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RESEARCH

Technology Adoption In Manufacturing Industry and Its Policy Implication

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Abstract

Technology adoption is an attempt to accelerate controlling, learning, and utilizing technology from the outside. This will encourage the organization to be able to improve its product, process and competitiveness. A survey conducted by the Ministry of Research and Technology in collaboration with the Agency for the Assessment and Application of Technology on large manufacturing industries (national private, SOE and FI) in Indonesia showed that: (1) respondents conduct technology adoption due to the awareness of the importance of technology innovation in improving company's performance; (2) the mechanism of technology adoption is mostly done by purchasing machinery and/or equipment from vendors or suppliers, and only few is done by license; and (3) most of national private companies and FIs adopt technology from other country, while the SOEs tend to utilize domestic technology. Some policy implications are suggested: (1) provide incentives for company utilizing a technology; (2) prepare competent human resource to encourage mechanism of technology adoption on industry; (3) encourage research activity in company and consortium and partnership research activity; and (4) build research area allowing every innovation actor to interact with each other.

Keywords: technology adoption, manufacturing industry, mechanism of adoption, source of technology, industrial policy.

I. Introduction

New technology gives a significant contribution towards the economic growth. It can be realized if the new technology is distributed widely and utilized in life (Hall and Khan, 2002). Massive new technology utilization in economic life will encourage economic improvement of a region/ country.

The success of technology innovation depends on the development and integration of new knowledge in innovation process. While many large organizations are competent to produce their own technology independently, they still require new technology and knowledge from their surroundings to obtain alternative source of knowledge to enable the organization to combine various technologies (Cassiman and Veugelers, 2000).

In addition, in a complex economic system, no companies are competent to produce a product or fulfil their needs independently. They need the supply or market from other companies or countries. Trade and technology transactions between companies and countries will encourage the economy to grow faster in the company or country. Technology transaction as a transfer of knowledge will require technology adoption activity. Technology adoption is done particularly by economic main actors such as industry or company.

Technology adoption is important since it can encourage a company performance to a better level (Ho and Mallick, 2006). Seen from time and the number of technology units adopted, technology adoption has a positive connection towards economic growth (Comin and Mestieri, 2010). New innovation adoption is an important part in the alteration and improvement of a company's technological capability (Riddell and Song, 2012). New technology and technology-adoption are important, if not crucial, and require strategic

decision so that a company is able to deal with competitive pressure and compete in product market (Zhu and Weyant, 2003).

Even though important, technology adoption process requires high cost and large resources. A main problem encountered by an organization is the absence of guarantee for the technology to be successful.

Certainly, every organization (including company) expects that technology adoption conducted will succeed. However, many companies or countries fail in adapting technology. The failure is caused by various factors; namely, the excessive focus on hardware instead of paying attention to social, institutional, economic and policy factor (IIED, 2013); ignorance of the motivation of the actors, technology and its mechanism, technology developer and technology complexity of the adopted technology (Douthwaite *et al.*, 2001); incomprehension of functional performance, acquisition cost, operational cost, convenience of utilization, reliability, compatibility, and convenience to repair (Burgelman *et al.*, 2004); ignorance of condition and support of top management, resource, adopter, organization behaviour, market, competitor, government and consultant (Ghobakhloo *et al.*, 2012).

From the failure overview above, there are three things that should be noted, namely: (1) what is the motivation or the reason for conducting technology adoption? so that the main objective is obvious; (2) how is the functional performance and compatibility mechanism of the to-be-adopted technology? so that the technology adoption is obvious and measurable; and (3) who is the technology developer or the source of technology? so that the origin and reliability of the technology are obvious. The three questions are the initial indications to measure the success or failure of the technology adoption. This paper will discuss those three questions.

II. Theoretical Overview of Technology Adoption

Technology adoption and diffusion are defined as a process where innovation is communicated through various ways in certain time between the members of social system (Rogers, 2006). Meanwhile, Law No.18 Year 2002 regarding National System of Research, Development, and Application of Science and Technology states that technology diffusion is the adoption and implementation of innovation result extensively by the inventor and/or other parties with an objective to improve its efficiency potential (Article 1, General Provision). Even though technology adoption and diffusion are often considered the same, generally diffusion is related to how the new technology/knowledge is distributed to adopter, while adoption is related to the decision to accept and utilize the technology (Suebsin and Gersri, 2009).

To conduct new technology adoption an industry requires series of important decisions and steps, since they implicate the future of the organization. The failure in utilizing or not utilizing a new technology for a company can result in the decline or improvement of market share, and eventually determine the life or death of the company. For example, Nokia, the producer of mobile phones leading the market in 1990s and early 2000s, had experienced a decline of market share from over 30% at first to only about 20%. In 2012, Samsung had bested Nokia as the biggest producer of mobile phones (Lunden, 2012). It was the result of the strategy in deciding the technology for their smartphone. Nokia still utilizes Symbian and MeeGo operational system that they have developed and Windows phone operation system, a result of collaboration with Microsoft, but ignores an operational system currently growing rapidly, namely Android (Blandford, 2011; Rasmussen, 2012). Since the second quarter in 2011, Android system operation has been the most widely utilized system operation than others (Gartner, 2013; IDC, 2012), thus Nokia's mobile phones with Symbian and Windows phone operational system falls behind.

