Indonesia

The Atlas of Islamic World Science and Innovation
Country Case Study

Priya Shetty, Husein Akil, Trina Fizzanty, Grace Simamora

The Atlas of Islamic World Science and Innovation is supported by an international consortium of partners listed below.

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Each country report within the Atlas project draws on in-country partners. In the case of Indonesia, special thanks go to the Ministry of Research and Technology (RISTEK), the National Focal Point, and the Indonesian Institute of Sciences (LIPI), the National Research Partner.

Cover image:
Wooden door of country house with carved ornament, Bali, Indonesia

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ISBN: 978-1-78252-005-4

Foreword

Foreword from His Excellency Iyad Ameen Madani, Secretary General of the Organization of Islamic Cooperation (OIC)

The Indonesia report is the fifth in the series of country case studies prepared under the Atlas of Islamic World Science and Innovation project. The report offers an assessment of the Science, Technology and Innovation (STI) landscape in Indonesia, which is the world's biggest Muslim population country and a very important member of the OIC family.

I am pleased to note references to the strong commitment of the government of Indonesia to prioritize science as a key driver of economic growth and transformation to knowledge-based society.

While acknowledging the positive trends in Science, Technology and Innovation in Indonesia, the report seeks to objectively identify areas which can be further improved. Given its recent remarkable economic progress, young and energetic population mostly in economically productive age bracket, abundance in resources, large number of universities and enhanced focus on R&D, Indonesia has strong potential to emerge as a global leader in science and technology. I hope that the relevant authorities in Indonesia will give due consideration to the recommendations of the report regarding the diversification of economic activity, strengthening efforts for human capital development and commercialization of research.

The Atlas project has been a unique initiative based on collaboration between institutions across the Islamic world and partners in Europe and northern America (Canada). The objective of the project has been to map key trends and trajectories in science and technology-based innovation in selected OIC Member States and thus facilitate formulation of evidence-based Science, Technology and Innovation (STI) policy in these countries.

I thank all the partners of the Atlas Project including Islamic Development Bank (IDB), Ministerial Standing Committee on Scientific and Technological Cooperation (COMSTECH), Qatar Foundation (QF), Islamic Educational, Scientific and Cultural Organization (ISESCO), British Council, International Development Research Centre (IDRC) and Nature for their constructive inputs. The invaluable contribution of the Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC), the National Focal Point of Indonesia and Research Partners in the preparation of this report deserve our appreciation.

Introduction

It's just over a decade after the Asian financial crash that devastated many Eastern economies, and Indonesia has made remarkable economic progress, outpacing many of its neighbours. Once, it had the potential to emerge as a global scientific powerhouse, yet decades of underinvestment in science and technology have left it lagging behind neighbours like Malaysia.

Indonesia has much to offer the world. Abundant in natural resources, the country's research strengths are in agriculture, the environment, and energy. As the planet's resources become ever depleted, however, an economy that is reliant solely on exploiting natural resources is doomed.

The nation is well aware that it needs to exploit its environmental strengths to transition to a knowledge economy. Its rich biodiversity could allow it, for example, to pioneer cutting-edge research into pressing issues such as the effect of climate change on forests and oceans. Its geothermal stores allow for experimentation with generating renewable energy from the earth as well as through solar and wind sources. With food insecurity on the rise, Indonesia could also pioneer agricultural techniques that improve food productivity and nutrition.

The transition to a knowledge economy is one that many developing countries find tricky to navigate. It requires extensive expertise and cross-sectoral collaboration, and it also demands a robust infrastructure of information technology, transport, and research facilities. Importantly, it requires enough highly skilled and trained people to be able to push not only R&D, but innovation.

While Indonesia is not lacking in scientific ambition, decades of neglect have left its infrastructure still too weak to build a robust R&D system. For now, the country needs to invest in the basics, ensuring that the foundation for good scientific practice is strong. It will also need the right people to make this happen, and it must focus on producing and rewarding high-quality researchers who are adept at critical thinking rather than just churning out high numbers of graduates.

An ambitious programme of decentralisation has left the responsibilities and remits of different districts and provinces in a confusing tangle, and made for a regulatory framework that is weak and ineffective. The frequent charges of corruption leveled at the government don't help instill confidence in foreign collaborators or investors.

Indonesia is politically interesting as it is one of the world's largest democracies and has the world's biggest Muslim population. Its links with the rest of the Muslim world may not be strong, but it is keen to broaden those connections, and to push for better science and technology in Islamic countries.

This report offers an assessment of science, research and innovation in Indonesia, as part of the Atlas of Islamic-World Science and Innovation[1] (see www.royalsociety.org/aiwsi/ and www.aiwsi.org). Drawing on the expertise of a consortium of partners, the Atlas project aims to map the changing landscape of science and innovation across the 57 member states of the OIC. We are particularly grateful to the Indonesian Institute of Sciences (LIPI) for their advice and assistance in the preparation of this report. Thanks also go to Luke Clarke, Susan Gillespie, Keri Hildick and Peter Gallimore who worked on the report at the Royal Society.

The report draws on two periods of in-country fieldwork: in March 2012 and June 2012, during which around 100 interviews were carried out with scientists, policymakers, students, journalists, and university and business leaders.

Indonesia is at a critical juncture of its science and technology development. Its researchers are keen to shake off the country's low scientific reputation and re-build its capacity to push it through as a scientific powerhouse for the 21st century. The government is keen to invest in R&D as an integral part of its economic strategy. If it keeps its promise, and this will require enormous national commitment, the Asian scientific landscape could look very different in a decade's time.

A summary of each chapter in this report is provided below:

1. Mapping

Indonesia's science and technology system has been neglected for several years, but the government is starting to prioritise science as a key driver of economic growth. The country has had moments in its history when it invested heavily in research and human resources, and many researchers hope the government will return to taking science as seriously again. This chapter maps Indonesia's scientific history, including its colonial ties with the Netherlands, and outlines the policies that have led to its current scientific system. We look at human resources, funding, publications and patents to offer a snapshot of Indonesian science.

2. People

One resource that Indonesia is not short of is people. The country has the fourth largest population in the world, and it is growing. Over the next decade, much of its population will be in an economically productive age bracket, which is a demographic shift the country could exploit. The country has a large number of universities and has begun to invest heavily in education, yet there are changes to be made to ensure that graduates are ready for the job market. Indonesia still has a shortage of trained scientists, and this disconnect needs to be rectified.

1 See www.royalsociety.org/aiwsi and www.aiwsi.org

3. Places

Indonesia is geographically diverse and spread over several islands, yet the lack of connectivity and infrastructure mean that exchanging ideas and services between regions is not easy. Despite the decentralisation of the past decade, most universities and R&D institutes are still concentrated on the central island of Java, where the capital Jakarta is based. The country is trying to extend education to other regions, and to encourage more collaboration between the islands, but the country's infrastructure needs to improve first. Different regions of Indonesia have developed their own research niches, which this chapter explores.

4. Business

Despite high levels of foreign investment, Indonesia's infrastructure has not improved nor has there been much technology transfer from multinationals to local industry. In general, few businesses undertake any R&D in the country, and industry rarely collaborates with public R&D institutions or universities. Innovation-based R&D is low, given the lack of either funding or an enabling innovation environment.

5. Culture

Indonesia encourages women to work in science as much as it does men, but women still need a greater representation at high positions in organisations, and there are changes to be made to make it easier for women with families to work as scientists. This chapter looks at how researchers feel about the intersection of Islam with science, and what collaborations they would like with Islamic countries. Science communication is an integral part of the practice of science, and while Indonesia's media has become vastly more open since Suharto's regime, its reporting of science is still in its infancy in many ways, with a lack of critical thinking.

6. Sustainability

Indonesia's biodiversity is one of its greatest strengths, but a resource that the country has often treated poorly. Environmental destruction is still common, and the country needs to take a stronger line on enforcement. It could become a leader in much-needed research, such as the development of clean energy, but to do so it will need to significantly up its game in terms of the level of research it undertakes.

7. Collaboration

Scientists are keen to collaborate, but the country's bureaucracy is still difficult to negotiate, which means that international collaborations may happen on an institutional or governmental level, but rarely at the level of individual scientists. And yet, this type of collaboration is vital because higher level partnerships can take years to get off the ground. Since Indonesia's scientific system will take some time to become as advanced as some of its ASEAN neighbours, collaboration would be a great way for it to absorb knowledge through technology or knowledge transfer, and for the country to be engaged in high-level research.

8. Prognosis

Indonesia's scientific system has a great many strengths but also some fundamental weaknesses. The flaws are not fatal, however, and if addressed soon, and with genuine commitment, the country could start to change its scientific fortunes. Politicians are promising that they will ramp up investment and bring its scientific system into the 21st century. Indonesia has the capacity to do so, but it needs a careful roadmap of action.

1 Mapping

Indonesia is a massive country – its population of 242 million is the fourth biggest in the world[2] – yet it makes remarkably little impact on the global scientific scene. It spends little of its GDP on R&D – just 0.08% – and while it talks about stepping up this proportion to 1% by 2014, and raising it to 3% by 2025,[3] it is hard to believe that the country will achieve such a hike in spending, when the amount it spends on R&D has languished for many years.

In some ways, one of its key strengths – its size – is also holding it back. The population is spread over an archipelago of 17,500 islands. A poor state of modern communication networks and infrastructure means that there is very little connectivity between and within the islands, which is not conducive to collaboration within the country.

The country is keen to transform into a knowledge economy, however, and is investing heavily in education in order to do so. Its current development plans suggest – at least on paper – that it very much puts science, technology and innovation (STI) at the core of its economic growth.

Table 1.1 Summary of economic and social data in Indonesia.[4]

Indicator	Figure	Year
GDP growth	6.2%	2012
Foreign Direct Investment (FDI) inward flows[5], US$	17.36 billion	2012
GDP per capita, $PPP[6]	3,557	2012
Population	247 million	2012
Number living at national poverty line (% of population)	11.4%	2012
Internet users per 100 people	15.4	2012
Mobile phone subscriptions per 100 people	114.2	2012
Literacy rate (population aged 15 years or over)	93%	2011

2 World Bank (2014). *World Development Indicators.* World Bank: Washington, DC, USA.

3 Coordinating Ministry For Economic Affairs (2011). *Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011 - 2025.* Coordinating Ministry For Economic Affairs, Jakarta, Indonesia.

4 Source: World Bank (2014). *World Development Indicators.* World Bank: Washington, DC, USA.

5 Balance of Payments (BoP)

6 Purchasing power parity.

1.1 A brief history of science, technology and innovation in Indonesia

The 1970s saw President Suharto and Professor B J Habibie, Suharto's science and technology minister, push the agenda of scientific development forward. Habibie briefly became president in 1998 after Suharto's regime ended, leaving office in 1999, but it is for his stint as science minister that he is best known (see Box 1.2).

Indonesia had already begun to prioritise science and technology for economic growth after independence from Dutch Colonial rule in 1945, and 1956 saw the formation of the Indonesian Council of Sciences to advise the government on science and technology. After President Suharto came to power in 1966, things moved even faster.

A broad-brush look at the country's scientific progress reveals how it proceeded through a series of carefully designed five-year plans. Initially (1969 – 1974), the goal was to become economically stable. It sought help from aid organisations and foreign governments in both monetary and knowledge terms, to begin planning science and technology activities. During this time it set up the Ministry of Research and Technology (RISTEK) in 1970. Then (1974 – 1979), it began to focus on R&D in the key sectors of agriculture and mining, with an eye on building industry. It also set up the National Research Centre for Science and Technology (PUSPIPTEK) in 1976. Later, Indonesia started categorising research activities into basic and applied science designed to meet both short and long-term goals (1979 – 1984). At the start of the fifth five-year plan (1984 – 1989), the government created the National Research Council (NRC) in 1984, with members from academia, R&D institutions and industry to advise the government on science and technology.[7]

For a time, it looked like Indonesia could, with the right support, eclipse Malaysia and Singapore in scientific capacity. But then financial disaster struck in the late 1990s, and all of Asia's stock exchanges went into meltdown. Indonesia was the hardest hit, and the slowest to recover. While economic indicators have changed considerably in the past decade, some social indicators such as life expectancy have improved only marginally (see table 1.2). In 1999, a staggering 82% of the population was living on US$2 a day or less, and in 2010, that number has come down considerably but is still a massive 46%.[8] By contrast, in 2009 in Malaysia just 2% of the population lived at or below the US$2 poverty line, with this percentage being 5% in Thailand. Just over a decade and another global economic crisis later, and Indonesia's scientific promise has yet to be fulfilled.

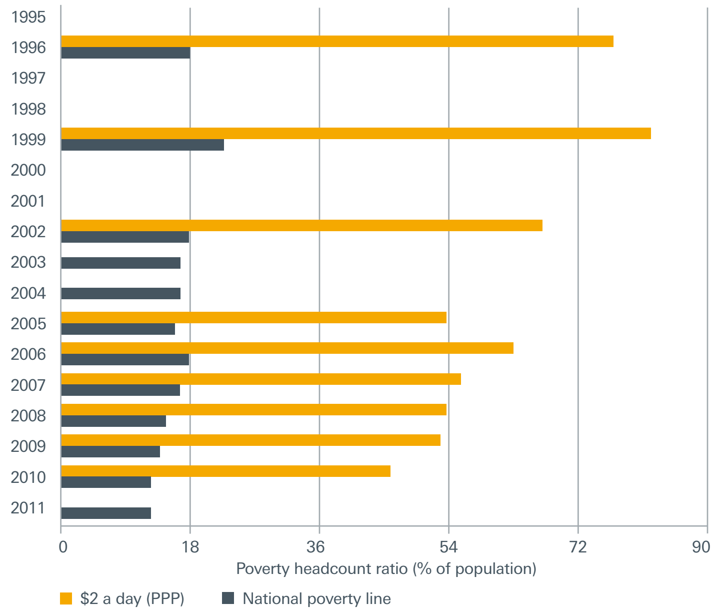
7 Krishna, V. V. (2006). *The republic of Indonesia,* UNESCO: Paris, France.

8 The World Bank (2014). *World Development Indicators,* The World Bank, Washington, DC, USA.

Table 1.2 Changes in economic and social indicators, 2000-2012[9]

Indicator	2000	2012
Human development index[10]	0.54	0.63
Life expectancy at birth, years	67.3	70.6
Adult literacy[11], female, %	86.8	89.7 (2010)
Adult literacy[12], male, %	94.0	95.6 (2010)
Population, millions	208	247
Population below the national poverty line, %	18.2 (2002)	12.0
GDP per capita, USD purchasing power parity	2,380	4,890
GDP per capita, USD	790	3,560
Average GDP per capita growth per year, %	4.9	6.2

Figure 1.1 Indonesians living on US$2 a day or less[13]



9 Data from the World Bank (2014) unless stated otherwise. World Development Indicators. The World Bank: Washington, DC, USA.

10 United Nations Development Program (2009). *The missing link: the province and its role in Indonesia's decentralisation.* UNDP,Jakarta, Indonesia.

11 UNESCO Institute of Statistics (2012) *Adult and Youth Literacy, 1990-2015,* UNESCO Institute of Statistics, Montreal, Canada.

12 UNESCO Institute of Statistics (2012) *Adult and Youth Literacy, 1990-2015,* UNESCO Institute of Statistics, Montreal, Canada.

13 Source: *World Bank: World Development Indicators (2012).* World Bank: Washington, DC, USA.

Box 1.1 Colonial ties: Indonesia and Netherlands

The history of science and technology in Indonesia can be traced back to the colonial era – when it was known as the Dutch East Indies prior to independence – at least in terms of the emergence of education and research.

Education during the colonial era was characterised by a lack of opportunities for Indonesians to access school and higher education, particularly in the Dutch system, in which only a few Indonesians were allowed to enrol. These included Indonesia's first President, Sukarno, who studied at the *Technische Hogeschool* (Technical Institute) in Bandung. In addition, a very small minority of Indonesia's national leaders have studied in the Netherlands, including the first Vice President, Muhammad Hatta, a graduate of the Rotterdam School of Commerce.

Perhaps mindful of the lack of opportunities, many of Indonesia's prominent figures in the early 20th century helped to establish schools for the Indonesian population. Many were primarily religious in nature such as Muhammadiyah, Indonesia's oldest Islamic organisation,[14] in Yogyakarta (Central Java) – created by KH. Ahmad Dahlan, the son of a popular religious teacher, in 1912.[15] The religious schools he established also taught some general knowledge, including the Dutch language.[16] More than 10,000 schools have since been established by Muhammadiyah at all levels from kindergarten to high school, as have 172 Universities, and 67 Islamic schools.[17] In 1917 Dahlan's wife, Siti Walidah or Nyai Ahmad Dahlan established the Islamic women's organization Aisyiyah, which has gone on to play a significant role in Indonesian women's education and social welfare.

A second school, Institut Talenta Indonesia was originally set up as Indonesische Nederland School (INS) in West Sumatra in 1926 by Mohammad Syafei, a close friend of former Vice President Hatta, who was also educated in the Netherlands.[18] Syafei was a keen believer in the role of education in empowering the nationalist movement and in overcoming Dutch rule, and INS was set up to revolve around three educational concepts: academic capacity, creativity and 'akhlaq' or good deeds.

During the colonial era, several research organisations were established by the government of the Dutch East Indies, many of which supported profitable Dutch plantation industries. One such institute is the Bogor Botanical Garden (BBG) – Indonesia's first – located in Bogor, West Java, established in 1817 by Casper Georg Carl Reinwardt, a German botanist originally based in Amsterdam, who became its first director under its original title of 'Lands

14 The Berkeley Center (2014). *Resources on Faith, Ethics and Public Life: Aisyiyah,* The Berkeley Center, Washington, DC, USA.

15 The Berkeley Center (2014). *Resources on Faith, Ethics and Public Life: Aisyiyah,* The Berkeley Center, Washington, DC, USA.

16 Source: Encyclopaedia Brittanica.

17 Muhammadiyah Organisation (2012) *Muhammadiyah profile,* Muhammadiyah, Jakarta, Indonesia.

18 The Indonesian Institute of Sciences, LIPI (2012)

Plantetuin'. Based on an 87 hectare site, the BBG became a centre for the promotion of agriculture and horticulture in the region, a training centre for specialists in tropical botany, and it was also used to introduce tropical plants from other parts of the world into the region. Today it has outstanding collections of palms, bamboos, cacti, orchids and ornamental trees.[19]

Another centre set up by the Dutch colonial authorities that survives today is the Indonesian Sugar Research Institute (P3GI-Pusat Penelitian Perkebunan Gula Indonesia) in Pasuruan, East Java.[20] Established as Het Proefstation Oost Java (or POJ) in 1887 to support the Dutch sugar industry, following the foundation of similar institutes in West and Central Java,[21] its original aims were to find new solutions to the problem of pest control, and to help compete with the rapidly expanding beet sugar industry elsewhere in Europe. Among its most notable early successes was the release of new varieties of sugar cane in the 1920s, which demonstrated increased yields and resistance to certain pests.

Other notable institutions set up under Dutch colonial rule include the Pasteur Institute in Bandung, West Java, which was established in 1895 to provide vaccines and serum to combat tropical diseases such as typhus, cholera, smallpox and paratyphus.[22] Since 1961 it has been trading as the state-owned company Bio Farma, the culmination of a biochemical research programme that began in the 1920s.

The APA (Algemeene Proefstation der AVROS/Algemene Vereniging voor Rubber Ordernemingen ter Oostkust van Sumatra), set up in 1916 in Sumatra, was the first research institute in the region to focus on rubber plantation, which expanded to undertake research on other plantation commodities such as tea and palm oil. It is now primarily focusing on palm oil, operating as the 'PPKS (Pusat Penelitian Kelapa Sawit or Palm Oil Research Center) in Medan.

