

## Human Resources of Research and Innovation in Indonesia: Reality, Policy Strategy, and Roadmap

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### *Abstract*

This article reveals the reality, policy strategies, and roadmap plans for human resource development in Indonesia's research and innovation field. The result of human resources in a lot of research and innovation is an important one, especially after the government's commitment through the issuance of Presidential Regulation Number 18 of 2020 concerning the National Medium-Term Development Plan (RPJMN) for 2020-2024 and also the Presidential Decree of the Republic of Indonesia Number 21 of the Year 2021 concerning the National Talent Management Task Force, where research and innovation are one of the sectors developed in national talent management. This study uses a qualitative method with a descriptive approach. The investigation resulted in four aspects of concern, namely the existing conditions and the Indonesian government's experience in developing human resources in the field of research and innovation, which had been initiated since the era of President Soekarno, then the presence of a scholarship program created by Prof. Eng. BJ Habibie, who at that time served as Minister of State for Research and Technology by providing scholarships to more than 1,500 people during 1982-1996 to study in several countries which would later become talents for the national strategic industry and research and development institutions in Indonesia. The results of talent management policy mapping in the research and innovation sector are discussed in the next section. To enrich understanding, a comparative study of talent management and policy was carried out in Japan, the Philippines, and Malaysia. In the end, a proposed strategy and roadmap for implementing research talent and innovation in Indonesia are presented.

**Keywords:** human resources of research and innovation; policy strategy; policy research; history of science.

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## I. Introduction

Human resources constitute seventy percent of capital in implementing research and innovation, twenty percent is infrastructure and work equipment support, and ten percent is budget support<sup>1</sup>. The placement of human resources as the main capital in implementing research and innovation is not without reason; several global measurement indicators always place human resources as an assessment element. The Global Innovation Index, for example, places human capital and research as one of the measurement indicators, and there are several other sub-indicators on the Global Innovation Index that are related to human resources, such as researchers (FTE/mn pop), research talent (% in business enterprises), and females. Employed advanced degrees (%) (Cornell University, INSEAD, 2019; Dutta et al., 2017, 2020). Likewise, The Global Competitiveness Report places human capital as an indicator of its measurement.

Today, innovation is not only seen as creating value for individuals, businesses, and society. Today's innovation has a broader goal: to help shape a smart future where people can enjoy the highest possible quality of life (Kesavan, 2022). Therefore, the meaning of innovation is increasingly complex by positing intelligent solutions to solve social problems, adopting a more proactive approach to predicting an uncertain future, and overcoming obstacles to a smart future. This condition requires science and technology human resources who can respond quickly and contribute to solving problems. In several previous studies, human resources in science and technology are an important component of innovative talent (Hui et al., 2017). Of course, an important role in developing human resources in science and technology requires strong commitment, support, and direction from the government (Awang, 2004).

It is not surprising that the Government of Indonesia places the management of national talent as one of the development agendas in 'Increasing Qualified and Competitive Human Resources, and it is contained in Presidential Regulation Number 18 of 2020 concerning the 2020 National Medium-Term Development Plan (RPJMN). -2024. Recently President Joko Widodo issued a Presidential Decree of the Republic of Indonesia Number 21 of 2021 concerning the National Talent Management Task Force by placing research and innovation talents as one of the talents that are of concern to immediately draft a national talent management grand design 2022-2045.

Based on these conditions, the formulation of research questions, namely: RQ = "What are the realities, policy strategies, and road maps for human resource development in the field of research and innovation in Indonesia."

## II. Methodology

This study uses a qualitative method with a descriptive approach. Based on its type, this research is known as 'policy research using documents and other methods' (Tight,

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<sup>1</sup> The results of an interview with the Head of the National Research and Innovation Agency, Laksana Tri Handoko, on 04 May 2021, regarding the strategy for developing R&D human resources and managing research and innovation talent in Indonesia.

2019a), where policy documents are not the only source of research. So there are other data collection techniques (see Figure 1). The data collection technique in this study used a regulatory survey (Putera et al., 2022), secondary data research, and interviews. The data collected from the regulatory survey is in the form of policy documents to be analyzed later using content analysis which helps disclose important points from regulations related to talent management regulations in Indonesia. Meanwhile, secondary data research uses amplified analysis (Tight, 2019b). That is, several secondary sources originating from journals, books, and research reports that are used to compare and also serve as a reference in secondary analysis, primarily related to the practice of implementing human resource development in research and innovation in several countries (Japan, the Philippines, and Malaysia).

