

Towards Industry 4.0: Is Indonesia's Manufacturing Industry ready to Transform?

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ABSTRACT

Industry 4.0 focuses on technology that can improve efficiency and solve problems in the production process. Therefore, investment in research and development (R&D) activities and ownership of a researcher that has capability becomes a necessity. This study provides an overview of aspects that can affect the readiness of Indonesia's manufacturing industry towards Industry 4.0. These aspects are limited to the R&D expenditure, and researcher, based on medium and large scale businesses. By using the results of an assessment survey about the readiness of the manufacturing industry towards industry 4.0 conducted by the Ministry of Industry and the R&D survey of the manufacturing industry by the Ministry of Research and Higher Education (now Ministry of Research and Technology), this study through descriptive analysis found identification of aspects towards Industry 4.0. In the end, this study produced an overview related to aspects that need to be considered in strengthening the readiness of the industry towards Industry 4.0.

Keyword: Industry 4.0, R&D expenditure, Researcher, Manufacturing.

1. INTRODUCTION

The global competitive environment, marked by uncertainty, constant change, and varying dynamics and market demand inevitably leads the manufacturing industries to dynamically exploit core competencies, develop innovation, and invest in technology radically [1].

Core competencies are exploited through the acquisition of technology, in-house R&D, assimilation, transformation, and absorption of new knowledge to create innovation in both processes and products. More than a century ago, the governments in the European Union established ambitious R&D policies to push innovation and economic growth, which in turn produced competitive industries [2] [3][4]. This indicates that the intensity of R&D is positively related to innovation.

Furthermore, information technology grows rapidly, transforming the manufacturing industry by digitalization and exploiting the potential of new technologies. The production system becomes more flexible and allows products to be adjusted individually and specifically. Germany has the most competitive manufacturing industries in the world, especially in the

machining and automotive sectors, and then initiates a concept of industry 4.0 [5]. The basic concept presented at the 2011 Hannover Exhibition then became a subject matter of general discussion among the research, academic and manufacturing industry communities. The main idea is to exploit the potential of such new technologies and concepts as availability and use of the internet and Internet of Things (IoT), integration of technical and business processes in companies, digital mapping, and virtualization of world realities, as well as 'Smart' factories [5]. It is a fact that the manufacturing industries in developed countries are pioneers in developing R&D, innovation, and continuing to develop the industry 4.0.

How about developing countries? Are they also taking advantage of innovation and industrial transformation to boost their economies? Or, are they just followers and continue to be in demand with high imports? Currently, the manufacturing industries of the developing countries such as Indonesia, Vietnam, the Philippines, and Pakistan manufacture most products for export to foreign companies in developed countries. When the manufacturing companies are capable of creating innovation and undertaking a radical efficiency of their managerial and production chain sectors, the rate of output per unit would increase substantially [6].

This corroborates the belief that the application of Industry 4.0 is crucial to those countries.

Indonesia, as a developing country ranked 85 in the Global Innovation Index (2019), seeks to strengthen its economy by increasing GDP. For this reason, the government has confidence, through policies, programs, and strategies, in driving the manufacturing industries to enter Industry 4.0 to boost the Indonesian economy [7].

However, the proper policies, programs, and strategies require the knowledge and data describing the real condition of Indonesia's manufacturing industries. Unfortunately, the researches on this matter are scantily undertaken. That Indonesia's manufacturing industries are less confident in their capability of making leapfrog into a brand new era is groundless when the current conditions and their characteristics are unknown. This paper seeks to describe the real conditions and unique characteristics of the manufacturing industries conducting R&D activities in the era of Industry 4.0. The data presented are the results of two surveys, namely the R&D survey in the manufacturing industries and the survey of the manufacturing industry readiness towards industry 4.0. This paper is aimed at providing ideas to explore the industry characteristics in terms of their potential, environment and problems or constraints, etc.

