

Public Research Organisations' Output vis-à-vis National Research Policy in Indonesia: Bibliometrics and Visualization

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Abstract

Public Research Organizations and universities are key players in research activities. In Indonesia, publication output of Public Research Organizations is lower than universities whereas they had balanced funding. The Indonesian government has been developing some strategies to improve research output in Indonesia by establishing national research policy and agenda, which encompass national focus research areas and provision of access to online journal databases. This article evaluates the effectiveness of these strategies by analyzing the productivity, trend, and references of PROs publications using bibliometrics and map visualization. The results revealed that Indonesian PROs productivity is low. Only 11% of Indonesian PROs had publications in reputed international journals. Physics was the dominant subject. There was a mismatch between research output and national research focus areas. There were still many research topics, which were determined as priority areas, but not many publications were produced in these areas such as research in transport and defense. The provision of journals strategy had not worked since 80% of the journals cited was unsubscribed. This study could be used to assess the effectiveness of research policy specifically for developing countries where the research budget is limited.

Keywords: Indonesia, Productivity, Public Research Organizations, Research Policy, Science Mapping

1. Introduction

Research and Development (R&D) institutions are of two types; Public Research Organizations (PROs) and universities. In developed countries, PROs show better performance than universities, in terms of patents and collaboration with industries^{1,2}. In ScimagoInstitutions ranking in which publication output was one of the indicators, the top 3 were PROs, not universities. In developing countries such as Indonesia, however, universities had more publication output than PROs. Moreover, none of Indonesia PROs got ranking into ScimagoInstitutions ranking (<http://www.scimagoir.com/>). Universities are the primary agencies of research productivity in Indonesia. After the merger of the Ministry of Research and Technology with Ministry of Higher Education, the new strategic policy also discussed issues specific to universities than PROs^{3,4}. In Indonesia, there have hardly been any studies that specifically

addressed evaluation of research productivity of PROs. PRO's role and contributions also need to be reviewed and evaluated for formulation of research policy and strategies in developing countries.

In Indonesia, there are 92 PROs that include 622 research units (<http://peneliti.lipi.go.id/peneliti.cgi>). Indonesia science and technology indicator reports prepared by the Indonesian Institute of Sciences (LIPI) indicated that only a few PROs had international publications and patents. Publication output of PROs was also far below that of universities, even though regarding input, PROs, and universities have balanced funding⁵. Indonesian government has adopted many strategies to improve research outputs, especially by PROs. One of the strategies was to identify priority science subject areas and regulate research funding; seven focus research areas identified included: (1) food security, (2) energy, (3) information and communication technology, (4) technology and transportation management, (5) defense

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technology, (6) medicine and health technology as well as (7) advanced materials. The effectiveness of the strategy has not been analyzed. Indonesia also began increasing access to electronic resources by subscribing to online databases; however allocation of funding was still low at around 0.09% of GDP. Until now, evaluation only in terms of extent of use and article downloads have been carried out. Evaluation of journal usage, especially as references in scientific publications, has not been done yet.

2. Methods

This article analyzes the relation between national research focus areas and the actual publication output of PROs in Indonesia. Bibliometrics, despite its limitations, has been widely used as an indicator of the quality of researchers, research, institutions, and even countries⁶⁻⁹. This paper examines publication data from Scopus database, widely considered as one of the sources for analysis of scientific publications¹⁰. Details of publications of Indonesian PROs published between 2006 and 2015 (10 years) and indexed in SCOPUS were retrieved by searching for 'Indonesia' in the affiliation field and then filtering the output for publications of PROs.

The analysis focused on productivity, visualization of research trends and references used in publications. Productivity analysis was carried out by comparing the number of publications with the number of PROs and number of researchers. Visualizing was done by creating a map based on text in title and abstract for terms occurring 10 times or more and relevance rate of 60% or higher using Vos viewer application. The result was a map that clustered terms by proximity¹¹. As for the reference, the mapping was carried with techniques creating a map based on bibliographic data - co-citation of publication source of cited references. Analysis of research trend was done by comparing the keywords that appeared most and most co-occurrence strength with research topics that had been assigned priority in the seven national research focus areas. References analysis was carried out by comparing most used journals as a reference with the journals in the two major databases subscribed by the Ministry of Research and Technology as well as Indonesian Institute of Sciences (LIPI).

3. Findings

3.1 Productivity

According to The Organisation for Economic Cooperation and Development [OECD]¹², there are four types of PROs:

Mission-Oriented Centers (MOCs) that are units under a ministry to carry out research on a particular topic based on department objectives; Public Research Center and Councils (PRCs) that act as a national scientific authority; The third is Research Technology Organizations (RTOs) intended for technology transfer to industry and society; The fourth was Independent Research Institutes (IRIs) that contributed more to handle specific problems and sometimes called as semi-public research organizations.

