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Analysis of the Importance of the Application of Robotics to Increase Company Profits in the 4.0 Era Using the Why-Why Analysis Method

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Abstract
This study analyzes the positive impact of the application of robotics in the manufacturing industry in the 4.0 era. The results of the study show that automation through robotics can significantly improve productivity, efficiency, and product quality. In addition, robotics also contributes to the reduction of production costs and the improvement of the company's competitiveness in the global market. This study aims to deeply examine the influence of the application of robotics technology on increasing the profitability of manufacturing companies in the industrial era 4.0. Through literature analysis and case studies, this study identifies several key factors that contribute to increased profits, such as increased production efficiency, reduced human error, increased production flexibility, and optimized resource use. The results of this study provide important implications for manufacturing companies in making investment decisions in robotics technology to achieve competitive advantage. The 4.0 era is marked by rapid technological disruption, including the development of robotics. This research explores the crucial role of robotics in the transformation of the manufacturing industry. By leveraging data from various companies that have adopted robotics, this study shows that investing in robotics not only improves productivity and product quality, but also allows companies to adapt quickly to changing market demands and dynamic industry trends.

Keywords: Robot Automation, Collaborative Robots, Artificial Intelligence, Manufacturing Industry, Industry 4.0.

Introduction

The Industrial Revolution 4.0 has brought about significant transformations in the global industrial landscape. Hit by the wave of digitalization and automation, companies in various sectors are required to adapt quickly to remain relevant and competitive. One of the technologies that is in the spotlight in this era is robotics. The application of robotics in the production process is increasingly widespread, promising to increase efficiency, productivity, and ultimately, profitability of the company.

In the face of increasingly fierce competition, manufacturing companies are constantly looking for ways to improve production efficiency, reduce costs, and improve product quality. One of the promising solutions is the application of robotics technology. Although investing in robotics requires significant costs upfront, the potential long-term benefits that this technology offers are very attractive.

Competitive advantage has become the key to the company's success in the era of globalization. To achieve a sustainable competitive advantage, companies need to continue to innovate and adopt the latest technologies. Robotics, as one of the most transformative

technologies, offers great potential to increase the competitiveness of companies. With the improvement of the quality and quality of a machine, the company gains a significant direction of effectiveness as well as the ability to produce more products. Van Harling (2018) through his research proves that the use of quality machines can produce results more efficiently, with a ratio of 1:3 juxtaposed with conventional methods. This is in line with the goal of the industrial revolution 4.0 which minimizes the role of humans as operators. The purpose of this research focuses on proving that the entry of robotics into the industrial world has a very significant impact on everything for example on production results, costs to be incurred, optimization of production time, company income even though there will be many challenges faced by the transition of work process changes and the need for skilled labor

Eco-Friendly Manufacturing

Eco-friendly manufacturing is a method in manufacturing to minimize waste and pollution through the design of products and processes with the primary goal of a sustainable environment. and the impact of better working conditions and energy efficiency as examples of precision automation, process optimization and predictive maintenance. The use of environmentally friendly raw materials and more precise processing of raw materials, robots can process raw materials with more precision, allowing the use of fewer raw materials and reducing waste. Recycling and recovery, robots can be used to separate and process recycled materials, supporting the circular economy. Reduction of greenhouse gas emissions energy efficiency As already mentioned, robots can help optimize energy use, thereby reducing greenhouse gas emissions. More efficient transportation in factory internal logistics, robots can optimize the transportation routes of raw materials and finished products, and reduce emissions from industrial vehicles.

Energy Efficiency

Energy Efficiency is an effort to reduce the amount of energy required in the use of energy-related equipment or systems. Energy efficiency can also mean systematic, planned, and integrated efforts to conserve domestic energy resources (energy diversification) and improve the efficiency of the use of energy resources.

