

The Problematic and Urgency About Scientific Research of Knowledge Development in Indonesia

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Abstract. Based on SCImago data, throughout 1996-2016, the number of global indexed publications in Indonesia reached 54.146 publications. When compared to Singapore, Thailand and Malaysia, Indonesia's ranking was still far below the three ASEAN countries. In 2016, at the world level, Indonesia was ranked 45th for the number of internationally published documents. The purpose of this paper was to identifying the factors that became a problem of research and the urgency of research scientists in the development of the world of science in Indonesia. This study used literature study with a conceptual approach. The results of this study explained that Indonesia had not been able to balance the rapid transformation of science and technology in the international world with quality research results, so that even though Indonesia had natural resources and potential human resources, Indonesia had not been able to produce enough research products.

Keywords: Science, Research, Scientific Research, Knowledge, Knowledge Development

1 Introduction

Indonesia's deterioration in the development of science and technology could be seen from parameters such as research and development (R&D) funds which were ranked 42 of the 46 countries surveyed by IMD, thinked tank based in Switzerland. Under Thailand and Malaysia but still above the Philippines. But judging from the size of the per capita fund, Indonesia was only at the level above Venezuela which was at the bottom. More worrying was the interest of the younger generation in science and technology. Indonesia's position was far behind with neighbor countries trying to advance like Singapore (1st), Malaysia (14th), Philippine (29th) and Indonesia (39th). One of the causes, the lacked of international scientific publications which had an indicator of the low quality of research in Indonesia was the limited access of our researchers to international journals. The cost of subscribing to a journal in a year was quite expensive for a researcher. Especially to be optimal, a researcher must subscribe to more than one journal because in a particular discipline, there were usually several scientific journals that recognized as international references.

Indonesia's low ranking in science and engineering were related to the ¹ low national investment in the field of research and development closely. Indonesia, with a population of more than 230 million, which was the fourth largest country in the world by population. Illiteracy rates were very low and the country had several good universities and research institutions. Unfortunately, during 1996-2010, Indonesia was ranked 64th in the world in the number of scientific articles published in journals that had gone through a peer assessment process. In addition, around 74% of science projects in Indonesia were international

collaborations, so they must share their recognition with other countries. Although patents were more related to productivity in industry closely, many companies in various sectors did not apply for patents (or publish scientific articles) for business reasons [1].

However, the low level of private sector was spending on research and development may be an important factor in the low number of patents granted to Indonesia. Research and Development (R&D) activities were actually carried out in many institutions in Indonesia, with more than 80% of the budget coming from the government. Most researchers and engineers worked in government scientific institutions, and they received the largest share of the country's R&D budget. However, almost all researchers at the doctoral level work at state universities. Of all countries in the Southeast Asia region, apart from Vietnam which was a communist country, the contribution of the private sector to research in Indonesia was among the lowest and the contribution of the university was also very small.

This could be seen in the low output of R&D institutions in Indonesia about international publications. Based on SCImago data, throughout 1996-2016, the number of global indexed publications in Indonesia reached 54,146 publications. When compared to Singapore, Thailand and Malaysia, Indonesia's ranking was still far below the three ASEAN countries. In 2016, at the world level, Indonesia was ranked of 45th for the number of published documents internationally. In the Asian region, Indonesia's position was ranked of 11th, while at the ASEAN level It ranked of 4th. In addition, the trend in the number of publication documents in Singapore, Thailand, Malaysia and Indonesia continued to increase. Starting in 2010, Malaysia shifted Singapore's position to 2nd place. Regarding the published documents in Indonesia, the number increased to 46,41% (11.470 publications) compared to 7.834 publications in 2015. Despite the increase, this figure was still far compared to Singapore (19.992 publications) and Malaysia (28.546 publications). Looked at Figure 1 below:



Fig. 1. Comparison of International Publication between Indonesia and Some Countries of ASEAN (Source: SCImago, 2016)

Interestingly, the number of citation experienced a downward trend since 2013. In addition, although Malaysia was ranked of 1st about published documents, when viewed from the number of citation, Malaysia was ranked of 2nd (19,024 citations) after Singapore (32,504 citations) in 2016. Thailand ranked of 3rd (11,331 citations) and Indonesia ranked of 4th (4,604 citations). In addition to publications, another way to s¹² research positions and contributions were the number of patents produced. Sourced from the United States Patent and Trademark Office, up to 2015, the total Indonesian patents registered with the US Patent Office total 333. This number was still very far compared to other ASEAN countries, such as Singapore (10,044 patents), Malaysia (2,690 patents), and Thailand (1,043 patents). Not only lagging, the grew of Indonesian patents but also showed a stagnant trend since 2005. This could be seen in the following figure 2:



Fig. 2. Comparison of Patent between Indonesia and Some Countries of ASEAN Totally (Source: USPTO, 2016)

The low number of documents published internationally, one of them was due to the small number of researchers in Indonesia. Data from the Indonesian Institute of Sciences (LIPI) in 2017 showed researchers in Indonesia (only) amounting to 9,685 people. This figure was the number of researchers in all researchers functional officials from all Ministries in Indonesia. Indeed, there was a trend of increasing quantity since 2010. In 2010 the number of researchers in Indonesia reached 7,502 people, in 2012 there were 8,075 people. Figures continued to increasing about 9,128 people in 2014. This was due to one of them because these institutions did not have access to the latest information on the development of research and development of science and technology from international sources, due to limited funds allocated by the government. As a result the researchers did not have the opportunity to gained the latest access to the development of science and technology, through international journals in their fields. This was results in the quality of research conducted by researchers in research and development institutions that could not be increased or even worsen and they were unable to make publications that suitable for publication in international journals consequently.

The Ministry of Research, Technology, and Higher Education as the ministry that coordinated research activities in Indonesia, must answered this problem. One of the things that could be done was to collecting subscriptions to international scientific journals and managing an online library network system so that international scientific journals could be accessed by researchers from their respective laboratories collectively. Bador and Lafouge stated that a country had greater potential to be able to market Its findings if It had a scientific community that widely publishes publications in various fields and produced innovations that

deserve a patent [2]. Almost all scientists in Indonesia agreed that this country had not been able to produce as much patent knowledge or innovation as expected. This was supported by evidence of the limited number of publications and patents produced by Indonesia. Comparative data generated from international sources stated that every dollar invested in Indonesia did not show results that were equivalent to the achievements of researchers in other countries.

Indonesia's productivity in the field of science and technology was not also comparable with other countries that were vast and the amount of resources such as Indonesia. Scientists believe this was due to the difficulty of seeking support to finance research projects and inflexible financial reporting and reporting systems. Another obstacle that was rarely mentioned that the heavy burden of teaching at the university and the offered of higher salaries for a career in non-science of Non-Ministry Government Institutions of Indonesia. **1**ough, these two things were made scientists reluctant to do research. Indonesia did **not have the financial infrastructure to** supported innovative **science and technology**. The country also did not have the infrastructure to allocated and chained the channel funds to researchers, provided research facilities, and flexibled budgeting systems to conduct **1**d scientific research. In addition to these issues, there were bigger problems, namely the **low national investment in research and development. Indonesia's gross investment** in research and development was less than 0,1% of GDP, almost too low to be able to appeared in published report **3**harts.

All of these problems could be handled at once in a system **through the establishment of the Indonesian Science Fund**, an independent body that on the basis of competition could provided funds to scientists and engineers to conducted world-class research directly. One of the conditions for granting funds was the existence of institutional supported for researchers to increase productivity. Instead, this agency would provided compensation for the costs incurred by the agency. Many countries had recognized that the establishment of a national fund body that provided competitive grants was the most effective way to support world-class engineering science and science. The selection processed and extensioned of grants based on results such as publications and patents encouraged the value of scientific productivity. Given that scientific publications were selected by the best international journals to be published competitively, researchers must had an extensive network throughout the world if they wanted to make their research efforts leading.

Scientists who wanted to participate in research projects funded by donor agencies must collaborated with overseas colleagues. These colleagues from other countries would received grants and replace all Indonesian partners' expenses. This scheme could not be the basis of equal cooperation. The low number of scientific publications did not reflect the number of scientists and engineers in Indonesia necessarily, nor the level of investment in science and technology. A number of countries were smaller than Indonesia, with far fewer scientists and engineers, in fact able to outperformed Indonesia in producing research compared to the amount of money invested. The problems were more systemic and related to the allocation of resources including human resources and the research environment which was likely not to provided freedom and autonomy that conducived to promoting innovation. Career paths for scientists were too rigid and limit opportunities for researchers.

