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Science, Technology and Innovation (STI) ecosystems in Indonesia (1945–2021): A historical policy analysis

Abstract. *The aim of this research is to study the policy efforts conducted by the Indonesian government since the beginning of independence in 1945 to present, in advancing science and technology and innovation. By the mid 2019, the President of Republic of Indonesia Joko Widodo had stipulated Law No. 11/2019, concerning the National System of Science and Technology. This regulation served as an efforts from the Indonesian government to build the science and technology and innovation ecosystem lies in terms of strengthening innovation policies. The implication of this policy mandates that the National Research and Innovation Agency serves as the only research and innovation institution owned by the Government of Republic of Indonesia. Efforts in establishing the science and technology ecosystem and innovation have been initiated since the era of President Soekarno (1945–1965), which was further continued in the leadership of the next president. The aforementioned efforts are additionally described in this study from the perspective of policy history. A content analysis approach is employed to identify each stipulated regulation in Indonesia in the form of Laws, Government Regulations, Presidential Regulations, Presidential Decrees, and Presidential Instructions. There are 78 regulations in the field of science and technology and innovation that are analyzed. The results of the analysis are described based on the emergence of regulations and institutional implications generated as part of the ecosystem. Based on the results of field findings and analysis, there are five periods of formation of a research and innovation ecosystem in Indonesia, namely 1) The Era of Foundation Ladders and Pioneers of Science and Technology Systems and Innovation (1945–1966), 2) Era of National Strategic Industrial Project Development (1966–1998), 3) Era of Restructuring the National System of Research, Development, and Application of Science and Technology (1998–2004), 4) the era of awakening the National Innovation System (2004–2014), and 5) The Era of Integration of the National Research and Innovation System (2015–2024).*

Keywords: *STI Policy; STI Ecosystem; Historical of Policy; historical policy analysis; STI Institutions; Regulatory and institutional frameworks*

Introduction.

Science and technology and innovation are of paramount instruments in measuring competitiveness as well as in inclusive and sustainable economic growth for a country, such as in America (Padilla-Pérez & Gaudin, 2014), European continent (Karo, 2011), African continent (Saidi & Douglas, 2018), and in developing countries (Chaurasia & Bhikajee, 2016). Developing countries require policy support in the development of appropriate science and technology and innovation, to captivate and master the science and technology and innovation to encourage growth for their countries (Niosi, 2010). For a country such as Indonesia, an integrated policy is deemed

pivotal that places science and technology as well as other related sectors in a common policy corridor, such as the health and food sector (Mustangimah et al., 2021).

The Government of Republic of Indonesia has crafted efforts to establish the science and technology and innovation ecosystem, even if referring to a number of literatures, efforts have been initiated since the era of President Sukarno. However, it was not until 2002 that Indonesia had a law-level regulation that provides regulation on science and technology and innovation through Law Number 22 concerning the National System of Research, Development, and Application of Science and Technology (Sisnas P3Iptek). Sisnas P3Iptek served as a reference in the development of science and technology and innovation in Indonesia for almost 17 years, before replaced by Law Number 11 of 2019 concerning the National System of Science and Technology.

Based on the above conditions, this research navigated specific policy efforts conducted by the Indonesian government from the beginning of independence in 1945 to the present. So, the formulation of the research questions (R.Q) is as follows: R.Q. = How to policy efforts conducted by the Indonesian government since the beginning of independence in 1945 to advance science and technology, and innovation?

Research methods.

Therefore, the identify regulations in Indonesia since the beginning of independence through a content analysis approach (Hall & Steiner, 2020; Pramana et al., 2021; Putera et al., 2022), obtaining the 78 regulations with details as follows: 1 regulation in the form of Provisional People's Consultative Assembly Decree of Republic of Indonesia, 28 regulations in the form of Law of Republic of Indonesia, 19 regulations in the form of Government Regulation of Republic of Indonesia, 13 regulations in the form of Presidential Regulation of Republic of Indonesia, 14 regulations in the form of a Presidential Decree of Republic of Indonesia, and 4 regulations in the form of Instruction of the President of Republic of Indonesia. Furthermore, these regulations are mapped and analyzed by regarding the type of regulation emergence and the institutional implications generated as part of the ecosystem. Policy history description (Sharkansky, 1995; Taylor, 1998) or acknowledged as historical policy analysis (Hanberger, 2003) in this research, is utilized as an effort to navigate the government's paces in forming, establishing, and strengthening the science, technology and innovation ecosystem in Indonesia. At the same time, such efforts are utilized to observe the alignment of national leadership (president tenure) in constructing the science, technology and innovation ecosystem.

