# The Response of Indonesian STI Actors in the Mitigation of COVID-19

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**Abstract.** The Novel Coronavirus 2019 (COVID-19) pandemic spreads rapidly in Indonesia at the beginning of 2020 that requires quick action from various parties, including the Science, Technology, and Innovation (STI) community. The community from universities and Research and Development (R&D) institutions that responsible to produce research and innovation products are expected to provide solutions to accelerate COVID-19 pandemic mitigation in Indonesia. This research aims to map how the STI community response to the COVID-19 pandemic through research in the form of international scientific publications and innovation products. This study collects data from 108 scientific articles from the SCOPUS database, COVID-19 consortium products issued by Kemenristek/BRIN, and 127 news articles related to innovative products by independent actors. The research applies quantitative method and scientometrics using social network analysis to show how research networks are formed in producing research and innovation products in the first six months after the first case of COVID-19 in Indonesia. The study argued that in the first six months of pandemic in Indonesia, the STI community rapidly contributes to filling the discussion by their interest even though there is only a small central actor from Indonesian Institutions. Otherwise, the study views the most valuable government policy was that the research consortium that successfully imposes STI community to collaborate with industrial actors to produce innovative products

*Keywords:* COVID-19, social network analysis, COVID-19 mitigation

## Introduction

The pandemic of Coronavirus disease 2019 (COVID-19) that spread rapidly worldwide in early 2020 caused many countries to face their economic and political security uncertainties. Many countries are experiencing a situation where their economies are expected to deteriorate by 2020 (Fernandes, 2020). As a result, the number of extreme poverty is estimated to increase by 40-60 million people (Mahler et al., 2020). This impact is also particularly vulnerable to developing countries with large middle-class communities (Sumner, Hoy, & Ortiz-Juarez, 2020). Furthermore, Indonesia was the country that has the largest mortality rate, and the number of confirmed cases ranks as the second-largest in Southeast Asia in the first six months of the pandemic (WHO, 2020). The scholars estimate the direct impact of the COVID-19 pandemic on social and economic aspects already occurring (Budastra, 2020; Hadiwardoyo, 2020; Hanoatubun, 2020).

The first actions of Indonesian government were in the direct impact of pandemic as the improvement of health care and economic recovery (Almuttaqi, 2020; Suparman, Sakti, & Anwar, 2020). While the response from the Science, Technology, and Innovation (STI) actors was uncommon (Mas`udi & Winanti, 2020). In fact, the role of STI can support long-term prevention through research and product innovation, especially in the provision of medical products and virus dissemination mitigation tools.

In details, in the first six months, various policies issued by President Joko Widodo to address the pandemics of COVID-19 in Indonesia. Widaningrum & Mas`udi (2020)

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count at least 9 legal products were released to accelerate the mitigation of the COVID-19 pandemic as policies for the management of budgets, social issues, and public health through the establishment of the COVID-19 Response Acceleration Task Force and policies of Large-Scale Social Restrictions. In addition, the government also issued a policy regarding improving social welfare in the form of incentives and loosening loans for people directly affected by the pandemic (Naryono, 2020). This shows that the priority of the Indonesian government was focused on efforts to reduce the spread of the virus between regions and aid the affected communities.

However, some researchers have found policies considered inappropriate and less strategic in addressing the COVID-19 pandemic. Almuttaqi (2020) considers some policies have deviant indicate such as 4 (four) instructions issued after the Indonesian cabinet meeting on February 25, 2020, that maximize conference activities and increase the promotion of domestic tourism. The policy is regarded not to prioritize the prevention of COVID-19 spread.

Another issue arises that the government is considered not to be transparent in informing data on COVID-19 victims and the lack of harmony between central and regional government policies, thus strengthen what Almutaqqi conveyed as a 'wrong priority' policy. Furthermore, Mas`udi & Winanti (2020) argue a policy crisis in Indonesia that caused uncertainty in the handling of COVID-19 where policies issued without strong evidence, instead tended to trial and error. The crisis was based on the absence of science at the beginning of the pandemic. The response of the STI actors, especially universities and R&D institutions, tends to take place independently without going through funding schemes based on national policies and programs. Whereas, long-term planning needs to be done through the role of researchers, such as accelerating vaccine treatment where diplomatic efforts are needed to conduct international collaboration processes and process the information through data-sharing in rapid time (Gates, 2020).

On the other hand, one of the dominant efforts emerging from the STI actors in the national context comes from the Ministry of Research and Technology/ National Research and Innovation Agency (Kemenristek/BRIN) through the Research and Innovation Consortium of COVID-19 program (Kemenristek/BRIN, 2020a). The program was established based on the Government Regulation in Lieu of Law Number 1 of 2020 concerning State Financial Policy and Financial System Stability for Handling the 2019 Corona Virus Disease (COVID-19) Pandemic and/or in Facing Threats Endangering the National Economy and/or Financial System Stability.

The program is expected to produce products that can be utilized in efforts to prevent, screen, detect and diagnose medical tools and support, therapy, and social humanities (Kemenristek/BRIN, 2020b). This program can be a platform to fill the product shortage needed to accelerate the handling of the COVID-19 pandemic. The program is carried out by universities, public and private research institutions that produce prototypes, and innovative products.

In addition, creating an innovative product that the community can utilize, an idea resulting from research or development needs to go through a long process. Fagerberg & Mowery (2009) explained that innovation is the first experiment to implement an invention into practice. That is, a prototype built on research or development will not be immediately utilized by users because there needs to be an effort to realize it first before it can be utilized as an innovative product. One is by what Fargerberg and Mewry call the 'time-lag between invention and innovation. Time lag' can occur because there are no parties who need the findings to be commercialized, or there is a set of sciences that have not yet been found to support and realize the discovery. In the case of COVID-19 in Indonesia, triple helix concept can be used to shorten the distance of 'time-lag' (Etzkowitz & Leydesdorff, 1995), which emphasizes collaboration and networking between academics and industry through government support. Besides, if the distance problem is sourced in unmet science capacity, according to Gates (2020), an effective effort is to collaborate with international institutions.

