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Smart manufacturing adoption in supporting technologies infrastructure in Indonesia: The case of South Sulawesi SMEs

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Abstract. This paper aims to give a unique view of looking at how SMEs in Indonesia applying the concept of smart manufacturing along with the challenges of smart manufacturing adoption in supporting technologies infrastructure in Indonesia and its current implementation. There are several challenges that were identified through the smart manufacturing adoption in Indonesia. The manufacturing industry has a great contribution to developing countries such as Indonesia. It is considered as the engine power for Indonesia's economic growth. Moreover, by considering the value of SMEs in Indonesia, this research puts more attention on smart manufacturing implementation on SMEs. This study provides two cases from SMEs based on the SMEs scale and measuring their productivity from using the traditional method and after adopting the technology used on their business operations. The two cases indicate that the firms have an awareness of the importance of smart manufacturing implementation and its effect to the performance of the firm. However, direct migration to an advanced cyber-physical manufacturing system is not a practical option for the firms.

1. Introduction

Manufacturing in this modern era is considered as an integrated concept at all levels, from machines to production systems to an entire business-level operation [1]. Today, technology is an inseparable part of business operations. By leveraging new technologies, such as the internet of things and autonomous vehicles, many companies can seize the opportunity to increase their productivity.

The trend of manufacturing industries involving smart technologies and the productivity of their system has found to be increased by 17-20% [2] with improved machine utilization and optimization of energy usage by smart manufacturing systems. However, in the era of technology advancement and industrial modernization, there are some considerable challenges that can be turned to obstacles in implementing the smart manufacturing concept.

In this modern era, the manufacturing industries are required to maintain their competitiveness by utilizing cutting-edge Information and Communications Technology (ICT). This demand has triggered the emergence of the smart manufacturing concept. The term 'smart manufacturing' related to the fourth revolution in the manufacturing industry and also considered as a new paradigm in the business development world. It is part of the cutting-edge technologies which support effective and accurate engineering decision-making in real-time through the introduction of various ICT technologies and the convergence with the existing manufacturing technologies [3]. The term 'smart' used when the



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production process involves smart devices and sensors in producing goods with fewer human interventions.

There are two reasons why the application of technology advanced is urgently needed in the current era. First, the competitiveness among the manufacturers forces them to provide their best to fulfill the market demand. Second, the current market situation requires the manufacturer to increase its productivity.

Furthermore, the smart manufacturing paradigm has spread to several countries in the world, including Indonesia. The government of Indonesia has committed to supporting the manufacturing industry's performance by promoting the "Making Indonesia 4.0 roadmap" since 2018. In this program, the Indonesia government put more attention to the five priority sectors, namely, food and beverage sectors, textile & apparel sectors, automotive sectors, chemical sectors, and electronics sectors. The five priority sectors were chosen by considering its industrial values. The government has fully aware of the current competitive environment in the manufacturing industry in national, regional, and international scope. Therefore, focusing on the priority sectors will help the government and the industries to be more concentrate on developing those most contributed sectors. Interestingly, the objective of improving the technologies infrastructure is in line with the Sustainable Development Goals (SDGs) for building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation.

In the context of SMEs, Indonesia has lots of opportunities to develop technologies infrastructure by empowering the SMEs sector. In terms of sustainable growth and employment, SMEs are important to Indonesia's economy due to its contribution. It is believed that maximizing the Indonesian SMEs potentials will lead Indonesia to become a middle-income country by 2025. The key findings of Deloitte report [4] show that the transformation in SMEs digitalization will bring significant benefits, including increasing revenue up to 80% and being 17 times more likely to be innovative.

According to the Cooperatives and SMEs Ministry, 2014, the number of SMEs in Indonesia shows a high contribution to the GDP by 58,92% and absorbed 97,30% of the country's workforce. However, this contribution was dropped by almost 3% to 56% of the total GDP in the following year. This number indicated that SMEs face challenges in this modern era.

The recent technology update requires some local SMEs to transform their process into a modern system. Yet, it must be recognized that the national technologies infrastructure is still facing some challenges. According to [5], the current literature mostly focuses on big firms when they discuss smart manufacturing concepts. This study, therefore, offers a unique view in looking at how SMEs in Indonesia applying the concept of smart manufacturing. Identifying the challenges of smart manufacturing adoption is important in determining the proper strategy to seize the opportunities in developing technologies infrastructure in Indonesia.

This study provides two case studies from two SMEs, which based in South Sulawesi Province, in Indonesia. This study examines how digital technologies trigger changes in the business process of manufacturing in small and medium-sized enterprises (SMEs) in Indonesia, particularly in South Sulawesi.

The following section discusses the literature on smart manufacturing and how SMEs adapt it, before describing the changes that occur in smart manufacturing. Empirical evidence is presented from two cases, followed by findings and recommendations regarding actions for SMEs, and the government as well as suggestions for future research.

2. Literature Review

Smart manufacturing is a concept that using technology to the interconnected machines and tools for manufacturing performance and optimizing the energy and workforce required by the implementation of big data processing, artificial intelligence, and advanced robotics technology and interconnectivity of them [6]. The term "smart" refers to the technology advanced that used in the production operations.