But the risks and sanctions in the career level were also small so they did not spur researchers to be more productive. Career advancement in the field of science in universities and other institutions should be based on the quality of results and contributions to knowledge or technology. A competitive funding source such as the Indonesian Science Fund which had given based on excellence, ideas originality, and ability, would provided incentives and rewards that were good for achieving these goals. Many program models had succeeded in

training and supporting entrepreneurs and encouraging entrepreneurship. Some of the most successful programs were those based on universities, where they helped students and lecturers to develop and sell the results of their research, sometimes for the benefit of the university itself. The purpose of this study was following: 1.) To describe the problematic and urgency about scientists' research of knowledge development in Indonesia to find problem solving; 2.) To identify the factors of problematic and urgency about scientists' research of knowledge development in Indonesia.

2 Literatures

2.1 Research

Etymologically, research means "searching back" for new facts which were then developed into a theory to deepen and expand certain knowledge. Every scientist, both exact and non-exact, who carries out research must be based on curiosity. Curiosity could lead to their desire to conduct research to deepen and expand the knowledge they pursued. Karlsson, *et. al.* stated that research was a scientific activity based on analysis and construction that was carried out systematically, methodologically and consistently and aimed to reveal the truth as a manifestation of human desire to know what it was facing [3]. Ary, Jacobs, and Razavieh said that research was the application of a scientific approach to an assessment of problems in obtaining useful information and results that could be accounted for [4].

Research is the fact-finding according to a clear objective method in finding the relationship between facts and producing certain laws [5]. Morgan revealed that research was a search for everything that was done systematically, with the emphasis that the search was carried out on problems that can be solved by research [6]. Gozali, *et. al.* revealed that research is an attempt to find, develop and test the truth of a knowledge by using scientific methods [7]. Tous, Guerrero, and Delgado described that research as a process of collecting and analyzing or processing data that was carried out systematically and logically to achieve certain goals [8].

2.2 Characteristic Identification of Research

According to Hoyles, *et. al.*, research has several characteristics and characteristics, among others, as follows: 1.) Passive, just wanted to get a picture of a situation or problem; 2.) Active, wanted to solve a problem or test a hypothesis [9]. His own research position in general was to link among others: human desires, problems that are science, and scientific methods. The characteristics of scientific research were following: 1.) *Purposiveness*; 2.) *Rigorous*; 3.) *Testability*; 4.) *Replicability*; 5.) *Objectivity*; 6.) *Generalizability*; 7.) *Precision*; 8.) *Parsimony* [3].

Research conducted by scientific methods is called scientific research. A study must fulfill several characteristics to be said to be scientific research. Generally there are five characteristics of scientific research, among others: 1.) Systematic (a study must be arranged and carried out sequentially according to the correct pattern and rules, from easy and simple to complex); 2.) Logical (a study is said to be true if it is acceptable to reason and based on empirical facts); 3.) Empirical (a study is usually based on everyday experience); 4.)

Objective (a study of subjective aspects that did not mix it with ethical values); 5.) Replicative (a study that had been carried out must be retested by other researchers and must provide the same results when done with the same method, criteria and conditions) [4].

2.3 Scientific Research Method

Research could be classified in two, in accordance with the quality measures, namely scientific research and unscientific research or carried out by ordinary people [4]. Unscientific research had characteristics that were not systematic, data collected and methods of collecting data were subjective which were loaded with emotional and feelings of the researcher. Therefore, unscientific research was a subjective research. While scientific research was a systematic and objective activity to examine a problem in an effort to achieve an understanding of its fundamental principles and applied (theory) about the problem generally [3]. Research conducted, according to Hoyles et al. were guided by various information (manifested as theories) that had been produced in previous studies, and the aim was to add or refine existing theories about the problems being subjected to study [9]. Unlike scientific research, scientific research was carried out based on scientific methods.

The scientific method was a basic framework for the creation of scientific knowledge. In science was done by using methods of observation, experimentation, generalization, and verification. Whereas in the social and cultural sciences, the most was done using interview and observation methods; experiments, generalizations, and verification were also carried out in research activities by experts in the fields of social sciences and cultural knowledge to obtain certain research results in accordance with the objectives of the research [6]. The scientific method was based on the idea that knowledge was realized through what was experienced by the senses, especially through observation and hearing. So that if a statement regarding the symptoms must be accepted as truth, then the symptoms must be verified empirically. So, every law or formula or scientific theory must be made based on the existence of empirical evidence.