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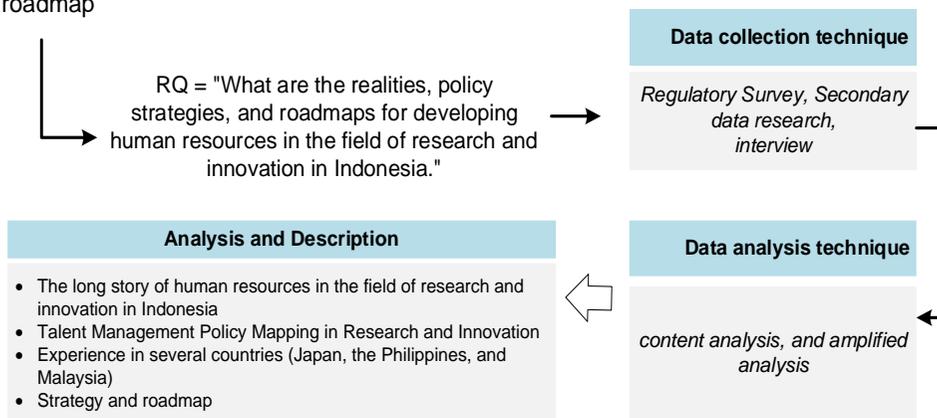


Figure 1. Research framework

### III. Results and Discussions

#### 3.1. The long story of human resource development in the field of research and innovation in Indonesia

The existence of human resources in Indonesia's research and innovation field cannot be separated from the existence and objectives of the research-implementing institutions themselves. In Indonesian history, the implementation of research began in the Dutch East Indies era, with the establishment of the *Bataviaasch Genootschap van Kunsten en Wetenschappen*, which aims to advance research on natural sciences, social sciences, and humanity for the benefit of agriculture, trade, and welfare of the Dutch East Indies (Makagiarsar, 1965). Of course, the researchers came from several countries, especially the Netherlands. This is evident based on records in 1945, with 1320 experts from the Netherlands and only 110 experts from Indonesia who worked in the field of research before 1942 (Committee for Drafting the Book of 20 Years of Independent Indonesia, 1966; Honig & Verdoorn, 1945).

**Table 1.** Calculation of Projected Human Resource Needs in The Field of Research and Innovation for The Period 1980 – 1986

Years Field of Science	1959		1960		1961		1962		1963		1964		1965	
	DC T	OVS	DC T	OVS	DC T	OVS	DC T	OVS	DC T	OVS	DC T	OVS	DC T	OVS
1. Biology	-	-	-	-	-	--	11	-	14	-	22	-	22	-
2. Economy and Society	-	-	-	-	-	-	3	-	3	6	3	13	3	13
3. Electronics	-	-	-	-	-	-	5	-	6	1	6	1	6	1
4. Physics	-	-	-	-	12	-	22	-	23	-	23	1	23	1
5. Geology and mining	-	-	-	-	-	-	6	-	6	-	17	-	17	-
6. Instrumentation	-	-	-	-	9	-	21	-	21	2	21	2	42	2
7. Chemical	-	-	-	-	4	-	18	-	22	2	22	2	22	3
8. Policy Science	-	1	-	1	-	1	-	2	-	2	-	4	-	4
9. Documentation and library	-	1	-	1	-	1	-	1	-	1	-	3	-	3
10. Scientific Publishing	-	-	-	-	-	-	-	1	-	1	-	1	-	1
11. Metallurgy	-	-	-	-	-	-	-	-	-	-	-	2	-	2
12. Oceanography	-	-	-	-	-	1	-	2	-	2	-	2	-	2
13. Zoology	-	-	-	-	-	-	-	-	-	3	-	4	-	4
14. Botany	-	1	-	1	-	1	-	4	-	8	-	8	-	8
<b>Total</b>	<b>-</b>	<b>3</b>	<b>-</b>	<b>3</b>	<b>25</b>	<b>4</b>	<b>84</b>	<b>10</b>	<b>95</b>	<b>28</b>	<b>114</b>	<b>43</b>	<b>235</b>	<b>44</b>

notes: DCT=domestic; OVS = overseas

**Source:** rewritten from the Committee for Drafting the Book of 20 Years of Independent Indonesia, 1966

This condition continued at the beginning of Indonesian independence, where research was carried out completely lacking facilities, experts (researchers), research tools, and budget. The lack of human resources in research and innovation made the government issue a policy that 1) students at tertiary institutions in Indonesia whom the government gave scholarships through the Indonesian Science Council (Majelis Ilmu Pengetahuan Indonesia<sup>2</sup>), after completing their education, were placed in research institutions. These