The research that discusses the collaboration and networking among stakeholders in the term of COVID-19 is still rare. Hamida, Sriyono & Hudha (2020) mapping global research topic on COVID-19. The other topic related to networking in the discussion of COVID-19 is commonly using


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social media as a network of discourse. Hung et al. (2020) analyze the positive, negative, and neutral sentiments on COVID-19 presented by Americans in a discussion on Twitter in five themes: health care, emotional, economic, and business support, social change, and psychological effects. Bellingeri et al. (2020) conducted a study on the consequences of applying social distance in many countries to control the spread of COVID-19 using social network analysis. Gruzd and Mai (2020) use social network analysis to see how conspiracy theories and hashtag virality about the COVID-19 pandemic spread on Twitter. Belso-Martínez et al. (2020) use social network analysis to analyze the social responsibility of the health crisis caused by the COVID-19 pandemic in Spain. Santis, Santis, Martino, and Rizzi (2020) use social network analysis to analyze key topics on Twitter during the lockdown period in Italy. Adiyoso (2020) uses social network analysis to assess the organization's emergency response in Indonesia to COVID-19 using data from TEMPO magazine.

However, research that addresses the views of networking research results and innovative technologies produced by researchers in Indonesia is still rarely discussed. Thus, this research aims to map how the STI community response to the COVID-19 pandemic through research in the form of international scientific publications and products resulting from research, development, and innovation. Therefore, some specifics questions need answers, which are (1) how the pattern of social networks formed based on co-authorship in Covid-19 research; and (2) who are the central actors and institutions that produce scientific articles related to Covid-19 research.

Social network analysis (SNA) is closely related to the research in the field of sociology which examines how actors are connected and how information flows between individuals in networks. SNA focuses on studies on the properties of relationships between individuals (type, direction, strength, and network density), not on individual traits (Watts, Sheridan, & Newmann, 2002).

A social network consists of a set of nodes (sometimes referred to as actors or vertices in graph theory) connected via some type or relations, which are also called ties, links, arcs, or edges. The nodes usually represent actors: individuals, groups, teams, communities, organizations, political parties, or even nation-states. The relations between the nodes can be multidimensional and can include a whole array of different relationship types (Yang, Keller, & Zheng, 2016).

Monclar et al. (2011) state that a social network is a set of links that organize people, groups, and institutions in an equal and democratic way, and around a common purpose. That is a dynamic and flexible model with freedom and spontaneity between the links, respect for individuality, and based mainly on mutual trust. The members of a social network can collect and disseminate data, information, and knowledge. Social network analysis also serves to identify strengths and weaknesses within and among research organizations and institutions, companies and countries, to guide scientific development and financing policies. We can also identify scientific relationships such as co-authorship, co-advising, funding, and others.

SNA is a tool that can be used in co-authorship studies. SNA has been used in various fields, one of which is in the field of policy. It has been used in policy development and evaluation, namely to view collaboration networks, communication networks, and technology networks (Van Den Brink & Han, 2015). In the context of research policy, SNA can capture aspects of impact and scientific benefits that are not accommodated by other measures (Bollen, Van de Sompel, Hagberg, & Chute, 2009). In research policy, SNA is used to map and measure the relationship between scientific articles, scientific journals, researchers, and institutions.

SNA is also often used to describe patterns of scientific collaboration seen from the co-authorship relationship (De Stefano, Giordano, & Vitale, 2011). Several studies analyze co-authorship using SNA (Wasserman & Faust, 1994), for example, to explain the structure of knowledge dissemination among researchers (Barabasi, Jeong, Neda, Ravasz, Schubert, & Vicsek, 2002), to describe the characteristics and trends of collaborative networks among researchers (Goyal, Van der Leij, & Moraga-Gonzɔalez, 2006), and to determine the characteristics of co-authorship networks (Said, Wegman, & Sharabati, 2010).

## Research Methodology

Besides innovative products, research is also the key to fill the needs of knowledge of COVID-19. Scientometric research is often done in mapping the pattern of research. According to Van Raan (1997) and Lianou & Fthenakis (2020), scientometric research is devoted to the quantitative study of science and technology, especially bibliometric methods which are based on scientific and technological literature data. It aims to advance knowledge about scientific and technological developments, social issues, and policies. Specific topics within this field refer to the measurement of the impact of research papers, the understanding of scientific citations, and the use of the results of such assessments in policy and management contexts.

The two main bibliometric methods are citation analysis for research performance assessment and co-word analysis for science mapping and visualizing the scientific field, both of which can be derived from the same networking principles (Van Raan, 2014). Co-word analysis uses keywords from an article to study the conceptual structure of a field (Callon et al., 1983). Co-word analysis is a content analysis technique using the co-existence pattern of multiple pairs of items (noun words or phrases) in a collection of text to identify the relationship between ideas within the subject area presented in the text (He, 1999).

In this study, the authors used SNA and reviewed collaboration networks related to COVID-19 research from international articles derived from Scopus databases during the first six months of the COVID-19 pandemic in Indonesia. The study focused on the authors and institutions with the highest number of articles, collaboration patterns, research trends based on keywords in the article. The search for articles in the SCOPUS database was carried out on August 14, 2020, using the keyword (TITLE-ABS-KEY (corona) AND AFFILCOUNTRY (Indonesia)) AND PUBYEAR> 2019 AND (LIMIT-TO (DOCTYPE, "ar")). From these search results, we obtained 108 articles that matched the keywords.