Smart manufacturing basically includes big data, artificial intelligence, cloud computing, cyber-physical systems, augmented reality, flexible manufacturing systems, simulation, virtual reality, and additive manufacturing [7]. The term Industry 4.0 focuses on interconnectivity through the Internet of Thing (IoT), machine learning and focuses more on the processing of real-time data [8].

Since 1965, the industrial robot has been widely used in various applications, mainly because this technology is very helpful in carrying out operations quickly, repetitively, and accurately. Given its professional technical ability and production flexibility, making the business sector have the ability to produce more variety of products and at more affordable prices. In the manufacturing industry, it has helped achieve optimum results that provide benefits not only to producers but also consumers.

The benefits of automation include increased productivity and quality, improved accuracy, saving material costs, and energy [9,10]. Automation systems consider cost, performance, and the feasibility of industry-scale implementation.

Given the nature of SMEs, previous research indicated that the lack of capital, managerial skills, to the use of technology, and the nature of SMEs create challenges for SMEs [5,11]. Several studies indicated that SMEs face various issues when it comes to implementing smart manufacturing. The factors such as the importance of information management in the manufacturing sector [12], SMEs are not involved in the spread of advanced manufacturing technology (AMT) [13], good leadership, fact-based decision making, strong networks with universities and government bodies [14] can help SMEs in its process to implementing smart manufacturing. In addition, mass customization is believed to be the core of why the attention to smart manufacturing is broadening [8].

Manufacturing is a main factor for the prosperity of the nations and an essential source of innovation and development. To many countries, manufacturing considered an engine of economic growth [5]. To ensure the competitiveness of the manufacturing industry, factories have always needed to adapt to new challenges and trends, resulting in several changes of manufacturing paradigms over the last two centuries. During the time, factories overcome several evolving trends like customers demanding for highly personalized products, the necessity for an eco-friendly production reducing its environmental impacts, increasing importance of social aspects including the requirements of production-related learning, a still lasting technology push regarding ICT as well as the need for improved integration of factories to their spatial context [15]. Automation will be a significant contributor to the productivity boost needed to projected GDP per capita growth [16]. Connectivity environment, performance improvement, and the use of digital tools were the characteristic of smart manufacturing adoption. The concept also emphasizes the effort to avoid material waste and energy waste [15].

3. Smart manufacturing and SMEs

Facing the rapid development of new digital technology has reemphasized the importance of advanced manufacturing. To maintain industrial competitiveness, the SMEs players are required to follow the recent updated technologies. The smart manufacturing paradigm seems to bring consideration to the SMEs player to make a transition from a traditional producer to a smart manufacturer. However, previous researches show that SMEs struggle to meet the complexity of smart manufacturing [5]. Limited access to finance and investment is one of the main factors that affect SMEs in implementing the proper smart manufacturing system [5].

Technology is another factor that limits the way SMEs implement smart manufacturing compare to most large businesses [17], which leads them to a condition where SMEs' research and development programs are not performing well [5]. In many countries, the government plays an important role in dealing with the obstacles. There are many success stories which show the collaboration between industry, government and SMEs could help SMEs facing the complexity surrounding smart manufacturing system. In Indonesia, for example, PT. TELKOM is a telecommunication state-owned company currently promoting the Digital SME Village Development program. This program focuses on utilizing information technology in a comprehensive and integrative way to support business

processes that run at the center of SMEs in order to create millions of advanced, independent, and modern SMEs [18].

4. The Cases

We have studied several Small and Medium Enterprises (SMEs) on how they perceived smart manufacturing and to what extent the concept is clearly understood by the firms, including the implementation of the daily operation.

By considering these issues, the provided two cases which are categorized as SMEs, namely Azzahrah and D&D bakery, is expected to draw an illustration on how SMEs and smart manufacturing in Indonesia, including how technologies can increase the productivity of the firms.

Azzahrah is a producer for fish meatball and shredded fish. The owner of Azzahra came with the ideas to produce such nutritious food without preservatives. Then he finds tuna fish as the main ingredients of the food. He executes this idea after completing market research about what people really expect by consuming healthy food yet instant to eat. After launching his product, the owner of Azzahra finds that product demand is significantly increasing. Measuring the demand for the product, he decided to make an improvement in his business process. Subsequently, the owner of Azzahra realized that involving technology tools on the production process will meet customer demand and expectations.

The owner of Azzahra overwhelmed by receiving lots of consumer demand. By then, he tried to invest in his business by buying machines to enhance the operational process. "A great decision to invest, I don't regret myself by spending money on buying those machines," revealed the owner.

In the beginning, the firm reluctant to invest more in automation technology, given the nature of demand on the sector that unstable in previous years. However, after projecting the increasing demand due to the increasing awareness from the consumer along with an opportunity to expand its markets, the owner finally invests in upgrade machines and technology.