Results and discussion.

To reveal the strategic phases of the national leadership in Indonesia in advancing science and technology and innovation, a mapping of policies related to science, technology and innovation was conducted since the beginning of independence (1945). Science, technology and innovation have long been a concern of public policy researchers, including studying innovation systems (Miller, 2016).

The Era of Founders and Pioneers of Science, Technology and Innovation Systems (1945–1966).

The period of President Sukarno's administration (1945–1965) was regarded as the toughest effort to establish a system of science, technology and innovation in Indonesia. In the early days of independence in 1948, the *Organisatie Voor Natuurwetenschappelijk Onderzoek* (ONO) was formed which later changed its name into the Natural Sciences Research Organization (OPIPA). The establishment of this scientific institution is expected to coordinate research activities proliferated across many institutions and departments at that time. This effort was unexpectedly less successful; the Ministry of Education, Teaching and Culture in 1950 further considered establishing the *Academie van Wetenschappen* which was also less successful (*Panitia Penyusun Naskah Buku 20 Tahun Indonesia Merdeka* (Committee for Drafting the Book of 20 Years of Independent Indonesia), 1966).

Dated on March 19, 1956, Law Number 6 of 1956 was stipulated concerning the Indonesian Science Council (MIPI). The existence of this policy was instrumental as it provided a concrete step taken by the government to abolish all national scientific bodies inherited from the Dutch colonial government, further reshaping it as a scientific institution of the Indonesian government. MIPI was constructed as an effort to implement Article Number 40 of the Provisional Constitution, established as an assigned body (coordinating center) in guiding efforts to advance science in the territory of Republic of Indonesia. Additionally, MIPI was formed as an effort to advance and guide science fulfilling national principles that protect the freedom to pursue science by referring to the national as well as peace and mankind principles, executing its tasks under the Ministry of Education, Teaching and Culture.

Interestingly, the composition of MIPI's membership is regulated based on the MIPI Law, which means that one-half of the members must consist of experts in one of the sciences of the first group and one-half of the second group. This second group includes religious experts, for example scholars who are regarded as well-known experts in other religions (religions recognized by the Government).

MIPI was born amidst the difficult circumstances, because research as a national effort had to be conducted with inadequate scientific facilities. Efforts to gather strength from all experts in the field of science from all regions of Indonesia were conducted by holding the National Science Congress I in Malang, taken place in 1958. At the congress, President Sukarno stated that 'A just and prosperous society cannot be held without the proper use of science' (*Committee for Drafting the Book of 20 Years of Independent Indonesia*, 1966).

In 1960, initiating a new step at the stage of development planning in the field of science, technology and innovation was included in the Decree of the Provisional People's Consultative Assembly of the Republic of Indonesia Number II/MPRS/1960 on the Outlines of the Planned Universal National Development Pattern for the First Stage (1961-1969). In this policy, the government places research as an important part of the pattern of national development, and research policies were adapted to a free and active foreign policy involving the people without leaving scientific requirements. In

Appendix A, the mental/religious/spiritual/research areas of the Provisional People's Consultative Assembly Decree Number II/MPRS/1960 mentioned that:

“MIPI will therefore soon be retooled into a National Research Agency. It is better if there is only one highest scientific institution in Indonesia. At the same time, it should be noted that as long as research institutions, proliferating in the Government are not retooled, their efficiency remains in doubt. MIPI, which was expected to be the only highest scientific institution, did not or had not succeeded in positioning itself”. (MPRS and Ministry of Information, 1961, p. 69)

In 1961 along with the dynamics of changes in government, initially MIPI was under the Minister of Education, Teaching and Culture. However, due to changes in the Cabinet nomenclature, which was the Department of Basic Education and Culture, and the Department of Higher Education and Science, MIPI was under the Department of Higher Education and Science. Changes re-occurred in 1962 through Presidential Decree Number 94 of 1962 concerning the New Regrouping Structure of the Working Cabinet, in which the Department of National Research Affairs (Durenas) was formed in the Working Cabinet III and was classified in the Production sector, included in the Development Compartment. The existence of Durenas did not replace the existence of MIPI and also the functions of the Department of Higher Education and Science (Department of Information, 1970).