In addition, the authors process data on institutions that produce the most innovative products and forms of collaboration in producing innovative products and visualize them in the institutional network. The data used is the product data of the COVID-19 consortium issued by the Ministry of Research and Technology/BRIN and 127 news articles in the same period (Kemenristek/BRIN, 2020a). The news article is needed to map products resulting from independent schemes, especially those conducted by non-priority research and development programs or by small actors not involved in national financing schemes.

The analysis is divided into two stages. First, descriptive data is related to the number of authors and international scientific articles, and the most widely used journals to publish the results of their research. Second, the pattern of collaboration/co-authorship and COVID-19 research trends in Indonesia.

At the data processing stage, building a co-authorship network and a co-word network is carried out in three major stages as explained below.

Pre-processing

This stage is divided into three more steps: data cleaning such as checking inconsistent data, completing or reducing missing or incomplete data, identifying the number of actors and affiliations. Data integration, such as categorizing data, combining data, checking for duplication, and eliminating duplication. Transformation data such as identifying actors and affiliations.

Processing

This stage is a process of calculating the number of nodes or actors, the number of ties or relationships, reducing dimensions, and the process of network building. A sociogram matrix was made for the co-authorship network used SQL.

Interpretation

The interpretation stage is carried out on established networks, such as network patterns, network size, and centrality using UCINET and NETDRAW.

## Results and Discussion

108 The data collected in the study are institutions. 215 authors of 504 articles from shows the top ten of Indonesian 1 Table 19-institutions that contributed to the COVID research articles. The number of articles and authors from Universitas Pelita Harapan (UPH) is highest than other institutions; then Universitas Indonesia (UI) produced authors, Universitas 26 articles from 15 articles 10 Padjadjaran (UNPAD) produced


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**Table 1. Ten universities in Indonesia that produce the most international scientific publications on Indonesia COVID-19 research**

| Institution | Number of authors | Number of articles | Ratio of authors by article |
|---|---|---|---|
| Universitas Pelita Harapan | 55 | 15 | 3.67 |
| Universitas Padjadjaran | 29 | 10 | 2.90 |
| Universitas Pendidikan Indonesia | 27 | 8 | 3.38 |
| Universitas Indonesia | 26 | 15 | 1.73 |
| Universitas Gadjah Mada | 20 | 8 | 2.50 |
| Universitas Bina Nusantara | 17 | 7 | 2.43 |
| Universitas Syiah Kuala | 11 | 4 | 2.75 |
| Universitas Negeri Makasar | 11 | 4 | 2.75 |
| Universitas Airlangga | 6 | 4 | 1.60 |
| Universitas Hasanuddin | 6 | 3 | 2.00 |

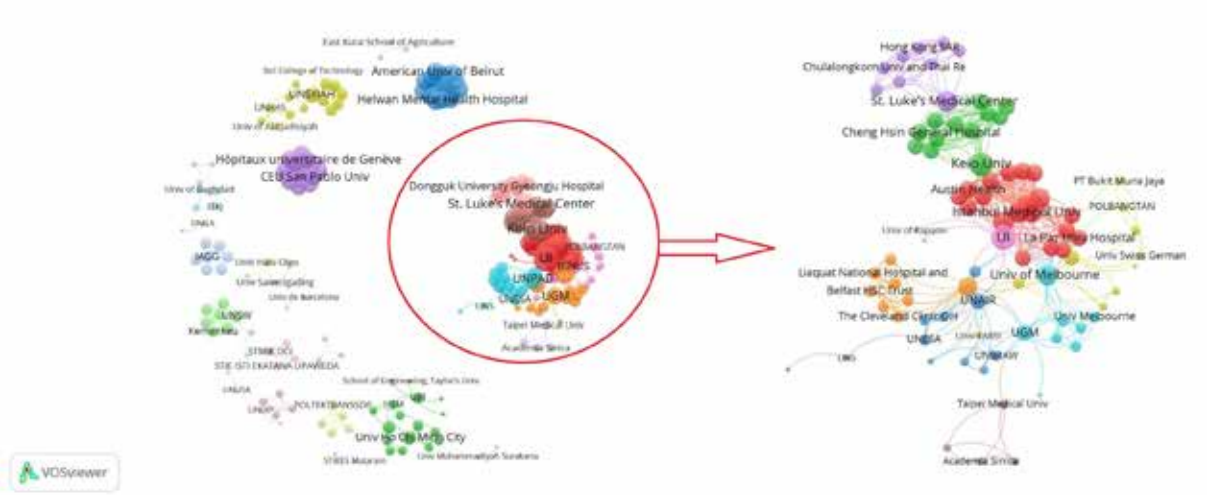
Source: processed by authors from SCOPUS, August 2020

from 29 authors, Universitas Pendidikan 10 Indonesia (UPI) produced 8 articles from 27 authors; and Universitas Gadjah Mada .(UGM) produced 8 articles from 20 authors

On the other hand, the top three universities in Indonesia based on QS Quacquarelli Symonds (2020) which are the University of Indonesia (UI), Bandung Institute of Technology (ITB), and Gadjah Mada University (UGM) were not included in the top three universities that contributed to the publication of international scientific articles on COVID-19 research in that period.

Collaboration between actors in the first six months of the pandemic represented in the network analysis has not been fully integrated. From figure 1, it can be seen that there are several large clusters, but some small clusters are still visible. As in figure 1, the network of institutions with Indonesian affiliates in COVID-19 research has 1506 relationships formed from 203 institutions divided into 27 clusters. The social network shows that the institutions are largely unconnected, indicating that most institutions have weak and uneven relationships or connectivity in conducting COVID-19 research collaborations. This may cause the number of articles to be inadequate yet with a large knowledge field to connect with each other.