2. R&D AND INDUSTRY 4.0

R&D activities are those creative activities undertaken systematically to increase the stock of knowledge, including knowledge of man, culture, and society, and to use this knowledge to devise new applications [8]. The developed countries allocate more than 1% of their GDP for R&D activities. The manufacturing industries account for more than 70% of the investment. South Korea, for example, invested 4% of GDP in 2018, Japan 3.4%, United States 2.7%, Singapore 2.1%, and Malaysia 1.2% [9]. A study by A. Coad et.al. (2017) found that, despite the decline in the manufacturing sector in many industrial countries in Europe and North America, policymakers continued to recommend improving R&D. The results of this study indicate that the level of innovation of a company is influenced by the level of R&D expenditure [10].

Developing countries remain heavily dependent on government funding for their R&D development. Their R&D investments relative to GDP is less than 1%. Argentina invested 0.5% of GDP in 2016, Colombia 0.26% of GDP, Thailand 0.78 %, and Indonesia 0.24% [9]. According to the Science and Technology Indicators developed by the OECD, the R&D characters of the developing countries, in terms of input, are low R&D spending especially in the industrial sector, R&D personnel with low levels of education, and inadequate infrastructure. In terms of output, it includes a small

number of scientific publications and patents [11]. The term "Industry 4.0" was originally coined by the German government, describing and encapsulating a series of technological changes in making and setting priorities for a coherent policy framework with the aim of maintaining the global competitiveness of German industry. Industry 4.0 constitutes a new phase in the industrial revolution, focusing on the utilization of technological developments, automation, machine learning, big data, and real-time information/data technology [12].

Utilization of this technology creates a more connected ecosystem, especially in focusing on aspects of production and supply chain management. Despite the currently varying operations of every company and organization, the challenges faced remain the same, namely the need for connectedness and real-time information access to products, people, and partners in all process lines. Industry 4.0 in manufacturing is referred to as Smart Manufacturing which includes Cloud, Big Data Analytics, Machine-to-Machine (M2M) Interaction, Man-to-Machine Interaction (M2MI), 3D Printing, Robotics, etc. connecting organizations with specific expertise [13].

With the Smart Manufacturing and Industry 4.0 revolution, many products are expected to become smart products through Cyber-Physical Systems (CPS), based on connectivity and computing power, which leads to self-management capabilities [13]. Most manufacturing equipment is transformed into Cyber-Physical Production Systems (CPPS), which is a machine-enhanced software with its computing power, utilizing various embedded sensors, which are beyond connectivity and processing power [13].

Smart manufacturing requires R&D to develop simulation models, virtual prototyping, virtual testing, development of feed-drive control techniques, diagnostic machines etc. Many manufacturing industries in Europe have their research facilities to develop their technology. For example, Prusa, a company in the Czech Republic, has its research facilities to develop 3D printers. Today, the company is globally leading the development of technology. It is for this reason that countries or manufacturing industries continue to maintain large investments in R&D activities.

In developing countries, including Indonesia, there is scant information on R&D-performing manufacturing industries, not to mention smart manufacturing development at the same time. The government has started the efforts to provide an incentive of tax deductions to R&D-performing manufacturing industries that, at the same time, develop education for operating technology 4.0. This indicates the government's serious effort to boost the country's economy. This paper provides an initial description of the manufacturing industries with R&D activities. Are

they also interested in developing their industry into smart manufacturing? This remains premature to identify, but this information is indispensable to determine the capacity and capability of the manufacturing industry in Indonesia, which is a developing and middle-income country.

3. METHOD OF DATA COLLECTION, PROCESSING AND ANALYSIS

Data on the characteristics of Indonesia’s manufacturing industries derived from the results of two surveys conducted in 2018 with respondents from the manufacturing industry. The first survey was a survey of R&D in the manufacturing industry conducted by the Indonesian Ministry of Research and Higher Education concerning the definition in sub-section 2. The results indicate that 452 manufacturing companies were claiming to conduct R&D. The data taken in this survey were: 1) total R&D expenditure; 2) R&D expenditure by types of research (basic, applied, and experimental research; 3) total number of researchers; 4) the total number of researchers by levels of education and discipline.