<sup>2</sup> The Indonesian Science Council (MIPI) is a 'Central Agency' established as a coordinating center guiding efforts to advance Science in Indonesia. This body was formed based on the Law of the Republic of Indonesia Number 6 of 1965 concerning establishing the Indonesian Science Council. MIPI carries out three matters in organizing and providing assistance to 1) research efforts in science, 2) publishing efforts in scientific fields, and 3) knowledge

students were sent abroad to deepen their knowledge, and 2) scholars in research institutions were sent abroad to continue their studies/knowledge (Committee for Drafting the Book of 20 Years of Independent Indonesia, 1966). During 1959-1969, the Indonesian government developed human resources in research and innovation in fourteen fields of science, ranging from biology to botany (Table 1).

The need for human resources in research and innovation in Indonesia was calculated by the World Bank in a study in 1979 that Indonesia needed 3,900 engineers per year, 1,200 researchers, 700 researchers in agriculture, 700 accountants, 900 economists, and 500 trained managers (National Research Council, 1983). The same condition was also expressed by Sastrapradja (1983), based on a report in 1977, regarding the projected need for human resources in the field of research in Indonesia until 2000, with estimates of 33,650 (1975), 119,500 (1985), and 391,850 (2000) (Sastrapradja, 1983). So, from 1980 - 1986, additional human resources were needed by 8,275 personnel. The additional calculation uses an estimated 1.6% of college graduates who continue their careers as researchers in research institutions (Table 2).

**Table 2.** Calculation of projected human resource needs in the field of research and innovation for the period 1980 – 1986

school year	projected university graduates	estimated R&D manpower input
1980/1981	36.943	591
1981/1982	51.958	831
1982/1983	72.242	1.156
1983/1984	91.381	1.462
1984/1985	116.567	1.865
1985/1986	148.120	2.370
<b>Total</b>	<b>517.211</b>	<b>8.275</b>

Source: rewritten from Sastrapradja, 1983

During its development, in 1984, the Government of Indonesia opened the Overseas Fellowship Program (OFP). OFP is a program to increase scientific and technological capabilities by targeting 1,500 people to improve their education through study abroad, which includes undergraduate and postgraduate degrees. The focus at that time was physics, engineering, and technology. Even this program continued with the name 'Science and Technology Manpower Development Program (STMDP).' This program has produced around 500 alumni who fill several positions in research and innovation institutions in Indonesia. Furthermore, in April 1990, the Indonesian government resumed human resource development through Science and Technology for Industrial Development (STAID). When

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dissemination efforts in society. This body has an Advisory Council whose task is to assist the Board of Directors. The Advisory Council has two sections, namely the natural science section and the cultural, state, and community science section. MIPI was then disbanded, and in its place were born several institutions such as 'Durenas' (1962), then changed to 'Lemrenas' (1966), then became the Indonesian Institute of Sciences (1967). Law Number 6 of 1956 concerning the Establishment of MIPI was just repealed and declared no longer valid after the publication of the Law of the Republic of Indonesia Number 8 of 1990 concerning the Indonesian Academy of Sciences.

the STAID program was completed in 2003, 1,525 students used the program's facilities (Amir, 2012).

In subsequent developments, since 2013, Indonesia has had a new scheme for awarding scholarships through the Education Fund Management Institution (LPDP). LPDP is a non-echelon work unit in ministries that administers government affairs in the field of state finance that applies a pattern of financial management for public service agencies and manages Endowment Funds in the Education Sector following statutory provisions (Regulation of the President of the Republic of Indonesia Number 111 of 2021 concerning Endowment Funds in Education, 2021). From 2013–December 2021, recipients of LPDP scholarship services totalled 29,872 people. Based on this number, there are 5,934 students currently studying, and 68.50% (4,065 people) are studying domestically, 10.43% (619 people) in England, 5.88% (349 people) in the United States, as well as the remainder, are scattered in several other countries such as Australia, the Netherlands, Japan, Germany, Sweden, and others (Education Fund Management Institute, 2022).