At the beginning of its formation, this Department was led by the Minister and assisted by three assistant ministers, which included: a) Assistant Minister for National Research for Policy Affairs, b) Assistant Minister for National Research for Executive Affairs, and c) Assistant Minister for National Research for Scientific Administration. The existence of Durenas and MIPI provided a new dynamic in the management of research in Indonesia, one of the major steps taken is the construction of research facilities which include:

1. The Durenas and MIPI Complex in Jakarta, in accordance with Presidential Instruction Number 5 of 1964, dated on April 11, 1964, stipulated that this complex was erected on Jalan Gatot Subroto Jakarta, on an area of 31 hectares, which was originally intended for the International Exhibition and Fair Institute. On this land would be built: Durenas Building, MIPI Building, Clearing House and Printing Center Building, Marine Research Institute Building, National Scientific Documentation Center Building, Science Museum, Natuurhistorisches Museum, Employee Housing, Civic Center and a power plant (Committee for Drafting the Book of 20 Years of Independent Indonesia, 1966).
2. Cibinong National Research Center Complex, was built in 1963 on an area of 200 ha land. However, the groundbreaking was conducted on September 1964 by Deputy Prime Minister III, Dr. Chaerul Saleh planned for the National Institute of Chemistry, National Institute of Physics, National Institute of Metallurgy, National Electronics Institute, National Scientific Aircraft Center, and National Institute of Economics and Society. To immediately execute the research, the National Chemical Institute and the National Electronics Institute were placed at the Bandung Institute of Technology (ITB) due to a

shortage of scientific equipment. Meanwhile, the National Institute of Economics and Society has initiated to conduct its activities in Jakarta (Committee for Drafting the Book of 20 Years of Independent Indonesia, 1966).

3. The National Biology Institute in Bogor comprising all the facilities such as buildings and laboratories was transferred from the Ministry of Agriculture Affairs. The National Biological Institute at that time, consisted of the Botanical Gardens with branches in Cibodas, Purwodadi, Bali, North Sumatra and West Sumatra, the Botanical Research Institute, Herbarium Bogoriense, the Zoologicum Bogoriense Museum, and the Marine Research Institute (Committee for Drafting the Book of 20 Years of Independent Indonesia, 1966).

In 1966, President Sukarno issued Presidential Decree Number 63 of 1966 regarding the composition of the Dwikora Cabinet which was further refined. This change made the Department of National Research Affairs into a National Research Institute under the Deputy Prime Minister for Political Institutions along with the Atomic Energy Institute, the National Front, Uppenas, and the Institute for the Development of Revolutionary Spirit, as well as the National Defense Institute.

During this period, the government has developed space research projects, such as the Early Scientific and Military Rocket Project (PRIMA) affiliated with the Indonesian Air Force and the Bandung Institute of Technology. The PRIMA project succeeded in building and launching two Kartika I series rockets and their telemetry in 1964 (Sumatri, 2014), and culminating with the establishment of the National Institute of Aeronautics and Space through Presidential Decree Number 236 of 1963.

In addition, President Sukarno's concern with nuclear power was immense, actualized by the establishment of the State Committee for Radioactive Investigations in 1954. The State Committee had the task of investigating the possibility of radioactive fallout from nuclear weapons tests in the Pacific Ocean (Faqih et al., 2014). By prioritizing the development of atomic energy utilization for the welfare of society; then through Government Regulation Number 65 of 1958, dated on December 5, 1958, the Atomic Energy Council and the Atomic Energy Institute (LTA) were formed, which were later refined into the National Atomic Energy Agency (BATAN) based on Law Number 31 of 1964 concerning the Basic Provisions of Atomic Energy. In addition, several research, development, and engineering (R&D) facilities were established across various areas, including the Bandung Nuclear Area (1965) and the Pasar Jumat Nuclear Area, Jakarta (1966).

Efforts to give appreciation are additionally conducted, through Presidential Regulation Number 27 of 1960 on Scientific Prize Giving. This effort was conducted to encourage the ability of its citizens in participating, advancing and developing science for the benefit of the community, nation and state. The scientific prize is generally granted to a person or community whose scientific work includes: a. a new discovery or improvement of an old invention, either by personal or other's invention; b. an advancement and development of science; c. benefits for the progress and

prosperity of the Indonesian nation in particular, and for the mankind in general. (Presidential Decree No. Republic of Indonesia Number 5 /1965).



Figure 1. The strategic steps of the national leadership for science, technology and innovation in Indonesia, period 1945–2004.