The mistake in selecting technology adoption being developed gave a big impact for the viability of Nokia. Nokia suffered loss, growing from year to year. The mistake leads to Nokia's acquisition by Microsoft with a value of USD 7.2 billion in 2013 (from September 2013 to April 2014). In the acquisition process, Nokia tried to rise. In the early of 2014, Nokia started to launch an Android-based smartphone with Android Nokia X as the trademark (www.nokia.com). The alteration requires time to prove whether the sale of Android Nokia X will be going as expected or like other Nokia products. The first sale in China has been already booked for one million units (http://www.91mobiles.com/blog/nokia-x-pre-orders-success-in-china.html) and after the acquisition process is completed, the Microsoft alters the name of the unit business for Nokia's mobile phone to Microsoft Mobile Oy. However, it is not clear yet whether Microsoft will keep using Nokia's trademark for mobile phones that will be produced or use another trademark.

Selecting the right technology is not an easy task for anyone, including the organization head since the selected technology might be inappropriate for the organization in the future. Even if the selected technology has been decided, it does not mean that the technology is appropriate for the organization. It is possible that the technology adoption mechanism is less appropriate to the organization's resource, and thus the organization should spend large budget to adopt it. In addition, since the technology is an intellectual property, the source of technology is decisive: where the technology comes from and what the guarantee is that the technology application will succeed. For that reason, in applying technology adoption, there are three basics

consideration: (1) the reason for conducting technology adoption; (2) technology adoption model and mechanism; and (3) source of technology. The discussion of technology adoption in this paper will involve the reason for conducting technology adoption (Hall and Khan, 2002; Beal and Bohlen, 1981), technology adoption model and mechanism and its key to success (Park, *et al*., 2013; Coming and Mestieri, 2010; Weinberg, 2004; Hall and Khan, 2002; Skinner and Staiger, 2007; Wu *et al*., 2008; Doraszelski, 2004; Ma and Liu, 2004; Bridges *et al*., 1991; Shroff *et al*., 2011), as well as source of technology (Block and Keller, 2008; Cassiman and Veugelers, 2000: Zakić *et al*., 2008; Glass and Saggi, 2002; Arnold and Thuriaux, 1997: Ueki *et al*., 2008; Braga and Willmore, 1991; Acharya and Keller, 2007).

The Reason for Conducting Technology Adoption

There are many reasons why an organization (company) conducts new technology adoption. The most basic reason is for the sustainability of the company in the future, currently reflected from the profit and loss of the company. The profit a company can gain in technology adoption includes the increase in net profit. The increase of net profit by utilizing new technology innovation leads to better performance, including the increase of the efficiency of production activity that eventually reduces cost of goods sold.

For instance, the utilization of computer numerically controlled (CNC) technology that had been utilized widely in various automotive companies in USA in 1995s. CNC is different from machines utilized thus far, since it does not require manual operator control/setting. The setting for production activity is done by computer so that it can reduce operator costs, improve productivity and product's quality. CNC adoption in a company leads to three factors, namely, the increase of efficiency (operational cost reduction), the increase of market power (shown by market stock), and the stability of relation between company and customer that guarantees demand in the future (Hall and Khan, 2002).

The expense a company should spare for new technology adoption can be expensive or inexpensive depends on the accumulation of fixed cost and variable cost the company should spend in a specified period. The costs inflicted by new technology adoption are the cost of purchasing technology, the cost of installation and start-up, the cost of facilities and infrastructure preparation, the cost of employee training to operate the technology, the cost of treatment and repair, the cost of network and interface if the technology requires connection with other technology/system/equipment, the cost of utilization of new raw and additional materials, and other costs inflicted by the utilization of the new technology. Those costs and the comparison to the cost inflicted by the utilization of the old technology will be the consideration in deciding whether the company will adopt the new technology or not.

Tendency to conduct technology adoption also depends on the facility of information or network flow. One of the obstacles in technology adoption is difficult access between adopters and the source of technology. Incomplete information makes the technology users susceptible to asymmetric information about the new technology (Skinner and Staiger, 2007).

Another reason in adopting technology is time. Conducting new technology adoption requires sufficient time until the technology is ready to use. There is a time span between innovation and adoption of the new technology, depending on the type of technology. In addition to required time for socialization and adoption process, it is also because the adopter often waits for the technology to completely ready to use and has a clear description of the repair in the future (Doraszelski, 2004).

For various reasons above, it can be concluded that conducting new technology adoption is not an easy task for an organization. There are several factors to consider, since they determine the success or failure of the organization in the future.

Technology Adoption Mechanism

Process for technology adoption consists of five stages, starting from awareness, interest, evaluation, experiment and adoption (Beal and Bohlen, 1981). Basically, technology adoption is started from awareness of the technology's existence. The awareness process is started from searching for information on the technology and ended with technology application in accordance with the demand (Roger, 2006). The awareness process is followed by an attitude whether will utilize the technology or not. If accepted, the technology will be utilized to meet the demand, expected by the company.