Based on data from Indonesian National Research Board, in 2013 Indonesia had 622 research units. 67% of these units were university research institutions both public and private, while non-university public research units were 199 (32%). The other 1% was owned by private sector. Every research unit was attached to a parent institution. In this paper, PROs refer to the parent research institution. The number of PROs in Indonesia was 92 (<http://peneliti.lipi.go.id/peneliti.cgi>).

Data from Scopus revealed that there were 172 Indonesian affiliations of which 32 (18.6%) were PROs. Scopus was indexing some of the research units of PROs separately; so combining with their parent research institution was needed. For example, Herbarium Bogoriense and Museum Zoologicum Bogoriense were research part of LIPI, while National Institute of Health Research and Development was research unit of the Ministry of Health. After combining, 11 institutions were identified. This number was tiny compared to the total number of PROs. It meant that there were only 11% of PROs having international publication indexed by Scopus.

Table 1 lists the 11 PROs having publication indexed by Scopus in the last ten years. LIPI was the PRO with most publications. LIPI is a PRC type of PROs. Agency for the Assessment and Application of Technology that was a TRO type was ranked number two. The next nine PROs were MOC type, which in Indonesia are known as "BadanLitbangKementerian". The other two organizations are Indonesian Research Institute for Estate Crops with semi-public research organization status and National Development Planning Agency whose primary responsibility is not research but national development planning. Some PROs coming under Ministry of Education and Culture, Ministry of Industry, and Ministry of Home Affairs, which, had a large number of researchers, did not have publications indexed by Scopus.

The number of publications from Indonesian PRO from 2006-2015 and indexed in Scopus was 3,692; about 11.66% of the number of Indonesian publications (31,654) in the same period. Figure 1 shows the publication growth of 5 PROs with most publications (over 100 documents in 10 years). LIPI was the only PRO which grew quite

well, about 20% per year, while the other 4 PROs had slow growth or even stagnant with the number of publications below 50 documents per year.

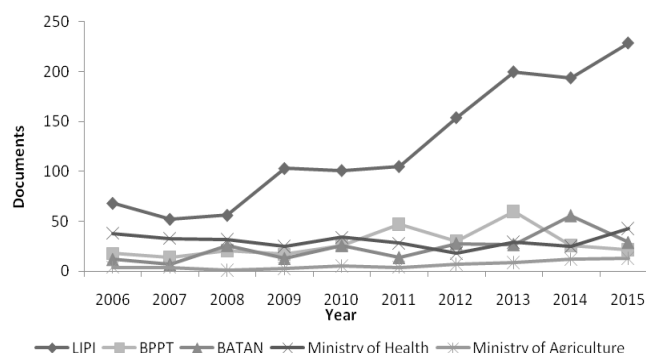


Figure 1. Chart of pros publication growth.

Table 1. Indonesian pros having publication indexing in scopus in last 10 years

No.	Name	Type of PROs	Document
1	Indonesian Institutes of Sciences	PRC	1271
2	Agency for the Assessment and Application of Technology	TRO	281
3	National Nuclear Energy Agency of Indonesia	MOC	240
4	Ministry of Health	MOC	314
5	Ministry of Agriculture	MOC	127
6	Ministry of Energy and Mineral Resources	MOC	53
7	Ministry of Public Works	MOC	29
8	Ministry of Forestry	MOC	20
9	Indonesian Agency for Meteorological, Climatological and Geophysics	MOC	17
10	Indonesian Research Institute for Estate Crops	IRI	19
11	Ministry of Marine Affairs and Fisheries	MOC	10
12	National Development Planning Agency	GO	7

3.2 Research Trends

The area with most publications was physics (42%); other fields were life science (33%), health sciences (19%), and the least was social science (6%). Physics science was mostly filled by engineering, earth, and planetary science, as well as environmental science topics. Life science was dominated by agricultural and biological science; biochemistry; genetics and molecular; immunology and microbiology. Health science was dominated by medicine

topic while veterinary and the nursing topic were far much less. Social science consisted of social sciences; business, management and accounting; as well as arts and humanities. The percentage of publication number from each field was shown in Figure 2.

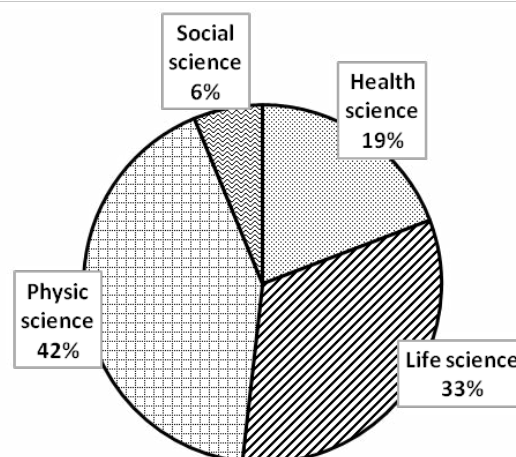


Figure 2. Chart of pros publication growth.