2.4 The Role of Research Journal Publications

Scientific journals were considered as the primary or most important source of information in the world of science and technology. Scientific journals contained a collection of articles that were published periodically, written by research scientists to report the results of their latest research [10]. Because of this, the existence of scientific journals was important to continued and advanced science and technology. Articles published in scientific journals had undergone a rigorous peer-review and selection process from experts in their respective fields. This peer-review process was carried out to guarantee the quality and scientific validity of the articles that were published. Publication of research results was an important part of scientific methods. Writing in scientific journals was intended for researchers and other experts in the same field [9].

Articles in a journal must be so clear that an independent researcher could repeat the experiment or calculation to verify the results of his research. Articles in journals would be part of a permanent scientific record. Scientific journals had 3 roles in the scientific communication process, such as: 1.) Social role, to build and maintain intellectual property, so that a creative and innovative work of a scientist would get recognition from the world of related scientific disciplines; 2.) The role of the archived, to provide scientific recognition that the published article had been evaluated and declared acceptable to the world of science;

3.) The role of information dissemination was very essential because of the cumulative nature of science (to grow continually) [11].

3 Method

This study used literature study with a conceptual approach. Literature study was a data collection technique by conducting of books, literatures, notes, and reports that had to done with the problem became solved [12]. A conceptual approach was an approach that moved on the concepts that developed in information sciences and libraries that were often used [3].

4 Result and Discussion

In many countries that had experienced advances in science and technology, scientific journals published in international journals were one important measure to measure the quality of research. In some developed countries such as Japan, England and America, the number and quality of published scientific journals were even used as a measure to determine how much research funding would be given to the laboratory. Scientific journals were considered representative of the assessment of the quality of research sufficiently, considered that the journal would be tested by researchers who were competent in their fields before being declared eligible for publication in the scientific journal [2]. Analysis from the National Science Foundation (NSF), a prestigious science institution belonging to the American government, stated that the number of scientific journals produced by the United States intended to remain year after year in the last decade, while other countries had increased. NSF stated that China, South Korea, Singapore and Taiwan had the highest growth among other Asian countries, besides Japan which had a strong tradition of publishing scientific journals. Indonesia had not been able to balance the rapid transformation of science and technology in the international world with quality research results, so that even though Indonesia's country had natural resources and potential human resources, Indonesia had not been able to produce enough research products. On the other hand allowances and facilities to conducted research were also inadequate, even though quality research products were produced from the quality of intellectual processes. Research publications could be used as an illustration of research culture in Indonesia. Research was the first gate to the contribution of science to the progress of the nation [13]. The condition of domestic research assessed from the Scopus index showed that research publications in Indonesia were still far behind compared to countries in Southeast Asia. The data of 2014 from Scimago showed that Indonesia's position was disappointing compared to other Asian countries [14].

The data description in Scimago showed that Indonesia had 113 articles indexed in Scopus, with H-index of 16, so It ranked of 11th under the Philippines which had 114 articles with H-index of 17th. It ranked of 10th. While Thailand had 290 articles, with H-index of 18, It ranked of 9th. We were still far behind Malaysia, which had 854 articles indexed in Scopus, with H-index of 19, It ranked of 8th. The 7th place was occupied by India with 1.559 articles and H-index of 36. The 6th place was occupied by Singapore with 1.152 articles, with H-index of 40. In the 1st place, Japan ranked the top five (7.496 articles with H-index of 74), the 2nd place is Hong Kong (2.504 articles with H-index of 69), the 3rd place is China (2.760 articles with H-index of 53), the 4th place is Taiwan (2.494 articles with H-index of 53), and the 5th is

South Korea (1.715 articles with H-index of 50). In 2014, the data from Scimago showed that Indonesia still lags far below Malaysia as an allied country. Indonesian compared to Malaysia, not only in research publications, but also in terms of the amount of research funding to supported research in universities [15].

