2023). The data collected by autonomous robots during operations can be analyzed to gain insights into the production process. Industries automation are always attempting to increase efficiency and produce high quality goods in order to fulfil market expectations and remain competitive. This trend has resulted in an increased need to move from manual control systems to automated alternatives. Advances task specification abstraction, enhancing robot autonomy in real-world scenarios by removing manual hand-specification and enabling multirobot teams for improved performance (Rayas, 2023). While computer-based solutions have showed promise in terms of quality and production, they are generally restrictive and expensive. The limits of computer-based systems have highlighted the need for more adaptable and affordable automation solutions. As a result, automated systems have been rapidly adopted for a variety of industrial operations, with a particular emphasis on activities such as picking and arranging products. Automation robots have the ability to simplify processes, decrease mistakes, and boost efficiency, making them an appealing alternative for sectors aiming to improve production and product quality.

Autonomous robots play an important role in the automation business by increasing productivity, improving product quality, lowering costs, strengthening safety measures, allowing for flexibility, promoting data-driven decision-making, and offering a competitive advantage. Autonomous robots can increase efficiency, productivity, reduce error, re-work, and risk rates, and improve safety for employees in high-risk work environments (Joshi, 2021). Automating jobs allows enterprises to simplify operations, boost productivity, decrease mistakes, and respond quickly to changing market needs. Autonomous robots not only speed up manufacturing processes and assure consistent output, but they also improve worker safety by doing dangerous tasks. Furthermore, the data created by automated systems enables enterprises to make educated decisions, promote continuous development, and maintain a competitive market position. Overall, automation is critical for contemporary industries looking to attain operational excellence, long-term growth, and a competitive edge. Honda Malaysia Sdn Bhd's use of sophisticated autonomous robots in automotive production has considerably increased productivity and efficiency. These autonomous robots are used at many phases of the production process, such as assembling, welding, and painting, to ensure precision and uniformity in each activity. Honda, a brand known for its leadership in industrial automation, is still devoted to serving the different demands of its customers. To continue this commitment, the firm is always exploring new ways to use autonomous robots, with an emphasis on increasing overall efficiency, raising quality standards, and safeguarding the safety of its personnel. By embracing these cutting-edge technologies, Honda not only reinforces its position at the forefront of the automotive industry but also demonstrates its dedication to innovation and excellence in manufacturing.

The purpose of this research is to assess how the integration of autonomous robots in manufacturing environments changes the efficiency of the production process, to identify the effect of autonomous robots towards worker safety, and to identify the effect of autonomous robots' implementation on the quality of manufactured products. This research was conducted at Honda Malaysia Sdn Bhd, an automated firm that specialises in automobile manufacture. Honda Malaysia Sdn Bhd serves as an example model for this research because of its sophisticated use of autonomous robotic systems in its manufacturing operations. The emphasis will be on how these technologies affect overall operating efficiency, safety regulations, and the quality of manufactured automobiles. This study, conducted in such a technologically advanced context, would provide vital insights into the practical uses and results of robotic integration in current production environments. The significance of this study comes from its ability to give practical insights for industry practitioners on the integration of autonomous robots in production within the context of Industry 4.0. The research will focus on Honda Malaysia Sdn Bhd, a premier automotive automation firm, to empirically show the efficiency advantages,

safety improvements, and quality control upgrades that may be achieved through the implementation of autonomous robotic systems. By analysing data from operator experiences and reviewing changes in safety measures, incident rates, and product quality, the research will provide practical recommendations for optimising robot integration to improve operational performance and market competitiveness. These findings are critical for influencing strategic decision-making and guiding future investments in autonomous technology, eventually driving the growth of smart manufacturing processes in the automobile sector.

