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Industry 4.0: Transforming E-Commerce and Startup Businesses Through Sustainable Innovation

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ABSTRACT

This study explores the transformative impact of Industry 4.0 on e-commerce and startup businesses, with a focus on sustainable innovation. It aims to identify the significant changes brought by Industry 4.0, examine the types of sustainable innovations implemented, and analyze their effects on business performance. Using a qualitative research approach and case study methodology, the research targets e-commerce companies and startups that have adopted Industry 4.0 technologies and sustainable innovations. Data collection involves in-depth interviews with managers and employees, participatory observations, and document analysis, including annual reports and relevant company articles. Data analysis is conducted through data reduction, data display, and conclusion drawing. Validity and reliability are ensured through data source triangulation, member checking, and maintaining an audit trail. The findings reveal substantial changes in e-commerce and startup operations due to Industry 4.0, diverse sustainable innovations adopted, and their positive impacts on efficiency, sustainability, and competitiveness. The study concludes with practical recommendations for e-commerce and startups to enhance the application of Industry 4.0 technologies and sustainable innovations in their business processes. This research provides a comprehensive understanding of how Industry 4.0 and sustainable innovation are driving the transformation of e-commerce and startup businesses.

1. INTRODUCTION

In the era of the industrial revolution 4.0, digital technology is a key asset for industry players to develop their businesses. The development of the industry that is closely related to technological advancements shows that the two cannot be separated. This progress has the potential to have a positive impact on a country's economy, by pushing it towards a digital economy.

Development has started since the 1980s with the use of personal computers (PCs) and the internet to improve business efficiency. The use of technology such as PCs and the internet is the foundation for the advancement of e-commerce or electronic commerce. E-commerce is a marketing system that uses the internet, either through websites, mobile applications, or browsers on computer or mobile devices to conduct business transactions, including commercial transactions between organizations or individuals. This is a combination of goods and services whose transactions are carried out online, which is expected to be able to encourage domestic economic growth and global integration. Along with the evolution of technology, the old era of the digital economy is changing into the era of the new digital economy, with the adoption of mobile technology, wider internet access, and the use of cloud technology in the digital economy process (Jamaludin et al., 2022).

The use of technology poses its own challenges for business people, who consider that maintaining sustainable business processes is the main goal of every company. However, the mindset that tends to be short-lived, especially among Indonesians, often focuses only on increasing income. The rapid advancement of technology and information has caused many business people or practitioners to neglect long-term strategies in maintaining the sustainability of the company. This happens because they still face uncertainty in reading the opportunities and challenges that exist.

One of the leading startup companies in online business today is Shopee, which is attracting attention with its potential for a large market share in Indonesia, supported by high internet penetration and the active participation of people in online commerce (Chong et al., 2022). The growth of information technology infrastructure, such as fast internet access, also plays a role in accelerating the development of internet networks. Sharing well-known startups such as Tokopedia, Blibli, Gojek, and others have been successful in creating product innovations and providing benefits in solving common problems.

Startups have the potential to identify and capitalize on opportunities by bringing innovative ideas to a dynamic and adaptable millennial generation, changing the paradigm from conventional business models to virtual models. Over time, traditional business models are changing to online business models, with information replacing inventory and physical products being replaced by digital products. In the digital realm, start-up owners must understand the digital marketing process that integrates digital technology. Online marketing today increasingly relies on technology such as smartphones and other supporting applications (Harahap et al., 2020).

The industrial revolution 4.0 opens the door to new creative innovations that can affect the readiness of consumers and business partners to adopt these innovative technologies. In addition, product diversification is also a response to consumer needs, while the creative industry in Indonesia seeks to survive and contribute to increasing the creativity of business people through the use of available digital business platforms (Jamaludin et al., 2022).

According to Chong et al., (2022), the industrial sector remains a key element in every country's economy, providing a boost to economic growth and job creation. In

manufacturing companies, the industry provides added value through the process of transforming raw materials into finished products. The term "Industry 4.0" became widely known in 2011, when it was promoted by a small group of business, political and academic representatives in Germany. Germany as a global leader in the manufacturing equipment sector, has one of the most competitive manufacturing industries in the world. Since the German federal government established industry 4.0 has become a popular topic among many companies, research centers, and universities.