Why-Why Analysis

Why-why analysis or 5 Whys is an approach to investigate the root of the problem by asking "why" repeatedly to find a solution. This method functions as a root cause analysis tool in solving problems. This tool helps determine the cause of the non-conformity in the process or product, allowing for more effective remediation. The why-why analysis method was developed by Sakichi Toyoda who is the founder and developer of Toyota, which is the world's leading automotive company, and then this method is used within Toyota Motor Corporation. In the 1970s, the why-why analysis method was popularized by Toyota Production Systems.

Method

This study uses a combined approach between qualitative and quantitative research methods to ensure scientific results with valid supporting data. The qualitative approach is applied through several main methods, namely:

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1. Systematic Literature Review (SLR)
   SLR is a systematic process of finding, evaluating, and interpreting all relevant study materials in order to provide answers to specific research questions. This approach is used to ensure the validity and reliability of data from various relevant sources.
2. Interview
   The research involved interviews with key figures, such as Universal Robots President, Kim Povlsen, and Universal Robots' Asia Pacific Regional Director, James McKew. This interview provides first-hand insights into the implementation of collaborative automation and regional prospects in Asia Pacific, as well as its impact on the industry in the new normal era.
3. Research References and Industry Events
   This research also refers to the research report "Collaborative Robot Market by Payload, Component, Application, Industry, and Geography - Global Forecast to 2026" published by Markets and Markets. Additional information was obtained from the "Collaborative APAC-Cobot Expo 2021" event, which involved presentations and panel discussions by automation experts in Asia Pacific.
4. Data Search Process
   The data search process is carried out systematically to identify, collect, check, and select relevant and reliable sources of information in accordance with the research objectives.

Quantitative approaches are used to support analysis through statistical data from market reports, such as the increasing adoption of collaborative robots (cobots) in the manufacturing industry. The combination of these two methods is expected to provide comprehensive and in-depth research results.

Result and Discussion

From the results of the Systematic Literature Review (SLR) we can find that:

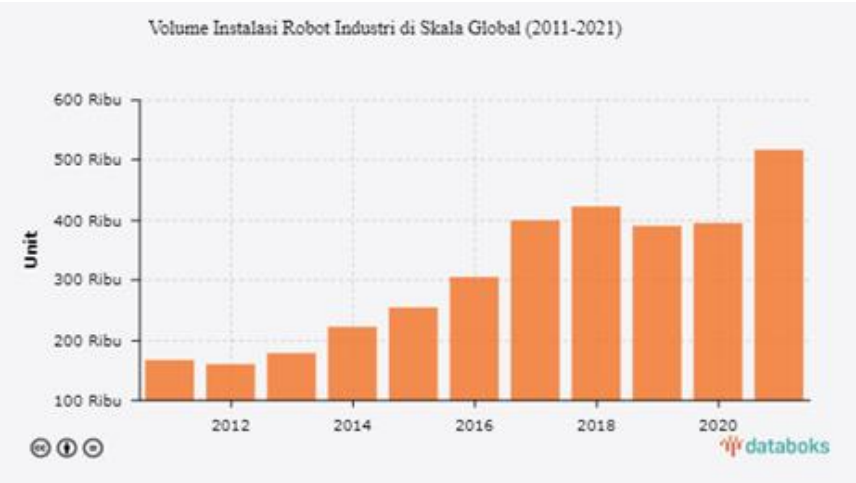

Figure 1: Robot Installation Volume Development Diagram

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The data has explained that the volume of industrial robot installations from 2012 – 2020 has increased so significantly because the transition to industry 4.0 is indeed very important in competition in the industrial world itself. If we turn away from the results of direct interviews with resource persons from various plant industries in the Cikarang area, the results we get are that there is a 10% increase in production and it results in a very significant increase in income and also proves that the Industry 4.0 revolution has a very big influence on the industrial world in all fields.