2. Literature Review

2.1 Industry 4.0

Industry 4.0, also known as the fourth industrial revolution, is a disruptive movement in manufacturing and industrial processes that involves the integration of sophisticated technologies such as autonomous robots, the internet of things, big data, and so on. However, our research will concentrate on autonomous robots. Autonomous robots, which serve as the foundation of industry 4.0, improve an industry's manufacturing and production processes by making fewer errors. Acceptance of autonomous robots is critical to helping the sector satisfy rising demand in an increasingly competitive global market. Several technologies contributed to the emergence of autonomy in industry 4.0. Among them are artificial intelligence (AI) and machine learning (ML), which enable these robots to learn about their work environment and performance. This robotic system is also connected to the Industrial Internet of Things (IIoT), which allows it to communicate with sensors and central control systems. The independent connectivity of this robot with other components in industry 4.0 allows it to function effectively, ensuring the quality of the commodities produced. In conclusion, an autonomous robot is critical for usage in industry, particularly in industries with complicated and risky labour, such as the automated industry. The robot's capacity to work autonomously without regard for time makes it a significant tool in industrial production. If the industry continues to use this technology, supply management will become nimbler and more sustainable.

2.2 Autonomous Robot Implementation

According to the National Institute of Occupational Safety and Health of Malaysia (2020), training is an essential element of the organization and must be implemented for each employee responsible for occupational safety and health (OSH) and also indispensable for safety and health practices to ensure that every safety and health program in the workplace is satisfied. Training empowers administrators, bosses, and laborers to comprehend the lawful consistency required and the working of safety management systems. In general, the term safety training is defined as a particular sort of training directed inside an association to improve worker skills. As indicated by Europe PMC, 2016 safety training is a casual or formal technique to assist people in performing safe work practices, changing perspectives, or procuring information. Indirect training can expand the degree of capability of a worker (Ismail, 2006). According to Mustazar & Peng (2009), most employees are interested in engaging in safety training organized by the company and the training should involve all parties for more workers to receive knowledge about OSH and this would reduce the risk of accidents at the workplace. Indirectly, as more workers comprehend OSH, it can reduce the risk of hazards, illness and reduce workplace accidents. Therefore, all workers need to be provided with an adequate amount of safety and the right kind of training to increase their safety and health awareness against the hazards and risks of daily life at their workplace. Thus, the terms of training on the perspectives of this research are described as the safety training that provides a program about OSH to reveal the knowledge and procedure about safety and health at the workplace and how to prevent any injuries or illness during work

2.3 Efficiency

Efficiency is the capacity to do a task without wasting money, energy, or effort and without making mistakes in order to get the desired result. According to the Cambridge Dictionary (2024), efficiency is the ability to perform the most valuable job with the least amount of energy, fuel, labour, and so on. Doing work efficiently is beneficial for sustaining and growing job quality in order to compete with others, particularly across sectors. Evaluating company effectiveness is essential for maintaining and improving competitiveness, as well as making sound management decisions (Dmitry Zaykin *et al.*, 2020). In term of this research, autonomous robot can do a repetitive task such as assembly and material handling faster than human. Robot can perform repetitive tasks like picking and transporting goods more efficiently than humans, allowing workers to focus on complex responsibilities (Logan Krueger, 2023).

2.4 Safety

Management Safety is defined as the protection of a person from harm or danger that might lead to injury, an accident, or death. According to Dictionary.com (2024), safety is the state of being free from injury, danger, or loss.

This is also included as a proactive and preventative strategy to minimise accidents, decrease risk, and keep property and the environment safe. Safety is critical for maintaining health and well-being, necessitating control of circumstances that might cause damage to persons and communities (INSPQ, 2018). In term of this research, the autonomous robot is equipped with a sophisticated sensor system that is useful in lowering the danger of accidents at work and when dealing with people. Bexten *et al.* (2022), autonomous robots are designed with safety in mind, equipped with advanced sensors and technology to autonomously navigate around obstacles, including humans, reducing the risk of accidents and injuries in the workplace.

2.5 Quality

Quality is a characteristic or trait of an existing object that adds value to it. According to Dictionary.com (2024), quality is an important or distinguishing trait, property, or attribute. It is also used to determine whether something is excellent or terrible, which may be applied to products, services, or individuals. The price of an item does not reflect whether it is of high or low quality. This attribute is the perception of someone who uses something and achieves his goals. In term of this research, quality of autonomous robot in making something shows the best quality even if they do repetitive work and ensure the quality of the goods that the customer gets is always the best. Autonomous robots equipped with advanced sensors and LIDAR technology can perform tasks with high precision and accuracy, ensuring consistent quality with minimal errors (SLB, 2024).