Almost all scientists in Indonesia agreed that this country had not been able to produce as much knowledge or innovation as expected. This data was evidence of the lack of publications and patents produced by Indonesia. Comparative data generated from international sources stated that every dollar invested in Indonesia did not show results that were equivalent to the achievements of researchers in other countries [5]. Indonesia's productivity in the field of science and technology was also not comparable with other countries that were vast and the amount of resources such as Indonesia [16]. Scientists believe this was due to the difficulty of seeking supported to financed research projects and inflexible financial reporting and reporting systems [17]. Another obstacle that was mentioned the heavy burden of teaching at the university and the offer of higher salaries for a career in non-science in Non-Ministry Government Institutions rarely. Though these two things were what made scientists reluctant to did research. Indonesia did not have the financial infrastructure to supported innovative science and technology. The country also did not have the infrastructure to allocated and chained the channel funds to researchers, provided research facilities, and flexibled budgeting systems to conducted scientific research. In addition to these issues, there were bigger problems, namely the low national investment in research and development.

In addition to passion in conducting research, the problem in forms of funding must be solved and improved so that it could be handled at once in a system through the establishment of the Indonesian Science Fund, an independent body that on the basis of competition could provided funds to scientists and engineers to conduct world-class research directly. One of the conditions for granting funds was the existence of institutional supported for researchers to increased productivity. Instead, this agency would provided compensation for the costs incurred by the agency. In Indonesia, there were not many relationships built between science institutions and universities and the private sector includes science-based small and medium- sized companies which were centers of innovation in many countries.

According to the data, only a few scientists worked in the private sector, while investment in technical innovation was also small. The small size of the company, the lack of clarity about what was included in the research, and the limited relationship between government research institutions and private companies were often referred to as obstacles in adopting technology [6]. Most non-extractive industries were based on imported products, which had little added value. For this reason, additional policy incentives were needed to encouraged value and innovation. At the same time, the current government financing mechanism offered very little incentive for government R&D institutions to collaborated with the private sector. For example, the latest fiscal law stated that all government agencies must be funded by the Government State Budget fully.

The allocation of Government State Budget was also considered adequate to conducted all research activities. This meant that all R&D funds from the private sector and external sources to state institutions or universities must be provided through the Ministry of Finance. The fund would be non-tax state revenue and could only be taken through the budget line in the process of budgeting the annual State Budget. Scientists who wanted to participate in research projects funded by donor agencies must collaborated with overseas colleagues. These colleagues from other countries would received grants and replaced all Indonesian partners' expenses. This scheme could not be the basis of equal cooperation.

The low number of scientific publications did not reflect the number of scientists and engineers in Indonesia, nor the level of investment in science and technology necessarily. A number of countries were smaller than Indonesia, with far fewer scientists and engineers, in fact able to outperformed Indonesia in producing research compared to the amount of money invested. The problems were more systemic and related to the allocation of resources including human resources and the research environment which were not provided freedom and autonomy that was conducive to encouraging innovation likely [18]. Career paths for scientists were too rigid and limit opportunities for researchers.

But the risks and sanctions in the career level were also small so they did not spur researchers to be more productive. Should, career advancement in the field of science in universities and other institutions based on the quality of results and contributions to knowledge or technology. A competitive funding source such as the Indonesian Science Fund which was given based on excellence, originality of ideas, and ability, would provide incentives and rewards that were good for achieving these goals. Grants could be given to universities to create incubators to serve the academic community and other parties.

5 Conclusion

For Indonesia, the contribution of domestic scientists in fact was quite alarming. From the funding problem which was only 0.9% of the state budget until the licensing problem became a big obstacle in optimizing research by scientists [17]. This caused Indonesian scientists to choose to go abroad and join leading universities, research institutions, or research institutions in the country to develop their potential in the scientific field. Even though, Indonesia had human resources in the scientific field that were quite capable. But the lack of synergy between the government and educational and industrial institutions seems to turn them off. It would be a wise move if Indonesia optimized research conducted by domestic scientists, giving them a place to conduct scientific research.

Of course this would benefit the human life in Indonesia later. Indonesia could start by circulating the capabilities of innovation, intelligence, research and technology, and improving the quality of human resources. In addition, it was also very important to build intensive communication and networks by the government, industry, and academic institutions with relevant institutions abroad [18]. Then Indonesia built communication with Indonesian human resources in overseas research institutions to contribute actively and cooperate in developing technology in the country. Of course, it also provided opportunities for scientists and related human resources to be involved with research projects directly. Equally important, the government also did not forget to give awards to scientists for their work in their respective scientific fields.

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