Publication trend in Physical sciences is shown in Figure 3. This map visualizes research in physical sciences in Indonesia. Material Science consisted of publications about the characterization of material by temperature measurement, reaction, and utilization in, e.g., bio-energy. The engineering cluster consisted of publications in performance measurement, implementation and social aspect such as policy, and risk analysis. The third cluster is geology with publications about region, earthquake, and sediment.

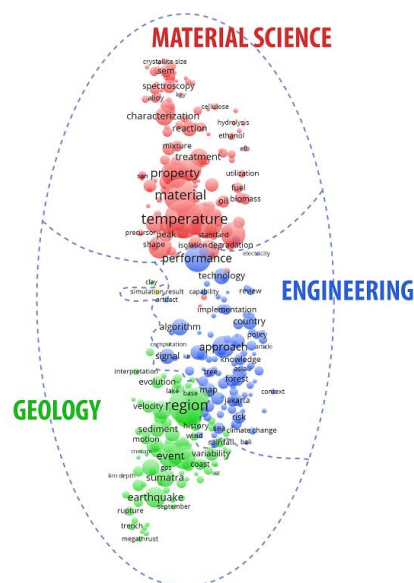


Figure 3. Map of physical sciences research terms.

international publications, only 21.28% were covered by the two databases.

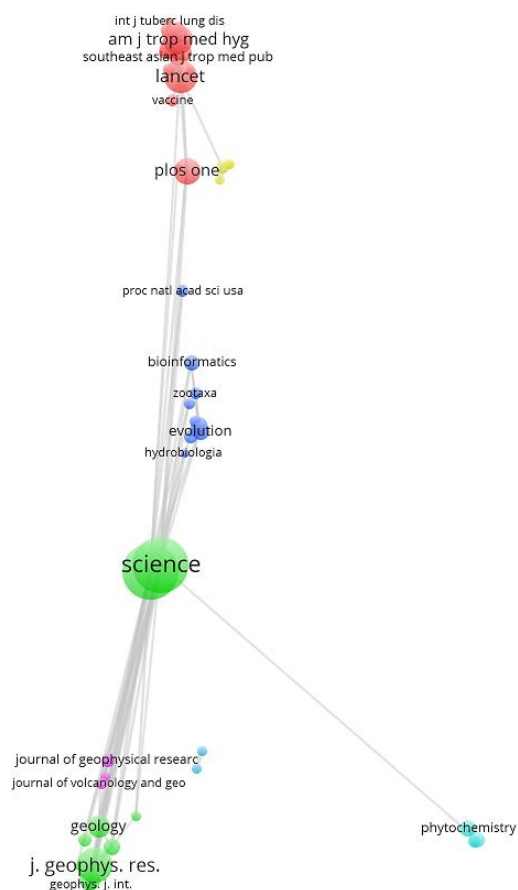


Figure 7. Map of the cited core journals.

4. Discussion

Productivity can be defined as the ratio of output to input¹³. The term scientific productivity is often used to refer to publication output. Research produces some outputs as publications, innovations, etc. Scientific productivity measurement was done in several previous studies by examining the publication of a country vis-à-vis total population, Gross Domestic Product (GDP) and per capita income¹⁴. Some studies measure this productivity in relation to a variety of input factors such as R&D expenditure and the number of universities¹⁵; source of grants or research funding¹⁶; as well as collaborative research via triple helix model¹⁷.

Bibliometrics uses quantitative methods for analyzing publication documents^{8,18}. Some previous studies compared the publication output of Indonesia with countries in Southeast Asia or with other nations in the Asia-Pacific region and Europe. The result of these studies indicated that Indonesian publications were few compared

to nations such as Malaysia, Singapore, and Thailand^{19–23}. Even the present study suggests that the productivity of Indonesia - both PROs and universities - is still small. The publications of PROs is lower than universities i.e., 11% of total Indonesian publications. Only 11% of 92 PROs could produce international publications indexed in Scopus. A third of the publication outputs were produced by LIPI. The average of productivity per researcher was 0.35 articles per year (less than 1 article per researcher per year). The major factor contributing to low output of PROs and universities in Indonesia is: limited national investments in research and development leading to inadequate infrastructure. These were compounded by fund management mechanism which is not flexible, and the system of promotion and incentives for researchers that does not support the research productivity^{3,24}. The allocation of research funding was still below 0.1% (0.09%), far below what the developed countries and other nations in Southeast Asia spent⁵. In fact, some studies demonstrated that the amount of research funding affected the number of research publications^{16,25,26}.