In detail, some actors have a strong position in the networks. The measurement to describe the strength of each actor can




Source: processed by authors from SCOPUS, August 2020

*Figure 1. Network of institutions conducting COVID-19 research on Indonesian affiliates*

**Table 2. Fifteen institutions involved with Indonesian affiliates in COVID-19 research that have the highest number of co-authorship relationships in 2019-2020**

| Institution | Country | Degree centrality | Number of articles |
|---|---|---|---|
| Univ of Indonesia (UI) | Indonesia | 28 | 26 |
| Univ of Keio | Japan | 26 | 2 |
| Univ of Medipol | Turkey | 21 | 4 |
| Kulkarni Reconstructive Urology Center | India | 21 | 2 |
| Sunnybrook Health Science | Canada | 21 | 2 |
| Univ of McGill | Canada | 21 | 2 |
| National Univ of Andres Bello | Chile | 21 | 2 |
| St. Luke's Medical Center | Philippines | 20 | 2 |
| Univ of Melbourne | Australia | 18 | 3 |
| Univ of Padjadjaran (UNPAD) | Indonesia | 17 | 29 |
| RSUD Tarakan | Indonesia | 14 | 1 |
| American Univ of Beirut | Lebanon | 14 | 1 |
| Anticancer Hospital | Greece | 14 | 1 |
| Univ of Auckland | New Zealand | 14 | 1 |
| Univ of Barcelona | Spain | 14 | 1 |

Source: processed by authors from SCOPUS, August 2020

be measured through the degree centrality which can be described as the number of connections connected to a node (the number of relationships owned by a node, i.e an institution) that describes the size of popularity or acting as a central actor (Hansen, Shneiderman & Smith, 2011).

Based on figure 1, table 2 shows the top 15 institutions as central institutions in the network of institutions in the COVID-19 research of Indonesian affiliates in 2019-2020. Most institutions are dominated by non-Indonesian institutions (foreign institutions). However, Universitas Indonesia (UI) is still the most dominant actor in the network. This fact shows that even though one actor becomes the most central actor, in this case, the collaboration with international institutions is the essential factor to publish the articles. However, this visualization