One of developed models in technology adoption is Technology Acceptance Model (TAM). The model identifies the connection among technological attribute perception, technological attitude and the real utilization. The model is developed based on the consideration that the technology adoption is affected by various perceptions about the technology, namely perception about the utility and simplicity in technology utilization. Both perceptions encourage attitude in utilization that determines the utilization intensity, and eventually determines the system utilization in reality (Davis *et al.*, 1989).

Technology adoption is conducted through two levels, namely first adoption in organizational level and second adoption in individual level (Darmawan, 2001). In organization level, the adoption is conducted because the organization is required to

fulfill its objective (as well as vision and mission). Organization tries to obtain information and knowledge to be able to determine whether it will adopt a technology or not. If an organization decides to adopt a technology, the adoption application will be conducted by the assigned employee (individual) (Suebsin and Gersri, 2009). There are seven influential things in applying the adoption, namely: customer requirements, human resource quality, management support, change management expertise from leader of the project, clarity of scope activity and commitment, and communication of individual implementer (Suebsin and Gersri, 2009).

In technology adoption and transactional mechanism, there are several ways to be done. Generally, technological transaction and adoption between a country with another country is conducted through two ways, namely internalization and externalization (UNCTAD, 2001). Internalization is technology adoption of a company in a country from its main company in other country. Internalization is conducted by direct investment of transnational companies (TNC), so that the ownership and management belong to TNC. The adoption by internalization is difficult to measure since the technological development activity, and technology cost, etc. are conducted within the company. Externalization is technology adoption by a company in a country from other TNCs from another country, and both companies have special relation. Special relation between both companies and technology adoption are conducted through many ways, such as joint venture, franchising, direct sale and purchase, sale and purchase of capital goods, license, training and technical assistance, sub-contract (cooperation contract) or agreement on purchase and manufacture of production equipment or machine. To measure adoption by externalization is easier, since it can be seen from the development of technological capability in the company.

In technology adoption by purchasing, there are two choices, namely by turning it into an asset of the company (embodied) and by direct purchase of the technology from outside (disembodied) (Cassiman and Veugelers, 2000). Embodied is not done by purchasing the technology directly, but by internalizing it by purchasing machine and equipment and or recruiting new human resource (from other companies) having the ability to adopt the technology. In other side, disembodied is done through other company specialized on R&D and consultant institution.

Technology adoption by externalization is often conducted by license. Basically, license is a permission granted towards intellectual property (IP) for a technology, protected by a legal right. The protection is intended to keep the technology utilization by other parties (WIPO, 2005). IP consists of: patent (in the form of invention results), copyright (such as software, formula, scheme, technical manual, documentation, etc.), know-how (such as experience, skill, training ability, knowledge of the working process, etc.), trademark (such as logo, brand, product name, etc.), trade secret, industrial design, layout design of integrated circuit, and plant variety protection.

Technology license can be categorized into three categories, namely: (1) pure IP license, including license for IP only, such as copy, sell, or distribution of the technology; (2) product and technology license, including license for all IPs, enabling to develop a new technology, produce, use, market, and sell the product based on the type of the technology, and (3) standard license, including license to produce and sell product in accordance with technical standard from the technology (WIPO, 2004).

Source of Technology

Generally, technology comes from two sources, namely internal, that is, through result activity of R&D conducted by the company itself and external, that is, adopting a technology coming from outside the company (Block and Keller, 2008; Cassiman and Veugelers, 2000). Basically, when an organization intends to utilize a technology as the basis of its product or service development, there are two options to choose: either producing it or purchasing it from outside (Cassiman and Veugelers, 2000). The choice depends on the technological capability owned by the organization.

In deciding whether to produce or sell, there are things that should be considered, so that the choice will bring benefit to the organization. The things are: industry maturity, needs and expectations of consumers, technology opportunity, investment attractiveness, intensity of competition, the business size, the ownership of technology and export orientation (Zakić *et al*., 2008). It is important, because, for an instance, creating a technology for a weary industry will make the technology obsolete when launched.

When the choice is to create the technology independently, the first thing should be considered is the internal ability of the organization, particularly the ability to manage and develop the basis of the source of technology either tangible or intangible, as well as the ability to manage organization and possible alterations when developing the technology independently. Even though developed independently, it should be noticed that there are external capabilities (through network), particularly in knowledge access outside the organization, access to partners supporting the development, as well as relation between supplier and user of the product produced by the organization (Arnold and Thuriaux, 1997).

The development of independent technology requires proper policy, since there is a movement in

the emergence of the source of technology. In the past, the source of technology comes from R&D division of a large company, then from spin-off company, university and R&D institution, then in 2000s it tends to be a result of collaboration between R&D institution of government, university, or private institution with researchers who wants to build a start-up company in the field of technology, funded by the government (Block and Keller, 2008).

In policy perspective, based on the experience in Brazil, technology imports and technology effort complete each other. Technology imports from other country require internal technological capability to assimilate and adapt in accordance with the environment of the country (Braga and Willmore, 1991).

Based on the research conducted in Indonesia, Thailand and Vietnam, it is better for a local company, having financial and infrastructure ability, to utilize technology from other country (by technical assistance). However, it is better for a local company with a relatively weak financial system to utilize internal technology sources from local university and R&D institution (Ueki *et al*., 2008).

