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INTERNET OF THINGS (IOT) AS A DRIVER OF THE INDUSTRIAL REVOLUTION 4.0 TOWARDS ECONOMY 5.0

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Abstract

The Internet of Things (IoT) is a key element in driving the Industrial Revolution 4.0 and the transition to Economy 5.0, by utilising connected devices to collect and analyse data to improve efficiency and productivity across various sectors. In the context of Industry 4.0, IoT plays a role in automating production processes, optimising resource management, and facilitating predictive maintenance through real-time data analysis. IoT not only reduces downtime and operational costs, but also improves product quality and reliability. As we move towards Economy 5.0, IoT goes beyond industrial efficiency and focuses on achieving greater social welfare. It supports the creation of a more inclusive and sustainable ecosystem, from remote patient health monitoring to energy-efficient smart city management. The positive impact of IoT spans various aspects of life, contributing to the improvement of quality of life and the broader well-being of society. However, the implementation of IoT in industry and the economy faces various challenges, including data security and privacy issues, device interoperability, and adaptive regulations. Cooperation between the government, private sector, and society as well as investment in education and relevant infrastructure are needed to overcome these obstacles. Thus, IoT can continue to play a role as a driver of innovation and quality of life improvement, supporting the achievement of the Industrial Revolution 4.0 and Economy 5.0.

Keywords: Internet of Things (IoT), Industrial Revolution 4.0, Economy 5.0.

Introduction

Since the last few decades, the development of information and communication technology has driven major transformations in various industrial sectors. One of the most significant technological developments is the Internet of Things (IoT), which is defined as a network of physical devices connected via the internet, enabling efficient data collection and exchange. IoT has brought about a revolution in the way we live, work, and interact with our surrounding environment (Lee et al., 2016) .

The Internet of Things (IoT) has the main goal of connecting physical devices into the internet network, so that they can communicate and exchange data automatically without the need for human intervention. By integrating various sensors, actuators, and computing systems into everyday objects, IoT aims to create a connected ecosystem that makes the process of data collection and analysis more efficient. This enables various sectors, such as manufacturing, transportation, healthcare, and agriculture, to increase productivity, reduce operational costs, and make decisions based on more accurate data (Li & Han, 2019) .

In addition to operational efficiency, another goal of IoT is to improve the quality of human life by delivering smart solutions that can optimise the use of resources, enhance security, and provide more convenience for users . In urban environments, for example, IoT can be used to develop smart cities that optimise energy use, reduce traffic congestion, and improve public safety through real-time city monitoring and management (Hong et al., 2017) . Overall, IoT aims to create a more connected, secure, and intelligent ecosystem, which can provide day-to-day benefits to individuals, businesses, and society at large.

The main benefit of the Internet of Things (IoT) lies in improving efficiency and productivity in various sectors. With IoT, manufacturing industries can optimise production processes through real-time monitoring and data analysis, which enables predictive maintenance and reduced downtime (Kumar & Yadav, 2020) . In the agriculture sector, IoT enables more accurate monitoring of environmental and soil conditions, which in turn improves crop yields and resource use effectiveness. In the transport sector, IoT systems can be used to effectively manage traffic, reduce congestion, and improve safety through interconnected vehicles (Davies & Cozzoli ., 2016)

In addition to the economic benefits, IoT also has a positive impact on the quality of life of individuals. In healthcare, IoT devices enable continuous monitoring of patient health, provide early warning of critical medical conditions, and enable remote therapy. In households, smart devices can improve comfort and efficiency by automating various daily tasks, such as temperature regulation, lighting, and home security systems. Overall, IoT is instrumental in creating a more responsive, adaptive, and sustainable living environment, which provides broad benefits to the economy, environment, and human well-being (Prause, 2021) .