Based on the long story of human resource development in the field of research and innovation that the Indonesian government has carried out, it is to continue the tradition of human resource development, which is full of contemporary demands and developments. So currently, efforts are being made to enhance human resources development in Indonesia through a national talent management policy.

### 3.2. Talent Management Policy Mapping in Research and Innovation

Eight regulations form the basis for implementing research and innovation talent management in Indonesia (Table 3).

**Table 3.** Results of policy mapping related to national talent management in the field of research and innovation in Indonesia

No.	Regulatory	Aspect settings
1.	Law of the Republic of Indonesia Number 11 of 2019 concerning the National System of Science and Technology	<p>a. The long-term, mid-term master plan for the advancement of science and technology and the annual master plan for the advancement of science and technology contain the potential and development of scientific and technological resources. Human resources are one of the three aspects of science and technology resources.</p> <p>b. Science and technology human resources are classified as follows: 1) researchers, 2) engineers, 3) lecturers, and other science and technology human resources (among others, nuclear officers, radiation supervisors, and mapping surveyors).</p> <p>c. The mobility of human resources in Science and Technology is one of the partnership models in implementing science and technology. The concept of mobility is interpreted as the placement of human resources in science and technology from research and development institutions and/or research and application institutions belonging to the Central Government or Regional Government to Business Entities. (<i>Undang-Undang Republik Indonesia Nomor 11 Tahun 2019 Tentang Sistem Nasional Ilmu Pengetahuan Dan Teknologi</i>, 2019)</p>

No.	Regulatory	Aspect settings
2.	Regulation of the President of the Republic of Indonesia Number 111 of 2022 concerning the Implementation of the Achievement of Sustainable Development Goals	In the 2024 sustainable development goal target matrix, there is a global goal of "Building resilient infrastructure, enhancing inclusive and sustainable industries, and encouraging innovation," the fifth global goal, "Strengthening scientific research, enhancing the technological capabilities of the industrial sector in all countries, especially developing countries, including by 2030, drive innovation and substantially increase the number of R&D workers per 1 million people and increase public and private spending on R&D." targeting an increase in the proportion of human resources in science and technology with a Doctoral degree (S3) by 20%. (2019 base year: 14.08%) as the 2024 target. ( <i>Peraturan Presiden Republik Indonesia Nomor 111 Tahun 2022 Tentang Pelaksanaan Pencapaian Tujuan Pembangunan Berkelanjutan, 2022</i> )
3.	Decree of the President of the Republic of Indonesia Number 21 of 2021 concerning the National Talent Management Task Force	<ol style="list-style-type: none"> <li>1. Talents in research and innovation are among the talents that are of concern to immediately draft a national talent management grand design for 2022-2045 apart from the arts, culture, and sports fields.</li> <li>2. The Head of the National Research and Innovation Agency is the coordinator for preparing the national talent management grand design in research and innovation.</li> <li>3. In carrying out its duties, the National Talent Management Task Force coordinates, collaborates, cooperates, and partnerships with relevant ministries/agencies, provincial and regional governments, regency/municipal governments, individuals, academics, philanthropy, higher education, community organizations, professional organizations, the business world, mass media, development partners, and other stakeholders related to National Talent Management.</li> <li>4. The work output of this task force is in the form of the 2022-2045 National Talent Management Grand Design and the Mechanism for implementing, monitoring, evaluating, and controlling the implementation of the 2022-2045 National Talent Management Grand Design and to be completed no later than 12 (twelve) months from the date of this Presidential Decree is set (10 December 2021). (<i>Keputusan Presiden Republik Indonesia Nomor 21 Tahun 2021 Tentang Gugus Tugas Manajemen Talenta Nasional, 2021</i>)</li> </ol>
4.	Presidential Regulation Number 18 of 2020 concerning the 2020-2024 National Medium-Term Development Plan (RPJMN)	<ol style="list-style-type: none"> <li>1. National talent management is one of the development agendas in "Increasing Quality and Competitive Human Resources."</li> <li>2. The policy direction and strategy regarding National Talent Management consist of five important points. First, mapping the need and supply of talent based on areas of expertise and profession; second, management of inventory database and talent needs; third, increasing expertise, capacity, and performance as well as career development and talent achievement; fourth, creating a conducive environment as an attraction for acquiring talent, as well as for developing potential, interests, expertise, and talent achievements, and; fifth, the establishment of the Indonesian Talent Management Institute (<i>Peraturan Presiden Nomor 18 Tahun 2020 Tentang Rencana Pembangunan Jangka Menengah Nasional (RPJMN) Tahun 2020-2024, 2020</i>)</li> </ol>