According to the resource person, the Industrial Revolution 4.0 is a new era in the development of artificial intelligence (AI), Internet of Things (IoT), and big data where digital technology, such as artificial intelligence (AI), Internet of Things (IoT), and big data, is integrated into the production process. It is an evolution of the previous ar akit revolution, which was characterized by automation and mechanization. The impact is far-reaching.we are seeing increased production efficiency, product personalization, and smarter supply chains. On the other hand, in everyday life, this technology is changing the way we work, interact and consume. For example, the emergence of smart homes, autonomous vehicles, and data-driven services. Indonesia has great potential in the Industrial Revolution 4.0. However, we need to increase competent human resources in the field of technology, develop digital infrastructure, and create a conducive innovation ecosystem. The younger generation needs to continue to learn and develop skills in the field of technology. Additionally, it is important to have creative and innovative thinking to be able to contribute to creating new solutions.

Figure 2 : Example of the Robotics Process of the Industrial World Working

Pros and Cons of Robotics in the Industrial World
Pros (Advantages) of Using Robots:

- Increased efficiency and productivity: Robots can work non-stop, reduce human error, and increase production speed.

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- Better product quality: Robots are able to perform tasks that require high precision, resulting in products with more consistent quality.
- Reduced production costs: In the long run, the use of robots can reduce production costs due to high efficiency and reduced human labor.
- Safer jobs: Robots can take over tasks that are dangerous for humans, such as working in extreme environments or lifting heavy loads.
- Flexibility: Modern robots can be reprogrammed to perform a variety of tasks, so they can adapt to changing market demands.

Cons (Disadvantages) of Using Robots:

- Unemployment: The use of robots can replace human labor, thereby increasing the unemployment rate.
- High investment costs: Buying and maintaining robots requires a large investment, especially for small and medium-sized companies.
- Dependence on technology: In the event of a malfunction in the robot, production can be stopped, so the company becomes heavily dependent on technology.
- Lack of creativity and flexibility: Robots find it difficult to perform tasks that require creativity and critical thinking like humans.
- Ethical and social: The use of robots raises questions about ethics, such as how to treat robots and how to ensure that robots are not used for harmful purposes.

Why-Why Analysis

The results of the why-why analysis method used in this study are to find out the main cause of the high use of robotics in the industrial world consisting of 5 reasons that describe problems that continue to occur in the production process and are given suggestions for improving existing problems.

Table 1. Why-Why Analysis

Case	Why 1	Why 2	Why 3	Why: 4	Why 5
Problems that can occur since the entry of the industrial revolution 4.0	Human labor is limited and prone to errors.	Work accidents can cause great losses.	Companies find it difficult to adapt to technological changes.	Robot Importer process is still difficult	The amount of cost of Robot maintenance
Repair	Provide a proper training process.	Re-tighten K3 and improvise dangerous areas.	Bring in trainers / experts from abroad.	Look for partnerships that match the Company's criteria.	Provide special costs for robot maintenance

Prevention	Pay attention to the skill that the operator clicked again.	Re-examine the area of the hazardous area and create a warning board.	Fix Back general information about the 4.0 revolution	Improve Cooperation Relations between Importers	Pay attention to unnecessary costs

From various researches and events in industrial robotics, it explains the challenges that will be faced before entering the industrial revolution 4.0 and the following is an example of a comparison of production costs if there are robots and no robots at the beginning of entering industry 4.0.

The description of one of the stations.

Table 2 : No Robot

Operator	Production	Salary / Gaji	Income
8 persons / Operator	1000 Units per year	Operator Salary = $400,000 per year	$15,000,000 per year

1. Income
   1 unit = $15000 (1000 units x $15,000 = $15,000,000)
2. Cost
   For 1 Operator = $50,000 per year (8 Operators x $50,000 = $400,000)

3. Net Income
   $15.000.000 - $400.000 = $14.600.000

Table 3 : With Robot

Operator	Robot	Production	Salary / Gaji	Income
4 persons / Operator	Price for 1 robot $200,000	1300 Units per year	Operator Salary = $200,000 per year	$19,500,000 per year
1 Robot Technician			Technician Salary = $60,000 per year	$19,500,000 per year