After three centuries of colonisation by the Netherlands, Indonesia became an independent nation in 1945.[23] Like many previously colonised countries, Indonesia is still tied to its former coloniser, though that relationship can be uneasy at best and politically volatile at worst.

For instance, it was only in 2011 that the Hague Civil Court ruled that Indonesian victims of a 1947 massacre by the Dutch deserved compensation.[24] In 2010, President Yudhoyono was to have made the first presidential visit to the Netherlands since Suharto in the 1970s. He cancelled his visit at the last-minute when he was told that the Republic of the South Moluccas, a separatist movement in Indonesia, had asked a Dutch court to issue an arrest warrant

19 Botanic Gardens Conservation International (2012). *Our work,* BGCI, Bogor, Indonesia.

20 Indonesian Sugar Research Institute (2012). *About us,* P3GI, Pasuruan, Indonesia.)

21 Indonesian Planters Association for Research and Development (2012) See http://www.ipard.com (access date: Nov 1st 2012)

22 Bandung Heritage (2012). See http://www.bandungheritage.org (access date: Nov 1st 2012)

23 Central Intelligence Agency (2012). *The World Factbook: Indonesia,* CIA, Langley, VA, USA.I

24 Al Jazeera (2011). *Dutch state liable over Indonesia massacre, 9th December 2011,* Al Jazeera, Doha, Qatar.

against him because of human rights violations.[25] The Netherlands later said that Yudhoyono would have had full diplomatic immunity, but the visit was not rescheduled.

Despite these political difficulties, scientists within both countries are trying to forge strong links. In 1992, the Dutch Minister of Education, Culture and Science and the Indonesian Ministers of Research and Technology (RISTEK) and of Education signed a memorandum of understanding, which was renewed in 2002. Collaboration between these two countries is explored in more detail in section 7.[26]

Box 1.2 Spotlight: Professor B J Habibie – from science minister to president

Few names resonate as strongly with Indonesian scientists than former Indonesian President Professor Bacharuddin Jusuf Habibie. An engineer who trained and worked in Germany, Habibie developed a strong interest in electronics and aerodynamics, and is widely respected as a scientist.[27] Habibie was responsible for several advances in thermodynamics, engineering, and aerodynamics, such as the Habibie Factor, Habibie Theorem, and Habibie Method.[28] These made a significant contribution to aeroplane safety in a number of ways, including more accurately predicting the propensity of aircraft wings to crack, thus making aircraft maintenance easier, cheaper and safer; and enabling planes to withstand more air pressure and weight through a number of aerodynamic innovations.

Habibie, who aimed to transform Indonesia from a primarily agricultural economy to one based on technology,[29] was seen by many as the architect of the Indonesian aircraft industry. He was an advocate of the concept he referred to as "progressive manufacturing", which starts from the premise that the technology transfer cycle operates differently in developed and developing countries. In his formulation, the technology/product cycle in developed countries goes through four stages: research, development, design and production, in that order; whereas in developing countries, the stages run in the reverse order: production, design, development and research.[30] Habibie popularised the slogan "begin at the end and end at the beginning", which

25 Jakarta Globe (2010). *Netherlands regrets Indonesian President's postponed visit, 6th October 2010,* Jakarta Globe, Jakarta, Indonesia.

26 For more on Dutch-Indonesian scientific collaborations, see http://www.knaw.nl.

27 Rice R.C. (1997). *The Habibie approach. In Indonesia's technological challenge,* Hill H. & Kian Wie T. (eds), (ISEAS Publishing) 185-198.

28 Penang Monthly (2013). *B.J. Habibie: Leading a country in transition, 1st January 2013,* Penang Monthly, Penang, Malaysia.

29 BBC News (1998). *Profile: President B.J. Habibie, 21st May 1998,* BBC News, London, UK.

30 United Nations Economic and Social Commission for Asia (2007). *The Role of Technology Transfer Services in Technology Capacity Building and Enhancing the Competitiveness of SMEs,* UNESCAP-APCTT, New Delhi, India.

implied that firms on the receiving end of technology transfer should begin with production, and then move backwards to look at research.[31]

Habibie also drove Indonesia's foray into aerospace technology, playing a pivotal role in making it the only country in Southeast Asia to produce and develop its own aircraft, in addition to making aircraft components for Boeing and Airbus, with its state-owned aircraft company Indonesian Aerospace.[32]

Habibie's understanding of how basic science could link up with industry drove him to push for collaborations that led to Indonesia being the first developing country to have its own domestic satellite system. The series of satellites called Palapa were built in the 1970s for Indonesia's state-owned telecommunication company, Indosat. Projects such as these fitted with Suharto's goal to keep Indonesia united through communication. Habibie's fervour for applied science led him to set up the Agency for the Assessment and Application of Technology (BPPT) and Puspiptek Centre of Science and Technology Research, intended to be a hub for both public and private enterprise; both of these are discussed later in the report.

The quality that Habibie, who is now based in Bandung, is most remembered for is his forward thinking. His belief that Indonesia needed to carry out cutting-edge research if it wanted to compete globally, led him to revitalise the Eijkman institute in the early 1990s at a time when many scientists believed that the country simply did not have the capacity (see box 1.4). Nevertheless, Habibie has not been without his critics, not only for his associations with the Suharto regime;[33] he has also been accused of wasting resources on projects which did not make a return.[34]

There is much to be hopeful for, however. Indonesia's economy was largely sheltered from the 2008 economic meltdown, partly because domestic demand from its 247 million consumers, which accounts for about two thirds of its GDP,[35] cushioned the blow of reduced international demand for Indonesia's exports such as palm oil and coal.

It also has a smaller export-to-GDP ratio than neighbouring countries like Malaysia, making it less dependent on the health of the global economy. In August 2012, it announced a healthy 6.4% growth in its economy, and financial consultancy McKinsey predicts that by 2030, it could become the world's 7th largest economy.[36] Over the past decade, its GDP growth has been exceeded only

31 United Nations Economic and Social Commission for Asia. *An Overview of Technology Transfer and Technology Transfer Models,* UNESCAP-APCTT, New Delhi, India.

32 BBC News (1998). *Profile: President B.J. Habibie, 21st May 1998,* BBC, London, UK.

33 The Economist (1999). *Habibie loses more friends, 17th June 1999,* The Economist, London, UK.

34 BBC News (1998) *World Analysis - Indonesia: B.J. Habibie profile 20th February 1998,* BBC, London, UK.

35 Bland B (2013). Indonesia growth slips as China slowdown hits. Financial Times, 6 May 2013.

36 Oberman R., Dobbs, R., Budiman, A., Thompson, F., & Rossé, M. (2012). *The archipelago economy: unleashing Indonesia's potential,* McKinsey Global Institute, New York, NY, USA.

by China and India. It is a testament to Indonesia's ambition that in its National Economic Acceleration Development Masterplan (MP3EI), its target for GDP growth is 7-9%.[37]

Table 1.3 Indonesia's future potential?[38]

2012	2030
16th biggest economy	7th biggest economy
53% of urban-dwellers producing 74% of GDP	71% of urban-dwellers producing 86% of GDP
55 million skilled workers	113 million skilled workers needed
US$0.5 trillion market opportunity	US$1.8 trillion market opportunity

But financial experts advise Indonesia not to get too complacent, and warn that it is not totally immune from the continued economic turbulence around the world. The World Bank, for instance, warns that despite the economic bubble Indonesia inhabits because of its growing consumer market, the continued fall in prices for the country's main exports could seriously hamper its growth.[39]

1.2 Strategic plans

Indonesia's national medium-term development plan (RPJMN) runs from 2010 to 2014. This is guided by its national long-term plan, which runs from 2005 to 2025. Science and technology feature strongly in the medium-term plan, with a particular focus on food resilience, renewable energy, and environment and disaster management.[40]

1.2.1 Long-term goals

The national long-term development plan puts science and technology at the heart of its drive for economic growth, through seven key focus areas:[41]

Food security

- Expanding agricultural capacity
- Reducing yield loss
- Increasing the welfare of farmers and rural communities
- Enhancing nutrition and food diversity
- Devising a food production system that is responsive to climate change

37 Coordinating Ministry For Economic Affairs, (2011). *Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011 - 2025.* Coordinating Ministry For Economic Affairs, Jakarta, Indonesia.

38 Oberman R et al (2012). The archipelago economy: unleashing Indonesia's potential. McKinsey & Company: London, UK.

39 The World Bank (2012). *Indonesia Economic Quarterly: Rising to present and future challenges, 12th July 2012,* The World Bank,Washington, DC, USA.

40 Indonesian National Development Planning Agency (2010). *The National Medium-Term Development Plan (RPJMN) 2010 – 2014.* BAPPENAS, Jakarta, Indonesia.

41 Information provided by the Indonesian Institute of Sciences (June 2012). LIPI, Jakarta, Indonesia.

Various research initiatives are under way in Indonesia in the area of food security, with efforts ongoing to integrate and unify the research being carried out by organisations such as LIPI, BATAN and BPPT. These have led to the development of food-specific 'roadmaps' in specific food areas such as rice, maize, sorghum and soybeans; a focus on other commodities such as wheat, salt, cattle and fish flour; and mapping of the science and technology development needs required in order to effect a policy of import substitution.[42]

Energy

- Mapping potential sources of renewable energy such as solar, wind, geothermal or biofuels
- Development of technology
- Improving efficiency of energy use

A number of new power plants which deploy various renewable energy technologies have recently been built in Indonesia, including hybrid plants in Cipularang, Rote Ndao and North Central Timor which mix solar and wind; trials on wind-powered generators in Yogyakarta; and the utilization of "microhydro", a type of hydroelectric power, in Ciajur regency. A geothermal plant is about to begin construction in Kamojang, and further projects are being planned elsewhere in the areas of biofuels and nuclear energy.

Transport

- Development of transport infrastructure technology to support capacity of domestic industry
- Creating an environmentally friendly urban transport system

A collaborative research effort between Lembaga Pemerintah Non Kementerian (LPNK, a non-departmental government institution), PT Len (a state-owned electronics company) and the Ministry of Transportation has focused on the development of computer-based interlocking, an electronic system of rail signaling which is designed to replace older mechanical technologies, in an effort to increase Indonesia's self reliance in this area and to negate the need for imports, and to provide a successful model of collaboration between government, research institutions and industry to meet the needs of the market. If field trials are successful, further research will be directed towards implementing a prototype of the technology.

42 Information provided by the Indonesian Institute of Sciences (June 2012). LIPI, Jakarta, Indonesia.

Information and communication technology

- Boosting ICT infrastructure
- Development of open-source ICT frameworks
- ICT human-resource development

Government administration and services will become increasingly electronic to improve efficiency and transparency.

The development of Indonesia's ICT infrastructure has involved, among other things, the preparation of a 'Grand Design Population Administration System' in order to enable more strategic analysis of population data, as well as support for animation software developers and other creative software collaborations. It has also involved the widespread adoption of legal software for government agencies, many of which were working from unauthorised software packages[43]; this migration has so far taken place in a number of provincial and local governments.

Defence and security technology

- Research on technology to support military movement
- Combat, logistics, and technology to support command, control, communications, surveillance and espionage

Indonesia's increasing financial commitment to defence – as demonstrated by a target to increase defence spending to 1.5% of GDP by 2014[44] – is providing ample opportunities for research in this area. One recent innovation is ISRA (Indonesia Sea Radar) – a coastal surveillance radar to monitor the waters that constitute 75% of Indonesia's territory,[45] with a view to preventing the smuggling of illegal goods, to which it is particularly vulnerable. This radar emits at a low frequency, making it difficult to detect and less likely to interfere with other radar systems; furthermore, it also works in stormy and dark weather which enables it to help ships avoid reefs in a storm.

Health

- Reveloping medical devices to reduce the dependency on imports
- Developing the integration of traditional medicines into conventional healthcare
- Boosting the capacity to develop new drugs and vaccines
- Increasing nutritional research to improve child health

A five year National Research Agenda (Agenda Riset Nasional 2010-2014[46]) on health and medicine, covering the period 2010-2014 and encompassing a wide variety of stakeholders, prioritises six general research areas. These are:

43 Information provided by the Indonesian Institute of Sciences, LIPI (2012). LIPI, Jakarta, Indonesia.

44 Jane's Information Group (2012). *IHS Jane's Sentinel Security Assessment: Indonesia,* Jane's, London, UK.

45 Indonesian Maritime Security Coordinating Board (2011). *Radar ISRA " Sea Patrol", 15th November 2011,* IMSCB, Jakarta, Indonesia.

46 Ministry of State for Research and Technology (2010). Agenda Riset Nasional 2010-2014,110-118, RISTEK, Jakarta, Indonesia.

- Societal nutrition
- Increasing the availability of medicine and utilising aspects of Indonesian traditional medicine
- Controlling infectious diseases and deadly non-infectious diseases
- Increasing health promotion and encouraging healthy and clean behavior
- Improving the quality of basic health facilities

One notable collaboration between various stakeholders– including a research consortium and the Eijkman institute – with the Ministry of Research and Technology and the national police, has seen the increased roll-out of DNA fingerprinting to solve various criminal cases.

Advanced material

- Advanced processing techniques for mining and agricultural materials, such as biomaterials and natural resource-based polymers
- Manufacturing of magnets, ceramics, glasses, composite materials, mineral, nanomaterials, metals and metal alloys

Nanotechnology has proved to be something of an emerging growth area for Indonesian research in the last decade or so.[47] Among its more notable developments include the pioneering of a high-energy milling technique for nanomaterials by Dr Nurul Taufiqu Rohman, a researcher at LIPI who is also Chair of the Indonesian Society for Nanotechnology. This process is performed by a grinding machine manufactured by an Indonesian firm, PT.Nanotech Indonesia, which only uses 12% of the energy used by the technology previously in widespread use. It has since been followed by the emergence of other products utilising cutting edge nanoscience, in areas as diverse as cosmetics, fertilizers, polymers, and food supplements.

Other applications have included the recent development of a prototype technology by the Bandung Institute of Technology (ITB), which uses nanotechnology-based membrane systems for the treatment of drinking water, without recourse to electricity.

In recent years, BPPT and LIPI have worked on projects relating to the solar cell industry in their labs, namely through the production of ingots into polycrystalline silicon wafers. BPPT is also working on developing materials for hydrogen storage and materials for the components of fuel cells.

47 Asia Pacific Nanotech Weekly (2005). *Indonesia Nanotechnology Current Status, Vol 3,* Nanotechnology Research Institute AIST, Tsukuba, Japan.

1.2.2 Economic masterplan

In addition to the existing strategies, in 2011, Indonesia launched the Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011 – 2025 (MP3EI)[48] to help push Indonesia's long-term vision until 2025. Strengthening national human resources capacity in science and technology is one of three pillars of MP3EI, the other two being creating economic "corridors" to connect the economic output of the different regions of Indonesia, and to strengthen national connectivity. According to the MP3EI, the six corridors will specialize in different areas. Sumatra for natural resources and energy; Java for national industry and service provision; Kalimantan for mining and energy; Sulawesi for agriculture, fisheries, oil and gas, and mining; Bali for tourism and national food support; and Papua-Kepulauan Maluku for food, fisheries, energy and mining.

Figure 1.2 MP3EI six economic corridors[49]

48 Coordinating Ministry For Economic Affairs (2011). *Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011 – 2025,* Coordinating Ministry For Economic Affairs, Jakarta, Indonesia

49 Coordinating Ministry For Economic Affairs (2011). *Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011 – 2025,* Coordinating Ministry For Economic Affairs, Jakarta, Indonesia

1.2.3 Core research areas

Indonesia's research strengths derive from its natural resources, and its R&D output and collaboration with other countries is heavily weighted towards agriculture, energy and the environment. Currently, however, the research it undertakes is still not advanced enough to compete on any significant scale globally. These areas cover urgent, technology-driven global priorities such as developing clean energy from renewable sources, and improved crop nutrition through agricultural genomic technologies, yet the country is seriously lagging behind, producing few well-cited papers or significant advances in these fields.[50]

1.2.4 Innovation and economic growth

Promoting innovation is a crucial part of using science and technology to drive the economy. To support innovation, the National Innovation Committee (KIN), an autonomous body consisting of 30 members, was established in 2010 to report directly to the President, led by former Minister of Research and Technology Dr Zuhal Abdul Kadir.[51] The committee was charged with devising a national innovation system by providing bold recommendations on innovation policy; enhancing intersectoral collaborations among innovation stakeholders; and monitoring the implementations of government innovation policies.

One of these key innovation policies was devised as part of MP3EI. In 2011, President Yudhoyono laid out the Innovation Initiative 1-747 (Table 1.4), in which 1% of GDP is allocated to R&D for seven steps to enhance innovation, aimed at driving economic growth in four areas, to fulfil the seven goals of Indonesia's Vision 2025. The KIN is key in advising this presidential initiative.

However, there are no clear plans as to how these goals can be achieved, in particular the target to increase expenditure on research to 1% of GDP by 2014, from the current figure of 0.08%. This will require a significant commitment from government – both financial and in terms of an increased recognition of the importance of science and technology in the country's development – which may be difficult to effect in a very short space of time.

50 Silberglitt, R. et.al., (2006). *The Global Technology revolution 2020, In-depth Analyses; Bio/Nano/Material/Information Trends, Drivers, Barriers, and Social Implication,* RAND Corporation, Santa Monica, CA, USA.

51 Komite Inovasi Nasional (National Innovation Committee) website: http://kin.go.id.

Table 1.4 Presidential Innovation Initiative 1-747[52]

1% of GDP	7 steps for innovation	4 areas to speed up economic growth	7 goals of Indonesia's Vision 2025
• Spend 1% of GDP on R&D • Encourage industry to invest in R&D	• Create incentive and regulation system to support innovation and use of domestic products • Improve human resources • Set up innovation centers to support small and medium enterprises • Develop regional innovation clusters • Improve pay for researchers • Develop R&D infrastructure • Create research funding system to support innovation	• Basic industries (food, medicine, energy and water supply) • Creative industry (culture and ICT) • science and technology and industrial parks • Strategic industry (defense, transportation)	• Increase scientists' intellectual property rights for research that affects growth • Improve infrastructure of science and technology parks to global standards • Achieve self-sufficiency in food, medicine, energy, clean water • Double the export for creative industries • Improve industrial value from all regions • Achieve self-sufficiency in products and systems for defence, transport, and ICTs • Achieve sustainable economic growth and equitable prosperity

The establishment of KIN was arguably a natural step in a process that had already included the adoption of a concept of a National Innovation System (NIS) by the Ministry of Research and Technology as a framework for innovation policy development at the National Science and Technology Coordinating Meeting of 2008 in Palembang. However, while a commitment has been made to this model in principle, there is little evidence of a coherent, integrated approach to innovation policy across industry, education and science policy, as such a framework might suggest. The signs are, on the basis of interviews conducted for this report, that the NIS framework, while much discussed in the science policy community, is yet to become conceptually embedded within industry or education in a major way.

52 Coordinating Ministry For Economic Affairs (2011). *Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011 – 2025,* Coordinating Ministry For Economic Affairs, Jakarta, Indonesia

Meanwhile, an examination of the current status of the Indonesian innovation system shows it to be a weak performer on a number of indicators. These include a low number of publications in international scientific journals, few patents granted either in foreign markets such as the US Patent and Trademark Office (USPTO) or in the domestic market by comparison with foreign markets, and a manufacturing export industry largely dominated by medium and low tech products.

1.3 The key players

The key stakeholders in Indonesia's STI system are mostly governmental. Private industry invests very little in R&D and there is very little collaboration between the public and private sectors.