2.6 Hypothesis Development

2.6.1 Efficiency and Autonomous Robots Implementation

The use of autonomous robots in industrial settings plays an essential role in increasing production efficiency. The combination of automation and advanced machine learning algorithms, particularly those supported by TensorFlow, dramatically improves the capabilities of autonomous robotic systems. TensorFlow, a Google-developed open-source toolkit, simplifies the construction of machine learning applications and allows for advanced mathematical computations (Rao *et al.*, 2021). Using TensorFlow in the operation of autonomous robots allows these machines to accomplish complicated tasks like pick-and-place procedures with better efficiency and precision, eliminating the need for manual intervention and increasing total productivity. This technique has a special use in the design and operation of autonomous robotic arms. These robotic arms are often operated by small but powerful computer devices such as the Raspberry Pi, which can meet the computational needs of machine learning algorithms. With servo motors, these robotic arms may perform precise motions required for sensitive jobs (Rao *et al.*, 2021). TensorFlow integration enables the robotic arm to use sophisticated object identification techniques, allowing it to recognise items more rapidly and correctly. When an object is spotted, the robotic arm can automatically decide the best method to grip and move it, ensuring that it is placed in the precise area with great precision. Such technology provides significant practical efficiency gains. TensorFlow-powered autonomous robotic systems help to simplify industrial operations by automating repetitive and labor-intensive activities. This automation not only speeds up processes but also assures a high degree of uniformity and dependability in the manufacturing process. For example, in a manufacturing scenario, an autonomous robotic arm may continually do pick-and-place activities without the tiredness or inaccuracy associated with human workers, resulting in a more steady and predictable production line, which is a key component of efficient manufacturing.

H1: Efficiency has significant impact on autonomous robot implementations.

2.6.2 Safety and Autonomous Robots Implementation

One One of the most notable advantages of incorporating autonomous robots into the industrial sector is a large decrease in human exposure to dangerous work settings. Transporting big objects is an inherently risky task that poses a significant risk of accidents and injury to human workers. Companies can efficiently limit these hazards by deploying autonomous robots to take over these hazardous jobs, therefore removing human workers from danger. For example, robots intended to carry and transport big products may do so with accuracy and efficiency, avoiding physical strain and lowering the possibility of human error. This not only improves workplace safety, but it also leads to a more efficient and error-free operation. According to a study by the International Federation of Robotics (IFR), the integration of robots into manufacturing processes has been shown to lower workplace accidents by 25-30% (IFR, 2020). To attain maximum efficiency and quality, certain items must be created cooperatively by robots and people, a process known as human-robot cooperation (HRC). With this current sensor technology, this robot can recognize whether there are humans or any alien things near it. The LiDAR sensor's 360° field of view and high resolution allow it to identify potential hazards and navigate around them safely (Omniverse IsaacSim, 2024). The HRC System has been created to operate more safely, which means that robots, with their accuracy and durability, can conduct repetitive and physically demanding jobs, whilst people, with their

problem-solving and adaptation talents, may manage activities that involve critical thinking and decision making. According to Graetz & Michaels (2018), collaborative efforts result in a 30% decrease in ergonomic injuries among workers.

H2: Safety has significant impact on autonomous robot implementations.

2.6.3 Quality and Autonomous Robots Implementation

The implementation of autonomous robots has a considerable beneficial influence on quality. Autonomous robots, equipped with cutting-edge sensors and artificial intelligence (AI), can do jobs with more precision than humans. In the commercial sector, where even tiny errors can result in significant product failures, such accuracy is critical. These robots can do jobs with pinpoint accuracy, dramatically lowering the possibility of manufacturing mistakes. Furthermore, its real-time monitoring and control capabilities enable the early detection and repair of any problems before they arise, hence improving overall product quality (Stephan Elliott, 2024). Autonomous robots help to a more consistent and dependable output by ensuring that each stage of the manufacturing process is completed with fine accuracy, reducing the possibility of faults and boosting the final product's reliability. In addition to their precision and consistency, autonomous robots' efficiency contributes significantly to quality improvement. These robots can operate continuously for 24 hours at high rates, outlasting human workers while preserving product quality. This continuous operation not only increases productivity, but also guarantees that the production process runs smoothly, decreasing downtime and enhancing overall efficiency. Furthermore, AI-supported solutions for human-robot cooperation (HRC) improve work organisation, resulting in higher employee engagement and lower failure rates. Businesses may optimise their operations by incorporating autonomous robots into the workforce, resulting in considerable product quality improvements. The collaboration between human workers and robots generates a more efficient and effective manufacturing environment, eventually resulting in superior quality product. (Marc Euchner *et al.*, 2021).