The Era of National Strategic Industrial Project Development (1966–1998).

Continuous efforts during the President Soeharto's tenure were evident by the launch of science, technology and innovation programs at the beginning of the government, with the formation of the Ampera cabinet. In this cabinet, the positions of the National Research, and the National Atomic Institute were outside the cabinet since the Ampera cabinet conducted policy politics, where the ministerial elements in the cabinet assisted the president in accomplishing daily tasks (Simanjuntak, 2003).

The presence of two bodies (National Research Institute and the Indonesian Council of Sciences) was terminated which both conducted the national research tasks, thus the Provisional People's Consultative Assembly issued the Decree of the Leadership of the Provisional People's Consultative Assembly Number 18/B/1967 dated on February 16, 1967 concerning the dissolution of the National Research Institute and the Indonesian Council of Sciences, and the establishment of the Indonesian Institute of Sciences. The aim was to simplify state institutions and to create efficiency and effectiveness in the implementation of national research tasks. The establishment of the Indonesian Institute of Sciences was a synthesis of the two previously existing bodies and later became the central body working in the field of science in Indonesia. Even the Decree of the Leadership of the Provisional People's Consultative Assembly Number 18/B/1967 mandated that the Indonesian Institute of Sciences; in addition to its functions, it should be upgraded to become the Indonesian Academy of Sciences which will be established by law.

The Acting President of the Republic of Indonesia further issued Presidential Decree Number 128/1967 concerning the Establishment of the Indonesian Institute of Sciences on August 23, 1967. After observing the results, the deliberations of the National Research Institute and the Indonesian Council of Sciences and research institutions was held on April 21–22, 1967 in Bandung.

In addition, the Indonesian Institute of Sciences was entrusted with the authority to organize coordination, integration and synchronization at the central and regional levels in the fields of technology and science. Institutionally, the Indonesian Institute of Sciences (LIPI) consists of the Chair, the Indonesian Science Trustees Board, the Deputy Chairperson of LIPI, and the Secretary of LIPI. The Deputy Chairperson of LIPI is divided into three fields, including: 1) Deputy Chair for Natural Sciences in charge of the National Biology Institute, National Geology and Mining Institute, and National Cancer Institute, 2) Deputy Chair for Technology in charge of the National Chemical Institute, National Physics Institute, Metallurgical Institute National Institute of Electrical Engineering, National Instrumentation Institute, and National Scientific Documentation Center (Indonesian Institute of Sciences, 1968).

In further developments, in the Development Cabinet II, there was again the Minister who coordinated research activities, who was referred to as the State Minister for Research. This is in accordance with Presidential Decree No. 9/1973. This task area was regarded pivotal to accelerate and expedite the implementation of development. Especially research activities that can produce concrete results that can be immediately applied to upsurge the development outcomes, in agriculture, industry, or other fields.

The existence of the State Minister for Research reduces the functions and duties of LIPI. Since then, two government agencies have been running similar function. Even when the Development Cabinet III (1978–1983), the Government added the function of the State Minister of Research to become the State Minister in charge of handling research and technology issues, the development and implementation were more focused and integrated in accordance with development needs, as the State Minister of Research and Technology (Simanjuntak, 2003).

The government's efforts in accelerating the development on a technology basis were proven by appointing Prof. Dr. Ing. B. J. Habibie as a government advisor in the field of advance technology and aviation technology who was directly responsible to the president. This appointment was based on Decree No. 76/M/1974 dated on January 5, 1974, and at the same time establishing the Pertamina Aviation Technology and Technology Division (ATTP). ATTP was later changed to Pertamina Advance Technology Division. This unit was later transformed into the Agency for the Assessment and Application of Technology based on the Decree of the President of the Republic of Indonesia Number 25 of 1978 concerning the Agency for the Assessment and Application of Technology, and was renewed through Presidential Decree Number 31 of 1982.

Hence, the government established a Board of Trustees and Management of Strategic Industries and Defense and Security Industries based on Presidential Decree Number 59 of 1983. The Board of Trustees of Strategic Industries served as an inter-departmental coordinating body whose main task was to perform the development and management of strategic industries in an integrated, efficient and effective manner. There are four industries that are included in the guidance of this board, conveying: a) PT. Krakatau Steel, b) PT. Indonesian Telecommunication Industry, c) Company Company PT. Nurtanio, and d) Company Company PT. Indonesian PAL.