For a developing country, the source of technology is mainly from other country, and the owner of the technology is commonly a multinational company (MNC) having superior bargaining power compared to local company. They perform technology transfer through foreign direct investment (FDI) in developing country, either by cooperating with local company or directly. Generally, the MNC will attempt to ensure that their technology is maintained by paying its labor far exceeding the ability of local company. For that reason, it is required to have a proper policy so that the MNC is willing to perform technology transfer to local company through various incentives (Glass and Saggi, 2002).

In many ways, technology comes from other country through multinational company gives a significant effect towards technological capability and productivity in the recipient country, even though with different level. The level occurs because of geographical proximity or intensity of relation between countries. For example, Canada gains a large profit from R&D activities from USA companies due to the geographical proximity. However, in many cases, the intensity of relation between countries (companies) is more dominant in technology-transfer through import goods trade or non-trade, having technological content within (Acharya and Keller, 2007).

III. Methodology

This paper is a result of a research, under the collaboration of the Ministry of Research and Technology and the Agency for the Assessment and Application of Technology. This research aims to find out: (1) how technology adoption conducted by companies in Indonesia is; (2) how technology transaction/adoption mechanism is; (3) where the source of the technology come from?. By finding out the three conditions above, policy analysis can be conducted to encourage technology adoption, performed effectively and efficiently.

Data, data sources and methods of obtaining data

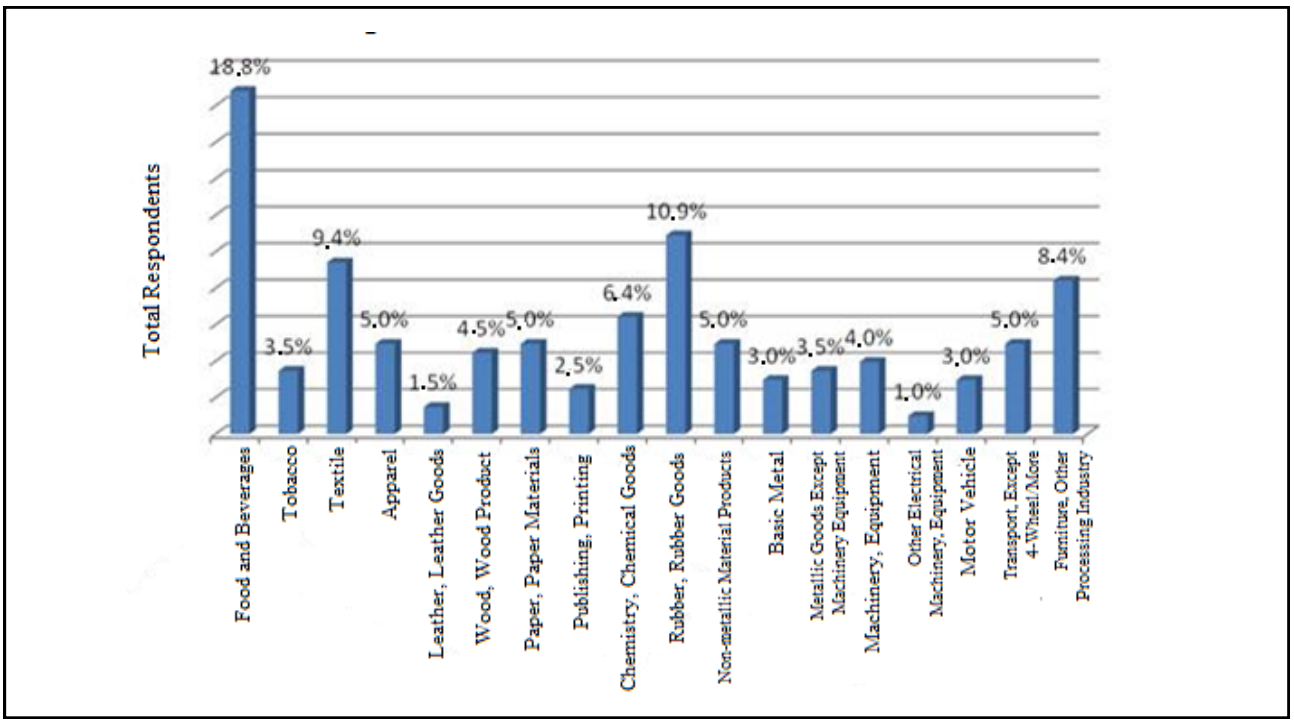
The data is obtained based on the answers of respondents from large processing companies in Indonesia. By using data from Statistic of Large and Medium Industry (BPS, 2010) and data from the Ministry of Industry, it is recorded that there are about 7,000 processing companies spread in several areas in Indonesia (Java, Sumatera, and Borneo). Those companies are categorized by using Indonesian Standard Industrial Classification (KBLI) adjusted with International Standard Industrial Classification of All Economic Activities (ISIC). There are nine industry groups, namely: (1) food, beverages, tobacco; (2) textile, leather goods and footwear; (3) timber and forest product; (4) paper and printed materials; (5) fertilizer, chemicals, and rubber goods; (6) cement, non-metallic mineral products; (7) basic metal, iron and steel; (8) transport, machinery, equipment; and (9) others.