No.	Regulatory	Aspect settings
5.	Regulation of the President of the Republic of Indonesia Number 38 of 2018 concerning the 2017-2045 National Research Master Plan	<ol style="list-style-type: none"> <li>1. Science and Technology Human Resources, from now on referred to as Science and Technology Human Resources, are researchers, engineers, lecturers, and other Science and Technology Human Resources who carry out research, development, study, and/or application of science and technology activities.</li> <li>2. Increasing the ratio of Science and Technology Human Resources to the population in 2045 to 8600 (eight thousand six hundred) people per 1 (one) million population, and increasing the ratio of Science and Technology Human Resources candidates consisting of masters program students and doctoral program students for undergraduate students in 2045 to 100% (one hundred percent) are two input indicators in the target achievement indicators of the national research master plan.</li> <li>3. Attaining the productivity of Science and Technology Human Resources in 2045 with as many as 22 (twenty-two) reputable international scientific publications for every 100 (one hundred) Science and Technology Human Resources is an output indicator on the target achievement indicators of the national research master plan. (<i>Peraturan Presiden Republik Indonesia Nomor 38 Tahun 2018 Tentang Rencana Induk Riset Nasional Tahun 2017-2045, 2018</i>)</li> </ol>
6.	Republic of Indonesia National Research and Innovation Agency Regulation Number 21 of 2022 concerning the Master Plan for the Development of Indonesian National Work Competency Standards in the Field of Research and Innovation	<ol style="list-style-type: none"> <li>1. To advance the development of research and innovation in Indonesia, strategic efforts are needed, one of which is by increasing the capacity of competent and professional human resources in the field of research and innovation following work competency standards.</li> <li>2. The development master plan is prepared to accommodate the needs for competency development for science and technology human resources with the scope of research and innovation consisting of the a. research process; and research and innovation management. (<i>Peraturan Badan Riset Dan Inovasi Nasional Republik Indonesia Nomor 21 Tahun 2022, 2022</i>)</li> </ol>
7.	Regulation of the President of the Republic of Indonesia Number 111 of 2021 concerning Endowment Funds in the Sector of Education	<ol style="list-style-type: none"> <li>1. The Endowment Fund in the Education Sector consists of a. Endowment Fund for Education; b. Research Endowment Fund; c. Cultural Endowment Fund; and d. College Endowment Fund.</li> <li>2. The results of the development of the Endowment Fund in the Education Sector are used to carry out service programs and operations and/or to add to the Endowment Fund in the Education Sector.</li> <li>3. The results of the development of the Endowment Fund for Education, including the Endowment Fund for Islamic Boarding Schools, are used for service programs, including a. degree and non-degree scholarships; b. degree and non-degree competency enhancement; c. research funding; d. religious education and pesantren education; and e. other service programs as directed by the Board of Trustees.</li> <li>4. The results of the development of the Research Endowment Fund are used to carry out service programs in the fields of research, development, study, and application to produce inventions and innovations. (<i>Peraturan Presiden Republik Indonesia Nomor 111 Tahun 2021 Tentang Dana Abadi Di Bidang Pendidikan, 2021</i>)</li> </ol>

No.	Regulatory	Aspect settings
8.	Republic of Indonesia National Research and Innovation Agency Regulation Number 25 of 2022 concerning Human Resource Development Programs Through Research-Based Postgraduate Education	<ol style="list-style-type: none"> <li>1. The Human Resource Development Program through Research-Based Postgraduate Education is a learning program to increase the capacity of civil servants and other human resources through research-based formal education.</li> <li>2. The Human Resource Development Program through Research-Based Postgraduate Education is carried out by considering: a. suitability of the field of Human Resource Development Program through Research-Based Postgraduate Education submitted by participants with Work Units; or b. the continuity of the availability of Research topics as long as participants carry out the Human Resource Development Program through Research-Based Postgraduate Education. <i>(Peraturan Badan Riset Dan Inovasi Nasional Republik Indonesia Nomor 25 Tahun 2022 Tentang Program Pengembangan Sumberdaya Manusia Melalui Pendidikan Pascasarja Berbasis Riset, 2022)</i></li> </ol>