The Industrial Revolution 4.0, often referred to as the digital transformation of industry, emphasises automation, data exchange, and smart manufacturing technology. IoT is becoming a key pillar in this era due to its ability to integrate the physical and digital worlds, creating systems that can make decisions autonomously and more efficiently. With the implementation of IoT, industrial processes become more efficient, product designs are more innovative, and supply chains can be better managed (Chen & Chen, 2021)

However, along with the development of the Industrial Revolution 4.0, a new concept has emerged known as Economy 5.0, which aims to create a human-centred society by leveraging smart technological advancements. This concept is more than just efficiency and production; it involves social welfare, sustainability, and creating broad added value for Society (Cisco Systems Inc., 2013) . Economy 5.0 focuses on using technologies such as IoT to drive innovation, well-being, and overall human security. Despite its great potential, the implementation of IoT in Industry 4.0 towards Economy 5.0 still faces various challenges, including issues of data security, privacy, and infrastructure and human resource readiness (Bakker & de Boer, 2017) .

Therefore, this research aims to explore how IoT can be a key driver in the transition from the Industrial Revolution 4.0 to Economy 5.0, and identify the challenges and opportunities it presents.

Research Methods

The study in this research uses the literature method. The literature research method, or literature study, is a data and information collection technique that focuses on the analysis and in-depth review of various written sources, such as books, scientific journals, articles, research reports, and official documents. The main purpose of this method is to identify, evaluate and synthesise existing knowledge in a particular field, so that researchers can understand the development of concepts, theories or findings related to their topic of study (Hart, 1998) ; (Hart, 2001) . In practice, desk research involves systematic steps such as searching for relevant literature, selecting credible sources, organising information, and compiling a comprehensive literature review to explain background, support arguments, or identify research gaps that require further exploration (Jesson et al., 2011) .

Results and Discussion

IoT Implementation in Industry 4.0

Internet of Things (IoT) is one of the main pillars in the development of Industry 4.0, which is often referred to as the fourth industrial revolution. The implementation of IoT in the context of Industry 4.0 involves integrating various devices and sensors that are able to communicate and share data through the internet network. This allows for automation and real-time data collection, which is crucial for fast and informed decision-making in the industrialised world (Prause, 2021) .

One of the implementations of IoT in Industry 4.0 is in the production line. With internet-connected sensors on machinery and equipment, companies can monitor and analyse machine performance in real time. The data obtained from these sensors can be used to detect problems early, perform predictive maintenance, and reduce downtime. This will certainly improve operating efficiency and reduce unexpected maintenance costs (Jha & Verma, 2020) .

In addition to operational monitoring, the use of IoT is also very useful in supply chain management. Sensors installed on products and delivery vehicles can provide accurate information about the location, condition, and status of shipments in real-time. This helps companies optimise distribution channels, respond quickly to changes in demand, and ensure product quality is maintained throughout the delivery process. As a result, logistics efficiency and customer satisfaction can increase (Gartner, 2021) .

In the field of asset management, IoT allows companies to track assets more effectively. Using technologies such as RFID (Radio-Frequency Identification) and GPS, companies can monitor the whereabouts and condition of their assets at any time and place. This not only reduces the risk of asset loss or theft, but also increases the optimisation of asset usage. In addition, the data collected can assist in planning and decision-making regarding future asset needs (Thompson & Smallwood, 2018) .

Workplace safety can also be improved with the implementation of IoT. Sensors installed in various areas of a factory or industrial facility can monitor environmental conditions such as temperature, humidity, and air quality. If there are conditions that could potentially jeopardise worker safety, the system can provide early warnings or even take automatic actions to prevent accidents. Thus, the work environment becomes safer and the risk of work accidents can be minimised (Thoben et al., 2017) .

The implementation of IoT in Industry 4.0 is not only limited to operational optimisation and efficiency improvement, but also opens up opportunities for new innovations. Data collected through IoT can be analysed using artificial intelligence and machine learning technologies to identify trends, patterns, and predictions that have not been thought of before. In this way, companies can continue to grow and innovate sustainably, face new challenges, and create greater added value in their industrial ecosystems.

Efficiency and Productivity Improvement through IoT

The implementation of the Internet of Things (IoT) has brought about major changes in various industrial sectors, especially in terms of efficiency and productivity. One of the main ways in which IoT improves efficiency is through automation and process optimisation. IoT sensors embedded in machinery or production equipment can collect and analyse data in real-time. This data allows companies to monitor machine performance, detect problems early, and make repairs before greater damage occurs. As a result, production downtime is minimised, and operational efficiency is significantly improved (Gilchrist, 2016) .