For total population (N) of 7,000 companies, statistically, according to Yamane and Slovin Method (Israel, 1992; Tejada and Punzala, 2012), with trust level of 95% (or significance level of a = 5%), it requires total samples of 378.4 or 379 companies. Trust level of 93% (a = 7%) requires total samples of 198.3 or 199 companies, and trust level of 90% (a = 10%) requires total samples of 98.6 or 99 companies. Sampling is conducted by stratified random sampling method.

There are 4,000 questionnaires sent proportionally in accordance with total population for each industry group. It is expected that at least 10% from total questionnaires is returned, to statistically meet the representativeness of samples for significance level of 5%. It turns out in the deadline for the collection that only 202 companies (respondents) give their answers. The effort to directly contact several respondents and extends the deadline of collection has been done, however, until the deadline, no additional answers obtained. Even though total samples obtained do not meet the trust level of 95%, the total samples meet the trust level of 93% and exceeds trust level of 90%.

Method of Data Analysis

Data is processed in accordance with the industry groups. Processing result is analyzed to find out how the tendency of the answers from each industry group is. According to the result of analysis, a policy recommendation is formulated.



(Source: processing result and Ministry of Research and Technology, 2011)

Figure 1. Classification of respondent's industry according to Indonesian Standard Industrial Classification.

IV. Result and Discussion

Respondents returning the answers consist of 51.2% national private companies, 27.9% companies of SOE (State Own Enterprises) and 20.9% companies of FI (Foreign Investment) spread and operate all over Indonesia. According to Indonesian Standard Industrial Classification adjusted with International Standard Industrial Classification of All Economic Activities (ISIC), the respondents consist of 18.8% food and beverages industry, 10.9% rubber and rubber goods industry, 9.4% textile industry, 8.4% furniture industry and other industries.

Why Company Conducts Technology Adoption

Generally, the reasons mainly affect a company in deciding to adopt a technology consist of:

a. Technology innovation results are in better performance.
b. Adopted technology is relatively inexpensive.
c. The source of information is easy to obtain.
d. It does not take too long to adopt the technology.

The answers of respondents show that the majority (about 73.6%) states that the main reason to adopt a technology is a perception that technology innovation can lead to better performance. Meanwhile, only 16.9% state that the price factor of adopted technology is relatively more inexpensive. In other side, only 7.0% respondents consider the simplicity in obtaining information, and 2.5% state that time factor (adoption time does not take too long) is the basis in adopting a technology. Meanwhile, about 5.0% respondents mention other factors, such as efficiency, effectiveness, testability, determined by headquarters, market and no effect.

From respondents' answers, it can be concluded that the reason for most respondents to conduct technology adoption is the confidence that technology innovation will lead to better performance. It shows that commonly large companies operating in Indonesia are aware of the importance of technology innovation as an absolute requirement to obtain better performance. Seen from the type of the company, the confidence is stated by 76.8% companies of SOE, 73.8% companies of FI and 71.8% national private companies. The awareness of big-business actors towards innovation is important, since technology development and technology adoption enable them to be the leading actors in product development in the future.

Mechanism in Conducting Technology Adoption

Mechanism in conducting technology adoption and transaction between company and other company is done through:

a. conventional sale and purchase (including rental service of facility, standard testing service, etc.)
b. Technical training or assistance.
c. Purchase of machinery and/or equipment.
d. License

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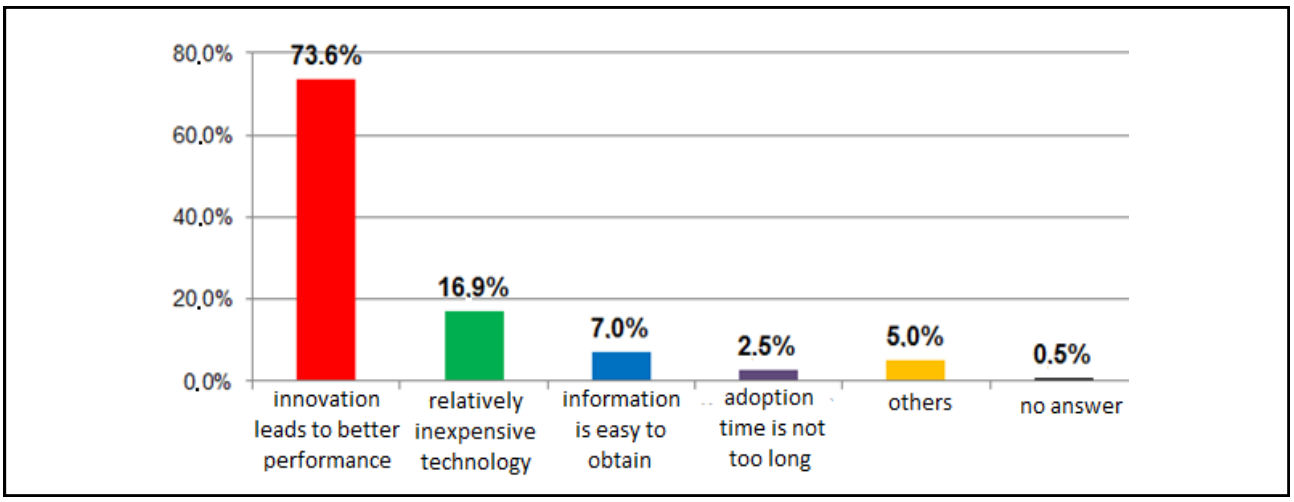


(Note: the total number is more than 100% because several respondents give more than one choice.)