H3: Quality has significant impact on autonomous robot implementations.

2.7 Research Framework

The research framework (refer Fig. 1) contains two main variables which are independent variables and dependent variables. The independent variables are efficiency, safety, and quality, while the dependent variable is the autonomous robots implementation. The relationship between these variables has been identified based on previous studies that support this theoretical concept for this study has been constructed as follows.

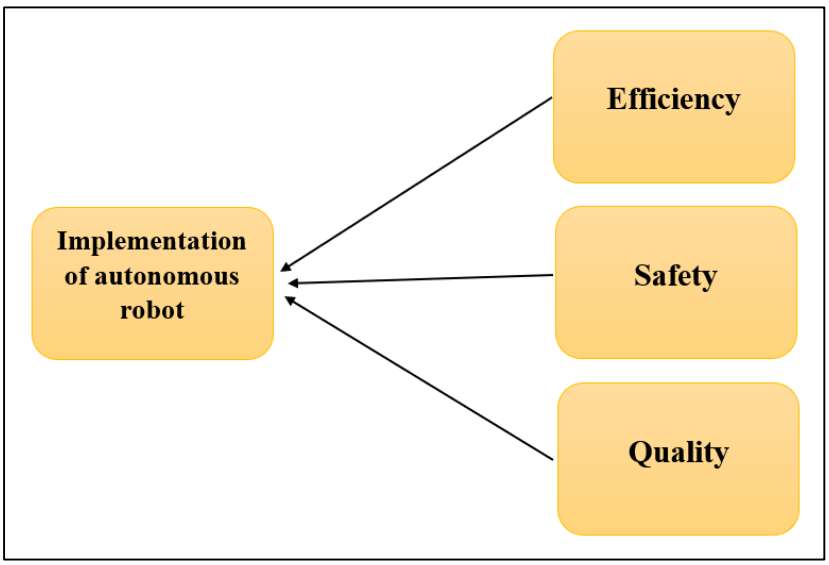

Fig. 1 *Research Framework*

3. Research Methodology

In this study, quantitative method was used to investigate the integration of autonomous robots into the Honda Malaysia Sdn Bhd and its influence on efficiency, safety, and quality. According to Wang Yuan Jijie (2021), the basic purpose of quantitative research is to test predefined theories. The researcher's goal in using quantitative approaches is to collect numerical data from a large sample so that statistical techniques may be used to find

patterns, connections, or trends. This strategy requires the collection of data from Honda car production workers, namely engineers, technicians, managers, safety officers and quality officers to ensure that respondents have relevant expertise and ideas. The focus will be on determining how technological improvements affect operational metrics and overall workplace dynamics. To acquire the relevant data, the researcher will employ a combination of primary and secondary data gathering methods. Primary data will be gathered using a standardized questionnaire delivered via Google Forms, which was chosen for its ease of dissemination and answer gathering. This strategy allows for efficient data collection from a large number of respondents while assuring complete coverage. Secondary data will also be used to supplement and contextualize the findings, resulting in a strong framework for analysis. By integrating these two data sources, the research aims to present a well-rounded and evidence-based evaluation of the effects of autonomous robots on various operational aspects within the Honda car factory.