The Ministry of Research and Technology (RISTEK) leads science and technology policy in Indonesia through seven R&D agencies: the Indonesian Institute of Sciences (LIPI); the Agency for the Assessment and Application of Technology (BPPT); the National Institute of Aeronautics and Space (LAPAN); the National Coordinating Agency of Survey and Mapping (BAKOSURTANAL); the National Standardization Agency (BSN); the National Nuclear Energy Agency (BATAN); and the National Nuclear Energy Control Board (BAPATEN). Two other key government institutions are the Eijkman Institute for Molecular Biology (box 1.4) and the Center of Meteorology, Climatology and Geophysics (BMKG). For the structure of Indonesia's science and technology system, see Appendix 1.

1.3.1 Ministry of Research and Technology (RISTEK)

The Ministry of State for Research and Technology (RISTEK) was established in 1962 to help the president formulate and implement national policies on STI research. The minister is assisted by five deputies who assist in executing different aspects of science and technology policy. The ministry works in six focus areas: food and agriculture; energy; transportation; ICTs; health and pharmaceuticals; and defence. Appendix 3 shows RISTEK's organizational chart.

The ministry oversees Indonesia's bilateral science and technology cooperation with more than 10 countries, including Germany, the Netherlands, China, South Africa, Australia, Italy, Iran, Austria, Hungary, and multilateral collaborations with ASEAN countries. The Association of Southeast Asian Nations (ASEAN) comprises Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam.

In 2011, RISTEK's budget was US$73 million, while government R&D centres received US$480 million.[53]

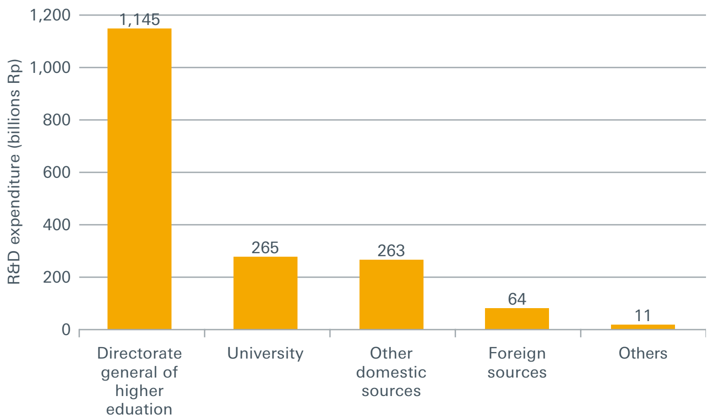
53 Data from RISTEK (2012).

1.3.2 Ministry of National Education

The Ministry of National Education holds a crucial role in Indonesia's science and technology system. The ministry already has a significant status in government because the country highly prioritises the improvement of education. In addition it is, through its Directorate General of Higher Education (DIKTI), responsible for allocating a significant portion of the government's R&D budget, and is therefore a major player in the country's R&D system. Within that system, the education ministry receives over one and a half times more funding from government spending on R&D than the science and technology ministry.[54]

For one thing, through universities, Figure 1.2 shows that the education sector controls more researchers than government institutions or the manufacturing industry.[55] Meanwhile, Figure 1.3 shows that even when university scientists' time spent teaching and on community service is taken into account, there is a greater research capacity there than in the other two sectors (government institutions and the private sector).[56]

Figure 1.3 University R&D expenditure by source[57]



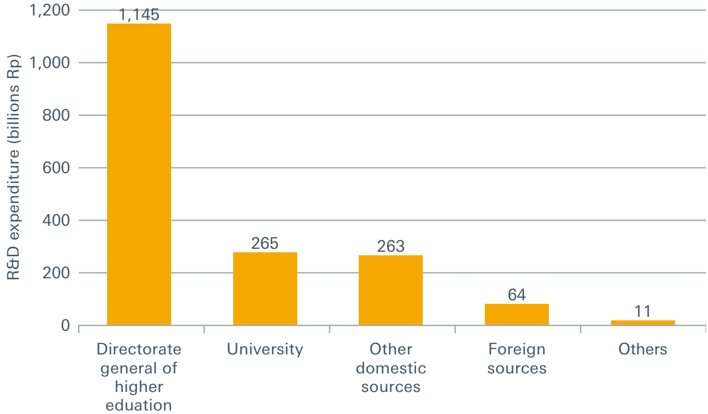
54 Ministry of Finance, Indonesia, 2007-2010 (data provided via LIPI).

55 Simamora, N.G., (2011). *Indonesian Science and Technology Indicators,* Country report presented at the 2011 South East Asian Regional Workshop On Science, Technology, and Innovation Indicators, Hanoi, Vietnam, December 2011. Indonesian Institute for Sciences (LIPI), Jakarta, Indonesia.

56 Simamora, N.G., (2011). *Indonesian Science and Technology Indicators,* Country report presented at the 2011 South East Asian Regional Workshop On Science, Technology, and Innovation Indicators, Hanoi, Vietnam, December 2011. Indonesian Institute for Sciences (LIPI), Jakarta, Indonesia.

57 Pappiptek-LIPI (2010). *R&D Survey in Public University Sector 2010.* Pappiptek-LIPI: Jakarta, Indonesia. Researchers in universities spend a third of their time on research, so their full-time equivalent (FTE) is measured as 0.33; based on a government survey, researchers in government institutions are 0.56 FTE.

Figure 1.4 Researcher headcount by sector, 2009[58]



1.3.3 Indonesian Institute of Sciences (LIPI)

Established in 1967, LIPI's main responsibility is to promote innovation in the service of Indonesia's economic competitiveness. In addition, LIPI assists RISTEK in the formulation of policy and is responsible for reviewing Indonesia's science policies. It also guides other government research institutions in their activities. LIPI undertakes substantial basic research and publishes more scientific papers than any of the other major government research institutions.[59] It has 47 research centres all over the country, focusing on topics as varied as oceanography, economics and engineering. LIPI also runs several online portals that support the dissemination and archiving of science and technology knowledge, such as the Indonesian Scientific Knowledge Center or PDII-LIPI – the only ISSN national center for Indonesia,[60] an electronic registration system for the various scientific competitions organised by LIPI,[61] an electronic registration system for national scientific journals, an e-library,[62] and several other scientific information portals and tools.[63]

1.3.4 Indonesian Academy of Science (AIPI)

The Indonesian Academy of Sciences was established in 1990 as an independent body to advise and guide the government and society on the development and application of science and technology. It currently has 51 members organised into five Commissions: Basic Sciences, Medical Sciences, Engineering Sciences, Social Sciences, and Art and Culture. AIPI organises scientific conferences and policy discussion forums to try to broker national and international scientific relations.[64]

58 Pappiptek-LIPI (2010). *R&D Survey in Public University Sector 2010.* Pappiptek-LIPI: Jakarta, Indonesia.

59 Indonesian Institute of Sciences, LIPI (2011). *Study on the status of science and technology development in Indonesia,* LIPI, Jakarta, Indonesia

60 See http://issn.lipi.go.id/ (accessed: 1 May 2014)

61 See http://kompetisi.lipi.go.id/ (accessed: 1 May 2014)

62 See http://www.pdii.lipi.go.id/ (accessed: 1 May 2014)

63 See http://www.arsip.lipi.go.id/ (accessed: 1 May 2014)

64 See http://www.aipi.or.id

1.3.5 National Research Council of Indonesia (DRN)

This is a small unit within RISTEK that was initiated by Dr BJ Habibie to report directly to the President. It was intended to be an independent entity, offering oversight on science and technology activities separate to RISTEK, but its purview and funding has been steadily eroded.[65] While the unit is not a research funder, it has a miniscule budget – less than 1% of LIPI's – and its reporting has been changed to RISTEK rather than directly to the President. It is advised by a mix of government ministers, researchers, academics, business people and the media, but government bureaucrats dominate.

1.3.6 The Agency for the Assessment and Application of Technology (BPPT)

BPPT, set up in 1978 by Professor Habibie, has an important role in formulating policies on the application of technology, particularly focusing on innovation, capacity-development, and technology transfer.[66] The organisation is also intended to act as a link between industry and the private sector, both domestically and overseas, in the application of technology. Some of its programmes include developing solar energy capacity in remote areas, product technology in engineering and energy, and devising an integrated technology management system, although it suffers from a lack of connection to private-sector investors or companies.

Box 1.4: Spotlight: The Eijkman Institute, cutting-edge research in Indonesia

The crisp white building that houses the Eijkman Institute of Molecular Biology reveals its Dutch colonial origins. The building's interior, with its glossy wood balustrades and chandeliers, has been carefully preserved as a piece of national heritage despite a major refurbishment, and Indonesia's colonial history coexists alongside high-end, almost futuristic, research.

Set up in 1888 as the Research Laboratory for Pathology and Bacteriology by Dutch Nobel-prize winning scientist Christian Eijkman, it is using modern DNA technologies to work on projects as varied as preventing human trafficking and locating missing children to tracking endangered wildlife. It collaborates frequently, particularly on infectious diseases, with international institutions such as Monash University in Australia and the University of Oxford in the UK.[67]

65 Oey-Gardiner M., et. al., (2011). *In search of an identity for the DRN,* AusAID, Canberra, Australia.

66 See http://www.bppt.go.id

67 Oxford University Clinical Research Unit. For more information see http://www.oucru.org.

The Eijkman Institute's accomplishments are even more remarkable considering its chequered history. It actually shut its doors for three decades after political turmoil in the 1960s made it difficult to run. It was only on Professor Habibie's appointment as Minister of Research and Technology, and his repatriation of Professor Sangkot Marzuki, now President of the Indonesian Academy of Sciences, from a tenured professorship in Australia to be its new Director, that the institute was re-opened in 1992. Battling through the Asian financial crisis, it struggled to convince policymakers and ministers that pursuing core basic research in areas such as genomics was worthwhile to a country that was often unable to provide basic healthcare to its people.

In 2004, however, its fortunes changed for good when its DNA profiling database helped identify the bomber who attacked the Australian embassy in Jakarta on 9 September. "Our funding almost tripled," says Professor Marzuki, as the government invested in developing forensic facilities and buying advanced molecular biology equipment. This win for Eijkman helped prove the value of the applied, results-driven research resulting from long-term basic science projects, says Professor Herawati Sudoyo, Deputy Director of the institute. "We don't produce vaccines or diagnostics, but we do produce key knowledge"

1.3.7 Industry

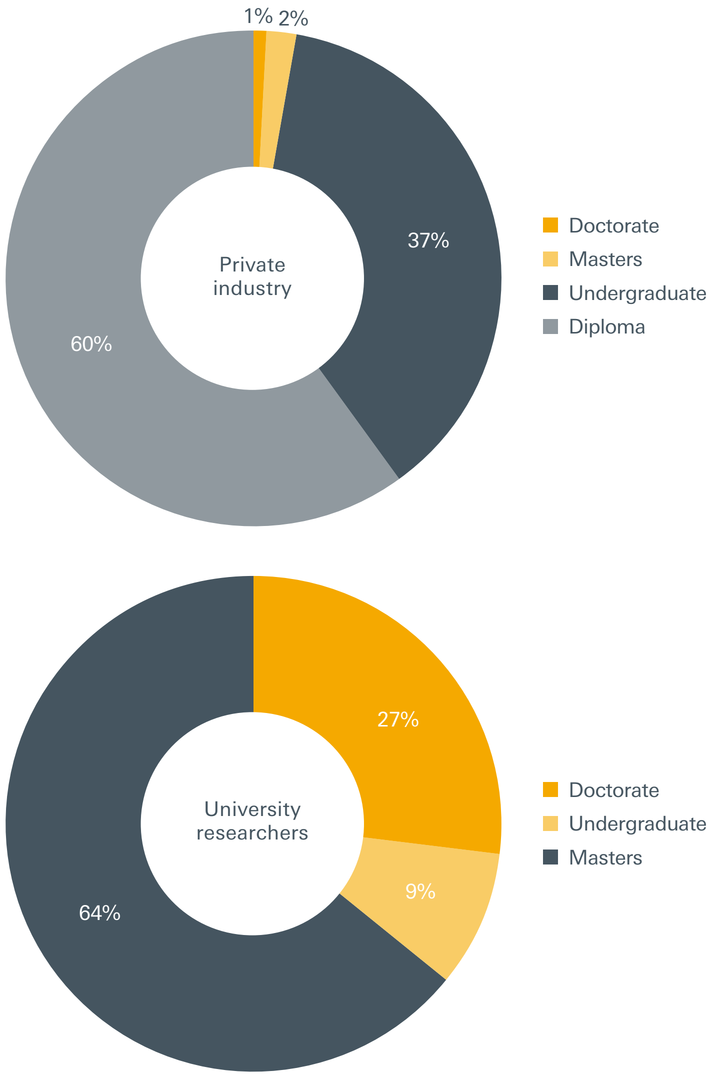
In terms of R&D, private industry plays a very small role. Few companies invest in R&D and those that do tend to be multinationals that simply have a base of operations in Indonesia. A mere 3.7% of GERD in Indonesia is done by business,[68] compared with 84.9% in Malaysia, 68% in the Philippines, 66.8% in Singapore, or 40.9% in Thailand.[69] It is also striking that most R&D personnel in industry are educated to a basic diploma level, where in universities, 27% of researchers have a PhD.[70] Industry investment in R&D (or rather the lack of) is explored further in section 4.

68 This figure is based on partial data from the UNESCO Science Report (2010). RISTEK claims the complete figure is 18.7%. See United Nations Educational, Scientific and Cultural Organization (2010). *UNESCO science report 2010: the current status of science around the world.* UNESCO, Paris, France.

69 United Nations Educational, Scientific and Cultural Organization (2010). *UNESCO science report 2010: the current status of science around the world.* UNESCO, Paris, France.

70 Indonesian Institute of Sciences, LIPI (2011). Study on the status of science and technology development in Indonesia. LIPI, Jakarta, Indonesia.

Figure 1.5 Researcher headcount by degree of education in different sectors[71]



71 Pappiptek-LIPI (2010). *R&D activities survey in manufacturing industry 2010.* Pappiptek-LIPI: Jakarta, Indonesia.

1.4 A nation of producers

While Indonesia produces a lot of raw materials, it lacks the capacity to process these materials domestically, and tends to export them heavily. In May 2012, the country announced a 20% tax on the export of raw metals such as tin, copper, gold and zinc, following similar taxes on the export of cocoa beans and palm oil. The aim is to drive down exports, ultimately banning the export of 14 key raw metals by 2014, in a bid to drive domestic processing.[72] Such a ban by 2014 is, as typical, unrealistic. Such obviously non-attainable goals make a mockery of planning efforts and seem not to be taken seriously.

Indonesia could shift the content of its exports so that it exports higher value goods. For example, if it advanced its agricultural techniques enough to produce crops with much higher yields, it could become a large net exporter of agriculture products, supplying more than 130 million tons to the international market.[73]

1.5 Applied vs basic research

Indonesia has increasingly favoured investing in applied research to the detriment of basic research, in the view of many scientists interviewed for this report. Underlying this bias is the drive towards short-term economic prosperity, as applied research is perceived to lead more immediately to products that can be commercialised.

This shift can be seen in Figure 1.6 that shows how the proportion of basic research proposals granted by RISTEK have dropped dramatically from 2007, to be overshadowed almost entirely by applied research in 2012.[74] This is the reason that "Indonesia is lacking in developing science based research," says Triarko Nurlambang, lecturer and Vice Dean for the Faculty of Mathematics and Natural Sciences, University of Indonesia for the past 22 years. "An indication of this situation is clearly shown at the university level, where few students are interested in studying basic or pure science such as mathematics, physics, chemistry, and biology."

However, researchers interviewed argue that the country needs a strong foundation of basic research to produce robust applied research; Indonesia is trying, and failing, to leapfrog this essential step in the development of a science and technology system. This means that applied research is often done without the expertise, innovation, or resources to make it really successful.

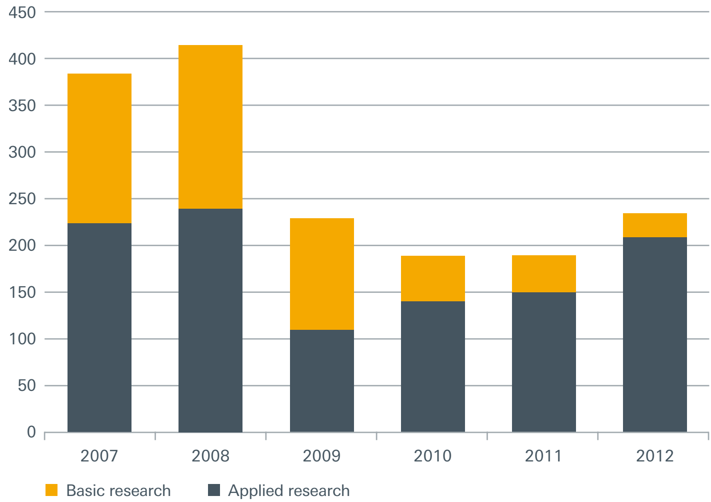
72 Jensen F. & Chatterjee N. (2012) *Indonesia to impose tax, curbs on raw metal exports, 12th May 2012,* Reuters, London, UK.

73 Oberman R., Dobbs, R., Budiman, A., Thompson, F., & Rossé M. (2012). *The archipelago economy: unleashing Indonesia's potential,* McKinsey Global Institute, New York, NY, USA.

74 Pappiptek-LIPI (2010). *R&D Survey in Public University Sector 2010.* The data referred to here and in Figures 1.7 and 1.8 are derived from survey data in which respondents were asked to define their research as per the definitions of the OECD's Frascati Manual (2002). This defines basic research as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view". Applied research is defined as "also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarly towards a specific practical aim or objective". Pappiptek-LIPI: Jakarta, Indonesia.

Figure 1.7 shows that the majority of research spending in universities is on applied research. Yet universities have extremely poor systems for commercialising research, both in terms of patents and industry collaborations.[75]

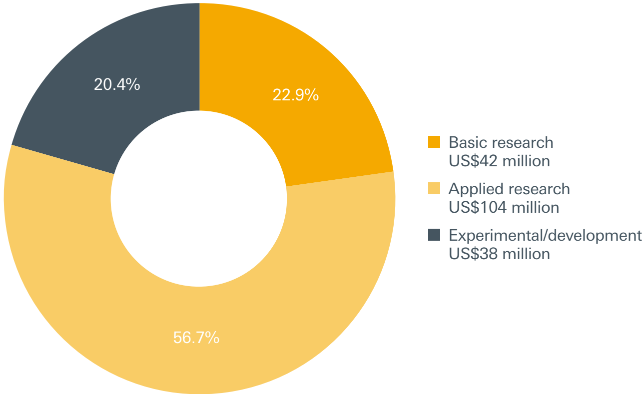
Figure 1.6 Numbers of approved research proposals: basic vs applied[76]



75 Dhewanto W. & Khamdan U.K., (2009). *Technology Commercialisation in a Developing Country: Current Condition and Its Challenge in Indonesia,* The Asian Journal of Technology Management, Vol. 2 1-7.

76 Pappiptek-LIPI (2010). *R&D Survey in Public University Sector 2010.* The data referred to here and in Figures 1.7 and 1.8 are derived from survey data in which respondents were asked to define their research as per the definitions of the OECD's Frascati Manual (2002). This defines basic research as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view". Applied research is defined as "also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarly towards a specific practical aim or objective". Pappiptek-LIPI: Jakarta, Indonesia.