Provisions regarding the Board of Trustees of Strategic Industries have been refined through Presidential Decree Number 44 of 1989. This Presidential Decree required the formation of the Strategic Industry Management Agency, tasked with technically fostering and developing strategic industries; thus technology, productivity and efficiency in their implementation is eligible to support national development and independence of the State's defense and security, to coordinate the implementation of policies for the management of industries that are environmentally friendly, and to oversee the implementation and management of strategic industries. The State Minister for Research and Technology served as the Chair of this Management Agency by fostering ten business entities.

The emergence of a new institution in 1984 was in accordance with Presidential Decree Number 1 of 1984 concerning the National Research Council. The National Research Council (DRN) was a non-structural coordination forum that prepared the formulation of the main national programs in the field of research and technology, which was under and directly responsible to the State Minister for Research and Technology. Interestingly, the Chairperson of the DRN was concurrently the State Minister for Research and Technology; meanwhile the Deputy Chair was in rotation between the Chairs/Heads of Non-Departmental Government Institutions under the

coordination of the State Minister for Research and Technology or the Head of the Department of Research and Development, whose implementation was further regulated by the State Minister for Research and Technology as the Chairperson of the DRN; and the Secretary of the DRN served as the Assistant State Minister for Research and Technology in the Coordination of Policy Formulation and Evaluation and the National Main Program of Research and Technology. Hence, elements of DRN members from representatives of Departments, Non-Departmental Government Institutions, Universities, and other scientists were deemed necessary and in accordance with needs.

Institutional dynamics in this period improved along with the issuance of Law Number 8 of 1990 regarding the Indonesian Academy of Sciences. The existence of the Indonesian Academy of Sciences (AIPI) in this Law was different from the spirit of the Decree of the Leadership of the Provisional People's Consultative Assembly Number 18/B/1967 expecting AIPI as a form of transformation from LIPI. AIPI was based on Law Number 8 of 1990 which was the only forum for leading Indonesian scientists to bring together leading Indonesian scientists and to provide opinions, suggestions, and considerations on their own initiative and/or requests regarding the mastery, development, and utilization of science and technology to the Government and society in achieving national goals.

In addition, the Government also established a Research, Science, and Technology Center through Presidential Decree Number 43 of 1976. The construction of the Research, Science and Technology Center (PUSPIPTEK) was conducted on land that has been controlled by the Government on behalf of the National Atomic Energy Agency located in Serpong, Tangerang Regency, and could be expanded as required. PUSPIPTEK serves as a means for the implementation of: a. a focused and integrated research to facilitate the implementation of national development; b. a fulfillment of the scientific community by improving awareness of the general public regarding the role of research, science, and technology in development.

An interesting note from this period, since the late 1970s, Suharto through B. J. Habibie has targeted and developed the ten high-tech industries acknowledged as the development of national strategic industries, such as: aircraft, shipbuilding, railways, telecommunications, electronics, steel and goods and machine stuff. The most famous part of this program was the development of the aircraft industry in Bandung (Okamoto & Sjöholm, 2003). However, these programs were immediately destroyed one by one before the economic crisis in 1997. As stated by Hill (1995), Indonesia's science and technology policies since the late 1970s illustrated that high-tech projects did not always lead to the development of broad-based and efficient technologies, especially when the underlying research, education and technical infrastructure was feeble (Hill, 1995). In addition, this era was popular for the numerous talented Indonesians who were educated with scholarship programs such as: the Overseas Fellowship Program (OFP), Science and Technology Manpower Development Program (STPMD), and Science and Technology for Industrial Development (STAID) (Isma'il & Mulyanto, 2003).

Era of Restructuring the National System of Research, Development, and Application of Science and Technology (1998–2004).

During the reign of B. J. Habibie (1998–1999), not much effort was performed to promote the growth of the innovation ecosystem in Indonesia. In addition to his short reign and high political transition, B. J. Habibie focused more on reforming the government sector. However, the idea and desire to establish a science and technology system and innovation remained the goal, such as through issuing Presidential Decree No. 40 of 1999 to build national industrial infrastructure in the context of increasing national resilience, which was obligatory to cultivate superior technology-based industries that were strategic in nature. Even engaging the President as Chairman of the Board of Trustees of Strategic Industries, with the State Minister of Research and Technology/Head of the Agency for the Assessment and Application of Technology as Chief/Chairman of the Daily Executive.