### 3.3. Experience from several countries

The development of human resources in science and technology is no longer a discourse or just a plan for several countries. Japan, for example, through Japan's Ministry of Education, Culture, Sports, Science, and Technology (MEXT), is carrying out strategic steps for comprehensive human development that includes everyone from children to leading researchers and scientists.

"Developing the talents of young children and broadening the horizons of those who are interested in science, fostering environments where diverse people including young, female, and international researchers can exercise their abilities, and promote a professional engineer system, will all help to create a strong knowledge infrastructure." (openaccessgovernment.org, 2021)

The development of human resources in Japan cannot be separated from science and technology policies which are regulated and planned following "the Science and Technology Basic Plan" based on "The Science and Technology Basic Law." The result is undeniable, and Japan has the world's second most Nobel Prize recipients in natural sciences in the 21st century. This proves that the development of human resources in Japan plays an important role. In fact, in the fifth science and technology master plan for 2016–2021, Japan proclaimed a culture of "boldly challenging the future" this design was developed to create future industries and change society by putting forward four pillars, one of which is "Building a systemic virtuous cycle of human resources.", knowledge, and funding for innovation." Therefore, Japan believes that Japan's competitiveness in the future depends on the utilization of human resources, knowledge, funding at home and abroad, the creation of new values, and the immediate implementation of new values in society as part of advancing global initiatives for open innovation.

The Philippine government in 1958 has launched the "Science Talent Search" program, which is intended to develop human resources with high talent to pursue careers in science and technology. In order to accelerate the development of human resources in Science and Technology, the Philippine government issued Republic Act (RA) No. 7687, "Science and Technology Scholarship Act of 1994". This policy provides scholarships to

gifted and economically limited students with priority studies in basic sciences, engineering, other applied sciences, and the teaching of science and mathematics. In addition, there is also Republic Act (RA) No. 10612, "An Act Expanding the Coverage of the Science and Technology (S&T) Scholarship Program and Strengthening the Teaching of Science and Mathematics in Secondary Schools" or better known as the "Fast-Tracked S&T Scholarship Act of 2013". This policy was made to accelerate science, mathematics, and engineering graduates who would then teach science and mathematics in secondary schools across the country (Republic Act No. 10612, Fast-Tracked S&T Scholarship Act of 2013, 2013).

Meanwhile, the Malaysian government is armed with the results of a study projecting that by 2050 Malaysia will need eight million workers in the 'Science, technology, engineering, and mathematics sector. However, there is concern that the existing human resources will be sufficient in quantity and competitive enough in the future because currently, only 30% of students are on the cyan pathway (Academy of Sciences Malaysia, 2017). The Malaysian government has invested heavily in education and research infrastructure support since 1967. Data reveals that in 1996 Malaysia had around 89 researchers per million people, then in 2011, it became 1,643 per one million people (Akoum, 2016). and in other data, it states that in 2014 there were 60.7 researchers per 10,000 workers, and in 2018 there were 58.9 researchers per 10,000 workers. This number decreased compared to 2016, reaching 74.0 researchers per 10,000 workers in Malaysia (Ministry of Science Technology and Innovation, 2021b).

Therefore, increasing the capacity and quality of human resources in the field of research and innovation in Malaysia is the priority of the six strategic policies of the "National Science, Technology and Innovation Policy 2021-2030", namely "Talents" (Ariffin et al., 2022).