The productivity of universities is higher than PROs, and this could be attributed to the availability of students in universities who published papers jointly with faculty members. In other countries where productivity of PROs was lower than universities it was partly due to bureaucratic reasons where researchers were involved in administrative activities. These bureaucratic regulatory processes hampered productivity in the PROs^{27,28}. The same is true of PROs in Indonesia where researchers often have to carry out paperwork. Procedure fund management and financial administration in Indonesia are often troublesome in research institutions²⁴. Another cause is that PROs in Indonesia categorized as MOC had the primary task of finding solutions to specific problems in the ministry; as such the results of research carried out was not for the purpose of publication. Only in LIPI, which is a PRC, priority output was publication. Other obstacles were in some MOC; many researchers were entering the profession when they were old and unproductive.

One of the strategies adopted to improve Indonesian publication output was focusing government research funding in seven areas of research. Every five years the topics for each area were explicitly determined. In the period of 2015-2019, to support food security, research was focused on finding quality seeds of food crops that were able to thrive in a sub-optimal land. In the energy sector, research was planned to concentrate on nuclear power and geothermal energy. In the area of health the focus was to on tropical disease research to produce a vaccine for HIV disease, dengue fever, and tuberculosis. In the field of transportation technology, the focus was on

development of aircraft. In the field of Information and Communication Technology (ICT), research was directed to the development of ICT infrastructure, especially IT security; development system and framework/platform software based on open source, especially ICT systems supporting e-Government and e-Business. In the field of defense and security the focus was on supporting the implementation of the industrial development policy of strategic defense and security. In the field of advanced materials the areas identified were: magnets, metal processing, solid battery material, and silicon-based material⁴.

Comparisons were made to check whether the actual research carried out matched the focus areas identified. Based on the map of terms, the trend of life science publications was more directed to the characterization of the compound, which was a species of plant or local genetic resource of Indonesia. While this was related to the focus on food security, it is important that research should be directed at quality seeds of food crops. Research on the cultivation of food crops themselves should be done by one of the research units in Ministry of Agriculture i.e., Research Centre of Food Crops, but its existing publication was still tiny at international level.

Health research in Indonesia was more on malaria, public health and health cases in Indonesia and Asia. With the goal to produce a vaccine, the research needs to focus on that goal. Research on disease treatment already existed but the trend had not been towards tuberculosis. Keywords associated with this disease were not found. There were some research papers on the treatment of dengue while research on HIV was more related to public health instead of finding a vaccine.

Trends in the field of physical science research showed a lot of research on materials science in accordance with one of the national research focus. Research on geology and disaster also had a significant portion. Research on energy was more on renewable energies such as bio-energy while only a few research papers were found on nuclear energy and geothermal energy.

Social science research does not figure in the Indonesian national research agenda. Based on the publications it may be said that Indonesian research trends in this field are scattered across many topics such as political, religious and conflicts, legal, gender, Islamic economics, banking, business and social aspects of disasters. Almost all areas of the social sciences had publications but only a few.

In addition to defining focus areas of research, another strategy used by the government of Indonesia to improve research productivity is subscription to international journal databases. Access to scientific journals are needed

in all stages of research from writing a research proposal, the conduct of research, as well as the writing of a paper publication. To be able to publish in good scientific journals, research must be supported with references from good scientific journals.

PROs and universities in Indonesia began subscribing to online database of scientific journals between 2000-2010. The impact of access to online databases on productivity of Indonesian has not been significant²⁹. Other evaluations of access and use were done by Kusmayadi³⁰ as well as Rufaidah and Widaningsih³¹. This article evaluated the usage of journals in the database as a reference in the published papers. The results revealed that many major journals used for writing international publication were not subscribed. Of the six major journals cited, the journal PLoS ONE was an open access journal, while five other journals namely Nature, Science, Lancet, Journal Geophysical Research and Zootaxa are not subscribed. Only about 20%, of the referred to journals were subscribed while 80% were not subscribed. Most of the journals in PROs publication references did not come from subscribed database. These references are probably due to collaboration in writing papers; approximately 50-90 % Indonesian international publications were the result of an international collaboration²².

5. Conclusion

Indonesian publications in international journals indexed in Scopus are not many. This caused the difficulty in measuring productivity and mapping correctly research trends in Indonesia. However, from this limited number of publications it may be inferred that much of Indonesian research is the area of physical sciences. The topics of research do not exactly match with the priority areas identified in the national research agenda.

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