In general, invoice refers to the process or result of using a product or resource that has existed before, with the aim of providing greater added value. Innovation includes a series of activities ranging from conceptualization of ideas, products, to marketing (Pradana, 2015). Some interpret innovation as the renewal of various resources to provide greater added value for humans. An important factor in the innovation process is the advancement in technology and science.

A company's success in achieving competitive advantage is determined by its ability to generate innovation and creativity through an effective and planned innovation process. To support this transformation, effective strategies are needed to create new products and improve the creative abilities of employees or team members within the company. Therefore, this literature study will explore the role of e-commerce and startups as a form of sustainable innovation in the era of industry 4.0 (Pradana, 2015).

2. RESEARCH METHODS

The research design uses a qualitative approach with a case study method to understand the phenomenon in depth. The subjects of the study are e-commerce companies and startups that apply Industry 4.0 technology and sustainable innovation, selected through purposive sampling. Data is collected through in-depth interviews with managers and employees, participatory observation to see first-hand the application of technology, and documentation in the form of annual reports and company articles.

Data analysis is carried out through three stages: data reduction to select relevant data, data display in the form of matrices and narratives, and drawing conclusions to answer the problem formulation. The validity and reliability of the data are maintained through triangulation of data sources, member checking, and trail audits. The results of the study are expected to show significant changes in e-commerce and startups due to Industry 4.0, the form of sustainable innovation implemented, and their impact on business efficiency, sustainability, and competitiveness.

3. RESULTS AND DISCUSSION

1) Industrial Revolution 4.0

An industry is a company that belongs to the secondary sector that focuses on economic activities. The industry involves the process of managing raw materials, raw materials, semi-finished goods, or finished goods to improve their function and benefits. In general, industry can be defined as a business that converts raw materials or semi-

finished goods into finished goods with added value to make a profit. Industrial products are not only in the form of goods, but can also be in the form of services (Xu et al., 2018).

The industrial revolution 4.0 creates opportunities through various breakthroughs for the better. The presence of e-commerce in Indonesia is very necessary and profitable, considering the vastness of Indonesia's territory (Siswanto et al., 2020). E-commerce is a hope for SMEs because it can reach a wider range of consumers. In addition, the e-commerce climate in Indonesia is very good and people's purchasing power continues to increase (Widagdo, 2016).

Industry 4.0 is based on 4 (four) main principles (Hadi & Murti, 2019). First, interconnection, which is the ability of devices, machines, sensors, and humans to connect and communicate through the Internet of Things (IoT) or Internet of People (IoP), which requires standards, security, and collaboration. Second, information transparency, which is the ability of information systems to create and form virtual data replicas from the physical world by enriching digital models using sensor data, including information provision and data analysis. Third, technical assistance, which includes: a) the ability of systems with the help of artificial intelligence to help humans overcome and solve problems; b) the ability of the system to support humans in performing various tasks (multitasking); c) assistance in physical and visual forms. Fourth, decentralized decision-making, which is the ability of virtual physical systems with artificial intelligence to make their own decisions and carry out tasks optimally and effectively (Hadi & Murti, 2019).

To achieve more effective and efficient productivity, automation in the digital era can occur in all sectors. The application of digital information technology in all work unit activities will reduce the role of humans who previously functioned as operators (Fitriyadi, 2020). In general, in the era of industry 4.0, the role of humans who were previously operators will shift to experts or professionals with high knowledge and competence. This era is also known as the digital revolution and the era of technological disruption. One of the unique characteristics of the Industry 4.0 revolution is the application of artificial intelligence in all areas of industry and automatic record-keeping in computer programs. This fourth-generation industrial revolution can be identified with the emergence of smart robots, advanced computers, and autonomous vehicles, which allow humans to further optimize brain function (Xu et al., 2018).

2) E-commerce by Era Industri 4.0

The industry usually has standard operational procedures, from the provision of raw materials to the final product that reaches the consumer. In the era of Industry 4.0, all these procedures have used intelligent automation. E-commerce, which emerged before industry 4.0, is a business transaction that is carried out electronically through the internet. This business transaction is part of industrial activities (Santoso, 2022). Therefore, in general, e-commerce is related and in line with industry 4.0. Therefore, it is important to discuss the form of relationship and harmony between the two in terms of framework, dimensions, and technology.

Industry 4.0 focuses on intelligent and automated manufacturing, and develops in many sectors, resulting in large quantities and high-quality products in various fields.

This will have an impact on increasing business transactions, especially in e-commerce. Marketplaces will become increasingly complex and sophisticated, allowing companies to thrive and spur the wheels of the economy around.