According to the owner, his business normally produced maximum 70 packs of meatballs and 50 packs shredded fish for a week with two persons using a traditional method. Later, after using machine tools, they can fulfill the market demand by producing approximately 500 packs of meatballs and 500 packs of tuna shredded fish for a week. Automation also helps the owner to save the labor cost.

Some challenges for Azzahra is in terms of the planning process. There are many factors that need to be considered, such as scheduling for production with the consideration of the quantity of each product to be produced, capacity of each production line, setup time between production lot sizes, manpower availability, material availability, and product safety stock. The owners still need to find the best possible way to deal with the issues. Most of the time, the decision-making process takes time and frustration since it cannot provide the best possible outcomes.

The second case study is D&D Bakery. The case also revealed that technology tools bring much improvement to their business. D&D Bakery is one of the typical SMEs business located in the city of Makassar. D&D owner started their business from scratch by using a traditional method on their production process. Following the higher demand day by day, the owner of D&D Bakery then realized how precise each time on their production process. They can measure and predict the number of products that they can produce each hour. Fortunately, they realize that the baking process required a high accuracy measurement to improve their quality.

"We realized that time measurement also plays an important role in the baking process and the precise number needed to maintain our quality, and we know using a conventional method is not enough to make our products competitive."

In practice, D&D combines manual methods and automated machine operations for their business. Automatic tools are used to mix their ingredients, and some processes still use manual processes such as packaging and sales. This automated process is far more efficient at producing their products than when they do it manually, especially in the mixing ingredients section. If they still use the manual method, they will not be able to meet the increasing consumer demand every day.

Interestingly, the mixing process ¹⁰ is an advanced mixer that can adjust the mixing time of ingredients. By having the right time to control the mixing process, the quality of the dough can be controlled accurately and consistently. Consistency in this mixture makes its products more acceptable to consumers. Some time ago, complaints from consumers mainly on different flavors and sizes and tended to be inconsistent.

During the repetition and cutting process, the dough must be in good condition to produce a high-quality product. In addition, this new technology used in the manufacturing process, together with modern ovens, improves product quality and becomes more accepted by consumers because it is considered to improve the accuracy of their quality standards. This modern method can also reduce the risk of over-cooked products - which can harm bakery products.

The decision on upgrading technology for their operations was made by the owners from both firms. Apart from the awareness of the importance of new technology, they also supported the inputs from local governments that provide them with information related to the latest development in the industry. In addition, supplier of the machine and tools regularly contact them with the offer for upgrading the technology.

As for Azzahra, the utilization of tools and machines with the new technology mostly on the basis of achieving economies of scale, the sustainability of the concept which required the interconnection will all parts remain overlooked by the owner. One main reason is that talent and capital for the development are strictly limited. The cost of electricity and stiff competition with several new players enter the market makes D&D Bakery reluctant to implement smart manufacturing comprehensively.

5. Discussion and Conclusion

This study expected to provide a snapshot of the understanding of SMEs on what smart manufacturing is and the challenges of smart manufacturing adoption in Indonesia. Thus, the government and other stakeholders can consider the possible strategies to overcome the challenges and to improve the national technologies infrastructure.

The cases in this study are aware of the phenomenon, but management is still taking the first steps towards identifying the most appropriate strategy to implement this smart manufacturing concept. Companies need to exploit all opportunities with the support of available data and information provides in terms of knowledge creation and decision-making support. In addition, investments in people skills and expertise and through an infrastructure that can support data gathering, analysis, and sharing [19].

Based on the discussion of the two case studies mentioned above, the essence of smart manufacturing in SMEs is how this system offers solutions in the production process. By identifying needs in the production process, owners can overcome challenges by involving new technologies. The two cases above confirm that the production process carried out with an automation and optimization system provides benefits to the company in the form of better quality physical goods and controlled supply chain processes. Information and communication systems have also improved following the upgrade of technology and business process.

Furthermore, the study provide some challenges that appeared in smart manufacturing implementation in Indonesia's SMEs that could be used by managers and entrepreneurs to assess the level of readiness for utilization of digital technologies and how to digitalize some operations process.

SMEs in Indonesia face a variety of challenges in efforts towards smart manufacturing. This hands-on challenge is in the form of general issues related to everyday business processes. In addition, coordination between software and hardware, and how they get talent and capital is also an obstacle to good efforts to implement smart manufacturing. Coupled with technical constraints, especially in the interconnection of equipment, and how to maintain standardization of the process, which, of course, requires a lot of time and costs.

To get maximum results, SMEs need to also pay attention to data standardization, software system integration, and online network utilization to boost their markets. Based on these problems, we suggest several things that need to be taken by a variety of stakeholders, namely the government, industrial

organizations, small and medium-sized businesses, and scientific research institutions at universities. All these stakeholders must have effective contributions and mutual cooperation in the process of making SMEs that implement smart manufacturing. The government and industry organizations must carry out top-level planning and prepare policies that support in this direction, provide financial support, and be a bridge for the birth of innovative research. In addition, large promotions need to be developed in developing new financial systems, promoting cross-institutional cooperation, and developing new modes of talent use.

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