In addition, IoT enables more accurate and efficient inventory tracking. Using RFID tags and IoT sensors, companies can track the location and status of each item in the warehouse in real-time. This reduces the risk of inventory errors and sudden stock-outs. This more efficient inventory management process not only saves time and costs, but also ensures that production is not hampered by shortages of raw materials or products (Smith & Brown, 2020) .

In the manufacturing sector, the application of IoT also helps in achieving more flexible and responsive production. With real-time data collected through sensors, companies can adjust production processes according to dynamic market demands. This allows companies to reduce excess production costs and minimise waste. This more adaptive production not only increases productivity but also improves customer satisfaction by providing the products they need on time (Wu & Mei, 2019) .

Supply chain management also benefits greatly from IoT technology. Sensors embedded in delivery vehicles and shipping containers enable end-to-end supply chain tracking and monitoring. Real-time data on the location, condition, and status of shipments ensures that products reach their destination safely and on time. These benefits help reduce the risk of delays and losses, while improving coordination between various parties in the supply chain (Singh & Kapoor, 2018) .

In the area of care and maintenance, IoT enables a more proactive, predictive approach. IoT-connected machinery and equipment can detect signs of wear and tear or minor damage before they become major problems. As such, companies can plan maintenance at the right time, avoiding unexpected downtime and extending the life of devices. This approach not only improves operational efficiency but also reduces typically high repair costs (International Telecommunication Union, n.d.) .

Overall, the application of IoT in various aspects of industrial operations does bring significant improvements in efficiency and productivity. By utilising real-time data, process automation, and communication between devices, companies can run operations better, reduce waste, save costs, and meet market demands more responsively. Therefore, IoT is not just a future technology, but a practical solution that can be adopted now to achieve a competitive advantage in the industry.

Transformation to Economy 5.0

The transformation towards Economy 5.0 is an evolutionary step from previous concepts, ranging from Economy 1.0 in the agrarian era, to Economy 4.0 which is strengthened by digitalisation and automation technology. Economy 5.0 is an economic model centred on human well-being while utilising advanced technologies such as artificial intelligence (AI), Internet of Things (IoT), big data, robotics, and other technologies. The goal is to create a society that is balanced between technological advancement and social welfare (Xu et al., 2014) .

In Economy 5.0, technology is not only focussed on efficiency and productivity, but also on solving complex social problems such as economic inequality, climate change, and quality of life. For example, AI technology can be used to improve the quality of healthcare with more accurate diagnosis and more personalised treatment. IoT and big data can also help governments and organisations manage natural resources and reduce negative environmental impacts through more effective monitoring (Brown & Goldsmith, 2018) .

Economy 5.0 also introduces the concept of more flexible and inclusive working. Using digital technology and collaboration platforms, workers can connect with various employment opportunities without being bound by geography. This enables broader economic inclusion, especially for individuals who live in remote areas or have physical limitations. In addition, more adaptive business models allow companies to be more responsive to changing market needs and provide added value for customers (Mansell & Steinmueller ., 2021)

Education and skills development are also focal points in the transformation towards Economy 5.0. The education system is expected to not only teach technical skills and science, but also enhance critical thinking, creativity and social skills. Lifelong learning will be the norm, with individuals continually developing skills to adapt to technological change and evolving industry needs (Silva & Martins, 2019) .

One of the key challenges in realising Economy 5.0 is to ensure that the benefits of technological advancement can be felt by all levels of society. This includes reducing the

digital divide, ensuring that access to technology and the internet is widely available, and engaging communities in inclusive development processes. Governments, the private sector and civil society organisations must work together to create regulations and frameworks that support the achievement of technological benefits for all (Yao & Gao, 2014) .

Overall, the transformation towards Economy 5.0 is an endeavour to create a more sustainable and inclusive future. By combining technological innovation with a strong focus on human well-being and environmental sustainability, Economy 5.0 aims to build a world where technology serves people, not the other way round. The challenges are great, but with cooperation and commitment from all parties, this vision can be realised for the common good.