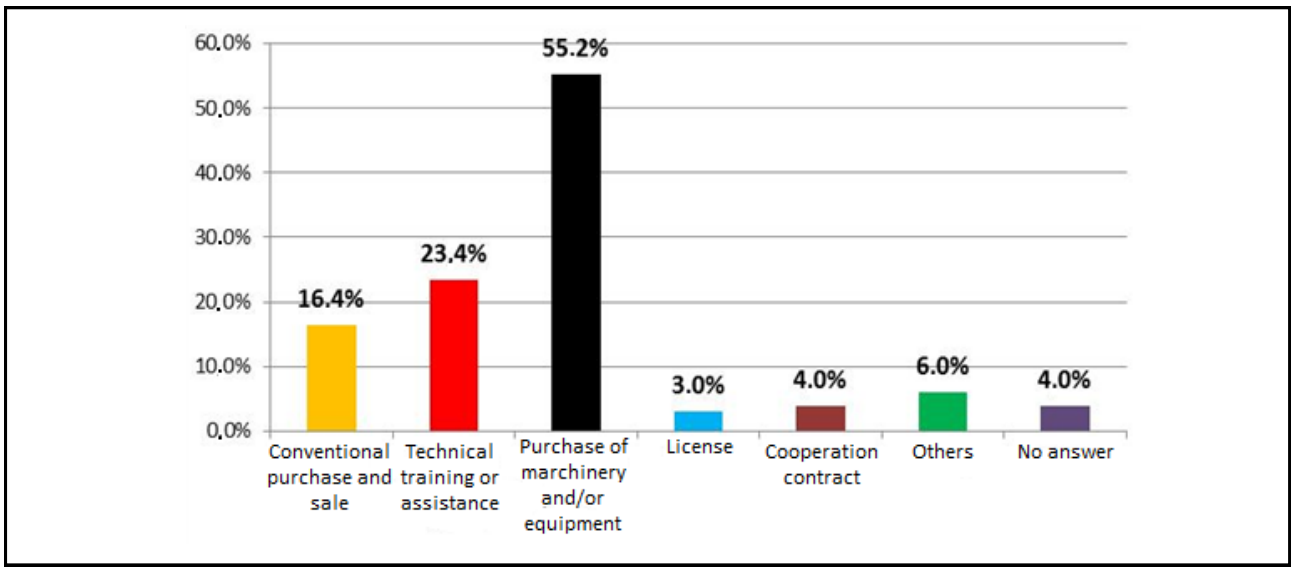
Source: processing result and the Ministry of Research and Technology, 2011

Figure 2. Why company conducts technology adoption

e. Cooperation contract (for example: financing sharing, built operating transfer (BOT), etc.).

Respondents' answers show that more than half (55.2%) respondents conduct technology adoption and transaction by purchasing machinery and/or equipment from suppliers or vendors. Meanwhile, other technology adoption and transaction is conducted by technical training or assistance (23.4%), conventional purchase and sale, including rental service of facility, standard testing service, etc. (16.4%), cooperation contract (4.0%), and only 3.0% companies conduct them by license.

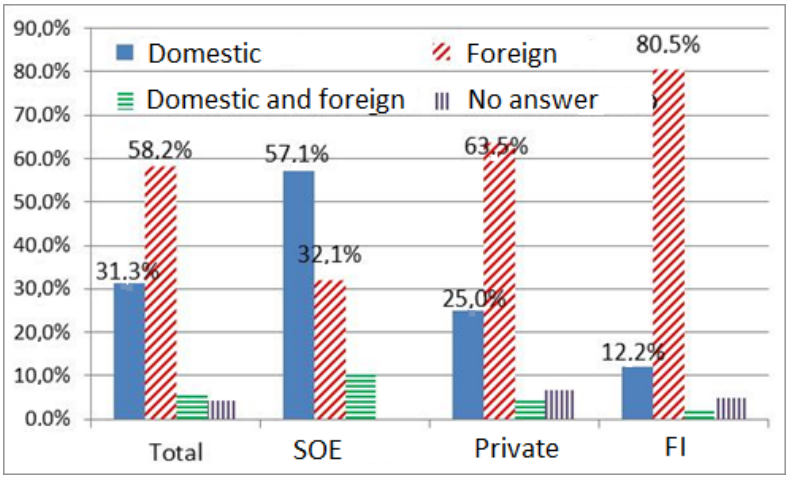
From the answers it can be concluded that the purchase of machinery and/or equipment from suppliers or vendors is a way many companies in Indonesia do in conducting the mechanism of technology adoption. The tendency is mostly done by national private companies (61.2%). Most of companies of FI and SOE apply the same way. In companies of SOE, besides the purchase of machinery and/or equipment, the mechanism of technology adoption is also done by technical training and assistance (33.9%). Compared to the purchase of equipment, technology adoption by technical training and assistance will enable the company to perform technology learning more intensively. The adaptors of technology will learn how to utilize the equipment and device in solving problem and repair of technical activity they conduct.