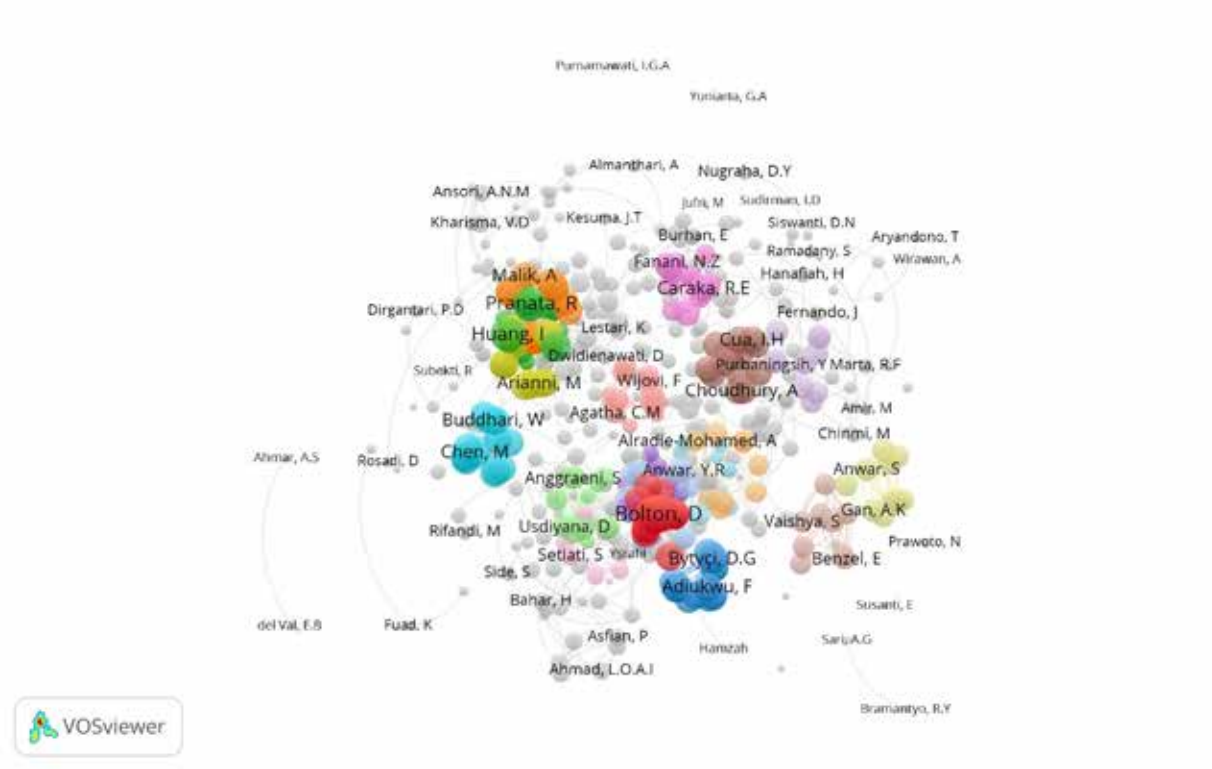



*Figure 2. Network of authors with Indonesian affiliates conducting COVID-19 research*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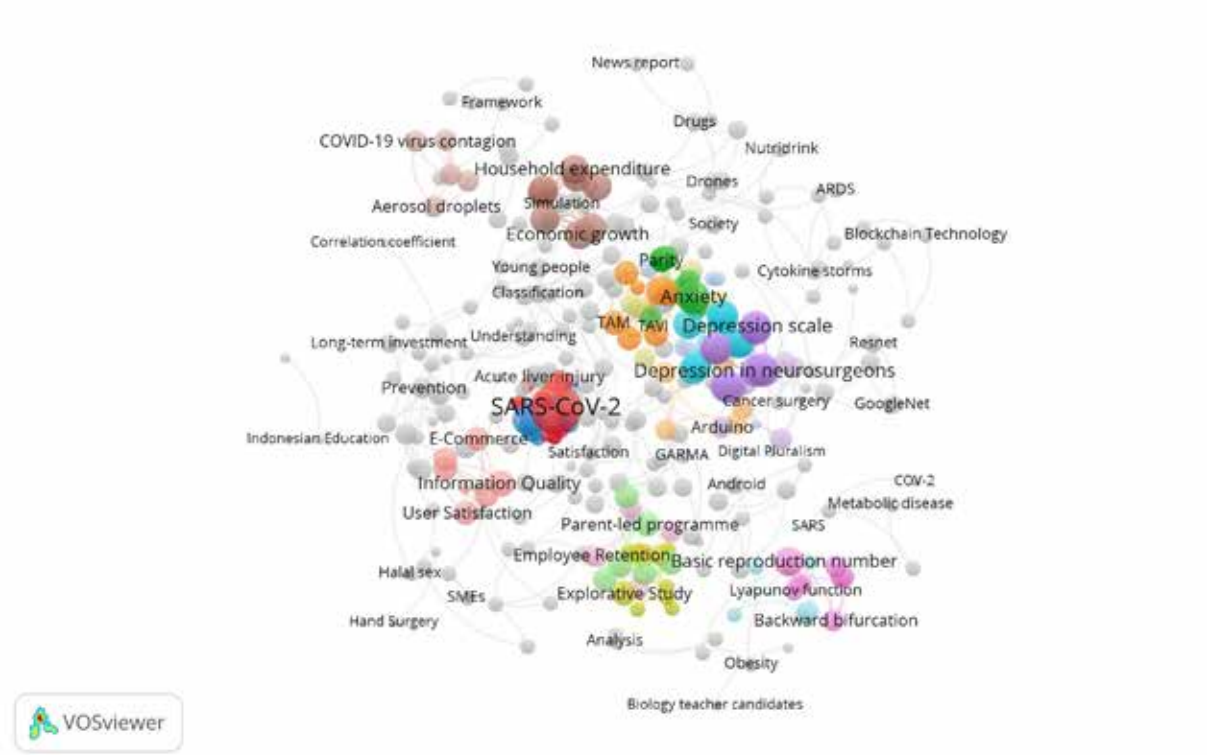



Source: processed by authors from SCOPUS, August 2020

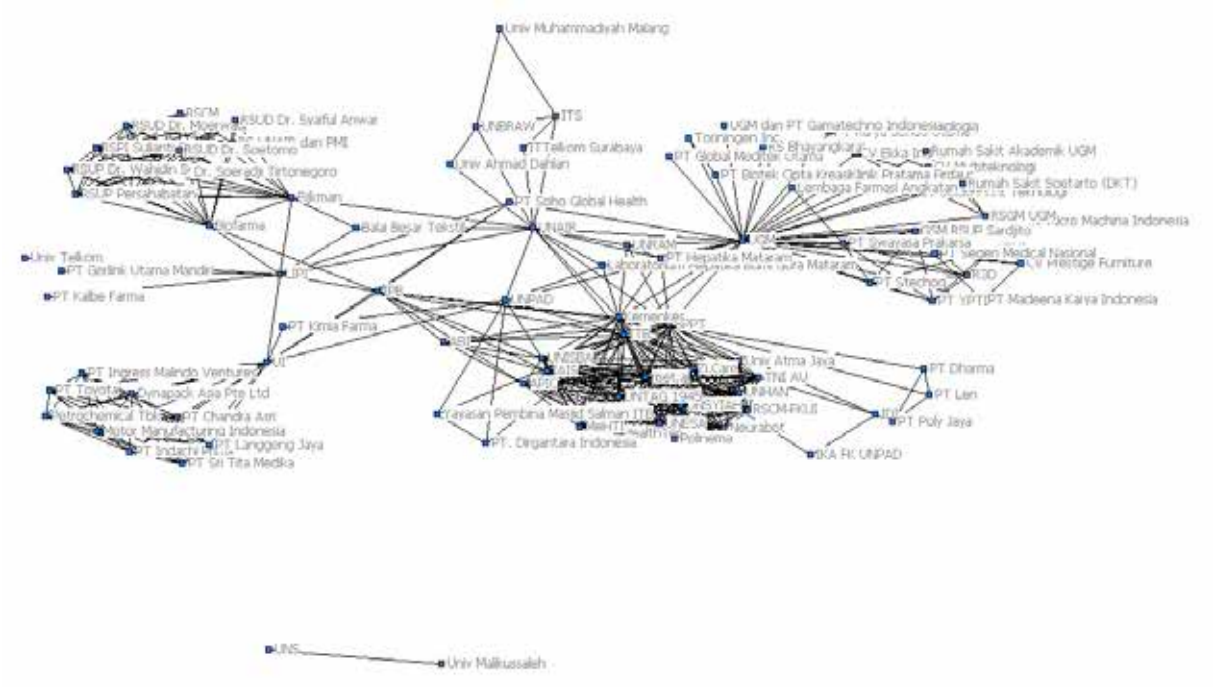
*Figure 3. Co-word network on COVID-19 research of Indonesian affiliates*

can be represented in another view that is Indonesian researchers is still rely on foreign researchers to publish Scopus indexed articles.