Challenges and Barriers to IoT Implementation

The implementation of the Internet of Things (IoT) brings various benefits, but it is also accompanied by various challenges and obstacles that need to be overcome. One of the biggest challenges is the issue of security and privacy. With billions of interconnected devices, the risk of data leakage and cyberattacks increases significantly. IoT devices are often easy targets for hackers due to the lack of strong security standards, as well as exploitable vulnerabilities. Data protection and privacy are critical issues that require advanced solutions, including data encryption, strong authentication, and effective identity management policies (Wang & Zhou, 2017) .

In addition to security and privacy, interoperability between IoT devices is also a major challenge. Devices from different manufacturers often use different protocols and standards, making integration and efficient communication difficult. This creates obstacles in building a cohesive and integrated IoT ecosystem. To address this issue, standardisation and a widely applicable framework are needed, allowing devices from different manufacturers to work together harmoniously (Zheng & Leung, 2018) .

Another challenge is network capacity and infrastructure. IoT devices generate huge amounts of data in a short period of time, which requires a network with high capacity to process and transmit the data. An inadequate network can cause delays, data loss, and degradation of overall system performance. Network infrastructure improvements, such as the implementation of 5G networks, are essential to support the growing communication needs of IoT devices (World Economic Forum, 2018) .

From a cost perspective, IoT implementation can be challenging, especially for small and medium-sized enterprises (SMEs) and developing countries. The large initial investment includes the cost of hardware, software, and system management and maintenance. In addition, the benefits of IoT are often not immediately visible in the short term, making companies hesitant to invest. More flexible financing schemes and government support can help reduce the economic burden and encourage wider adoption of IoT technologies (Nguyen & Tran, 2016) .

Regulatory and policy aspects are also barriers to IoT implementation. Policies that are too strict can stifle innovation, while policies that are too lax can pose security and privacy risks. Countries and regulators need to find the right balance in regulating IoT technologies, including in terms of data protection, cybersecurity, and individual privacy rights. International collaboration is also needed to set global standards and facilitate widespread adoption of these technologies (Kagermann et al., 2013) .

Finally, the lack of skills and knowledge in the IoT field is a challenge that needs to be overcome. The implementation of IoT requires experts who master various disciplines, ranging from cybersecurity, programming, data analytics, to network management. This skills gap requires serious attention from the education and training sector, including continuous skills development programmes for the existing workforce. By increasing the capacity and knowledge of human resources, it is expected that the implementation of IoT can run more smoothly and provide maximum benefits to society and industry (Kale & Nguyen, 2018) .

Overall, the implementation of the Internet of Things (IoT) offers great opportunities for increased efficiency, innovation, and ease of living. However, the journey towards widespread adoption of this technology is not easy and is faced with a variety of complex challenges and obstacles. Security and privacy concerns, device interoperability, network infrastructure capacity, implementation costs, regulations, and the lack of specialised skills in the IoT field are critical issues that need to be addressed.

To maximise the potential of IoT, collaborative efforts between the government, private sector, and educational institutions are required. Investments in infrastructure, standardisation of protocols, balanced regulatory policies, and comprehensive education and training programs are some of the important steps that can be taken. By effectively addressing these challenges, the full benefits of IoT technology can be realised, bringing significant positive changes to society and various industry sectors.

Conclusion

The Internet of Things (IoT) plays an important role as a key driver of the Industrial Revolution 4.0, which combines digital technology with automation to form a smarter, more efficient, and connected production system. By utilising data collected from various sensors and devices, IoT enables companies to better manage resources, monitor machine conditions, and predict maintenance needs. This not only reduces downtime and operational costs, but also improves productivity and product quality.

Furthermore, IoT is also a cornerstone for the transition to Economy 5.0, where technology focuses not only on efficiency and automation, but also on realising human values and social welfare. In this economy, IoT contributes to creating an environment that is more inclusive, sustainable, and more responsive to individual needs. From the healthcare sector that enables remote patient monitoring to smart city management systems that can optimise energy use, IoT brings a wide-ranging and significant positive impact.

However, to realise the full potential of IoT in the Industrial Revolution 4.0 and Economy 5.0, various challenges need to be addressed collaboratively. Data security and privacy issues, interoperability between devices, and adaptive regulations are some of the important aspects that require special attention. With cooperation between the government, private sector, and society, as well as investment in education and infrastructure, IoT can continue to drive innovation and improve quality of life, shaping a better and more sustainable future.

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