The second survey was a survey of the readiness of the manufacturing industry towards Industry 4.0 conducted by the Ministry of Industry. This survey was a perception survey involving 335 medium- and large-sized companies. The results were an index indicating the readiness of companies towards industry 4.0. There were five pillars assessed: Technology, Plant Operations, Product Services, Operations Management, as well as People and Culture. In this paper, the index is divided into two parts. The index scores of 2.5 to 4.0 are companies that are ready to mature to transform into Industry 4.0. The index scores below 2.5 are those companies that are just beginning to introduce industry 4.0 into the company.

The descriptive analysis method is used to describe the characteristics of R&D-performing manufacturing industries and the potential to transform into industry 4.0. Based on the descriptive analysis, this paper discusses policy alternatives that should be established in support of the transformation.

4. INDONESIAN MANUFACTURING INDUSTRY PERFORMANCE

The manufacturing industry is among the mainstay sectors of Indonesia, especially with regard to boosting economic growth. Over the past 10 years, the growth of the manufacturing industry ranged from 2.2 to 6.2%. The graph below shows the average national GDP growth (Fig. 1) [14].

As shown in Fig. 1, some parties are concerned about the decline in the contribution of Indonesia’s

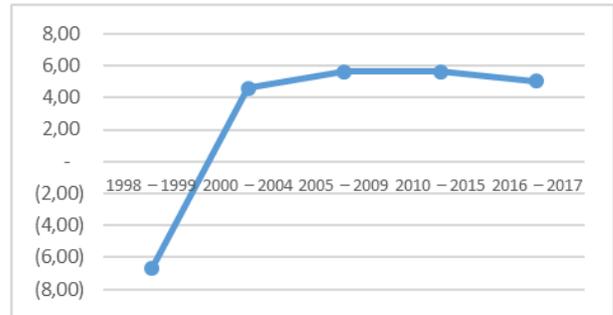


Figure 1 Average GDP growth, 1998-1999 – 2016-2017

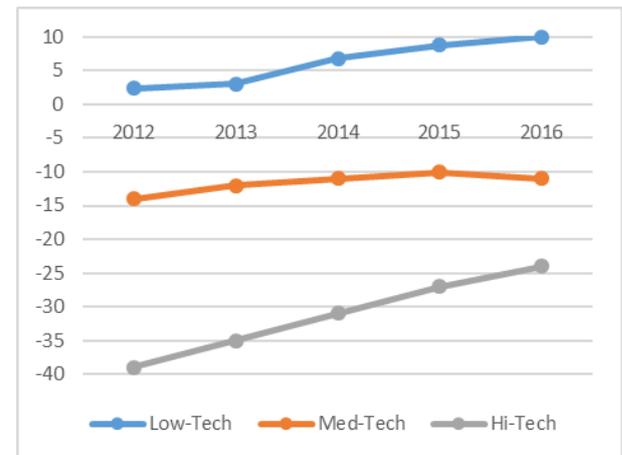


Figure 2 Industry Based on Technology Intensity, 2012-2016

manufacturing industry. The results of empirical studies show that the low competitiveness, inefficiency, and insignificant role of technology led to the decline in the growth of Indonesia’s industrial sector. The role of technology is indicated by the balance of trade which is the difference between the export and import values of products with high, medium, and low technology intensity (Fig.2).

Under these conditions, only approximately 10% of the total number of medium- and large-scale manufacturing industries in Indonesia performed R&D activities. The contribution of R&D expenditure to the manufacturing sector was around 9.51% of the total national expenditure of 0.02% of the total GDP in 2016 (Indonesian S&T Indicators, 2017). The survey results indicate that the three manufacturing industries with the most R&D activities are the Food Industry, Pharmaceutical Industry, and Chemical Industry (Fig.3).

Over the five years of the survey, Indonesian R&D-performing manufacturing industries are characterized as follows: most manufacturers did their own R&D activities and there was little co-operation performed. Almost all of their R&D budgets were spent on in-house R&D activities. In 2017 the ratio of intramural to extramural spending was 94 to 6. Company R&D

expenditure was divided into current and capital costs. The survey results show that there was no significant difference between current and capital spending. Only on the medium scale companies spend more on R&D assets such as laboratories or other R&D equipment. Meanwhile the large scale was spent more on salary/wages, allowances, or spending on disposables (Fig. 4).