On the other hand, the same pattern of the perspective of the author's network is established with the network of the author without institutions where the network is not integrated into one big pattern and tends to be formed in small clusters. In detail, there are 1434 relationships formed from 252 authors and divided into 47 clusters of most articles published in 2020 (figure 2). Therefore, it can be assumed that authors that are contributed to the articles are still rare and the collaboration process between authors has not been sufficiently established.

Similarly, the degree centrality value of authors of the COVID-19 topic is dominated by the collaboration of foreign authors who have a greater degree of centrality value than Indonesian authors. Table 2 shows the top 15 authors who become the central actors in the authors' network in the COVID-19 study of Indonesian affiliates in 2019-2020. The majority of these authors are dominated by Indonesian researchers. However, the 6 authors who have the largest degree of centrality come from non-affiliated Indonesian researchers, which means that Indonesian researchers collaborate with authors from more influential non-Indonesian institutions.

Therefore, the phenomenon in two research networks and institutions that are not connected to large clusters can be caused by a short discussion of COVID-19 lately. It is noted that at least this paper summarizes six months of research during 2020. In addition, the field of science that intersects with the research is quite broad and multidisciplinary, ranging from medical research, pharmacy, technology, management, economics, and social. These topics can be mapped from articles keywords or the co-words. Figure 3 shows the co-word network in the COVID-19 research of Indonesian affiliates in 2019-2020. The co-word has 1022 relationships formed from 319 keywords and grouped into 36 clusters. The co-word shows the keywords of SARS-CoV-2, urology, acute liver injury, mortality, practice management, basic reproduction number, TAVI, chronic liver disease, mental health, and epidemic. Furthermore, the keyword of personal protective equipment, framework, protective measures, guidelines, severe acute respiratory syndrome coronavirus 2, hand surgery, TAVR, hypertension valve




Source: processed by authors from COVID-19 Consortium of Kemenristek/BRIN, August 2020

*Figure 4. Indonesian institutional network that produces COVID-19 innovation products*

repair/replacement, interventions are the 20 most keywords that appear or discussed in the COVID-19 research Indonesia.

In details, these keywords are contained mainly in the articles by Universitas Pelita Harapan (UPH), Universitas Pendidikan Indonesia (UPI), Universitas Padjadjaran (UNPAD), Universitas Indonesia (UI), and Universitas Gadjah Mada (UGM) which produced the most international scientific publications in COVID-19 research affiliate Indonesia in 2019-2020. The 50 keywords most discussed by the five universities can explain how the research coverage of 5 universities addresses the problem of the impact of the COVID-19 pandemic in Indonesia. Some keywords directly discuss the COVID-19 pandemic in terms of health and medicines, such as hypertension, rapid test, drugs, ARS-CoV-2, Hydroxychloroquine, neurosurgery service, chloroquine, Angiotensin-converting enzyme inhibitors, diabetes, prognosis, mortality, COVID-19 virus contagion, Angiotensin receptor blockers, and Asymptomatic cases. At the same time, there are others topics beyond the issue of medicine and health, such as education, economy, transportation, and social which includes online learning, drones, rupiah exchange rate, machine learning for economic, social distancing, risk communication, low-and-middle-income countries.

In addition to scientific articles, researchers certainly produce innovative products derived from research and development. The product is made to answer practical obstacles. The products developed in this study are mostly from the COVID-19 Research and Innovation Consortium Kemenristek/BRIN along with other products sourced from news articles. In the mapping, the three dominant agencies appearing in the analysis process are UGM (33 products), LIPI (14 products), and UNAIR (14 products). Meanwhile, the resulting product is a supporting innovation product (56%) and key products in COVID-19 pandemic mitigation (44%). These products are mostly (approximately 55%) ready or already commercialized. Only about 30% are still in prototype form and 15% are still under the plan or in the development process.

The network that connects institutions shows the mix between actors with few clusters. Figure 4 shows a network of institutions producing innovative products in research and development to help mitigate COVID-19 in Indonesia by 2020. The network has 870 relationships formed from 96 institutions divided into 12 clusters. The network shows several large

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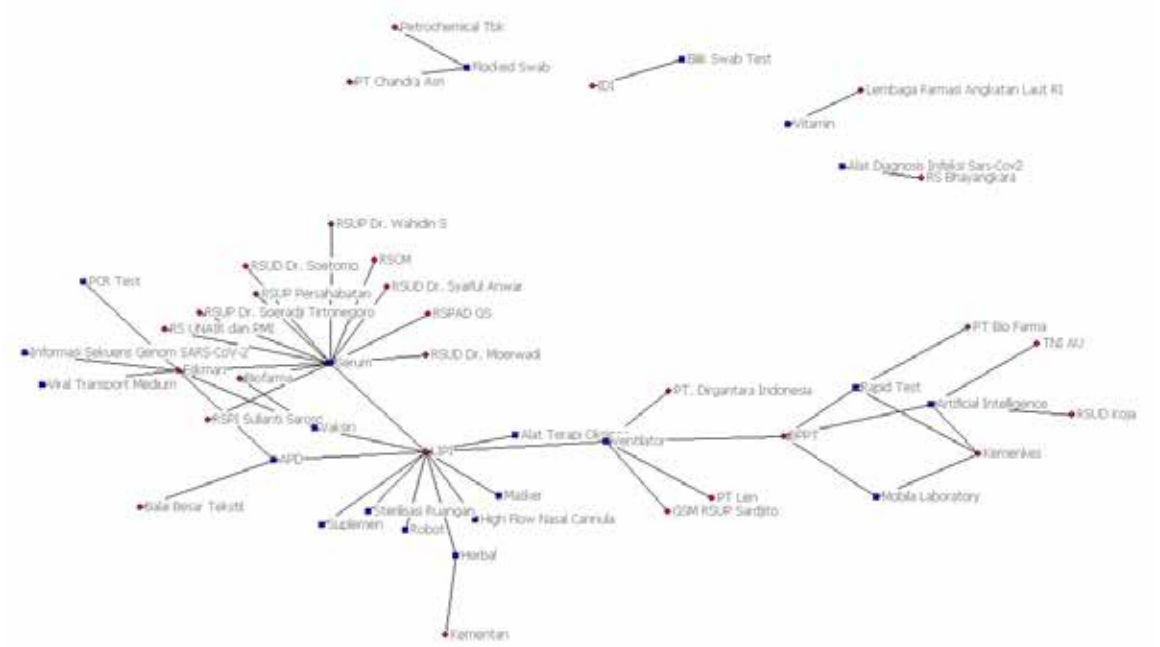