"Talent development is the backbone of technology development efforts. A competent, agile, and adaptive talent pool will drive the discovery and innovation of new products and technologies." (Ministry of Science, Technology and Innovation, 2021a)

There are four strategies carried out by the Malaysian government, namely first, strengthening national planning for science and technology talent and innovation that is competent and adaptive. This strategy uses two initiatives: a) to formulate a national science and technology and innovation talent plan at the central level through an integrated approach, and b) to take an integrated approach in planning the career mapping of workers in the science and technology and innovation sectors. This effort is in collaboration with the Ministry of Education Malaysia (MOE) and the Ministry of Human Resources (MoHR) through data mapping in education and employment. The second strategy is 'Leading STEM Education. The Government of Malaysia is taking initiatives by developing transdisciplinary 'Science, Technology, Engineering and Math' teaching and learning modules and streamlining TVET modules in the education system. The third strategy is called 'Expanding STI talent participation in the workforce, while the initiative is carried out through a) increasing skills and repeating existing skills from science and technology talent and innovation to be able to adapt to a changing environment, b) increasing women's participation in the workforce from the science and technology and innovation sectors, and c) encouraging the re-entry of women into the workforce. The fourth strategy, 'Increasing

the demand for STI talent,' is an initiative through a) strengthening public-private partnerships to increase demand for talent from the science and technology and innovation sectors, b) Strengthening mechanisms that support techno-entrepreneurship (Science and innovation-based entrepreneurship).

### 3.4. Policy strategy and implementation roadmap for research and innovation talent management

Prior to the establishment of the national research and innovation talent management program by President Joko Widodo, the Indonesian government also had a strategy for achieving research and innovation talent development based on the 2017-2045 National Research Master Plan in 2018. This strategy is related to implementing programs to increase the quantity and quality of Science and Technology Human Resources. The policy strategy is to strengthen Science and technology human resources by 1) increasing the number of post-graduate scholarships, both from the central government and regional governments as well as the private sector. 2) domestic postgraduate study incentives for new graduates, and 3) mobility of Science and Technology Human Resources between universities, research and development institutions, and other strategies. In addition, there is also a strategy of refreshing the research environment through research visits, guest researchers from ex-diaspora or foreign nationals, and other strategies (Peraturan Presiden Republik Indonesia Nomor 38 Tahun 2018 Tentang Rencana Induk Riset Nasional Tahun 2017-2045, 2018).

Meanwhile, Fachriansyah and Wulandari (2022) reveal a design flowchart for developing research and innovation talent through a basic stage known as scouting and selection, where this stage aims to identify, select, and actualize talent. Then stage 1, called talent nursery, is carried out through research apprenticeships, final project/thesis research assistance, and assistance in continuing Master's studies. Phase 2 is the development of potential talent, carried out through research assistantships, medium-term research grant funding assistance, and mobilization or assignments to various institutions/industries. Stage 3 is strengthening superior talent through long-term research support, adequate research facilities, and the freedom to form their research team (Fachriansyah & Wulandari, 2022).

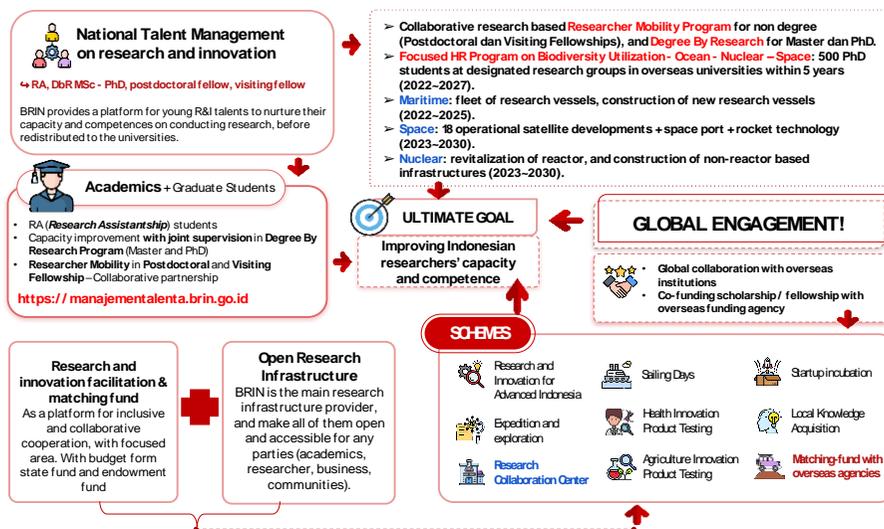


**Figure 1.** The grand macro stages of the national talent management design in the field of research and innovation 2022-2045

Source: Redrawn by the author from Fachriansyah & Wulandari, 2022

Furthermore, Fachriansyah and Wulandari (2022) provide a proposal for staging the implementation of national talent management in the field of research and innovation divided into five stages of implementation, with a five-year periodization, starting from 2022-2024 and ending in 2040-2045 (see Figure 1).