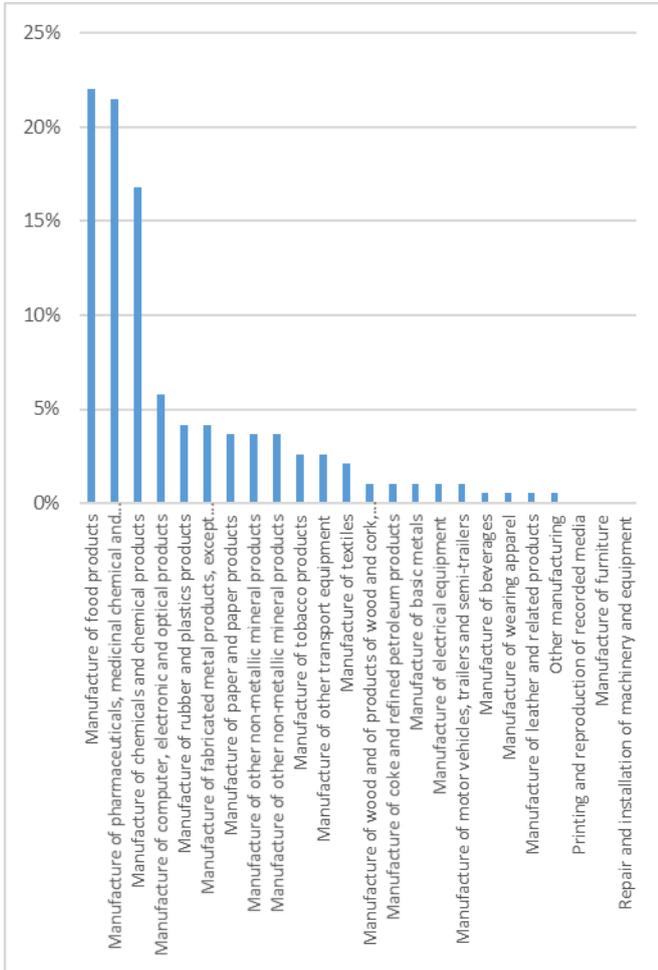


Figure 3 Distribution Companies that perform R & D activities by ISIC, 2017

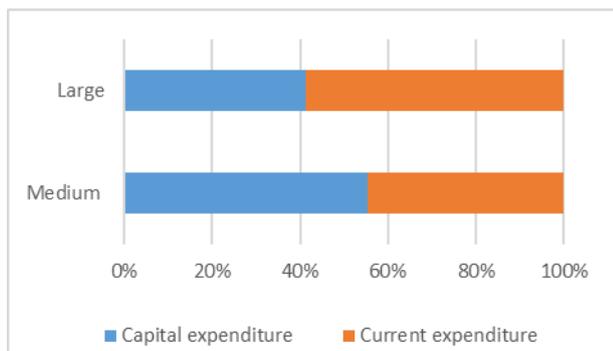


Figure 4 The distribution of R&D expenditure based on the type of expenditure, 2017

Researchers in the manufacturing sector had the following characteristics. Most fields of science of the researchers were Science, Technology and Social. The dominant field of science was Science, followed by Technology. With respect to sex, male researchers outnumbered their female counterparts; however, specifically in the field of Science, the difference between them was not significant relative to that of Technology. Another aspect to note is the levels of education. Despite the current inclusion of tacit knowledge, work experience and skills possessed into human capital, the levels of education constitutes an important measure to determine the capacity of researchers in the company. Basically, most researchers in the companies had undergraduate education and a very small number have Ph.D. degrees. More in-depth studies are required to investigate research conducted in the manufacturing industry (Fig. 5).