(Note: the total number is more than 100% because several respondents give more than one choice)

Source: processing process and the Ministry of Research and Technology, 2011

Figure3. Applied Mechanism of Technology Adoption and Transaction



Source: processing result and the Ministry of Research and Technology, 2011

Figure 4. The source of applied technology

Different from many literatures, apparently the mechanism of technology adoption in Indonesia is rarely done by license. License in national private company is only 3.9% companies of SOE and 2.4% companies of FI. It shows that technology adoption by license towards technology protected by Intellectual Property Rights (IPR) in Indonesia is relatively low. Whether it is because of expensive cost or other reasons need to be examined further. However, the awareness of IPR should be a serious concern, since in the future, each technology, no matter how small, will be protected by IPR. By IPR, a company can learn the technology in details and develop it, as well as combine it with the technology they develop independently.

Source of Technology

Generally, a technology utilized by company comes from:

a. Domestic, particularly from research institution, university or research conducted by the company independently, and
b. Foreign/import, particularly from companies producing certain required technology.

Respondents' answers show that mostly (58.2%) source of technology is from other country, 31.3% is from domestic, and 6.0% is from other country and domestic.

Seen from the type of the companies, about 80.5% companies of FI utilize technology from other country. It is natural, since most FIs operating in Indonesia run in production sector. Those companies do not perform research activity. The technology they utilize depends on the technology of the holding company (foreign principals). Besides FI, national private companies also utilize technology from other country (63.5%). They utilize technology from other country because mostly, machinery and equipment and technical assistance they utilize comes from other country. Different from companies of SOE, the utilization of technology from other country is relatively limited, only about 32.1%.

The source of technology from other countries is from Japan (24%), China (20%), Germany (15%), Taiwan (10%), South Korea (6%), USA (4%), Malaysia (3%), Singapore (3%), Italy (2%), Denmark (2%), and others such as England, Swiss, India, Mexico, the Netherlands, Sweden, and Belgium. The technology utilized in large companies in Indonesia is obtained from various sources. However, technology from Japan, China, and Germany is relatively dominant compared to technology from other countries.

Even though most companies in Indonesia utilize technology from other countries, companies of SOE mainly utilize domestic technology (57.1%). It shows that SOE appreciate and utilize more domestic technology.

The source of domestic technology mostly utilized is the technology produced by research institution (27%), domestic supplier (16%), company's R&D activity (13%), university (10%), media/exhibition (5%), training (3%) and others such as suppliers, sales agents, and banks. Research institutions mostly referred to are Indonesian Oil Palm Research Institute, Indonesian Rubber Research Institute, Indonesian Sugar Research Institute, Indonesian Tea Research Institute, Indonesian Institute of Sciences, Agency for the Assessment and Application of Technology, and others. Universities mostly made as the sources of technology are Bandung Institute of Technology, Sepuluh November Institute of Technology, Polytechnic, the Academy of Mechanical Engineering, and others.

The awareness of companies of SOE to utilize the domestic source of technology is something that should be supported. The opportunity to utilize technology (from R&D institution) to be applied in industry (SOE), enables the technology to be tested

in the market. The more technologies tested by market will encourage research and industrial institution to keep collaborating to perfect the technology, so that the technology will be accepted by market and can compete with other technologies from other countries.

V. Policy Implication

Technology adoption is a way to obtain, learn and utilize a technology properly to enable an organization to improve the quality of its product, the process, and its competitiveness. Even though many organizations are aware of the importance of technology adoption, not all of them are able to conduct it well. Many organizations fail to conduct it, since they do not understand the reason, the mechanism, the source, and the way to conduct it.

Respondents' answers from 202 large manufacturers in Indonesia show that most respondents consider that the main reason to adopt a technology is the perception that technology innovation lead to a better performance. The answer shows that there is awareness of the importance of technology innovation to improve productivity, competitiveness and performance of a company. The global competitions that have been going on and will come soon, such as AFTA (ASEAN Free Trade Area) and AEC (ASEAN Economic Community) that will be started in 2015, ACFTA (ASEAN-China Free Trade Agreement), WTO (World Trade Organization), and others, show that competitions between companies have been widespread, not only between domestic companies but also with other companies from other countries.

The mechanism of technology adoption is mostly conducted by large companies in Indonesia by purchasing machinery and/or equipment from suppliers or vendors and only few is done by license. It shows that technology is more often done directly by utilization activity (practice) of equipment/ machinery containing technology. Technology adoption is obtained from learning to operate purchased equipment/machinery. Adopting technology this way will make the company depends on the vendors of equipments. Meanwhile, technology development in the future is mainly determined by the company capability to conduct reverse engineering, and is not based on systematic research.

Technology from other country is utilized by most companies in Indonesia, especially national private companies and FI. They truly depend on technology from other country. It is a different case with companies of SOE. Most companies of SOE utilize domestic technology, either from R&D institution, university or even independent R&D activity.