Data collection is a process of collecting data and organizing it into the right information to identify the right information. Data are facts collected by the researcher with the aim of answering all the questions that arise. In the data collection process, there are two types of primary and secondary data. Primary data is data obtained or collected directly such as interviews, questionnaires or observations. Questionnaires and observations are used in this research as primary data to receive information from respondents. Questionnaires were collected from engineers, technicians, managers, safety officers and quality officers from certain product line at Honda Manufacturing as users and employees who work together with autonomous robots. Respondents have to answer all the questions in the questionnaire based on their experience. The researcher also made observations at the Honda Manufacturing Sdn Bhd factory to see the behavior of the workers there working with autonomous robots. Secondary data is data obtained by other researchers and not from the original data. Secondary data can be obtained from various sources such as books, journals, articles or websites. In this research, the researcher used several articles, journals and websites to get relevant support to help the research being done. All findings and available data have been analyzed using IBM SPSS statistics version 27. Data obtained from questionnaires that have been distributed to employees at the Honda Manufacturing Sdn Bhd factory and only users who have had experience working with autonomous robots are the only data taken. The researcher used descriptive analysis, reliability analysis, normality test, correlation analysis and regression analysis to obtain accurate results.

4. Results and Discussion

4.1 Reliability Analysis

The independent variables efficiency (0.853), safety (0.822), and quality (0.847) achieved Cronbach's Alpha values reflecting good internal consistency. The dependent variable, implementation of autonomous robots, yielded a Cronbach's Alpha of 0.752, indicating the questionnaire reliably supports achieving the study's objectives.

4.2 Demographic Analysis

The study involved 103 respondents comprising 56.3% male and 43.7% female participants. Most respondents were aged 31–40 years (42.7%), followed by 41–50 years (31.1%), 20–30 years (13.6%), and 51 years and above (12.6%). In terms of ethnicity, 32% were Indian, 28.2% Chinese, 18.4% Malay, and 21.4% from other ethnicities. Regarding work experience, 31.1% had 6–10 years, 28.2% had 11–15 years, 20.4% had 16–20 years, 12.6% had over 21 years, and 7.8% had 1–5 years of experience. Participants held various roles: technicians (26.2%), manufacturing managers (24.3%), safety officers (24.3%), quality officers (17.5%), engineers (5.8%), and others (1.9%). Notably, 82.5% of respondents had experience using autonomous robots. But there were 103 respondents in the questionnaire, but only 85 respondents had their data taken because they had used an autonomous robot.

4.3 Descriptive Analysis

The analysis of mean and standard deviation for the implementation of autonomous robots (DV) revealed moderate suitability values across all items. The highest mean (3.41, SD = 1.466) was for the perception that autonomous robots improve work efficiency by completing tasks faster and the lowest is the use of autonomous robots can enhance operational efficiency and contribute to increased company profit which is (mean = 3.36, SD = 1.387), that reflected moderate perceptions. For efficiency, the highest mean (3.48, SD = 1.419) was for the view that autonomous robots make tasks easier to handle and the lowest is autonomous robots make things run more smoothly by providing accurate information with way fewer human mistakes (mean = 3.32, SD = 1.474) that showed moderate suitability. In terms of safety, a sense of security when working with autonomous robots scored the highest mean (3.38, SD = 1.464), followed by the lowest which is autonomous robots may present risks (mean = 3.26, SD = 1.465), reflect consistent moderate perceptions. For quality, the belief that autonomous robots maintain product quality recorded the highest mean (3.54, SD = 1.460) and the lowest is artificially intelligent

devices, such as robots, providing more consistent service than human beings in services (mean = 3.31, SD = 1.480) that also indicated moderate perceptions.

4.4 Normality Test

Since the number of respondents exceeded 50, the Kolmogorov-Smirnov test was used to determine whether the data were normally distributed, guiding the appropriate analysis for addressing the research questions. The results indicate that the significance values for all variables implementation of autonomous robots (DV), efficiency (E), safety (S), and quality (Q) were below 0.05 (<0.001). This confirms that the data are not normally distributed

4.5 Correlation Analysis

Correlation analysis was conducted using the Spearman method due to the non-normality of the data (<0.05). The results, indicate positive relationships between efficiency (E), safety (S), and quality (Q) with the implementation of autonomous robots (DV), with correlation coefficients of 0.752, 0.746, and 0.701, respectively. All correlations were significant at the 0.01 level (2-tailed). Efficiency (E) demonstrated the strongest correlation with DV (r = 0.752), while quality (Q) had the lowest correlation (r = 0.701), highlighting strong, positive associations across all variables.