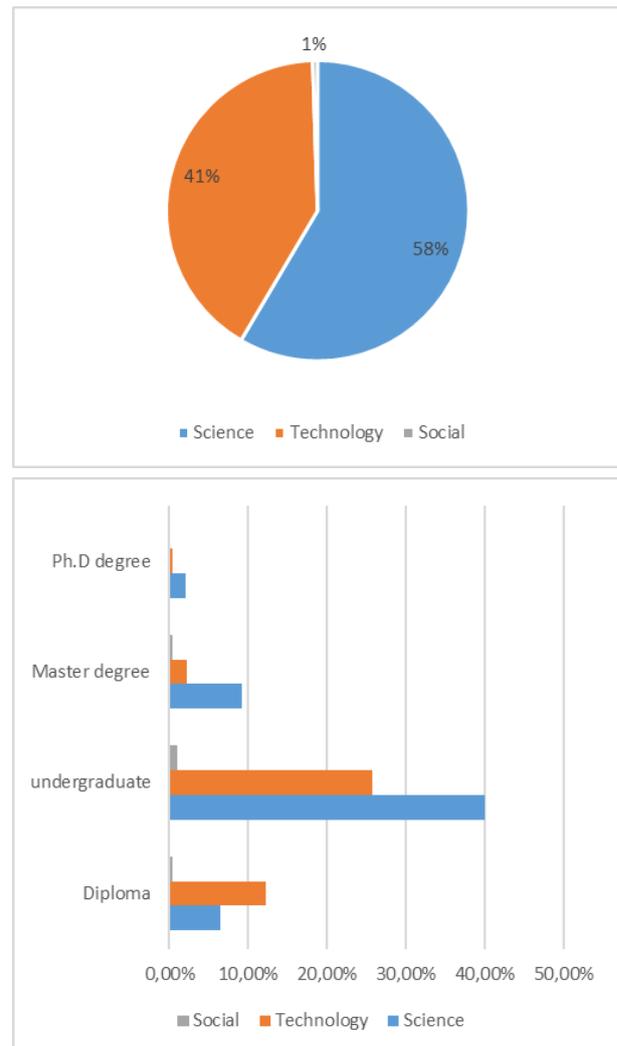


Figure 5 Distribution of Researchers based on the Field of Science, Education Level and Gender, 2017

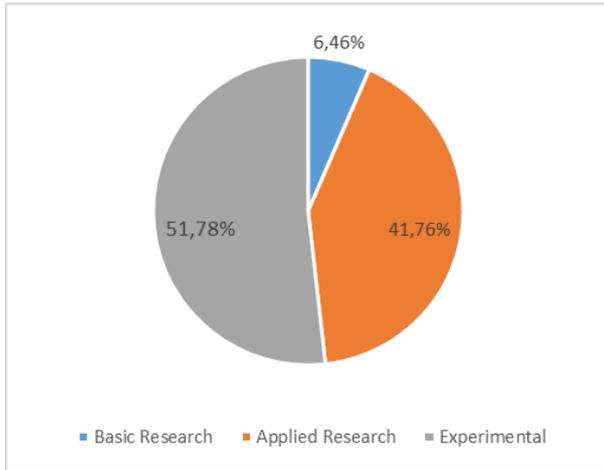


Figure 6. Distribution of types of research carried out in the Manufacturing Industry, 2017

With the capacity of researchers as described above, it is necessary to determine the types of research that is dominantly conducted in the industry. The survey results indicate that the majority of research activities were experimental research. These researches produced new products or processes usually intended to improve existing products or processes [8] (Fig. 6).

Under the conditions outlined above, a question is raised to the government; do Indonesia's manufacturing industries have the opportunity to transform into Industry 4.0? For this reason, there is a need for mapping the readiness level of the industries in Indonesia. Thus, a standard and nationally applicable index is required. It is the results of this indexing that would later be used as a basis by the government to determine the strategic direction to boost the industry. The index is called Indonesia Industry 4.0 Readiness Index (or INDI 4.0). INDI 4.0 is an index specifically designed according to the industry conditions in Indonesia. Thus, INDI 4.0 has its specificity. It has five main pillars to serve as the main measure to assess the readiness of an industry. The five pillars are: 1) Management and Organization; 2) People and Culture; 3) Products and Services; 4) Technology and 5) Plant Operations (using technology to operate plant activities). It has 0-4 levels, of which each level is defined as follows: level 0, companies with no change at all; level 1, already having a plan; level 2, transformation at an early stage; level 3, having transformed towards Industry 4.0; and level 4 having applied Industry 4.0.