Figure 1.7 University research spending, 2009[77]



1.6 Inputs to the STI system

1.6.1 Human capital

Table 1.5 Profile of Indonesia's STI human capital[78]

Type of R&D Personnel	Manufacturing Industry Sector	Government Sector	Higher Education Sector*	Total
Researchers	7,588	11,114	22,228	40,930
Technicians	2,135	7,572	1,484	11,191
Other Supporting Staff	1,144	8,575	1,334	11,053
Total	10,867	27,261	25,046	63,174

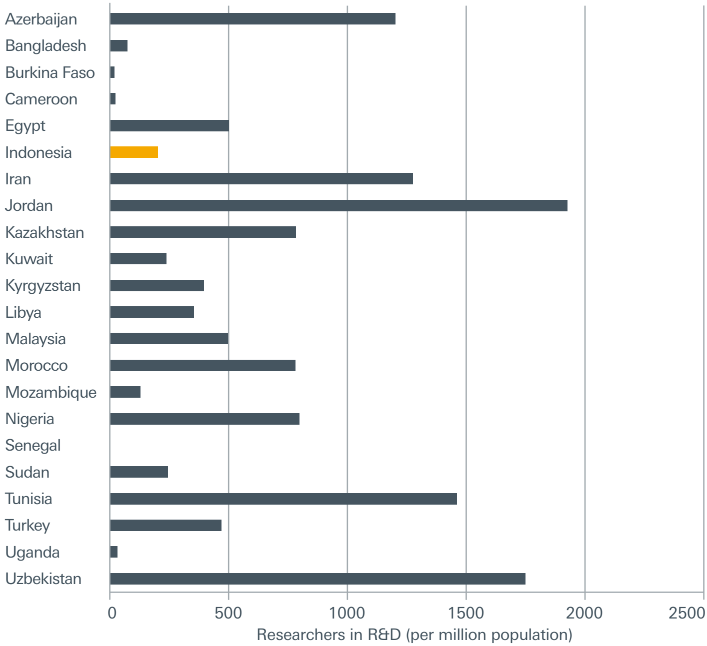
*State universities

77 Pappiptek-LIPI (2010). *R&D Survey in Public University Sector 2010.* Pappiptek-LIPI: Jakarta, Indonesia.

78 Source: Data from Pappiptek-LIPI.

Indonesia only has just over 40,000 researchers, most of whom are employed in the higher education sector (see Table 1.5).[79] But this figure does not mean that there are 40,000 researchers working full time. The nature of university research (in which teaching and community work take two-thirds of scientists' time) and administrative responsibilities in government, means that the capacity is even lower. Estimates from LIPI suggest that the full-time equivalent in 2009 was actually 21,147.[80] This fits with the UNESCO estimate for the same year of 21,275.[81]

Figure 1.8 How Indonesia compares with OIC member states: R&D researchers[82]



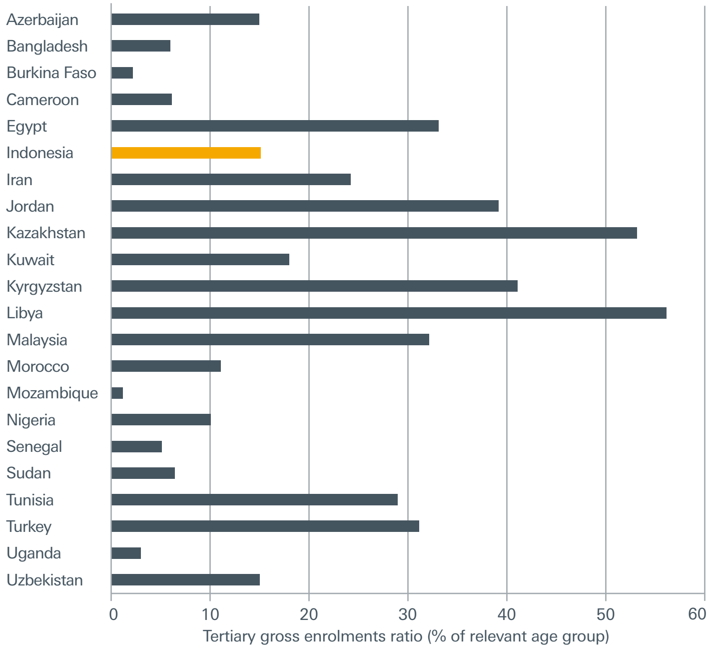
79 Indonesian Institute of Sciences (LIPI) 2011. Study on the status science and technology development in Indonesia. LIPI, Jakarta

80 Simamora, N.G., (2011). *Indonesian Science and Technology Indicators,* Country report presented at the 2011 South East Asian Regional Workshop On Science, Technology, and Innovation Indicators, Hanoi, Vietnam, December 2011. Indonesian Institute for Sciences (LIPI), Jakarta, Indonesia.

81 Unesco Institute of Statistics

82 Naim S.T. and Atta-ur-Rahman (2009). *Mapping scientific research in member states of the Organization of Islamic Conference (OIC),* UNESCO Forum on Higher Education, Research and Knowledge, Occasional Paper 17. Data are from different years ranging from 2002 to 2009. The most recent figure is used for each country.

Figure 1.9 How Indonesia compares with OIC member states: tertiary gross enrolments ratio[83]



1.6.2. Unrewarded researchers

Around a crowded table at the Bandung Institute of Technology (ITB), researcher Bob Situmorang says "I work in science because I love my country and want to it to succeed." This sentiment of national pride, and of wanting to remain working as a researcher in Indonesia despite the many challenges, is a common one. It is also distinctive to Indonesia in many ways, as fewer UK or US researchers seem likely to cite the national good as a reason for why they are in science. Most Indonesian scientists interviewed, however, said that a key reason for becoming a researcher was that they felt they were working towards a greater good.

Yet Indonesia's STI system would challenge even the most dedicated scientists. A country's reward systems for its researchers tends to be a good proxy for how well its STI system is doing, and Indonesia's system is made up of researchers who are, for the most part, struggling to stay in their jobs.

83 Naim S.T. and Atta-ur-Rahman (2009). *Mapping scientific research in member states of the Organization of Islamic Conference (OIC),* UNESCO Forum on Higher Education, Research and Knowledge, Occasional Paper 17. Data are from different years ranging from 2002 to 2009. The most recent figure is used for each country.

While RISTEK is taking measures to try to improve researchers' salaries, most government institutions offer poor pay and an average scientist's salary in a government institution can be as low as US$500 per month.[84] Universities pay marginally better, but even so, it can be difficult to manage.

One university researcher interviewed said, only half jokingly, that his "monthly salary just about pays for his cellphone bill". Another said that when he compared his take-home pay as lecturer and researcher at the university to the market price of what he might be paid in a non-governmental research institution, his take-home pay is only one-fifth of his 'market price'.[85]

A typical researcher's take-home pay includes basic salary, a salary for time spent on a research project, expenses for meals, and other benefits such as health insurance. The average monthly salary in the public sector works out at about 5 to 7 million rupiah (approximately US$500-750),[86] with the specific rate depending on the researcher's seniority. To this can be added other honoraria such as per diems for field research or other academic activities, such as presenting at a seminar or editing/reviewing, but this does mean that academics often have to take on extra work over and above their day job to reach a more reasonable standard of living. Lecturers in public universities, such as the University of Indonesia,[87] can expect to earn between IDR7-18m (approx US$700-1,800),[88] while academics whose main activity is research can expect to earn between IRD18-30m (up to just over US$3k per month),[89] the latter figure having recently been raised following a 2012 review.

Except for the highest ranking academics, the contrast with what one could expect to earn in the private sector is significant. For example, an HR manager with 5-10 years experience could expect to earn IDR15-25m (approx US$1.5-2.6k), and an IT project manager at a similar level around IDR10-18m (approx US$1-2k)[90]. Some action has been taken to improve researchers' pay, such as a provision to include performance based incentives for R&D employees which was due to take effect from January 2013, and an August 2012 Presidential Directive aimed at increasing researchers' salaries overall.[91]

What this means is that most scientists also have what is known informally in the local scientific community as "side jobs", usually consultancies, to supplement their income. This is not uncommon in science, and researchers around the world often take consultancies on, perhaps advising government or industry on specific issues. But in countries like the US and UK, these engagements are closely scrutinised so that they don't conflict either in time commitments or in areas of study with the researchers' paid position. In Indonesia, however, researchers may take on so much extra work that it seriously compromises their main job.

84 Interviews with staff at LIPI.

85 As told by a science lecturer and researcher at the University of Indonesia.

86 Authors' calculations based on rates at http://www.xe.com, 6th November 2012.

87 Bisnis Jabar (2011). *Menristek usulkan tunjangan peneliti Rp7,5 juta, 27th October 2011,* Bisnis Jabar, Jakarta, Indonesia.x (access date: Nov 2nd 2012)

88 Authors' calculations based on rates at http://www.xe.com, 6th November 2012.

89 Authors' calculations based on rates at http://www.xe.com, 6th November 2012.

90 Kelly Services (2011). *Employment Outlook and Salary Guide 2011/12 – Indonesia,* Kelly Services, Jakarta, Indonesia.

91 For more details please see http://www.setkab.go.id

This assertion may rely on anecdotal evidence, and is not one that can be backed up by documented evidence, precisely because of its informal nature, but it is a theme that emerged repeatedly in interviews with scientists. One senior government researcher admits that at one point in his career, he took on a two-day a week job in one institution when he was already employed full-time by another. This meant that he only worked three-fifths of the time he was being paid for, which clearly compromised his effectiveness in the role, but his supervisor agreed to it because it was the only way to make a decent living. “It’s not ideal, but when you have children to feed, clothe and send to school, most managers turn a blind eye,” said the researcher, who asked to remain anonymous.

This is not the only situation in which institutions agree to look the other way. Complex and unclear regulations on patents and industry links mean that setting up collaborations between universities or government institutions and industry are almost impossible. Often, researchers are not allowed to profit from patent royalties themselves.

This means that when researchers have research ideas that could be highly commercially lucrative, they are unable to set-up spin-off companies to accrue the financial benefits. Sometimes, these difficulties are enough of a disincentive to the researcher, and they drop their idea, or they allow it go ahead with all the benefits going to their institution.

But while researchers interviewed would not admit to doing so themselves – the penalty is losing their job – they often knew of scientists who had bypassed their university or institutional system to collaborate directly with industry. This is against their institutional regulations, but if the institution is faced with losing a talented scientist, they prefer to be pragmatic.

These informal ways of working that make the whole system much more inefficient do not just happen in small institutions; researchers shared these experiences even from the country’s most highly regarded organisations. None of this is to malign Indonesian researchers. These scientists are not dishonest, nor are they trying to get rich at the expense of their institution or to make a quick buck, but the extremely poor remuneration and incentives those researchers are given means that they are often left with very little choice.

1.6.3 Funding

Table 1.6 shows just how little Indonesia spends on R&D. The most recent estimate is just 0.08 per cent (US$490 million) of its US$ 586 billion gross domestic product (GDP) on R&D,[92] much lower than the one per cent that most developing countries aim for.[93] Indonesia’s R&D spend is also outranked by other OIC member states too (see figure 1.10).

92 Simamora, N.G., (2011). *Indonesian Science and Technology Indicators,* Country report presented at the 2011 South East Asian Regional Workshop On Science, Technology, and Innovation Indicators, Hanoi, Vietnam, December 2011. Indonesian Institute for Sciences (LIPI), Jakarta, Indonesia.

93 Economic and Social Commission for Asia and the Pacific (2011). *Statistical Yearbook for Asia and the Pacific 2011,* US ESCAP, Bangkok, Thailand.

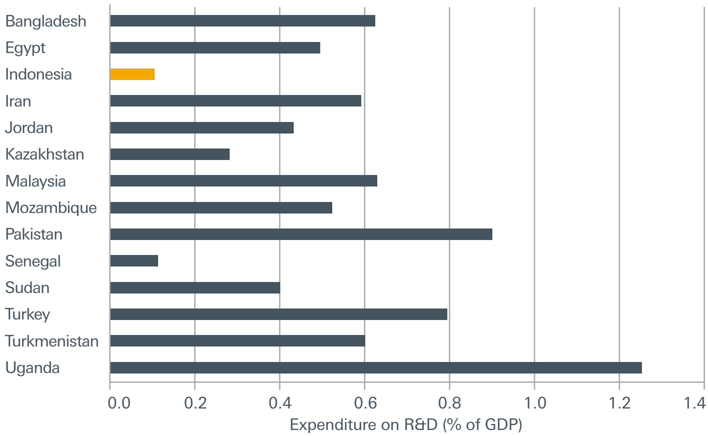
Table 1.6 Indonesia's R&D spending[94]

R&D Expenditure	US$	% of GDP
Higher education	US$ 189 million	0.03
Manufacturing industry	US$ 91 million	0.01
Government	US$ 210 million	0.04
Gross Domestic Expenditure on R&D (GERD)	US$ 490 million	0.08

Table 1.7 Percentage Change in GERD since 2000[95]

	2001	2005	2009
GERD	0.05	0.05	0.08

Figure 1.10 How Indonesia's R&D spending as a percentage of GDP compares with other OIC member states[96]



1.6.4 A national science fund

A key weakness of Indonesia's science funding, say scientists like Sangkot Marzuki, is that funding is too short-term and tends to be only for a year. "The money that is available is not used efficiently; by only offering short grants, scientists cannot plan long-term research projects," says Marzuki. The Indonesian

94 Simamora, N.G., (2011). *Indonesian Science and Technology Indicators,* Country report presented at the 2011 South East Asian Regional Workshop On Science, Technology, and Innovation Indicators, Hanoi, Vietnam, December 2011. Indonesian Institute for Sciences (LIPI), Jakarta, Indonesia.

95 United Nations Educational, Scientific and Cultural Organization (2010). *UNESCO science report 2010: the current status of science around the world.* UNESCO, Paris, France.

96 Naim S.T., and Atta-ur-Rahman (2009). *Mapping scientific research in member states of the Organization of Islamic Conference (OIC),*. UNESCO Forum on Higher Education, Research and Knowledge, Occasional Paper 17. Data are from different years, ranging from 2002 to 2009. The most recent figures are used for each country.

Academy of Sciences (AIPI), in collaboration with the World Bank, has been working on the creation of a body similar to the US National Science Fund (See Box 1.5 Spotlight: An Indonesian Science Fund).[97] Mark Doyle, who until October 2012 was policy advisor at USAID, and previously worked at the NSF, welcomes it. "Grant reports are due so soon after the grant is given that people are writing it up almost as soon as they have started their project," he says. In addition, the mechanism of allocating grant money – the funds don't clear for many months after they are due in January and yet need to be spent by the year's end – means that the money is often difficult to use efficiently.

Box 1.5: Spotlight: An Indonesian Science Fund

Poor science funding is one of the major barriers to improving the country's science and technology output. Increasing the amount of R&D funding is critical, but as in many low-resource countries, it's not simply a shortage of funds that is holding back research output, but that the funding that is available is poorly and haphazardly distributed.

Sangkot Marzuki of the Eijkman Institute for Molecular Biology is also Chairman of AIPI, which has long been advocating for a central science fund. Science funding must be merit-based rather than at the whim of a particular official, says Marzuki, and "researchers need to be able to rely on sustained funding so that they have the assurance that their grant will not be jeopardised every time the political party changes".

In its report on the state of science funding in Indonesia,[98] AIPI outlined the framework for such a fund. It would operate as an autonomous body that would give grants on a competitive basis directly to scientists, as well as providing financial support to institutions to allow the researchers to undertake their work. The fund would offer research grants, travel grants, and student fellowships as well as entrepreneurship support and industrial cooperative fellowships. The AIPI report also estimates the initial costs for the fund. It suggests a research budget of 360 billion rupiah (37 million USD) for 250 new 3-year grants per year, averaging 1.5 billion rupiah.

AIPI also makes clear that the restrictions that government research organisations are under mean they cannot receive overhead payments to support the indirect costs of research. These additional costs can substantially drain the institution's funding, but current regulations prevent institutions from taking these 'structural' funds from a non-governmental organization.

97 Brodjonegoro S.S., Greene M.P., (2012) *Creating an Indonesian Science Fund,* Indonesian Academy of Sciences (AIPI), Jakarta, Indonesia.

98 AIPI (2012). *Creating an Indonesian Science Fund*. Akademi Ilmu Pengetahuan Indonesia (AIPI) - the Indonesian Academy of Sciences: Jakarta, Indonesia.

1.7 Outputs from the STI system

1.7.1 Publications and citations

A major indicator of scientific output is the number of publications a country produces, and the number of times those publications are cited. The research areas in which Indonesia publishes the most have remained fairly unchanged for the past 15 years.[99] In 2010, agriculture leads, followed by medicine, physics and astronomy, earth and planetary sciences, and environmental sciences (figure 1.11). The picture changes dramatically when looking at the research that comes out top in the number of citations. Agriculture, in which researchers turn out 16.14% of all publications, languishes in 14th place, while the biological sciences – molecular biology, microbiology and immunology, all take the lion's share of citations. This is likely to be because while agricultural research lends itself to publication, the impact of it on the global scientific stage is still small. Drug discovery and genetics are more likely to produce citable publications.

Indonesian researchers feel that they are perpetually lagging behind Malaysia, and this is not a mere inferiority complex, as the difference in publication numbers shows (see figure 1.12). From being roughly neck and neck in the mid 1980s, Malaysia's publication rate started soaring after 2005, and by 2009 it was publishing about five times the number of articles that Indonesia was.[100]

Figure 1.13 shows the massive heterogeneity in publication numbers across the Islamic world, with even countries that are investing heavily in science such as Qatar languishing with less than 100 papers a year. However, it is clear that even those OIC members that publish comparatively high numbers of papers are far behind the rest of the world, and Indonesia's publication number of 262 is far behind other ASEAN countries. China publishes a staggering 74,019, India 19,917, and Indonesia's neighbours Thailand (2,033) and Singapore (4,187) outrank it too.

A stark indication of just how poorly Indonesia's research efforts translate into publications can be seen in a comparative analysis of publications and citations in ASEAN countries in key areas of R&D including nanotechnology, ICTs, energy, and environment.[101] Unsurprisingly, Singapore leads by a clear margin in high-tech fields such as nanotechnology and ICTs. For instance, between 2004 and 2008, Singapore published 4001 articles on nanotechnology (and had 25,040 citations) compared with the next highest Thailand, which published 757 (2051 citations).

But Singapore trumps Indonesia in fields it should be much stronger in, such as environment and energy research. That a country like Singapore, which has few natural resources of its own, should dominate in these areas is a damning indictment of how badly its competitors are doing (see figure 1.14).[102] The Center

99 SCImago Journal & Country Rank database, http://www.scimagojr.com.

100 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

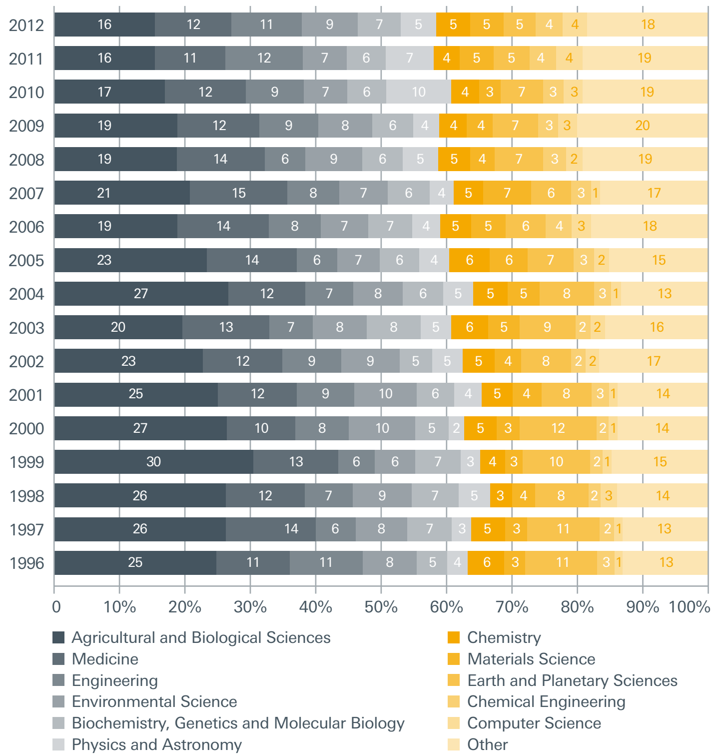
101 United Nations University (2012). *Analyses of research strengths of SEA countries for SEA-EU-NET under task 4.9 bibliometric analysis of science and technology strengths in Southeast Asia,* UNU International Institute for Software Technology, Macau.