Source: processed by authors from COVID-19 Consortium of Kemenristek/BRIN, August 2020

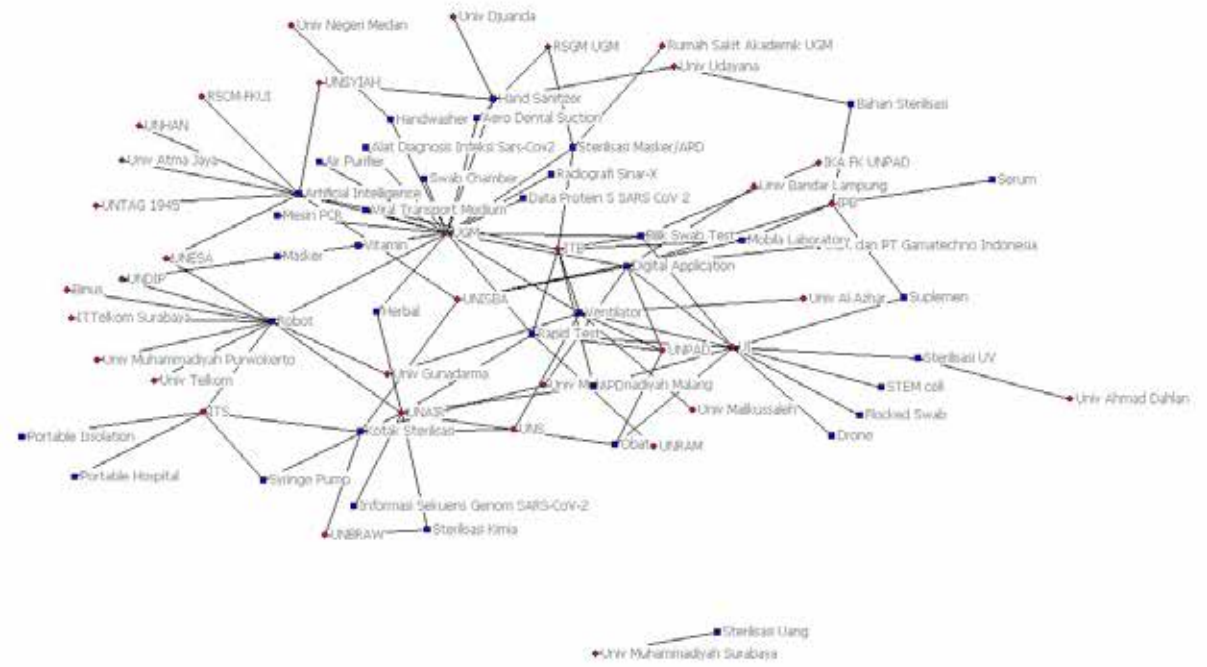
*Figure 5. Two-mode government institution network that produces COVID-19 innovation products*

clusters that are interconnected and there is a collaboration between government institutions, universities, and private institutions. The collaboration is formed to accelerate the commercialization of research and development products. Five institutions that have the largest degree of centrality, which is the number of links incident upon a node or most collaboration, are UGM (34), ITB (29), BPPT (28), Ministry of Health (25), and UNISBA (22), while LIPI ranks 37th with a degree centrality of 10.

In general, there are three categories of actors in innovation production to support mitigate the COVID-19 pandemic, which are government institutions, private institutions, and universities. The three categories of actors have different patterns in the network resulting from collaborations among actors. First, the government-generated network shows one large cluster supported by several small clusters connected within the network. Figure 5 shows a two-mode network of 28 government institutions in Indonesia that produce research output in products or prototypes to help the COVID-19 handling. The red dot describes the name of the government institution, while the blue dot describes the type of research output.

From figure 5, the top 4 government institutions that produce the most research output are as follows: LIPI as many as 14 products includes herbs, supplements, oxygen therapy tools, PPE, serums, sterilization rooms, vaccines, high flow nasal cannula, ventilators, masks, and robots; BPPT produces 6 products including rapid test, ventilator, artificial intelligence, and mobile laboratory; Eijkman Institute produces 6 products including serum, viral transport medium, vaccine, SARS-CoV-2 genome sequence information, PPE, and PCR test: and the last one is the Ministry of Health produces 5 products that include artificial intelligence, rapid test, and mobile laboratory. The main products that seem to be central to the network produced by government actors are serums and ventilators.

Second, a network involving actors from Indonesian universities shows the integration that connects between universities. Figure 6 shows a two-mode network of 36 universities in Indonesia that produce 37 research outputs in the form of products or prototypes to help with COVID-19 handling in Indonesia. The red dot describes the name of the college, while the blue dot describes the research output. From the network, it can be seen that 5 universities produce the most research output, namely ERM as many as 33 products (herbal, rapid test, hand sanitizer, digital application, air purifier, sterilization mask/ APD, swab chamber, ventilator); UNAIR




Source: processed by authors from COVID-19 Consortium of Kemenristek/BRIN, August 2020

*Figure 6. Two-mode university network that produces COVID-19 innovation products*

as many as 14 products (robot, rapid test, medicine, chemical sterilization, PPE, syringe pump, herbal); UI as many as 12 products (flocked swab, UV sterilization, rapid test, swab test chamber, digital application, stem cell, drone, supplement, ventilator, PPE and medicine); ITB as many as 9 products (rapid test, ventilator, sterilization mask/ PPE, artificial intelligence, PPE, swab test booth, mobile laboratory); and ITS as many as 8 products (robot, sterilization box, syringe pump, portable hospital, portable isolation). In contrast to the networks produced by institutions in Indonesia, universities contribute to a wide range of products and in general, it is difficult to see the central product becomes the dominant product being produced.