In addition, B. J. Habibie finalized the National Research Council (DRN) through Presidential Decree Number 94 of 1999. DRN was designated as a non-structural institution that assisted the government in formulating a national science and technology development strategy, as well as the formulation and implementation of research activities according to the demands of the times. The position of the DRN was under and directly responsible to the President as the Head of Government.

President B. J. Habibie had issued Presidential Instruction Number 33 of 1998, addressed to Rachmat Saleh, Economic Advisor in the Banking Sector to study and convey his views and suggestions for funding through the capital market mechanism for the former strategic industries as referred to in Article 2 paragraph (1) of Presidential Decree Number 44 of 1989 concerning the Strategic Industry Management Agency. The issuance of this decree indicated that B. J. Habibie still had a hope to navigate the solutions for the existence of strategic industries.

The next era was under the leadership of President Abdurrahman Wahid (1999–2001), having the National Development Program (Propernas) 2000–2004 through Law Number 25/2000. This era also succeeded in providing regulations for: 1) Protection of plant varieties (Law No 29 of 2000), 2) Trade Secrets (Law Number 30 of 2000), 3) Industrial Design (Law Number 31 of 2000), and 4) Layout Design of Integrated Circuit (Law Number 32 of 2000). In addition, this policy provides recognition of intellectual property.

The leadership era of President Abdurrahman Wahid also paid attention to national standardization (Government Regulation Number 102 of 2000), soil damage control for biomass production (Government Regulation Number 150 of 2000), Fertilizer for plant cultivation (Government Regulation Number 8 of 2001), and the application and development of appropriate technology (Presidential Instruction Number 3 of 2001). In this era, the Board of Trustees of the Strategic Industry which was formed based on Presidential Decree Number 40 of 1999 and the Secretariat which was formed to support the implementation of the duties of the council, was declared dissolved through Presidential Decree Number 45 of 2000.

Furthermore, the national leadership was carried out by President Megawati Soekarnoputri (2001–2004). The beginning of the leadership of President Megawati

Soekarnoputri was marked by the birth of the Patent Law (Law Number 14 of 2001). This step was occupied in line with Indonesia's ratification of international treaties, the rapid development of technology, industry and trade, which was compulsory to have a Patent Law providing reasonable protection for Inventors. The equivalent step was also performed by allotting the Law on Trademarks (Law Number 15 of 2001). One year later, the government issued Law Number 19 of 2002 concerning the Copyright. This step was regarded as an effort to protect ethnic and cultural diversity as well as wealth in the arts and literature with developments that require copyright protection for intellectual property generated from such diversity.

This era recorded important achievements in the field of science, technology and innovation policies in Indonesia, with the issuance of Law Number 18 of 2002 concerning the National System of Research, Development, and Application of Science and Technology. This policy aimed to strengthen the carrying capacity of science and technology for the purpose of accelerating the achievement of state goals, as well as increasing competitiveness and independence of the state in international relations. Furthermore, the science and technology institutions in the policy consist of elements of universities, R&D institutions, business entities, and supporting institutions.

Additionally, the government dispensed Presidential Instruction Number 4 of 2003, which is in accordance with the provisions of Article 18 paragraph (2) of Law Number 18 of 2002 concerning the National System of Research, Development, and Application of Science and Technology, constituting that the Government is obliged to formulate the direction, main priorities, and the Government's policy framework in the field of science and technology as outlined in the Strategic Policy for the National Development of Science and Technology.

In addition, President Megawati Soekarnoputri paid attention to the development of types and standards of plant cultivation tools and machines (Government Regulation Number 81 of 2001), by securing the domestic industry due to the surge in imports as part of the implementation of the commitment to trade liberalization within the framework of the Agreement Establishing the World Trade Organization. Her efforts were conducted through reducing tariffs and eliminating non-tariff barriers (Presidential Decree Number 84 of 2002); the policy of actualizing the availability of food that is sufficient, safe, quality, nutritious and diverse as well as steadily distributed throughout Indonesia and affordable by people's purchasing power (Government Regulation Number 68 of 2002); transfer of protection of plant varieties and use of varieties protected by the government (Government Regulation Number 14 of 2004); food policy that is safe, quality and nutritious is very important for the growth, maintenance and improvement of health status as well as increasing public intelligence (Government Regulation Number 28 of 2004).