The strategy for implementing national talent management in the field of research and innovation in Indonesia has the ultimate goal of 'Improving Indonesian research capacity and competence' (Figure 2). The achievement of these objectives cannot be separated from the open research infrastructure strategy and the research and innovation facilitation strategy, as well as the matching fund carried out by the National Research and Innovation Agency (BRIN). BRIN implements an open research infrastructure strategy by making BRIN the main research infrastructure provider and making all of them open and accessible for any party (academics, researchers, businesses, and communities). Likewise, with the research and innovation facilitation and matching fund strategy, BRIN Is a platform for inclusive and collaborative cooperation with focused areas. With a budget from state funds and endowment funds. The strategy includes implementing nine schemes: Research and Innovation for Advanced Indonesia, Expedition and exploration, Research Collaboration Center, Agriculture Innovation Product Testing, Matching-funding with overseas agencies, Local Knowledge Acquisition, Health Innovation Product Testing, Sailing Days, and Startup incubation.



**Figure 2.** Concept and strategy for implementing research and innovation talent management

Source: redrawn by the author from Handoko, 2022, and adapted to the interview results

The national talent management strategy in research and innovation involves Research Assistantship, Capacity improvement with joint supervision in Degree by Research Programs (Master's and Ph.D.), and Researcher Mobility in Postdoctoral and Visiting Fellowship – Collaborative partnerships. Efforts to be carried out with 1) a Collaborative research-based Researcher Mobility Program for the non-degree (Postdoctoral and Visiting Fellowships), and Degree by Research for Masters and Ph.D., 2) a Focused HR Program on

Biodiversity Utilization - Ocean - Nuclear - Space: 500 Ph.D. students at designated research groups in overseas universities within five years (2022~2027). Maritime: fleet of research vessels, construction of new research vessels (2022~2025). Space: 18 operational satellite developments, spaceport, rocket technology (2023~2030). Nuclear: revitalization of reactors and construction of non-reactor-based infrastructures (2023~2030).

#### **IV. Conclusion and Recommendation**

The development of human resources in the field of research and innovation in Indonesia must be distinct from the national talent management plans and policies in the field of research and innovation initiated by President Joko Widodo. Four perspectives can help to understand the reality, policy strategy, and roadmap of human resource development in research and innovation.

First is the history of human resource development in Indonesia's research and innovation field. The development of human resources in research and innovation started in the era of President Sukarno and until now. Several effective programs mark the existence of human resource development in research and innovation, including the Overseas Fellowship Program, the Science and Technology Manpower Development Program, the Science and Technology for Industrial Development, and a scholarship program through the Education Fund Management Institute.

Second, the policy forms the basis of its implementation. Eight regulations serve as references, namely one policy in the form of a law, four policies in the form of a presidential regulation of the Republic of Indonesia, one regulation in the form of a Presidential Decree of the Republic of Indonesia, and two regulations in the form of a Decree of the Head of the National Research and Innovation Agency. The policy contains rules regarding implementing human resource development in research and innovation. Only one policy contains implementation institutions for research and innovation talent management, namely the Presidential Decree of the Republic of Indonesia Number 21 of 2021 concerning the National Talent Management Task Force.

Third, experiences from countries such as Japan, the Philippines, and Malaysia can provide a good record of the implementation of human resource development in the field of research and innovation for Indonesia. In Japan, for example, human resource development cannot be separated from existing and well-planned science and technology policies. Then the Philippines 1958 launched a "science talent search" program to develop human resources with a high talent for careers in research and innovation in the country. Apart from that, there is also Malaysia, which places increasing the capacity and quality of human resources in the field of research and innovation in Malaysia as the priority of the six strategic policies of the "National Science, Technology and Innovation Policy 2021-2030".

Fourth, the policy strategy and roadmap for implementing national talent in the field of research and innovation in Indonesia has the ultimate goal of 'Improving Indonesian researcher capacity and competence.' The achievement of these objectives in the policy strategy must be distinct from the available research infrastructure strategy and the research and innovation facilitation strategy, as well as the matching fund carried out by the National Research and Innovation Agency (BRIN).

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