4.6 Regression Analysis

R Square is 0.779, or 77.9%. This indicates that 77.9% of the variation in the dependent variable Implementation of Autonomous Robot (DV) can be explained by the independent variables quality (Q), efficiency (E), and safety (S). The remaining 22.1% of the variance is unexplained by the model. The integration of autonomous robots has significantly enhanced manufacturing efficiency by streamlining operations, reducing manual efforts, and improving workflow management. The study reveals that these robots simplify tasks (mean score 3.48) and handle them with precision and consistency (mean score 3.46), minimizing human errors (mean score 3.32) and enabling higher productivity. By leveraging AI and machine learning, as noted by Adebayo *et al.* (2024), autonomous robots perform complex and repetitive tasks with accuracy, reducing downtime and fostering resource optimization. These advancements not only mitigate risks associated with human oversight but also contribute to sustainable and innovative production practices, ensuring competitiveness in the Industry 4.0 era. The implementation of autonomous robots in manufacturing has moderately but significantly enhanced worker safety by mitigating risks associated with hazardous tasks and fostering a secure workplace environment. These robots take over dangerous operations, such as heavy lifting and high-temperature processes, minimizing human exposure to potential harm (mean score 3.36). Their reliable and predictable functioning also instills a sense of security among workers (mean score 3.38), as noted by Bebon (2023), while proactive features like early warning systems (mean score 3.31) support effective risk management. However, concerns remain about potential risks associated with their use (mean score 3.26), highlighting the need for regular maintenance, adherence to safety protocols, and continuous monitoring to ensure comprehensive workplace safety. By addressing these challenges, autonomous robots can further solidify their role in creating safer manufacturing environments. The utilization of autonomous robots in manufacturing significantly enhances the quality of manufactured products by ensuring precision, consistency, and adherence to strict quality standards. The study reveals that autonomous robots are highly effective in maintaining uniform specifications and reducing defects, as indicated by the highest mean score of 3.54 (Q5). Their ability to execute tasks accurately and reliably (mean score 3.53) ensures consistency, particularly in processes requiring meticulous detail, such as assembly and quality inspections. Sure control (2024) robots equipped with advanced technologies like LIDAR and sensors, these robots replicate tasks under identical conditions without deviations (mean score 3.44), ensuring reliable production processes. Additionally, their role in guaranteeing consistent service quality (mean score 3.44) contributes to meeting customer expectations and enhancing market reputation. While their integration is transformative, continuous monitoring remains essential to maintain optimal performance in complex and dynamic manufacturing environments.

5. Conclusion

The integration of autonomous robots in Industry 4.0, while requiring significant capital investment for acquisition, installation, and maintenance, offers transformative benefits that make it a worthwhile endeavour. These robots significantly enhance productivity, efficiency, and quality while ensuring workplace safety by performing repetitive and hazardous tasks with precision and reliability. Their contributions reduce operational risks and bolster economic growth on both organizational and national levels, making them indispensable tools for industries aiming to remain competitive in a rapidly evolving technological landscape. However, successful implementation requires careful planning and a balanced approach. Businesses must prioritize workforce upskilling to handle, maintain, and optimize robotic systems, ensuring resilience against disruptions and minimizing reliance on specialized individuals. Companies should focus on using robots to support and

collaborate with humans rather than completely replacing them, preserving jobs and enabling employees to contribute creativity, problem-solving skills, and unique ideas. By aligning automation strategies with social and ethical considerations, organizations can drive long-term success, safeguard livelihoods, and create opportunities in emerging fields such as AI and robotics, ensuring sustainable and inclusive growth.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Muhammad Aqil Adam and Siti Norziah Ismail;* ***data collection:*** *Muhammad Aqil Adam;* ***analysis and interpretation of results:*** *Muhammad Aqil Adam and Siti Norziah Ismail;* ***draft manuscript preparation:*** *Siti Norziah Ismail. All authors reviewed the results and approved the final version of the manuscript.*

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