In fact, President Megawati Soekarnoputri issued Presidential Instruction Number 3 of 2003. This policy was implemented in order to expedite the information and communication technology in the government process (e-government), as well as to increase efficiency, effectiveness, transparency and accountability of government administration. In this era, PUSPIPTEK was reorganized into the duties and functions

of the State Minister for Research and Technology (Presidential Decree Number 49 of 2003)

The Era of Awakening the National Innovation System (2004–2014).

Policies in the field of research and innovation in the first period of President Susilo Bambang Yudhoyono (2004–2009) were pursued to increase the capacity of science and technology with policies directed at: (1) increasing the focus and capacity of research and development on science and technology; (2) accelerating the process of diffusion and utilization of science and technology products; (3) strengthening science and technology institutions; and (4) creating a climate of innovation in the form of incentive schemes. (Presidential Regulation Number 7/2005)

In the second period, President Susilo Bambang Yudhoyono (2010–2014), had a vision of “The realization of a prosperous, democratic and righteous Indonesia”. In the formulation of people's welfare, the government was committed to realizing an increase in people's welfare, through economic development based on competitive advantage, wealth of natural resources, human resources and national culture. This important goal was managed through the advancement of mastery of science and technology. In the second period of leadership, President Susilo Bambang Yudhoyono implemented a science and technology development strategy with two development priorities, covering: 1) enhancement of the National Innovation System (NIS) which functions as a vehicle for science and technology development towards a long-term vision of science and technology development, and 2) improvement of Research, Development, and Application of Science and Technology carried out following the directions outlined in the RPJPN 2005–2025 (Presidential Regulation Number 5 of 2010).

As a commitment to implement the National Innovation System, the government of the era of President Susilo Bambang Yudhoyono emphasized that the National Innovation System served as a chain network among public institutions, research and technology institutions, universities and the private sector in an institutional arrangement that was systemic; and in long term, it can encourage, support, and synergize activities to produce, utilize, engineer innovations in various sectors, and implement and disseminate the results on a national scale where the real benefits of innovative findings and products are fairly distributed to the community (Presidential Regulation of the Republic of Indonesia Number 32/2010). In addition, the Presidential Regulation Number 32/2010 was also issued on the Master Plan for the Acceleration and Expansion of Indonesia's Economic Development (MP3EI) 2011–2025. This regulation prioritized the competitiveness as a goal, “to complete the planning document in order to increase the competitiveness of a more solid national economy, it is therefore necessary to have a master plan for the acceleration and expansion of Indonesia's economic development which has a clear direction, the right strategy, focus and measurable”. One of the concepts promoted in MP3EI lies in the Innovation Initiative 1-747, becoming the main driver of the innovation-based economic system transformation process through strengthening the education system (human capital) and technological readiness.

Era of Research and Innovation National System Integration (2015–2024).

In the era of President Joko Widodo's administration (2015–2024), efforts to build the science and technology and innovation ecosystem were emphasized by the issuance of the Law on Science and Technology Systems on August 13, 2019. The National System of Science and Technology in this policy was mentioned as a pattern of relationships that shaped the planned, directed, and measurable, and sustainable linkages between institutional elements and resources to build a network of science and technology as a unified whole in supporting the implementation of science and technology and as a scientific basis in the formulation and stipulation of national development policies (Law Number 11 of 2019).

Furthermore, it was disclosed that to carry out research, development, study, and application, as well as integrated inventions and innovations, a national research and innovation agency was formed. In the explanation of Law Number 11 of 2019, it was also mentioned that what was acknowledged by 'integrated' was an effort to direct and synergize, among others, in the preparation of plans, programs, budgets, and Science and Technology Resources in the fields of Research, Development, Assessment, and Application to produce Inventions and Innovations as scientific foundations in the formulation and determination of national development policies.

This regulation, on the other hand, provided for the regulation of the mobility of Science and Technology human resources, such as the placement of Science and Technology human resources from research and development institutions and/or assessment and application institutions belonging to the Central Government or Regional Governments to Business Entities (Article 72 Paragraph (2) letter C, Law Number 11 of 2019).

The government in 2017 issued a policy for the establishment of a professionally managed vehicle to develop and encourage sustainable economic growth through the development, application of science and technology, and the growth of technology-based start-ups. This vehicle was later acknowledged as the Science and Technology Park (Presidential Regulation of the Republic of Indonesia Number 106 of 2017). Initially, the government was committed to building 100 Science and Technology Parks proliferated throughout Indonesia (Presidential Regulation of the Republic of Indonesia Number 2 of 2015).