102 United Nations University (2012). *Analyses of research strengths of SEA countries for SEA-EU-NET under task 4.9 bibliometric analysis of science and technology strengths in Southeast Asia,* UNU International Institute for Software Technology, Macau.

for International Forestry (CIFOR) In West Java, Indonesia, dominates among the country's institutes. Of the top ten universities in terms of citation market share, it takes 6% for environment, but Indonesia is not represented at all in publications on energy.

Indonesian scientists are keen to publish more. Like researchers everywhere, the pressure to publish is immense, and bonuses or incentives are often tied to publication numbers. A limiting factor in Indonesia, however, is that the lack of high-quality, modern laboratory equipment means that researchers are restricted in how advanced their research can be, which then means that they are less likely to be publishing new findings.

Figure 1.11 Indonesia's publications by subject area[103]



103 SCImago (2012). SJR — SCImago Journal & Country Rank. Retrieved May 9, 2014, from http://www.scimagojr.com

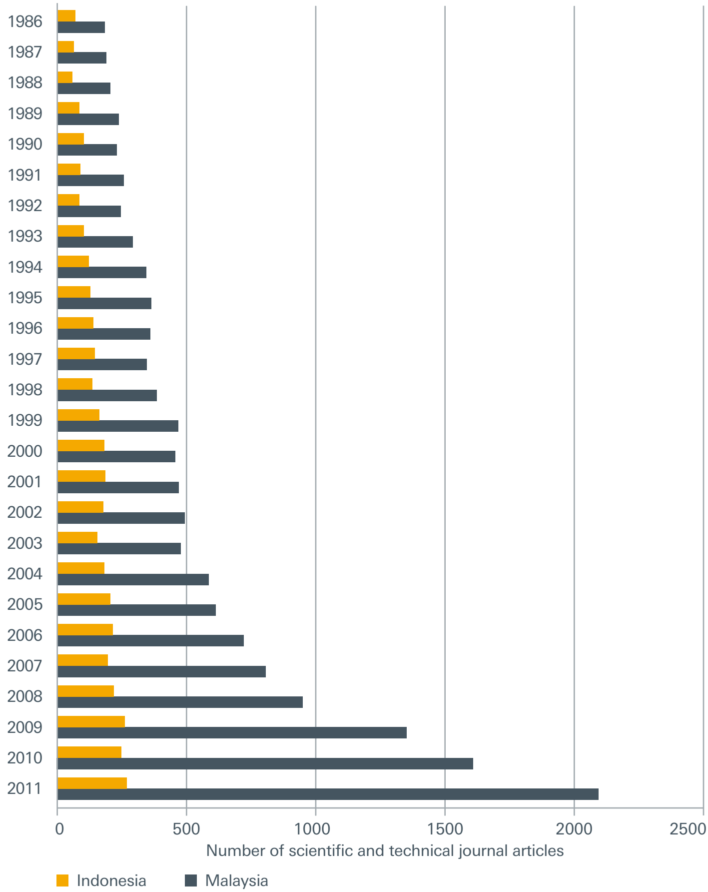
Table 1.8 Indonesia's citations by subject area, 2001 - 2011[104]

No	Field	Paper	Citations	Citations per paper
1	Molecular biology & genetics	85	1,267	14.91
2	Microbiology	239	3,303	13.82
3	Immunology	96	1,299	13.53
4	Space science	30	406	13.53
5	Environment/ecology	585	6,606	11.29
6	Clinical medicine	1,020	11,424	11.20
7	Multidisciplinary	8	81	10.12
8	Geosciences	430	4,262	9.91
9	Biology & biochemistry	236	1,813	7.68
10	Psychiatry/psychology	59	450	7.63
11	Chemistry	488	3,424	7.02
12	Social sciences, general	326	2,188	6.71
13	Plant & animal science	985	5,869	5.96
14	Agricultural sciences	365	1,933	5.30
15	Material sciences	207	903	4.36
16	Physics	321	1,356	4.22
17	Pharmacology & toxicology	119	445	3.74
18	Economics & business	126	429	3.40
19	Engineering	402	1,298	3.23
20	Computer science	68	191	2.81
	All fields*	6,312	49,201	7.79

* Includes data for all papers from ranked and unranked fields.

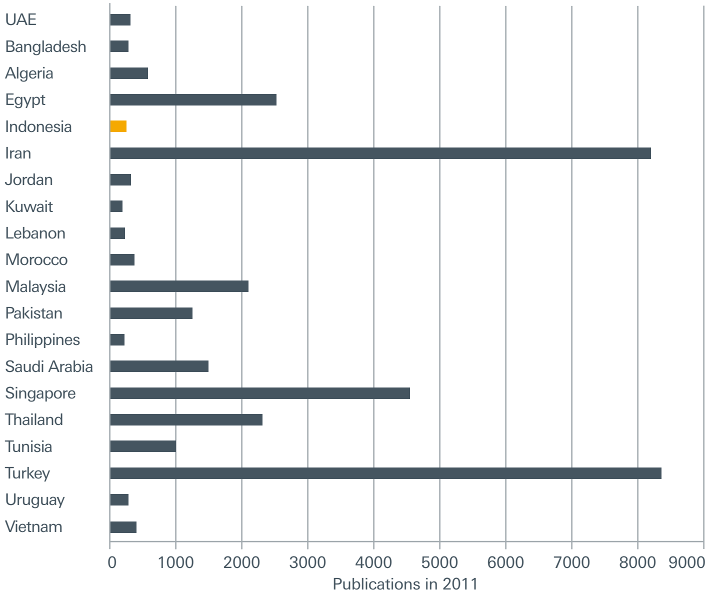
104 Thomson Reuters (2012). Essential Science Indicators. See http://thomsonreuters.com/essential-science-indicators/ Data as of July 1, 2011 to cover a 10-year + 4-month period, January 1, 2001-April 30, 2011.

Figure 1.12 Publication numbers from Indonesia and Malaysia 1986 - 2009[105]



105 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

Figure 1.13 Publications in OIC and ASEAN countries in 2011[106]



Note: 'Publications' refers to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences. Only countries with more than 200 publications are included for clarity.

1.7.2 Patents

Mention the words 'patents' or 'intellectual property' in an Indonesian research facility, and the response is either confusion or frustration. For most Indonesian scientists in the public sector, intellectual property is a concept that exists on the very periphery of their world. There is little understanding of why it is important to patent work or what sort of research is patentable.

This ignorance is rarely confined just to researchers. Institutions themselves can be reluctant to invest in patents, which is a major source of frustration to scientists. Eniya Listiani Dewi, an energy researcher at BPPT, has devised a new form of clean energy fuel cell, an invention that is sitting in limbo because private companies in Indonesia are not advanced enough to produce it. In a few years, they are likely to be able to, but Dewi's organisation is not willing to pay a few hundred dollars to extend the patent. Researchers who have pushed to get patents, such as technology researchers at ITB, are often exhausted by the effort as it can take up to 3 years to secure one.

106 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

Moreover, the royalties from patents are required by law to go to the university and the government, or to be shared with industry if a private company is involved. Scientists themselves are not allowed to profit in any way. Since Indonesian researchers are overworked and underpaid, few individuals are motivated enough to untangle the complicated bureaucracy around patenting work, only to see all the money accrue to their institution rather than themselves.

This lack of engagement with intellectual property is strikingly visible in the statistics on patents – the number of patents given to foreign researchers far outweighs by a long margin those given to Indonesian researchers.[107] The gap has slowly become marginally narrower, but it remains clear that there is enormous potential for Indonesian science to become more commercial. This is especially important for a country transitioning to a knowledge economy, as it is vital to exploit the commercial value of knowledge gained through research.

Indonesia is well aware it needs to rehaul its intellectual property system, says Alvini Pranoto, Director for Intellectual Property and S&T Standardization, RISTEK. Countries like Korea and Japan, both of which produce extraordinarily high numbers of patents, are role models, she says. Indonesia is collaborating with both countries to learn from them.

Pranoto's department is embarking on an ambitious programme to both increase awareness of intellectual property among researchers and also to alter institutional practices and regulations, to make them more IP-friendly. The government is already trying to increase the number of patent offices in the country, to ease the application and approval process, and between 2000 and 2004 set up almost 100 offices. Patent offices are under the remit of the Department of Justice and Human Rights, however, rather than Science and Technology, so any changes in how the country deals with intellectual property requires significant inter-ministerial coordination, which has been a challenge in Indonesia in the past.

One of the major reasons why the country has such a sluggish intellectual property system is the lack of incentives and since 2010, the science and technology ministry has introduced incentives both for individual researchers and for institutions. For instance, scientists can now receive up to US$1,000 to register a patent, and an institution can receive up to US$7,800. Plans are also underway to create a system in which institutions can give researchers a share of the royalties. The exact proportion has not yet been determined, but it may be close to the 30% that Malaysia gives its scientists.

Indonesia's intellectual property system has also been hampered by violation of copyright. "This is shameful but true," says Pranoto. RISTEK are one of 15 ministries who joined up in 2006 to create an IP taskforce to combat piracy and improve enforcement.

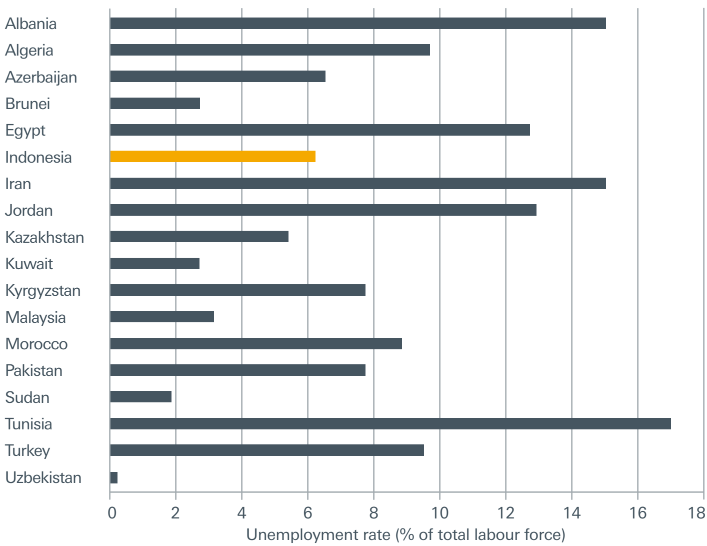
107 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

2. People

One resource that Indonesia is in no danger of running out of is human capital. The country's demographics are changing in such a way that its dependency ratio (which balances out the productive proportion of the population against dependants such as infants and the elderly) is reaching an all–time low in 2020.[108] At this point, Indonesia will have one of the biggest productive work forces in the region.

It is vital that the country capitalises on this, ensuring both that these individuals have access to education and training, and also that there are enough jobs for them to go into. Encouragingly, unemployment has been falling, reaching 6.3% in early 2014.[109] This is much lower than unemployment rates in much of the Western world – currently, the UK has 7.2% unemployment and the United States has 6.7%. Indonesia's unemployment rate is also much lower than several other OIC member states (see Figure 2.1).

Figure 2.1 Unemployment rate as a percentage of labour force in OIC member states[110]



108 Ananta, A. and Arifin, E. A., *Demographic window by Religion and Ethnicity: Indonesia, 2000-2050,* Presented as a poster at the International Union for the Scientific Study of Population (IUSSP) International Population Conference, Tour, France, July 2005.

109 Trading Economics (2014) *Unemployment Rate by Country, 15th April 2014,* Trading Economics, New York, NY, USA.

110 Source: World Bank (2014). *World Development Indicators.* World Bank: Washington, DC, USA.

2.1 Size matters

Indonesia's sprawling education system is the fourth largest in the world (behind only China, India and the United States), with over 50 million students and 2.6 million teachers in more than 250,000 schools. Of the 20 million Indonesians aged between 18 and 22 years, 5.4 million are in tertiary education (the UK has 2.5 million). This is set to rise to 7.7 million by 2020.[111]

Indonesia isn't short of universities either – it has over 3,000, most of which are privately owned, and only about 150 are public.[112] China, by comparison, is estimated to have about half that number, despite Indonesia's population of 248 million being dwarfed by China's 1.4 billion people.[113]

Indonesia invests a considerable proportion of government expenditure in education. Figure 2.2 shows that globally in 2009, Indonesia dedicated a bigger share of government spending to education than many developed nations, including the UK and United States.[114] This shows just how seriously the country takes education, and tertiary education in particular. Its expenditure per student, as a percentage of GDP per capita, for primary and secondary education has been falling but this has risen for tertiary education. For instance, in 2007 Indonesia spent 14% of GDP per capita on secondary education, which fell to 9% in 2010. Tertiary spending, meanwhile, rose from 19% to 23%.[115]

111 Unesco Institute of Statistics, Montreal, Canada.

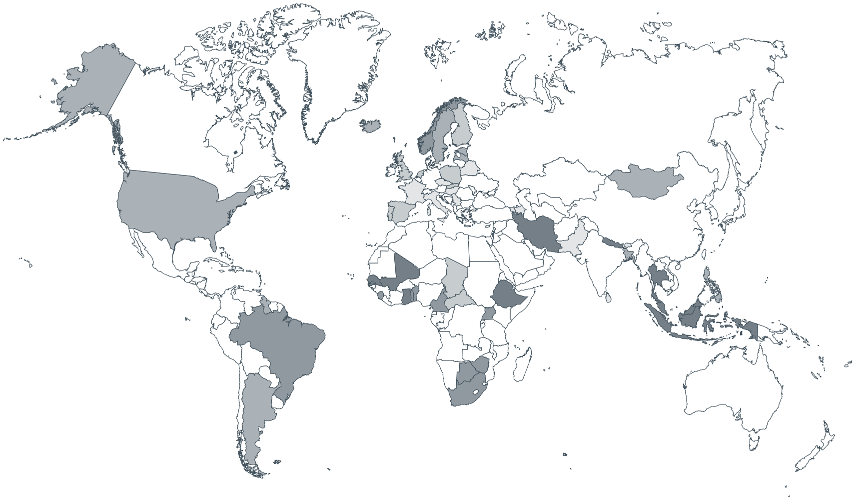
112 DIKTI, Ministry of National Education, Jakarta, Indonesia.

113 NAFSA: Association of International Educators (2012). *Overcoming Barriers to Implementing US/China Campus Collaborations,* NAFSA, Washington, DC, USA.

114 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

115 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

Figure 2.2 Public spending on education as a percentage of government expenditure[116]



Public spending on education (total % of government expenditure), 2009

Less than 11 | 11-13 | 13-15
15-19 | 19 or more | No data

2.2 Expanding education

Not content with the size of its education system, the government wants to grow tertiary education even more.[117] Harris Iskandar, Secretary of the Directorate General of Higher Education (DIKTI), has a clear view on what Indonesia needs to do to improve its tertiary education system. Addressing a group of policymakers, ministers, and educationists from around Indonesia and a few from Malaysia and Thailand, Iskandar said "there is a pressing need for more affordable access to higher education, with a much higher number of community colleges".

This new focus on community colleges in the past year or so is aimed at driving Indonesia's economy through dual pathways: academic and vocational. On the academic side, the aim is to increase the number of science and technology PhDs from 4,500 to 9,000 by 2014.[118] For example, currently only 16% of researchers, and only 1% of R&D personnel in manufacturing industry, have PhDs.[119] Understanding that not all its students want, or are suited to, highly academic

116 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

117 Ministry of National Education (2010). *2010 – 2014 Ministry of National Education Strategic Plan,* Ministry of National Education, Jakarta, Indonesia.

118 National Development Planning Agency *(2010)Masterplan for Acceleration and Expansion of Indonesia's Economic Development,* BAPPENAS, Jakarta, Indonesia.

119 Simamora, N.G., (2011). *Indonesian Science and Technology Indicators,* Country report presented at the 2011 South East Asian Regional Workshop On Science, Technology, and Innovation Indicators, Hanoi, Vietnam, December 2011. Indonesian Institute for Sciences (LIPI), Jakarta, Indonesia.

training, the government plans to offer significantly more vocational training (see Table 2.1).[120] It also wants to triple the capacity of existing polytechnics and the number of lecturers, as well as significantly upgrading the qualifications of those lecturers. Indonesia needs to be wary of focusing only on increasing the numbers of highly qualified students as they also need to find a job once they graduate. Worryingly, in 2003, tertiary-education individuals made up 5% of the total number of unemployed people, and this had doubled to 10% in 2008.[121]

Indonesia is also trying to streamline the accreditation system through the newly devised Indonesian Qualification Framework (IQF)[122] to allow the standardisation of qualifications, irrespective of whether the student is on an academic, vocational, or professional course. This would allow students to transfer credits from one course to another if they wanted to. In theory, this allows for students to be treated more uniformly, and for vocational courses to be given equal status.

In reality, this is immensely difficult to implement, as Malaysia knows. Malaysia began implementing its Malaysian Qualification Framework (MQF) five years ago, says Dr Rozilini Fernandez-Chung, vice-president of HELP University in Kuala Lumpur, "as a way to improve serious shortages of human resources". "In practice, implementing the MQF has been very difficult because of the complexity of determining parity between academic and vocational courses". This is not surprising because, after all, this is why vocational and academic courses have always run along parallel rather than connected streams.

Table 2.1 Indonesia's education acceleration plans[123]

DIKTI's plans	Target	
	2015	2025
Building new community colleges	269	823
Building new polytechnics	54	165
Expanding capacity of existing polytechnics (students)	90,000	275,000
Increasing number of lecturers	54,000	165,000
Increasing number of lecturers with PhDs from 10% in 2010	15%	50%

120 Iskandar, H. (2012). *Strengthening links and conquering challenges: forging partnerships in higher education for new opportunities in collaborative research and teaching, Presentation to Global Policy Dialogue 2012,* British Council, Jakarta, Indonesia.

121 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

122 Sunarto, K. (2010). *Indonesian national system of QA in education,* National Accreditation Agency for Higher Education, Jakarta, Indonesia.

123 Source: DIKTI (2012). Indonesian Ministry of Education Directorate General of Higher Education (DIKTI): Jakarta, Indonesia.

2.3 Quality vs quantity

The sheer heft of Indonesia's university education system does not necessarily equate to a high quality of education. Even the best universities in the country compare unfavourably in global rankings. In the 2012 world ranking of universities,[124] the country's top-ranking university, the University of Indonesia, a state university, slipped from a ranking of 273 in 2012 to 309 in 2013. Gadjah Mada University (UGM) also slid from 401-450th in 2012 to 501-550 in 2013, and the Bandung Institute of Technology (ITB) stayed between 451-500th place in 2013. As a striking comparator, Malaysia's University of Malaya in Kuala Lumpur was ranked 167th in 2013.