Of approximately 300 companies involved in the readiness survey of Industry 4.0, only about 9% of the companies conducted R&D activities. Sixty percent of the companies performing research and development admitted that they have made breakthroughs toward Industry 4.0. Fig.7 shows the readiness index of R&D-performing manufacturing industries towards Industry 4.0. The figure shows that no company has entered into

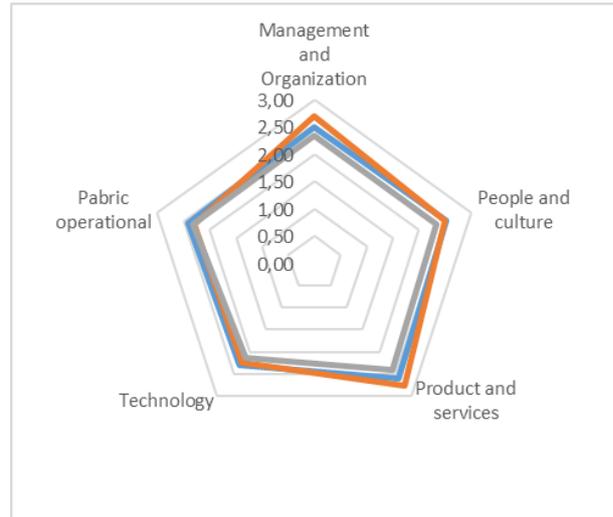


Figure 7 The readiness index of the manufacturing industry of R&D players towards industry 4.0.

level 3. All of them are between levels 2 and 3. This means that R&D-performing manufacturing companies were only in the early phase or in the process of changing or transforming into Industry 4.0.

5. GOVERNMENT EFFORTS TO ENCOURAGE THE MANUFACTURING INDUSTRY

Almost all Indonesian manufacturing sectors have not yet demonstrated the ability to transform into industry 4.0. For this reason, in the white paper 'Making Indonesia 4.0' launched by the Indonesian Ministry of Industry in 2018, there are 10 strategies that will be implemented. The 10 strategies include: 1) improving the flow of goods and materials in Indonesia; 2) redesigning the Indonesian Industrial zone, and building infrastructure related to industry 4.0; 3) accommodating sustainability standards in the global community; 4) Empowering Micro, Small and Medium Enterprises (MSMEs) by building e-commerce platforms for MSMEs, farmers and craftsmen, building technology centers in order to improve MSME access to technology acquisition, and providing mentoring support to encourage innovation; 5) Building a national digital infrastructure such as cloud, data center, security management, and broadband infrastructure; 6) Attracting foreign investment interests, Indonesia needs to involve more prominent manufacturing industry players to close the technology gap and encourage technology transfer to local companies; 7) improve the quality of human resources by overhauling the education curriculum by emphasizing more on STEAM (Science, Technology, Engineering, the Arts, and Mathematics); 8) building an innovation ecosystem; 9) building incentives for technology investment Incentives have the potential to drive innovation and adoption of advanced technology; 10) harmonization of

rules and policies Indonesia is committed to harmonizing rules and policies to support industrial competitiveness and ensure close coordination of policymakers between ministries and institutions related to regional governments.

Can this strategy improve the performance of the manufacturing industry in Indonesia? Further research is conducted.

6. CONCLUSION

The fourth industrial revolution will be implemented and cannot be rejected by every country, including Indonesia. The difference is whether a country is taking advantage of the revolution, especially improving their economy. For Indonesia, the real condition of the manufacturing industry has not yet demonstrated transformation capacity. It is not enough to implement ten strategies strictly, Indonesia needs to collaborate between various parties, including industry, entrepreneurs, the central government, regional governments, and social organizations in formulating Indonesia's strategy to face the industrial revolution 4.0.

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