President Joko Widodo attempted to develop a cooperation scheme between research and development institutions and all stakeholders of Construction Services, to protect intellectual property on construction materials and equipment as well as to construct technology resulting from domestic research and development (Law Number 2 of 2017), during this period there were also published national policies in the field of research acknowledged as the National Research Master Plan (RIRN). RIRN served as a guideline for ministries/institutions/regional governments and stakeholders to formulate action plans in the implementation of National Research. RIRN contains the vision, mission, objectives, targets, national research strategies, and national research planning (Presidential Regulation of the Republic of Indonesia Number 38 of 2018).



Figure 2. The strategic steps of the national leadership for science, technology and innovation in Indonesia, period 2005–2021.

Conclusions.

The strategic steps of the national leadership for science, technology and innovation have been evident from the regulations issued during the presidential reign, grouped into five eras (Figure 1 & Figure 2). This merit is based on the issuance of policies and implications for science and technology institutions and innovation as part of the dynamics of the science, technology and innovation ecosystem. The era of grouping is summarized as follows: First, The Era of Foundation Ladders and Pioneers of Science and Technology Systems and Innovation (1945–1966). This era was under the leadership of President Sukarno. Second, Era of National Strategic Industrial Project Development (1966–1998). This era was under the leadership of President Suharto. Third, Era of Restructuring the National System of Research, Development, and Application of Science and Technology (1998–2004). Although the period of this era merely lasted for seven years, there were three presidents who led this era, including: President B. J. Habibie (1998–1999), President Abdurrahman Wahid (1999–2001), and President Megawati Soekarnoputri (2001–2004). This era however succeeded in giving birth to Law Number 18 of 2002 concerning the National System of Research, Development, and Application of Science and technology. Fourth, the era of awakening the National Innovation System (2004–2014) led by the President Susilo Bambang Yudhoyono, establishing an innovation system in Indonesia. Fifth, The Era of Integration of the National Research and Innovation System (2015–2024), under the

era of President Joko Widodo's administration marked by the presence of the Ministry of Research, Technology and Higher Education (2014), further changed into the Ministry of Research and Technology/National Research and Innovation Agency (2019), and later altered to the National Research and Innovation Agency (2021).

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Conflicts of interest.

The authors declare no conflict of interest.

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Національне агентство з досліджень та інновацій, Індонезія

Наука, технології та інновації (НТІ) екосистем в Індонезії (1945–2021): історико-політичний аналіз

Анотація. Метою цього дослідження є вивчення політичних зусиль уряду Індонезії з початку незалежності в 1945 році до сьогодні, спрямованих на розвиток науки, технологій та інновацій. До середини 2019 року Президент Республіки Індонезія Джоко Відодо затвердив Закон № 11/2019 про Національну систему науки і технологій. Ця постанова стала результатом спроб уряду Індонезії побудувати науково-технічну та інноваційну екосистему з точки зору зміцнення інноваційної політики. Наслідки цієї політики передбачають, що Національне агентство досліджень та інновацій є єдиною дослідницькою та інноваційною установою, що належить уряду Республіки Індонезія. Зусилля щодо створення науково-технологічної екосистеми та інновацій були розпочаті з часів президента Сукарно (1945–1965), які були продовжені під керівництвом наступного президента. Вищезазначені зусилля додатково описані в цьому дослідженні з точки зору історії політики. Підхід аналізу вмісту використовується для ідентифікації кожного нормативного акту в Індонезії у формі законів, урядових постанов, президентських постанов, президентських указів та президентських інструкцій. Проаналізовано 78 нормативно-правових актів у сфері науково-технічної та інноваційної діяльності. Результати аналізу описані на основі появи нормативних актів та інституційних наслідків, створених як частина екосистеми. На підставі результатів польових досліджень та аналізу можна виділити п'ять періодів формування дослідницької та інноваційної екосистеми в Індонезії, а саме: 1) Ера початку фундаментальних досліджень науково-технічних систем та інновацій (1945–1966), 2) Ера розвитку національного стратегічного промислового проекту (1966–1998), 3) Ера реструктуризації національної системи досліджень, розробок і застосування науки і технологій (1998–2004), 4) Ера пробудження національної інноваційної системи (2004–2014), 5) Ера інтеграції національної науково-інноваційної системи (2015–2024).

Ключові слова: політика в області НТІ; система НТІ; історія політики; аналіз історичної політики; інститути НТІ; нормативно-правова та інституційна база

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