In most parts of the world where education is a mix of public and private, attending a state-run university means paying no or at least low fees, whereas private education is often perceived as offering a better education because fees pay for high-quality teachers, more resources, and small class sizes. In essence, you get what you pay for.

In Indonesia, however, educational facilities and the quality of teaching do not delineate so easily. Government universities charge fees too, sometimes much higher than that of private universities, and they can be much harder to get into as they hold high reputations. The University of Indonesia charges between US$ 2,000 and 4,000 for fees[125] – in a country where the gross national income per capita is US$ 2,940.[126]

In some years, an estimated 80% of those who take the national public university entrance exam are rejected. Entrance can also be biased towards students from well-off families, as most students who pass the exam have extra tuition, coaching and training.[127]

Students studying science, technology, engineering or mathematics are more likely to end up in a public university, however, because 44% of state universities offer these courses as compared to 10% of private universities. Those who want to study for postgraduate degrees are also likely to need to live in Java – a good example of Indonesia's Java-centric nature – as figure 2.3 shows.

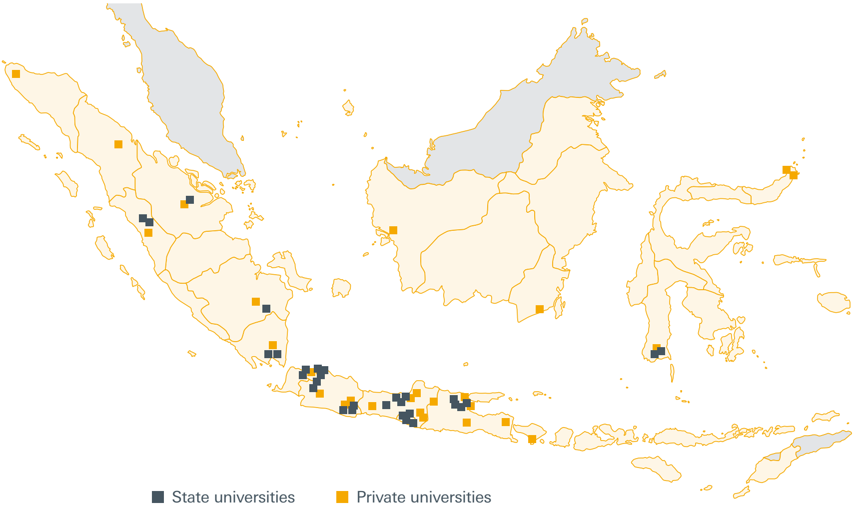
124 Quacquarelli Symonds (2013). *Top Universities 2013,* QS, London, UK.

125 Quacquarelli Symonds (2012). *Top Universities 2012,* QS, London, UK.

126 The World Bank (2013). World Development Indicators, The World Bank, Washington, DC, USA.

127 According to interviewees for this report.

Figure 2.3 Geographical distribution of universities offering postgraduate degrees in science, technology, engineering and mathematics, 2009[128]



2.4 Raising standards

Indonesia's national standardisation agency, Badan Standardisasi Nasional (BSN), is keen to improve the uniformity of teaching and education across the universities, and has involved 28 universities in a collaboration to discuss ways to standardise tertiary education. In 2012, it hosted a conference for the International Cooperation on Education about Standardization (ICES) in Bali.[129]

There has been talk of the country tightening up the accreditation system to raise standards and increase international appeal, but that would put the future of many of the bottom universities in jeopardy, says Benny Setianto, Vice Rector for Cooperation and Development, Soegijapranata Catholic University, in Semarang, central Java.

Instead perhaps, private universities might be able to be consolidated so that there are fewer, but better quality, institutions. Researchers don't hold out much hope for this happening, however. While the government can easily control state-run universities, it has much less say in what happens in private education facilities, as they are run according to their own mandate. Moreover, merging private universities would be as complex as merging two businesses – which is essentially

128 Indonesian Institute of Sciences, LIPI (2011). *Study on the status science and technology development in Indonesia,* LIPI, Jakarta, Indonesia.

129 National Standardization Agency of Indonesia (BSN) See http://www.bsn.go.id.

what they are – and agreeing on which university would take on which specialities would require more organizational power than Indonesia's education system currently holds.

Indonesia must carefully consider the way it improves standards, however. Some attempts to raise its game in terms of publication rates have been met with strong criticism. To push university graduates, and improve Indonesia's poor publication rate, in January 2012, DIKTI announced a new policy (no. 152/E/T/2012)[130] that is more stick than carrot: every science undergraduate and postgraduate student must publish a scientific paper if they want to graduate.

This announcement, which came into effect from August 2012, was met with some concern at a 2012 regional meeting of policymakers in Jakarta under the aegis of the British Council.[131] Education experts were concerned that students – and especially undergraduates – may not have the capacity to produce a good-quality paper at their level of experience. What's more, manuscripts take time to be peer-reviewed and edited, and may have long publication cycles – pegging a student's graduation on publication seems unfair and unnecessary, say critics of the policy. The Association of Indonesian Private Universities (APTISI) – and some members of Parliament too – object to the policy, though some argue that it could be adapted to be a way for students to publish through new online journals, if the requirement to publish in high-status journals was tweaked.[132]

Although improving the number of publications that Indonesia produces is a laudable goal, achieving it by forcing students to churn out papers does not seem to be the solution. Much better would be to encourage students who have ideas or research worth publishing to work with lecturers and professors on fine-tuning high-quality articles that are likely to make a real contribution and be well-cited.[133]

Indonesia often seems to try to reach too far without ensuring that the basics are in place. Just as it is trying to prioritise applied research without a robust foundation of pure science, demanding that every student publish a paper seems out of step considering the poor communication skills that many students have. Indonesian undergraduate students are not encouraged or required to write many essays, let alone scientific papers, says Farah Coutrier, a researcher at the Eijkman Institute for Molecular Biology. In his view, "they play with the words but they don't know how to put their ideas into writing."

130 McAdams, M. (2012). *Quality in Scholarly Research in Indonesia,18th Feb 2012,* Jakarta Post, Jakarta, Indonesia.

131 Iskandar, H. (2012). *Strengthening links and conquering challenges: forging partnerships in higher education for new opportunities in collaborative research and teaching, Presentation to Global Policy Dialogue 2012,* British Council, Jakarta, Indonesia.

132 Rochmyaningsih, D. (2012). Letter: *Efforts to increase scientific papers,* 16th February 2012, Jakarta Post, Jakarta, Indonesia.

133 McAdams, M. (2012). *Quality in Scholarly Research in Indonesia,18th Feb 2012,* Jakarta Post, Jakarta, Indonesia.

2.5 Losing control

State universities, meanwhile, have more pressing concerns. The government's recent decision to rescind a law enacted in 2000 that gave substantial autonomy to public universities is causing turmoil and anxiety among faculties across the country.

In 2000, the government decided to allow universities to set their own agenda, loosening the purse-strings so that universities themselves could decide how to manage their budgets.[134] This move was partly intended to reduce the financial burden of education on the government, which was struggling to recover after the Asian financial crash of the late 1990s. More importantly, it fitted with the country's post-democracy drive towards autonomy and transparency in government.[135] The importance of autonomy for an effective university system was quickly recognised by the then Director General of Higher Education, Satryo Soemantri Brodjonegoro, who said that universities needed to have "academic freedom" if they were to act as a "moral force" for society.[136]

Four of the country's top state universities were piloted to become autonomous legal entities.[137] The Javanese universities – the University of Indonesia, the Institute of Agriculture Bogor (IPB), the Bandung Institute of Technology (ITB), and Gadjah Mada University in Yogyakarta (UGM) – were intended to function as models of Indonesia's move toward greater academic and financial autonomy. This new autonomy heralded a total paradigm shift in how the four pilot universities would be managed. It meant that the university could decide how much they would charge students in fees, how much money they would allocate to each study programme, and how much to spend on marketing or bursaries and scholarships for overseas study and work. It also meant that universities could decide to shut down a programme that had poor uptake, without waiting for months for approval from the government.

This reform was much-needed, according to a critical review in 2009 by Sahid Susanto and M. Nizam, both at the Centre for Higher Education Planning and Management Studies, Gadjah Mada University. "Lack of autonomy, due to centralistic planning and bureaucratic regulations, causes university management to devote unnecessary time and effort to resolving trivial issues, leaving management with insufficient time to tackle the main academic tasks of education, research and community services," they said.[138]

134 Kurniawan, B. (2011). *Policy Reforms Assessment: case study in higher education sector.*

135 Albrecht, R. et al (2001). *Evaluation of the Indonesian science research and technology landscape to strengthen the national innovation system (PERISKOP)* Joint publication by RISTEK, Jakarta, Indonesia, and the German Ministry of Education and Research, Bonn, Germany.

136 Brodjonegoro, S. S. (2001). *Higher education reform in Indonesia,* Ministry of National Education, Jakarta, Indonesia.

137 Beerkens, E. (2002). *Moving toward autonomy in Indonesian higher education,* International Higher Education.

138 Susanto, S. & Nizam, M. (2009). *Gadjah Mada University, Indonesia.* In: *Higher education reforms: institutional restructuring in Asia,* Varghese, N. V. (ed), International Institute for Educational Planning, UNESCO, Paris, France.

Autonomy made the running of universities more efficient by freeing them from the lengthy bureaucratic processes of having each decision agreed by central government, says Ahmad Agus Setiawan, a lecturer in the Faculty of Engineering at Gadjah Mada University. Setiawan had just joined the faculty as a new lecturer when the law was enacted in 2000, and he remembers the extensive processes put into place to make best use of the autonomy. Transitioning was not a simple process and took almost a decade, as universities had to emerge from many years of state control to take over the reins of their own functioning. This involved working out how to position themselves within Indonesia, trying to compete with other ASEAN countries, and finally becoming competitive on a global scale.

By 2009, DIKTI had expected about half of all universities, both public and private, to become autonomously run.[139] But then in 2010, the government made an abrupt about-turn in policy. Just as universities such as Gadjah Mada and ITB were starting to reach a point where they believed that they could start to compete internationally, the government decided that the level of autonomy that universities had was "unconstitutional" and reversed the decision.[140] The decision was largely driven because of public protests at the rising cost of education at the top universities,[141] but, say researchers at ITB, "a good education is not cheap".

This policy change will, fear universities, usher in another era of bureaucratic delays and inefficiency. It could severely hamper the competitive edge that Indonesian universities are striving for, and that the government says it wants them to have. ITB's School of Business Management,[142] for instance, was set up in 2004 to compete with ASEAN countries like Malaysia and Singapore. They are now worried about how they will preserve their standard of excellence, and are concerned not only that lecturers will lose their motivation, but also that student exchange programmes may suffer if foreign students are put off by the reversal of reforms.

University autonomy was at the core of a government strategy introduced in 2003, the Higher Education Long Term Strategy 2003-2010 (HELTS) to reform education, in particular in improving quality to produce more skilled graduates. The reversal of this decision "is a blow," says Setiawan, "we were nearly there in competing with Malaysia but now, who knows."

139 Susanto, S. & Nizam, M. (2009). *Gadjah Mada University, Indonesia.* In: *Higher education reforms: institutional restructuring in Asia,* Varghese, N. V. (ed), International Institute for Educational Planning, UNESCO, Paris, France.

140 Kurniawan, B. (2011). *Policy Reforms Assessment: case study in higher education sector,* ***

141 Sulistiyono, S. T. (2007). *Higher education reform in Indonesia at crossroad, Paper presented at the Graduate School of Education and Human Development,* Nagoya University, Nagoya, Japan.

142 ITB School of Business Management website: http://www.sbm.itb.ac.id/

2.6 Competing priorities: teaching vs research

It is not uncommon for university researchers around the world to frequently feel torn about how to devote enough time to teaching students while maintaining a viable research career. Indonesian university lecturers have a third commitment–service to the community. They are supposed to allocate a third of their time to research, a third to teaching, and a third to serving the community. In Bahasa Indonesia, this is known as the Tri Dharma or Three Duties.[143]

These community development programmes might include literacy programmes, reforestation projects, or business incubator development. This function is an important part of Indonesia's focus on social development and is monitored closely. While the goal is admirable, it does put immense pressure on university researchers who frequently find they don't have quite enough time for any one activity. Lecturers must teach, and given the importance put on community work, what tends to suffer is research. In practice, say university heads, the amount of time allocated to research can be as little as 10%, mainly because research, especially with limited funds and facilities, is harder than teaching.

These high demands on the working day also mean that when university staff do undertake research, they are often not able to devote enough time to ensure that it is also commercially viable, which can deter industry from collaborating. The dynamics of collaboration with business are explored in section 4.2.

Indonesian universities might also need to revisit their teaching style, as many education experts now argue that lecturers need to engage their students with new technologies on top of the old-fashioned didactic method of teaching.[144] The use of digital learning tools should be a standard part of university teaching, and ensure that graduates are Internet-savvy when they leave university.

There has been a push in neighbouring countries like Malaysia to mandate that lecturers have PhDs. The Indonesian education ministry dictates that lecturers must have at least one higher qualification than the class they are teaching, and in a drive to ensure that more lecturers have masters and doctorates, in 2008, DIKTI began offering scholarships for university lecturers to travel abroad through the Overseas Postgraduate Scholarship Program (PBPLN).[145]

Several educationists argue that while lecturers need to be adequately qualified scientifically, ensuring that they have appropriate teaching qualifications and capabilities is just as important. This is a point rarely addressed in universities around the world, and Craig Mahoney, chief executive of the Higher Education

143 Purwadi, A. & Komang Tantra, D. (2007). *The role of Indonesian universities in community development, Presented at the 11th Unesco-APEID conference Reinventing higher education: toward participatory and sustainable development, 12th-14th December 2007.* Bangkok, Thailand.

144 Iskandar, H. (2012). *Strengthening links and conquering challenges: forging partnerships in higher education for new opportunities in collaborative research and teaching, Presentation to Global Policy Dialogue 2012,* British Council, Jakarta, Indonesia.

145 DIKTI scholarships for Indonesian lecturers. Asian Institute of Technology, Khlong Luang, Thailand.

Academy in the UK, admits to being perplexed that university lecturers all over the world (including the UK) teach classes without any specific teaching credentials. "Even if you are born with natural talent, in sports, for example, to become a good athlete, you need training," he told a policy dialogue on education held by the British Council in Jakarta in 2012.[146] In the UK that same year, Liam Burns, the then president of the National Union of Students, called for university lecturers to be forced to acquire teaching qualifications, though these moves have in the past drawn extreme opposition from universities who felt it impinged on their academic independence.[147]

2.7 Teaching more than theory

A key concern about Indonesia's education system is that it doesn't prepare students for the real world. Despite the 5.4 million students in tertiary education, there is a shortage of skilled researchers in Indonesia – the country only has 40,000 researchers. This is 1.7 per 10,000 of the population, compared with Malaysia's 17.9 per 10,000 and Singapore's 58.2 per 10,000.[148]

Many Indonesian postgraduates go into completely different professions than what they trained for. It's not uncommon for a doctor to become a banker or an engineer to become a businessman, says Charaf Ahmimed, Head of the Social and Human sciences Unit at UNESCO's Jakarta's office. Professor Ngurah Mahardika, based jointly at the Indonesian Biodiversity Research Center and Udayana University in Bali, estimates that out of 10-15 trainee scientists, only about one or two make science their career. The lack of incentives to become a researcher, or to stay in research, is probably one explanation.

University training also plays a part, however. Traditionally, Indonesia's university curricula separate theory and practice, and senior lecturers seem loathe to combine the two.[149] There are exceptions, and the top universities that have been fairly autonomous, such as UGM, do manage to combine the two and to ensure that theoretical and practical training complement each other. Most of the time though, says Mahardika, science graduates don't have nearly enough practical experience when they leave university, even if they have nominally had experience of laboratory work.

"Their lab supervisors think students are too inexperienced to use high-tech or expensive equipment, so they sometimes don't have the practical knowledge they should." Mahardika, by contrast, believes in encouraging even the most junior intern to use the equipment, and says that it only requires them to be trained to use it.

146 Mahoney C (2012). Presentation to British Council Global Policy Dialogue 2012.

147 Boffey, D. (2012). *Lecturers should need a teaching qualification, says NUS president, 22nd April, 2012,* Guardian, London, UK.

148 Information provided by the Indonesian Institute of Sciences (LIPI), June 2012.

149 Nederstigt, W., & Mulder, M. (2011). *Competence based education in Indonesia: evaluating the matrix of competence-based education in Indonesian higher education,* In: Deitmer, L., Gessler, M., Manning, S. (Eds.), *Proceedings of the 2011 ECER VETNET Conference 'Urban Education',* Berlin, Germany.

The fact that the high number of students does not translate into high numbers of researchers is driving Indonesia to pursue 'competence-based education', essentially so that students are better prepared for the job market.[150] The output-driven nature of this approach probably explains the requirement of publishing a scientific paper in exchange for graduation.

2.8 International exchanges

"Once upon a time, Malaysia used to send its students to us, rather than the other way around," says Professor Sangkot Marzuki, director of the Eikjman Institute of Molecular Biology, reminiscing about Indonesia's rosier scientific past. "Ten years ago, Indonesia was on a par with China, Malaysia and Singapore in areas as advanced as genomics and aeronautics. Then came the financial crash and we lost our momentum."

Given this history, it must be dispiriting for scientists like Marzuki to look at the statistics of student mobility today. Indonesia has an estimated 6,000 foreign students, which is dwarfed by Malaysia's close to 100,000.[151] Malaysia turned its education system around through dedicated reform. When it realised that it was spending an enormous amount of money sending its students abroad – in 1995, the government was sending 20% of its students overseas – it devised strategies to keep them at home. Malaysia began partnering with foreign universities to become an international hub of higher education. Now, the country attracts about 100,000 foreign students but wants to double this to 200,000 by 2020.[152] The proportion of Malaysian students in foreign countries has dropped as a result of its educational reform. In 1997, it sent 14,527 students to the USA; by 2006, this number had fallen to about a third at 5,515.[153]

Other South-East Asian countries are just as ambitious in their plans to attract foreign students. Taiwan plans to increase the number of foreign students from 40,000 currently to 100,000 in 2015 and 150,000 by 2020. Singapore wants to draw in 150,000 foreign students by 2015 from just over 90,000 now. All of this pales into comparison to China's goal of 500,000 foreign students by 2020 from 240,000 in 2012.[154]

Indonesia's Ministry of Education and Culture is trying to increase the number of scholarships it offers to international students. For instance, since 1993, the Indonesian Government has offered the KNB Scholarship (Developing Countries Partnership Program on Scholarship) to international students from other developing countries, particularly those who want to build careers in educational

150 Nederstigt, W., & Mulder, M. (2011). *Competence based education in Indonesia: evaluating the matrix of competence-based education in Indonesian higher education,* In: Deitmer, L., Gessler, M., Manning, S. (Eds.), *Proceedings of the 2011 ECER VETNET Conference 'Urban Education',* Berlin, Germany.

151 Foreign students in Indonesia mostly Malaysian. Waspada online. May 23, 2011.

152 Blessinger, P., & Sengupta, E. (2012). *Is Malaysia the regional leader in international higher education?,* 2nd July 2012, Guardian, London, UK.

153 Sirat, M. (2008). *The impact of September 11 on international student flow into Malaysia: lessons learned.* International Journal of Asia Pacific Studies, 4, 79-95.

154 Sharma, Y. (2012). *Foreign students are part of 'soft power', but targets are ambitious, 14th August 2012,* University World News, London, UK.

or government institutions, as the focus of the scholarship is on development. The students can choose a masters program in one of 13 universities in Indonesia. By 2011, Indonesia had granted the scholarship to more than 460 students from 44 countries.[155]

Once again, language is a barrier, however. The KNB scholarship requires that the student learn Bahasa Indonesia for 8 months, since lectures will be taught in the language, and the student will also need to write their dissertation in Bahasa Indonesia.[156] This seems an extreme requirement since, for example, a student travelling from the UK to France, with only a basic grasp of French, would not expect to write a masters thesis in French.