By paying attention to such condition, if an industry in Indonesia wants to have high competitiveness, there is no other way besides encouraging systematic technology adoption. There is a policy implication that should be done in order that the technology innovation is done by companies in Indonesia. Those policies consist of:

1. **Providing incentive for companies utilizing the technology.**

The awareness of the importance of technology innovation for a company should be encouraged, one of the ways is by incentive. Incentive is useful for industries (companies) to get stimulation to make an innovation as an important part in their business' activity. Incentives include tax allowance, extension of the period of asset depreciation, R&D cost reduction in income statement, consortium of research funding, lab testing assistance, and others. Several incentives have been regulated in the Government Regulation No.35 Year 2007 regarding the allocation of a proportion of income of enterprises for research activities and Government Regulation No. 93 Year 2010 regarding donation (including donation for research) that can be deducted from gross income. Both regulations give incentives in the form of tax, customs, and R&D technical assistance. However, both regulations are not completely explained and described in the Regulation of the Minister. In addition, the procedures of petition and registration are too bureaucratic to be conducted, and they are difficult for a company to obtain. For that reason, an obvious incentive policy is required (through Regulation of the Minister) consisting of simple procedures regarding incentives. For example, what research activity is given tax incentive, what the requirements are, how much, how long, and how to file to obtain the incentive. It will facilitate the company.

2. **Preparing competent human resources to encourage the mechanism of technology adoption in an industry**

Encouraging technology adoption is done not only by purchasing equipment/machinery and technical training, but also by other mechanisms such as license, cooperation contract, etc. It will encourage variation in technology adoption and create various patterns in technology development in the future. It is important, since each type of industry has different characteristic of technology adoption. For manufacturing industry with old technology such as paper industry, palm oil industry, and sugar industry, the mechanism of machinery and equipment purchasing are among the best choices. For fast-running industry such as telecommunication industry or banking, the mechanism of license will be the best choice. For longstanding activity requiring large financing such as construction of power plant, cooperation contract will be the optimal choice. However, there is an important thing should be prepared in each mechanism of technology adoption, namely the preparation of human resource with sufficient capability. The capability should be supported by educational factor

(science and technology as educational background) and educational degree (graduate to doctorate degree) as well as capability to adapt and absorb technology. These capabilities should be prepared by the government and industry.

3. **Encouraging research activity in company and consortium research activity and partnership between institutions.**

Research activity in industry (company) is relatively limited. Many research activities conducted by company are still in the form of market research and product research instead of process research, applied research, and basic research. In the long term this will make the company highly depends on technology from outside the company. Basic research and applied research are the bases in technology development in the future. This awareness can be grown by conducting consortium research activity and partnership research. Such research activities had been conducted through several programs such as National Strategic Priority Research (RUSNAS), Partnership Priority Research (RUK), International Joint Research Program (RUTI), Research Incentive of National Innovation System (SINas), Indonesian Agency for Agricultural Research and Development (KKP3N), Inter-Institutes and inter-Universities Cooperative Research, and others source from the Ministry of Research and Technology, the Ministry of Agriculture and the Ministry of Education and Culture. However, the research cooperation has not been able to encourage industry to develop the result of the research to be a product and process in their business. It is due to the fact that most research cooperation involving industry (company) are initiated and dominated by human resource research from R&D institution or university. Company is only a research object. Human resource of industry is not the main actor and the back bone of the research activity. The result of the research is mostly utilized as research database instead of an applicative technology utilized by industry massively. If the technology is utilized by industry and sold as well as tested in the market, the technology will develop rapidly to reach its establishment. Therefore, research cooperation should be based on a technology that can be applied and utilized directly by the community.

4. **Building a research area allowing every actor to interact with each other**

A research area in the form of science-park, techno-park, innovation cluster, technopolist and others are required to grow conducive environment for technology innovation. The area allows research institutions (independent, part of university, or division from a company) to interact with each other for the same field in order for them to learn from and strengthen technology development with each other. Until now such area has not existed yet in Indonesia. Even though there are areas named science-park or techno-park in Indonesia such as Serpong Area of Science and Technology Research Centre, Solo Techno Park, Batam Techno Park, Bandung Techno Park, Jababeka Research Centre, Agro Techno Park and others, they are still limited research areas. Those areas are only locations for individual research activity by each unit of research/ engineering, and have not become the locations for inter-institutions research activities. The area has not involved interactions and synergy among research actors yet, particularly the actors of R&D institution with industry. The effect is the unavailability of technology to be approved in national or international level. For that reason, it is required to build an area allowing every research actor from R&D, industry and users to interact with and learn from each other. Area of Science and Technology Research Centre is potential since there are units of research/engineering with high capability. However, clusters in the area are not designed to be a location for gathering of consortium research activity between similar units involving industry. The existing cluster is only one owned by one institution in accordance with technology categorization in the institution.

VI. Conclusion

Technology adoption is a simple and easy way to improve the technological capability of an organization, by absorbing the technology from outside. Technology adoption conducted by large companies in Indonesia has been based on the awareness that technology innovation can encourage the company to have better performance and improve the competitiveness. The adoption is mostly done by practical activities such as purchasing machinery and equipment for production activity conducted by companies whose base is in other country. To encourage more companies to conduct technology adoption, it is necessary to encourage (in the form of policy) industry (company) to conduct the adoption intensively.

Technology adoption is not the ultimate objective in activities of a company. A company (industry) should be encouraged to develop technology independently. Technology adoption is one important step so that the technological capability, human resource, and the culture of developing technology of the industry keep improving.

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