In the era of industry 4.0, e-commerce operations also still require human intervention, so the number of entities involved in this framework will increase. In addition, policy and regulatory aspects such as taxes and regulations also remain applicable in industry 4.0, similar to regulations and taxes in conventional industrial operations, so that there is harmonization of policies and regulations in the realm of e-commerce (Fitriyadi, 2020).

Marketing and advertising are important aspects of the e-commerce framework, involving promotion, web content, and marketing targets. In the era of industry 4.0, these activities remain relevant, with products that must have a clear target market, encouraging e-commerce marketing and advertising to be more intensive and creative. The e-commerce framework also includes supporting services such as logistics, payments, and system and network security (Santoso, 2022). In industry 4.0, payments use online banking services and electronic money, and system and network security uses cybersecurity. In addition, business partnerships are also an important part of the e-commerce framework with partnerships in the procurement of raw materials and distribution of finished products in the industrial era 4.0, which needs to be improved.

There are 2 (two) important aspects, namely ubiquity and global reach, which means the ability to be accessed anywhere and reach across national borders through the internet. This is becoming increasingly vital, where production control can be done through smart devices and accessed from various locations, so e-commerce technology must match these advances (Chong & Ali, 2022). Furthermore, universal standards refer to the use of a set of technology standards, such as the internet, which is also used in industry 4.0. Finally, richness refers to the richness of content such as video, audio, and text in product marketing, which is also used in industry 4.0 to optimize e-commerce.

Interactivity in this case refers to the ability of technology to interact with users. E-commerce just needs to adopt this technology into its interactive experience. Furthermore, information density refers to the ability of technology to reduce information costs while improving its quality (Widagdo, 2016). Technologies such as big data and the cloud are used to manage information more efficiently, reducing the cost of processing, storing, and communicating information. This has led to information becoming more abundant, affordable, and accurate, which e-commerce can adjust in its technology strategy.

Personalization/customization refers to the ability to convey information to customers according to their needs (Widagdo, 2016). This is done in the process of creating products, so that they are in accordance with the needs of the e-commerce market. Lastly, social technology allows users to create and various content with a global community through social networks which is also a technology strategy in industry 4.0 and will facilitate the growth of e-commerce.

3) E-commerce Challenges

The Industrial Revolution 4.0 encourages the emergence of various innovations around the world in the economic and business fields. The thought of innovating in the hope of keeping up with the times is often not easy. Various challenges and obstacles must be overcome with planned strategies and management. According to Fitriyadi, (2020), there are 5 (five) main challenges in the realm of digital economy in Indonesia today, namely:

1. **Human resource development**, this challenge cannot be solved in a short time. However, it can be overcome by educating the community and preparing an education system that is in accordance with current developments to increase competitiveness in the digital economy era.
2. **The increasingly fierce competition**, e-commerce, causes market competition to become more intense. The ease of entry of products from other countries into Indonesia through e-commerce has an impact on local products that can be eroded if they do not innovate.
3. **Cyber security**, the issue of digital security remains a major concern in various countries, including Indonesia as a developing country that has great opportunities with the increase in online transactions every year.
4. **Regulations that have not kept up with the times**, legal bases and regulations need to be designed in accordance with the times. The government must be proactive in making laws that regulate the national digital economy. Likewise with related institutions, to protect the rights of digital economy actors and consumers, so that they can contribute well in the future.

a. **The availability of adequate internet access**, currently internet access is still concentrated on large islands such as Java, while other areas, especially remote areas, are still minimal.

5. CONCLUSION

Industry 4.0 has changed the business landscape globally, including in the realm of e-commerce. With the adoption of advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data, and cloud computing, e-commerce has become more efficient, affordable and personalized. Additionally, the presence of e-commerce has expanded its reach across national borders and provided users with a more interactive and responsive shopping experience. With the right strategy in utilizing technology, e-commerce can continue to develop and adapt to changes in the industrial era 4.0, making it one of the main players in the global economy.

In the face of advances in digital technology, digital transformation is an important focus to be thoroughly investigated. With fierce business competition in the era of industry 4.0, innovation is key. It is appropriate to switch from a conventional business model to a digital business model. One of the steps is to utilize e-commerce and start-ups as an innovation effort to compete globally. As a current solution, counseling and training from related institutions or institutions regarding digital business is needed for individuals who do not understand information technology.

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