It is just as important for lecturers to have experience working abroad, and in 2012 the Ministry of Education (DIKTI) launched the Scheme for Academic Mobility and Exchange, a new incarnation of its Academic Recharging Program.[157] The idea is that lecturers holding doctorates or professorships can work abroad in foreign institutions for 2 weeks to 3 months, soaking up the working environment in another country, learning new techniques and making contacts.

2.9 The Indonesian diaspora

Although Indonesian scientists do travel abroad to study and work, the Indonesian academic diaspora is not extensive, in large part because of mandatory regulations on the government scholarships they receive. Most grants require the individual to return to their Indonesian university or institution and work for twice as long as the duration of their scholarship, sometimes longer.[158]

Once back home, researchers often become too embedded to leave again. For a PhD program, for instance, a scholarship might be as long as 4 years, and once the scientist has returned to Indonesia for another 8 years, they are likely to have built their career, and had a family, making it unlikely that they would uproot themselves and leave again.

Grants that are funded solely by industry or foreign organisations tend not to have this requirement, but almost all overseas scholarships are run with the collaboration of the Indonesian government's Ministry of Education (DIKTI), and thus Indonesian governmental strictures apply. For example, the Japanese government funds the Japan Indonesia Presidential Scholarship Program (JIPS)[159] to support PhD studies in an academic field of study covered by ten Indonesian Centers of Excellence, including the Bandung Institute of Technology and Bogor Agricultural University.

155 For more on the KNB scholarships, see: http://www.knb.dikti.go.id/

156 Jazidie, A. (2012). *KNB scholarship guidebook 2012,* Directorate of Institutional Affairs And Cooperation, and Directorate General of Higher Education Ministry of Education and Culture of the Republic of Indonesia.

157 Prasetya Online (2012). *Scheme Program for Academic Mobility and Exchange DIKTI 2012,* University of Brawijaya, Malang, Indonesia.

158 Inayati, T., Arai, T., Sarjono Putro, U. (2012). *Simulation analysis of brain drain phenomena from Indonesia using system dynamics,* International Journal of BRIC Business Research (IJBBR) 1, 1-14.

159 The Japan Indonesia Presidential Scholarship Program (JIPS). The World Bank: Washington, DC, USA.

The intention of this requirement is obvious, and understandable – if the scholarship comes from government funds, it is to see that the investment in the scientist is repaid, or if funded by a foreign country, to ensure that the money invested contributes towards Indonesia's economic and social development. Few Indonesians would argue that this is not a worthy national ambition. Nations such as China and India have seen their brightest researchers make careers in countries such as the UK and USA, never to return home. An estimate 90% of doctorate students in the USA from China and India never leave.[160] Now, these countries are desperately trying to staunch their brain drain, and are devising incentive schemes to draw these scientists back home to boost their own R&D systems.[161]

From an individual researcher's point of view, however, the demand to return home straight after a stint abroad can significantly stymie their career. Indonesia's laboratory infrastructure, funding and R&D resources are much poorer than any country its scientists would go to work or study in. Having just finished studying or working abroad, the Indonesian researcher is most likely to have made good contacts or begun working on interesting strands of scientific study; this is the time when they stand a good chance of being offered a job in a well-resourced laboratory to build their career. The right time to be required to return is after some postdoctoral work abroad that really launches a scientist on a research program.

As with all regulations in Indonesia, though, the requirement to return home is sometimes flouted since there seems to be little actual enforcement. Several scientists interviewed spoke of colleagues who they had worked with in countries such as Germany or the UK, and who had decided not to return, and do not seem to have been penalised by the Indonesian government. These researchers who decided not to stay tend to now be earning higher salaries than their counterparts who returned to Indonesia. But since there are seemingly no ramifications for ignoring the regulation, why most scientists abide by it is unclear – and unrecorded.

The moral and ethical imperative to return and repay their country's investment is one reason why researchers come home. What is also evident from even the briefest of encounters with the country is that both family ties and patriotism are valued extremely highly in Indonesian society. Most Indonesian scientists say that they would rather live and work in their home country, near their loved ones, rather than in a culture they are unfamiliar with. Another reason is probably that the host countries that take Indonesians on overseas programmes organise these projects in conjunction with the Indonesian government, and they may insist that the student or researcher return home so as to ensure good diplomatic relations.

160 Varghese, N. V. (2011). *Globalization and cross-border education: challenges for the development of higher education in Commonwealth countries,* International Institute for Educational Planning, UNESCO, Paris, France.

161 Subramanya, R. (2012). *Economics Journal: Who's Returning to India and Why? 18th April 2012,* The Wall Street Journal, New York, NY, USA.

To ease the difficulty that Indonesians may face on returning home after studying overseas, the National Development Planning Agency (BAPPENAS), has implemented an institutional initiative called the Human Development Plan (HDP) that ensures that institutions develop career plans for their domestic and overseas scholars. In time, this should mean that researchers don't suffer culture shock when they return home again.

2.10 The future of education

For a country that it is aligning all its political and scientific will towards becoming a knowledge economy, universities are the foundation. The type of education that students receive, the way those universities are run, and the amount of support that students receive in transitioning from study to work, whether home or abroad, are all key factors in ensuring a successful education system.

Indonesia's education experts are not lacking in vision. The former Director General of the Higher Education Ministry of National Education, Satryo Soemantri Brodjonegoro, envisioned that Indonesia's universities would one day "comprise a small core of faculty and a much larger periphery of experts of various kinds that are linked to universities in diverse ways. Universities will become a new type of "holding institution" in the field of knowledge production. Perhaps their role will be limited to accrediting teaching done primarily by others while, in research, playing their part by orchestrating problem-solving teams to work on fundamental issues".[162]

He also understood the need for universities to become competitive hubs of knowledge transfer: "In order to be effective in these spheres, the values of technology transfer will have to be brought from the periphery of universities, where they reside at the moment, to their core. Universities who are serious about playing a role in the complex game of technology interchange will enter into a complex array of partnerships, the dynamics of which will involve a combination of competition and collaboration."

This dazzling vision is a long way from where Indonesia's university systems currently stand. Universities have few resources for high-quality research, and staff either do not have the expertise or the time to push their research agenda. There is little exchange of knowledge between universities, or between universities and other institutions – especially industry. Its neighbouring countries have shown that it is possible to bring its education system into the 21st century, and Indonesia certainly has the manpower to do so.

162 Brodjonegoro, S. S. (2001). *Higher education reform in Indonesia,* Ministry of National Education, Jakarta, Indonesia.

3. Places

3.1 Diverse geography

While Indonesia extends over 17,500 islands and 741,000 square miles, only 6,000 are inhabited, and there are five main islands: Java, Sumatra, Borneo (Kalimantan in Indonesia), Sulawesi and New Guinea.

The islands are tectonically unstable, with volcanoes punctuating the land frequently. Earthquakes and landslides are an extremely common occurrence, but the biggest environmental disaster by far was the 2004 tsunami that devastated the region.

Figure 3.1 Map of Indonesia[163]

3.2 Urban domination

To say that much of life in Indonesia's urban sprawls like Jakarta is spent in traffic jams would not be facetious. Like many developing countries, Indonesia is rapidly becoming urban, with the proportion of people living in urban areas steadily increasing. In 2012, the proportion was 51%, and it is still rising.[164] The cities' infrastructure meanwhile is woefully equipped to deal with the number of people continually flooding into its cities.

Many researchers interviewed said it is not unusual to spend up 6 hours commuting each day. The costs of living in Jakarta means that most scientists cannot afford to live in it, and commute from the outskirts, from areas such as

163 Wikimedia Commons

164 Source: The World Bank (2013). *World Development Indicators. The World Bank,* Washington, DC, USA.

Bogor, for instance. But traffic jams can easily turn a 1.5 hour drive into a 3-hour crawl.

The archipelago holds enormous cultural and ethnic diversity – there are about 250 different ethnic groups, and as many languages spoken throughout the islands, though the national language is Bahasa Indonesia. Yet the island of Java, and Jakarta in particular, still dominates, despite Indonesia's extensive decentralisation. It contributes the lion's share (62%) of regional GDP to national GDP; by contrast, Sumatra, twice as big as Java geographically, contributes 21.55%.[165] Universities and research institutes are also concentrated in Java.

3.3 Decentralisation

After the end of the Suharto regime in 1999, Indonesia began an extraordinary process of decentralisation, transferring power from central government to local districts, and allowing each district to elect its own democratic leader.[166] In just a few years, it went from being highly centralised to almost totally decentralised.

On the whole, devolution has created harmony between the islands, and prevented the dissolution of the Indonesian state. It also has helped end, or at least weaken, attempts at regional secession. For instance, the 2005 agreement to make Aceh autonomous ended the 30-year secessionist war that had claimed thousands of lives.[167]

However, decentralisation has also brought with it increased bureaucracy, and administrative confusion, that has sometimes brought decision-making to a standstill. The duties and accountability of each tier of administration – districts, provinces and central government- is still muddled, says a 2009 UNDP report on the role of provincial governments.[168]

For example, Indonesia's 33 provincial governments are an interim layer of governance, below central government and above district or city government. However, since the provinces have no real administrative power over the districts, it renders their role in monitoring and coordination of districts to aid central government largely ineffectual. In addition, despite decentralisation, Jakarta is still responsible for raising and distributing most of the country's financial resources, which means that the districts have enormous power to spend money they are not required to raise.

From a researcher's point of view, decentralisation significantly increases the number of hoops needed to jump through for research permits. This is particularly relevant in environmental and agricultural research, two of Indonesia's key research foci, where scientists often need to work on projects in different districts to gather different types of data. In theory, each district must supply individual

165 Indonesian National Development Planning Agency (2010). *The National Medium-Term Development Plan (RPJMN) 2010 – 2014.* BAPPENAS, Jakarta, Indonesia.

166 The Economist (2009). *Things do not fall apart because the centre does not hold, 10th September 2009,* The Economist, London, UK. 10 September 2009.

167 Pan E (2005). *Indonesia: the Aceh Peace Agreement.* Council on Foreign Relations: Washington, DC, USA.

168 See http://www.undp.or.id/pubs/

permits for one research project, but the confusion in legal jurisdiction can mean that a district refers a scientist to central government, which might then refer the scientist back to the district, and going back and forth wastes valuable time and resources (see Box 7.1).

3.4 Regional hubs

Just as Indonesia's geography is distinctly different, its regions have different scientific specialties or foci. Much is concentrated in Java, though the country would like to decentralize this further.

3.4.1 Yogyakarta: university hub

Yogyakarta, or 'Yogya' as it is often referred to, has always held a special status in Indonesia, and has long been a seat of cultural and academic learning. Unusually, the region is still run by royalty – Sultan Hamengkubuwono X, who is also the governor of Yogyakarta. The sultanate is inherited, and attempted changes by central government to democratize this process were met with strong protests.[169]

The region is widely acknowledged as Indonesia's hub of higher education, with a higher density of universities than anywhere else in the country.[170] The Islamic University of Indonesia, the country's oldest private university, is based in Yogyakarta. The city is also home to Gadjah Mada University (UGM), one of the country's top universities.

3.4.2 Bandung: technology

The Bandung Institute of Technology (ITB), founded in 1959, has become a highly respected hub of innovation and technology research in Indonesia.[171] The university has had several notable alumni including several key politicians and Indonesian leaders. Its first president, Sukarno, is also an ITB alumnus, having earned a civil engineering degree from the institution. ITB ranks as one of the top higher education institutions in Indonesia, remaining the top choice for many Indonesians. It describes itself as a "research and development university", and has identified seven priority research areas for the decade up to 2020, namely infrastructure and disaster mitigation; energy; information and communication technology (ICT); food, health and medicines; cultural products and the environment; nanotechnology and quantum technology; and biotechnology. In 2004, it set up a business and management school to try to produce more critical thinkers who could improve the country's competitiveness.

3.4.3 Bogor: agriculture

Entering Bogor's leafy surroundings, it is immediately clear why this is the country's agricultural hub. Located south of Jakarta, and north of Bandung, the

169 The Economist (2012) *Yogyakarta's sultans carrying on, 6th September 2012,* The Economist, London, UK.

170 Data from British Council, Hong Kong.

171 See http://www.itb.ac.id/en/about-itb/

area is more rainy and humid than most other parts of the island. During Dutch colonization, Bogor began to become a hub of agricultural and biological research. Now it houses ten of the 12 research centres of the Indonesian Agency for Agricultural Research and Development, which is the research arm of the Ministry of Agriculture.[172] These centres coordinate research on food crops, horticulture, livestock, veterinary science, soil quality, machinery development, biotechnology and agricultural technology assessment.

The region is also home to the headquarters of the Center for International Forestry Research (CIFOR). After the first Earth Summit in Rio in 1992, CIFOR opened bidding for the base of its activities. This was a big win for Indonesia, says forestry scientist Herry Purnomo, based in CIFOR in Bogor, as Malaysia had also bid to host the location of the headquarters. CIFOR works closely with the Indonesia's Ministry of Forestry, especially the Forestry Research and Development Agency (FORDA), as well as LIPI and Bogor Agricultural University (IPB) on issues such as deforestation and mitigating climate change.

3.4.4 Kalimantan: energy

Kalimantan, the Indonesian part of Borneo, is the country's energy and mining hub (It produced 93% of the country's coal in 2011)[173], and has been designated as the country's energy and mining 'economic corridor' in Indonesia's economic masterplan.

Oil, gas and mining are big business in Indonesia, contributing about 50% of the total GDP, but there is now increasing pressure on other sectors such as palm oil – plantations now occupy over half of the total plantation area in Kalimantan.

Kalimantan is expected to be a production and processing center for energy and national stock for mining. Since 2014, exporting raw mineral and coal will not be allowed; thus, Presidential Regulation no.3/2012 states that a minimum of 45% of Kalimantan must be a conservation and tropical forest protection area. In line with this, R&D in Kalimantan is going to focus on renewable energy and mining recovery.[174]

Some stakeholders related to coal R&D are BPPT (Technology Assessment and Application Body) and R&D Center for Mineral and Coal Technology. PLN Engineering (a state-owned electricity company) is collaborating with BPPT to replace gas extraction technology with eco-friendly energy (such as Geothermal Energy). LIPI, BPPT, local universities (University of Lambung Mangkurat, Universitas Tanjung Pura), Regional Reserch Agency West Kalimantan, and business (State Plantation) are discussing these issues, including how to incorporate energy-efficient use of palm oil.

172 See http://iaard.go.id/unker/

173 Ministry of Energy and Mineral Resources (2006). *Stastistik Batubara Indnesia,* ESDM, Jakarta, Indonesia.

174 Ministry of State for Research and Technology (2012). *Laporan Satu Tahun Peningkatan Kemampuan Iptek untuk Mendukung MP3EI (One Year Report for science and technology Capacity Development for MP3EI),* RISTEK, Jakarta, Indonesia.

RISTEK has provided research incentives since 2012 for two programmes – PKPP (Researcher and Engineer Capacity Development) and SINas (National Innovation System). There were 77 research topics under the PKPP program with a total funding of 19.25 Billion Rupiah or about 19 million US$. SINas Program has 13 topics funded by a total amount of 4.024 Billion Rupiah. The PKPP second period (PKPP II) has been given 2.75 billion rupiah.

In 2012-2013, research initiatives in Kalimantan will cover oil palm as biomass energy, and the application of revegetation technology and land-recovery after mining production.

4. Business

Indonesia's economy has until now remained strong, but there are fears that its dependence on an export market for unprocessed natural products (which is faltering given the financial shakeup suffered by China and India, key importers of Indonesian products), could spell tough times ahead, notwithstanding Indonesia's relatively high domestic demand and the greater export-to-GDP ratios of some of its neighbours discussed in Chapter 1.

The country also lacks the processing power to exploit its own resources and ships out pretty much everything it extracts from its natural reserves. This means that it loses out on higher-value exports, and also needs to re-import some of the processed materials it exported in the first place. It will need to significantly build its manufacturing base, as this is a necessary prelude to a country developing a robust innovation system.

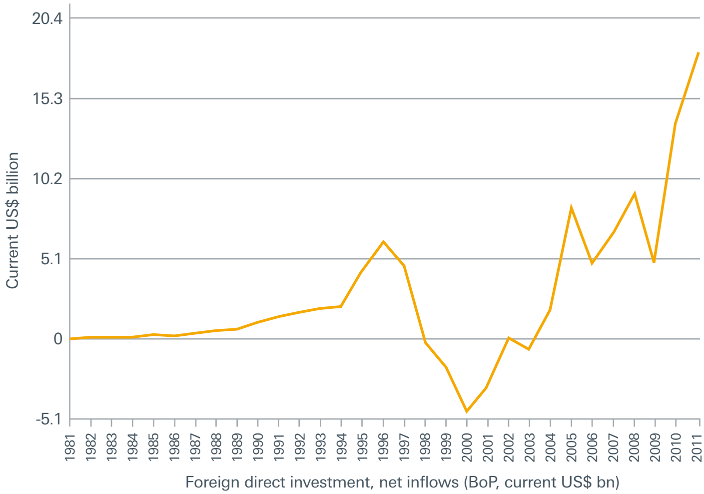
4.1 Squandering investments?

Indonesia's efforts to attract foreign direct investment (FDI) after Asia's financial chaos in the late 1990s has finally paid off; the level of FDI has recovered from a low of a negative investment of US$ 5 billion in 2000, soaring to a high of just over US$ 18 billion in 2011.[175] The 2008 global financial crash saw investment dip to US$ 4.8 billion in 2009, but this soon recovered.

By contrast, neighbouring countries like Malaysia, which saw investment fall to US$ 1.4 billion, have been slower to recover, and FDI reached US$ 10.8 billion in 2011.

175 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

Figure 4.1. Net inflows of foreign direct investment 1981 – 2011[176]

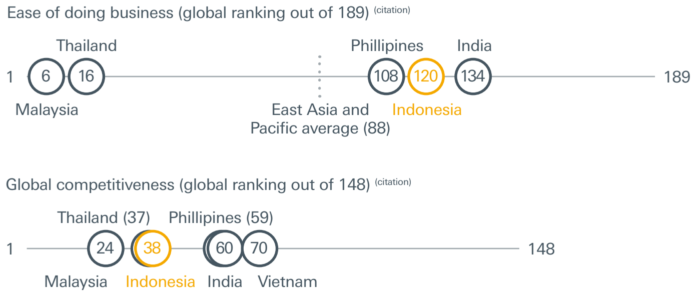


However, while Indonesia attracts a considerable level of FDI, some argue that this is not a major vote of confidence in Indonesia's capacity to absorb the investment, but instead because the pull of its abundant natural resources and large consumer class is substantial enough for investors to overlook a confusing policy and regulatory framework and poor infrastructure.[177] In general, Indonesia fares poorly on international indices of ease of doing business, compared with neighbours like Thailand and the Phillipines (Table 4.1), although it does fare better on measures of global competitiveness (Table 4.2).

176 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

177 Indonesia Investment Coordinating Board(2010). *FDI strategy paper 2010.* BKPM, Jakarta, Indonesia.

Table 4.1 Indonesia’s ease of doing business[178] and global competitiveness[179]



The Indonesia Investment Coordinating Board (BKPM) is an intermediary between industry and government that is aiming to ramp up FDI into Indonesia, and ensure that these investments also lead to social change such as lower unemployment, better infrastructure, and technology transfer.