Figure 7 shows a two-mode network of 49 private institutions in Indonesia that produce 20 types of research output in the form of products or prototypes to handle COVID-19 in Indonesia. The red dot describes the name of the private institution, while the blue dot describes the name of the research output. Private institutions produce artificial intelligence (AI) products, ventilators, and flocked swabs products.

Third, based on figure 7, actors involving private institutions have weak connectedness due to the private sector in practice having a role as a supporter of the commercialization of products. In some cases, it is challenging to cooperate between private parties.

The COVID-19 Research and Innovation Consortium of the Ministry of Technology/BRIN Cooperation conducted between governments, academics, and industry shows that the work is dominantly intertwined. 83.4% of the products produced are cooperation between universities or R&D and industry, 11.9% are cooperation between universities or R&D, and only 4.1% is the resulting product without a cooperation scheme. This gives the COVID-19 Ministry of Technology/BRIN Research and Innovation Conference a key tool in helping government-private-academic collaboration to accelerate innovation to be utilized as soon as possible.

## Conclusion

The response from the STI actors, especially researchers, shows the development of diverse studies during the COVID-19 pandemic occurring in Indonesia such as research in the field of health and medicine, education, social, economics, and other fields. In addition, institutions that produce international scientific publications come not only from universities with a global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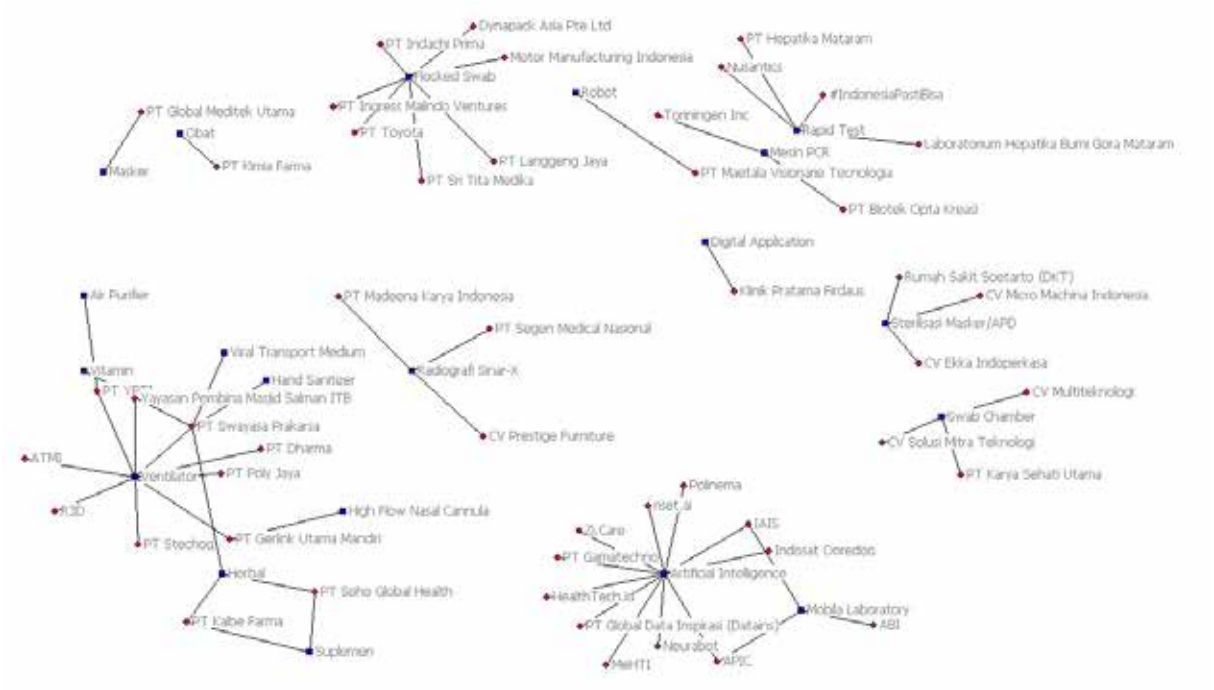


Source: processed by authors from COVID-19 Consortium of Kemenristek/BRIN, August 2020

*Figure 7. Two-mode private institution network that produces COVID-19 innovation products*

reputation but also from other public and private universities.

Authors with Indonesian affiliations are central actors in co-authorship networks with authors of foreign affiliations. The author relies on research collaborations to accelerate the achievement of the resulting publications collaboration with institutions and writers who already have strengths in international networks. Technology and products to support the mitigation of COVID-19 pandemic are diverse. Some innovation products that directly impact COVID-19 pandemic mitigation such as ventilators, medicine, and vaccine development, have been developed and some technologies have been produced or ready for production. To produce high-quality innovation products, the Triple Helix model should be used as an approach in creating a synergy of cooperation from three actors: academic/university, business/ industry/ private, and government to build a knowledge-based economy.

In conclusion, this research argues that in the first six months of pandemic in Indonesia, STI community has rapidly contributed to filling the discussion by their interest even though there was only a small central actor from Indonesian Institutions. The study views the valuable policy that the research consortium successfully gathers the research and realizes it into innovative products in a short time.

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