1. Income
   1 unit = $15000 (1300 units x $15,000 = $19,500,000)
2. Cost
   - For 1 Operator = $50,000 per year (4 Operators x $50,000 = $200,000)
   - For 1 Technician = $60,000
   - For 1 Robot = $200,000

   Overall Total = $200,000 + $60,000 + $200,000 = $460,000 per year

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3. Net Income
   $19.500.000 - $460.000 = $19.040.000
4. The results of the comparison showed that the increase in production with robots increased by 30% compared to not using robots

The following is an overview of the comparison diagram between production results using robots and manuals

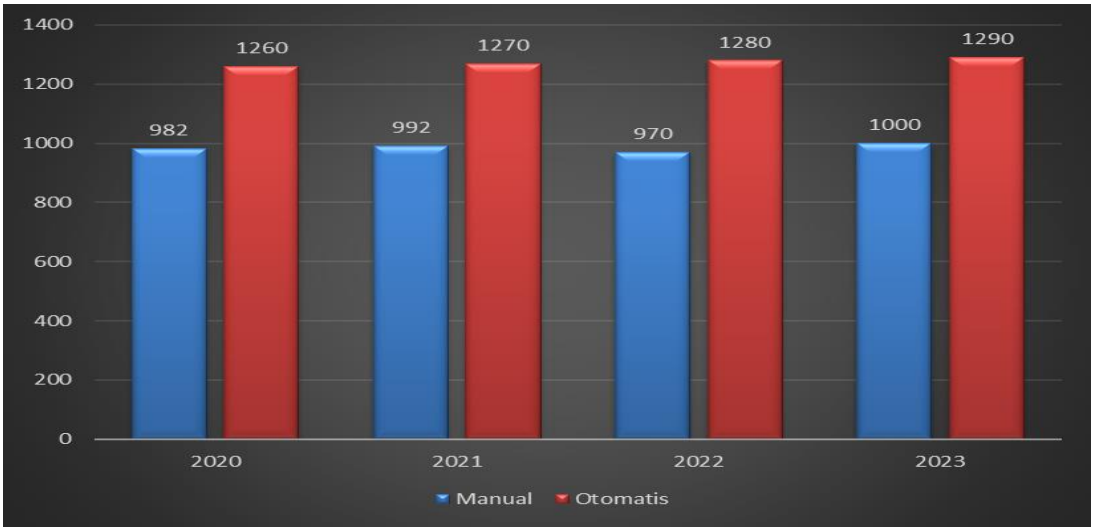

Figure 3 :D iagram of Results of Comparison of Production Results

From the results of the diagram above, it is clear that there is a very significant difference between the production results of the entry of robots into the industrial world, but things like this are still many pros and cons due to the reduction of production operators and the difficulty of finding expert labor in operating the robot and also the calculation for maintaining the robot which is difficult and also requires high costs.

Conclusion

The use of robots in the industrial world has great potential to increase efficiency and productivity. The very significant difference between the production results before and after the entry of robotics into the industrial world is also the center of attention. Based on the results obtained, before using robotics, the company could only produce 1000 units per year with a net income of $14,600,000 by using 8 operators per station. Meanwhile, with robotics, the company is able to generate a net income that is 30% larger than before using robotics, which is $19,040,000 by minimizing human labor as operators. However, keep in mind that there are also negative impacts to be aware of, such as unemployment and high investment costs.

To maximize the benefits of using robots, it is necessary to do several things, including:

- Training and development of human resources: Workers need to be trained to be able to work with robots and develop skills that cannot be replaced by machines.
- Investment in technology infrastructure: Companies need to have adequate infrastructure in place to support the use of robots, such as fast internet networks and advanced security systems.
- Clear regulations: Governments need to create clear regulations regarding the use of robots, including worker protections and ethics in robot development.

Overall, the use of robots in the industrial world is an inevitable trend. The challenge is how we can use these technologies wisely to strike a balance between technological advancement and human well-being.

Do you want to know more about certain aspects of the use of robots in the industrial world? For example, you can ask about the impact on various industrial sectors, or how developed countries are overcoming challenges in the application of robot technology.

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