According to its strategy outlined in 2010, the BKPM is looking to broaden Indonesia’s investment base, and ensure that significant investment is channeled into both hard infrastructure (eg roads, power-generating capacity) and soft infrastructure (eg health services, education). To harmonise with Indonesia’s bid to become a knowledge economy, the BKPM also wants to produce a globally competitive workforce who can push the economy locally, and also through international collaborations.[180]

4.1.1 Investing in infrastructure

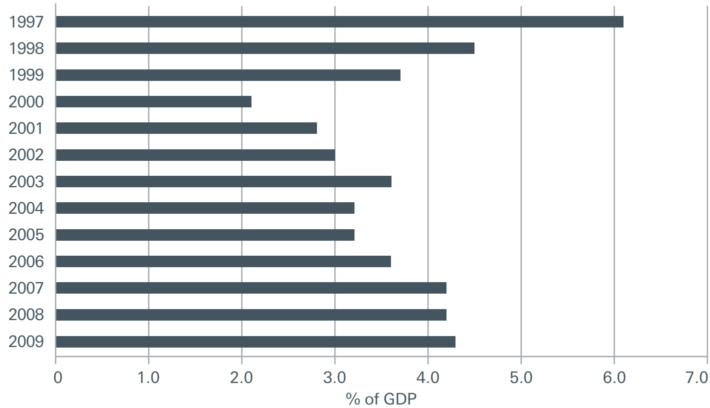
As well as driving foreign investment to have a bigger impact on infrastructure, it is clear that Indonesia needs to ramp up its own investment in infrastructure. This still hovers at about 4% of GDP, having never regained a high of over 6% in the late 1990s. But by 2005, investment levels in other countries such as Thailand and Vietnam were over 7%, which means that Indonesia has some catching up to do (see Figure 4.2).

178 World Bank (2014): Doing Business (2014). Economy Profile: Indonesia. World Bank: Washington, DC, USA.

179 World Economic Forum (2014). The Global Competitiveness Index 2013-2014. World Economic Forum: Geneva, Switzerland.

180 BKPM – Indonesia Investment Coordinating Board (2010). FDI Strategy Paper 2010.

Figure 4.2 Indonesia's infrastructure investment as a percentage of GDP[181]



Improving its investment will be critical if it is to transition to a knowledge economy – even the best-laid plans will not succeed if built on a crumbling foundation.

The new long-term national development plan and economic masterplan (MP3EI) both suggest that after decades of neglect, Indonesia is finally accepting that it must invest in infrastructure. For instance, it plans to spend about US$250 billion on infrastructure in six "economic corridors", including tourism and energy generation, between 2011 and 2025.[182]

These infrastructure investments will particularly focus on transport, improving airports, railways and roads, to improve connectivity between the islands and also between urban and rural areas. A planned US$1.5 billion refurbishment of Jakarta's Soekarno-Hatta International Airport intended to cater for 60 million passengers a year should improve connectivity to some extent. When the airport was built back in 1985, it was only designed with 20 million annual passengers in mind, whereas recent years have seen 50 million stream through it.[183] Developing the Sunda Strait Bridge which connects Sumatra and Java island would boost resource-based development in Sumatra and industrial-markets based in Java,[184] and create large multiplier effects economically, socially, and environmentally

181 Source: The World Bank (2013). *World Development Indicators.* The World Bank, Washington, DC, USA.

182 Coordinating Ministry For Economic Affairs (2011). *Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011 - 2025,* Coordinating Ministry For Economic Affairs, Jakarta, Indonesia.

183 Pathoni, A. (2012). *High hopes riding on Jakarta's airport, 11th October 2012, Wall Street Journal, New York, NY, USA. October 11, 2012.* http://blogs.wsj.com/searealtime/2012/10/11/high-hopes-riding-on-jakartas-airport/. Accessed October 11, 2012.

184 Coordinating Ministry For Economic Affairs (2011). *Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011 - 2025,* Coordinating Ministry For Economic Affairs, Jakarta, Indonesia.

to both islands directly. Indonesia's industrial expansion will require a bigger energy supply, but to fall in line with international climate treaties, it will need to devise ways to increase the capacity to generate more energy in a clean, non-environmentally threatening way.[185]

Yet time will tell how well the country implements these plans. MP3EI's infrastructure strategy relies on ambitious levels of private sector investment – its target is 50% of the total investment sum – and there are no details offered for how this will be generated, especially since private sector investment has been notoriously low in Indonesia because of a lack of incentives or regulation.[186]

4.1.2 Curbing corruption

Despite Indonesia's bullish economic growth and growing foreign investments, the fact remains that other countries and international companies tend to be nervous about collaboration because of the perception of corruption, and the related issues of weak regulatory frameworks.

Corruption is one of the country's major governance issues, and scandals make front-page headlines daily. Transparency International, a global NGO that fights corruption, gives Indonesia a corruption rating of 3, with 0 being totally corrupt and 10 being corruption-free, putting it on a par with India at 3.1 and China at 3.6.[187] Former President Yudhoyono warned that this pervasive corruption in parliament has negative effects on the country's economic growth.[188]

A 2010 study by the Asian Development Bank (ADB), the International Labour Organization (ILO), and the Islamic Development Bank indicates that the country is seen as having a weaker grip on corruption than it had before the 1997 Asian financial crash.[189] Moreover, businesses are not guaranteed to have contracts enforced, and the cost of enforcing a claim on a contract is roughly 123% of the amount of the claim – far exceeding 59% in Malaysia or 29% in Thailand.

All of this weakens the effectiveness of the government. In 2008, the World Bank Indicator for government effectiveness gave Indonesia a score of 47.3, one of the lowest in Southeast Asia. Singapore scored 100, Malaysia 83.8, Thailand 58.7, and the Philippines 54.9, with only Vietnam scoring below Indonesia at 45.3.[190]

185 Oberman R., Dobbs, R., Budiman, A., Thompson, F., & Rossé, M. (2012). *The archipelago economy: unleashing Indonesia's potential,* McKinsey Global Institute, New York, NY, USA.

186 Oberman R., Dobbs, R., Budiman, A., Thompson, F., & Rossé, M. (2012). *The archipelago economy: unleashing Indonesia's potential,* McKinsey Global Institute, New York, NY, USA.

187 Transparency International (2011). *Corruption Perceptions Index 2011,* Transparency International, Berlin, Germany.

188 Rondonuwu, O. (2012). *Indonesia president says corruption threatens economic growth, 16th August 2012,* Reuters, London, UK.

189 Asian Development Bank (ADB), International Labour Organization (ILO), and Islamic Development Bank (IDB) (2010). *Indonesia: critical development constraints,* ADB, Mandaluyong City, Philippines.

190 Asian Development Bank (ADB), International Labour Organization (ILO), and Islamic Development Bank (IDB) (2010). *Indonesia: critical development constraints,* ADB, Mandaluyong City, Philippines.

4.2 Industry R&D

Industry undertakes very little R&D in Indonesia. A survey by LIPI of over 1500 firms showed that only 12% invested in R&D.[191] The country offers little in the way of incentives for industry, though the government is keen to improve this. In large part, the corruption and lack of enforcement of contracts, discussed earlier, are enough of a disincentive for doing business in areas dependent upon R&D. Only when the industry feels that its investment in R&D will be protected will it invest to any degree.

Existing initiatives such as the Business Innovation Centre (BIC) and DRN's web-based OMRC (www.omrc-drn.or.id) are intended to bridge this disconnect.

Box 4.1 Kalbe Farma: Indonesia's pharmaceutical leader

Kalbe Farma is Indonesia's largest pharmaceutical firm, and is well known for its rags-to-riches history. The family-owned firm that began life in a garage in 1966 has expanded to become the biggest publicly listed pharmaceutical company in South-East Asia, with revenues of over IDR 10.9 trillion.[192]

With branches in nine South-East Asian countries, Kalbe spends more on R&D than any other Indonesian drug company. Even so, it only invests about 2-3% ($4.5 million) of its revenue in R&D.[193] This is less than half the amount spent by Indian drug firms, which invest about 6% on average, with some companies investing as much as 8.5%.[194]

Sitting across an enormous glossy wood boardroom table in the heart of Kalbe Farma's Jakarta offices, Johannes Setijono, the company's CEO, says that although the company does value R&D, and works in cutting-edge areas such as stem-cell science, much of its research is in, for instance, helping to implement clinical trials. The early research phases of these trials tend to be carried out by international companies, which Kalbe then collaborates with.

Setijono says that private companies like Kalbe collaborate only infrequently with government or university scientists, largely because of the major disconnect between the public and private sectors. "It's faster to do it ourselves," he says.

This disconnect manifests in two ways. One is in attitude. The fact that university researchers, for instance, don't just work in the lab means that their attention is divided by teaching and community commitments. Often, the organisation of university research teams means it can be unclear who takes

191 Simamora, N.G., (2011). *Indonesian Science and Technology Indicators,* Country report presented at the 2011 South East Asian Regional Workshop On Science, Technology, and Innovation Indicators, Hanoi, Vietnam, December 2011. Indonesian Institute for Sciences (LIPI), Jakarta, Indonesia.

192 Nonto, A. W. (2012). *Beyond pills and potions,* 3rd July 2012, The Jakarta Globe, Jakarta, Indonesia.

193 The Jakarta Post (2006). *Pharmacy industry needs to increase R&D spending, 20th March 2006,* The Jakarta Post, Jakarta, Indonesia.

194 Joshi, R., Tak, S. & Vaishnav, A. (2012). *Is pharma steering India's tryst as a major R&D hub? 17th July 2012,* Zee Research Group, Delhi, India.

responsibility for each aspect of the research. Universities and government in Indonesia can be extremely naïve in their understanding of commercialising research, which is obviously problematic for private organisations which need to be commercially viable.

The other barrier to collaboration is the legal tangle that surrounds intellectual property. In a university or government research institution, there are no clear guidelines or regulations on who – the researcher, the institution, or government – should receive profits from patent royalties. (For more on industry collaboration with public R&D institutions, see Section 7).

Kalbe's success is due in large part, says Setijono, because the founders had the foresight to realise that R&D can take years to pay off. Kalbe also cherry-picks from the best scientists, looking in particular for those who have been trained abroad. "In Indonesia, we have a lot of PhDs, but many don't have the right mind-set. If they are trained in universities or government institutions, they lack a systematic approach and the ability to see the bigger picture". Setijono would like to see the government offer tax incentives or subsidies to encourage them to invest more in R&D.

4.3 Entrepreneurship and innovation

On the face of it, Indonesia is a nation of entrepreneurs. Over a fifth – 55 million of its 248 million – of its population are engaged in business.[195] It has seen a steady rise in business-start ups, a mark of the growth of entrepreneurship, with around 25,000 new businesses registered in 2007, rising to 29,000 in 2009.[196] This is a positive trend. However, when contrasted with India, for instance, where new business registrations have shot up from 20,000 in 2006 to nearly 85,000 in 2008, it's clear that Indonesia needs to do much more to encourage entrepreneurs.

But the scope of this business is still too small-scale. Much of the innovation done in business is small-scale – new fabrics or furniture design, for instance, rather than electronic or technological (see figure 4.3.1).[197] In addition, the onerous regulatory burden means that much business occurs in the informal sector; nearly one-third of firms in Indonesia start operating without being formally registered. The reluctance to register is not due to laziness, say business experts, but because the burden of local bureaucracy means that registering a business is complicated and costly.

Despite improvements in the past few years, starting a business in Indonesia is still harder than in Malaysia or South Korea, for instance. Indonesia has cut the cost of doing business, as a percentage of income per capita, from 30% to 22% between 2010 and 2012, but this is still higher than Malaysia's 16.4% or South Korea's

195 World Bank and International Finance Corporation (2012). *Doing business in Indonesia 2012,* The World Bank, Washington, DC, USA.

196 World Bank (2014). *World Development Indicators.* World Bank: Washington, DC, USA.

197 Interviews with staff and students at the Bandung Institute of Technology (ITB), Bandung, Indonesia.

14.6%. Similarly, setting up a business in Indonesia in 2012 requires going through nine bureaucratic processes compared with Malaysia's four (down from ten in 2010) or South Korea's three (down from eight in 2010).[198]

The small scale and excessive informality of business in Indonesia means that while many Indonesians go into business, these enterprises do not fuel the economy significantly and push economic growth. Ramping up the scale of business means pushing into areas that Indonesia still lags behind on, such as technology.[199] Until now, its entrepreneurs have had very little know-how or funding to do so.

Perhaps as a legacy of the financial crash in the 1990s, Indonesians do not like to seem to take risks financially. Any investment into research tends to go to studies that seem guaranteed to pay off. This stops it from seeing a major leap in the quality of R&D, and in its progress in innovation. This parsimonious attitude to R&D investment is in many ways because the economy grew suddenly. "Having only had money recently, it's almost as if the government isn't quite sure how to spend it," says Charaf Ahmimed, head of the Social and Human Sciences unit at UNESCO's Jakarta's office.

Angel investors and venture capital are uncommon in Indonesia, and what there is tends to be focused on ICTs rather than on STI. While concrete figures on the level of venture capital in the country are hard to come by, Indonesia ranks below Thailand but above the Phillipines and Vietnam in terms of how attractive it is to venture capitalists.[200] The Indonesian government is trying to stimulate entrepreneurship but so far these efforts have been through small grants and competitions. The past five years have seen several new initiatives, both domestic and international to boost Indonesia's entrepreneurial base.

One major push is an increase in entrepreneurial training. Indonesian entrepreneurs themselves believe that business education is key to making it big in industry.[201] In a survey of Indonesian entrepreneurs, 98% felt that programmes at universities or business schools would help promote entrepreneurship. In addition to state-run programmes such as the University of Indonesia's Center for Entrepreneurship Development and Studies (CEDS),[202] private universities such as Ciputra University are opening entrepreneurship centres to train the next generation of Indonesians.[203]

In addition, business consortia with partners from Indonesia as well as the West are starting to promote entrepreneurship through conferences and mentoring programmes, as well as through networks that help entrepreneurs access angel

198 World Bank and International Finance Corporation (2012). *Doing business in Indonesia 2012,* The World Bank, Washington, DC, USA.

199 Jones, C., Austin, J. E., associates for USAID (2010). *MEASURE: Indonesia – the enterprise development diagnostic tool,* USAID, Washington, DC, USA.

200 Groh A, Liechtenstein H and Lieser K (2013). *The Venture Capital and Private Equity Country Attractiveness Index 2013 Annual.* IESE Business School, University of Navarra: Barcelona, Spain.

201 Ernst & Young (2011). *Entrepreneurs speak out: a call to action for G20 governments, at The Nice Cote d'Azur 2011 Entrepreneurship Barometer,* Ernst & Young, London, UK.

202 See http://ceds.ui.ac.id/

203 See http://www.ciputra.ac.id/

investors and other sources of finance. The Global Entrepreneurship Program Indonesia (GEPI) was founded by 13 business leaders in Indonesia, under the aegis of a US State Department programme called the Global Entrepreneurship Program. GEPI includes exchange programmes in which entrepreneurs from Indonesia work in the US and vice versa.

These schemes are promising, and should draw more funds for science, but researchers agree that in general, they will really only take off if industry investors in R&D become slightly less risk-averse and realise that investing in R&D is not guaranteed to pay off financially, and even if it does, the pay-off may not be realised for a decade or more.

4.4 Science and technology parks

Puspiptek Centre of Science and Technology was BJ Habibie's dream for Indonesian science. Established in 1976, it spans 420 hectares and was designed to hold 30 laboratories. The laboratories hold technicians from LIPI, BPPT, and BATAN as well as two laboratories supervised by the Ministry of the Environment. The hub was intended to provide an incubator both for cutting-edge innovation in the public sector, but crucially, to bridge the public and private sector, says Wisnu S Soenarso, Chairman of Puspiptek, Director of the S&T Supply and Demand Network in RISTEK, and the chairman of Puspiptek Center Office.

Despite the intentions, 36 years after it was set up, the centre still has no private industry occupying the laboratories. Since Sardjono admits that it offers no incentives for business, it is not surprising that private industry is unwilling to relocate to the park, which sits 30 km south of Jakarta in Serpong.

In many ways, Puspiptek is a reminder of the gap between some of the country's scientific goals and its capacity to implement. In the economic masterplan, Puspiptek has a central role and is due to be "revitalized" as a centre for science and technology.[204] In RISTEK's planning, this will be achieved through: (i) modernising facilities and infrastructure, creating laboratories for machinery and production techniques, such as large object 3D photo-scanning cameras, heavy duty lathe machines and heavy duty boring and milling machines; (ii) incentives for research and start-up capital; (iii) establishing intermediary institutions and technology incubators.[205]

A long term plan was developed during a 2011 Science and Technology National Coordination meeting which envisions limited operations in the near future during a period of consolidation, strengthening infrastructure and regulation, before Puspitek can perform two crucial roles by 2015: a business incubator and a high-tech industrial zone. Several universities, such as the University of Indonesia, have tried to engage with the technology park, says Triarko Nurlambang, "but it remains mainly unsuccessful due to its weaknesses in meeting industry's needs."

204 Ministry of State for Research and Technology (2011). *Developing Indonesia STP To Support National Economic Agenda, November 18, 2011,* RISTEK, Jakarta, Indonesia.

205 See http://ristek.go.id for more information.

5. Culture

5.1 Politics and governance

It has been argued, most recently in the national press, that openness and transparency are crucial to improving Indonesia's governance.[206] Indonesia has overwhelming difficulty in ensuring effective implementation of policies; in other words, actions often don't match words. Many NGOs also accuse Indonesia's law-enforcement officials of mistreating marginalised groups like drug users with impunity, by subjecting them to sexual assault and physical torture.[207]

The lack of accountability plays out in science and technology too: environment researchers say that illegal logging or poaching often goes unpunished, and government science and technology researchers across the country are still waiting for long-promised pay hikes – many researchers interviewed for this study actually laughed when asked whether the country would achieve an R&D spend of 1% of GDP. When the country has failed to achieve even a fraction of that, it seems incomprehensible that the country would suddenly multiply its spending to that degree.

5.2 The gender factor

While science is starting to see increasing numbers of women, especially in senior positions, in many countries around the world, men still outnumber women. According to the World Economic Forum's 2012 Global Gender Gap Index,[208] which ranks countries according to gender disparities in economic, political, and education indices, Indonesia ranks 97 out of 135 (falling from 90 in 2011). Unfortunately, Islamic countries feature highly in the bottom-ranked countries, with Yemen, Pakistan, Saudi Arabia, Iran and Egypt all in the bottom fifteen. Some OIC countries do rank highly, however, with Mozambique for instance at 23. What is striking is that although both Mozambique and Indonesia score equally highly in equality of education attainment and health survival in men and women, Indonesia fares much worse in women's economic participation and economic empowerment. Clearly, ensuring a decent science education is not enough.

In Indonesia, men and women are equally represented in universities and research institutes, according to a study by Women in Global Science & Technology (WIGSAT) on gender equality in six countries, including Indonesia.[209] University rectors, for instance, say they have no specific policies to attract women, and researchers agree too that women are not discriminated against in career progression.

206 Parker, E. (2013) *Why openness and transparency is crucial to improving Indonesia, 22nd May 2013,* The Jakarta Globe, Jakarta, Indonesia.

207 Open Society Foundation (2012). *Stop imprisonment, time for rehabilitation. Monitoring and documentation report of police abuse against people who use drugs in Indonesia.* Open Society Foundation, New York, NY, USA.

208 Hausman, R., Tyson, L.D., & Zahidi, S. (2012). *The global gender gap report 2012,* World Economic Forum, Geneva, Switzerland.

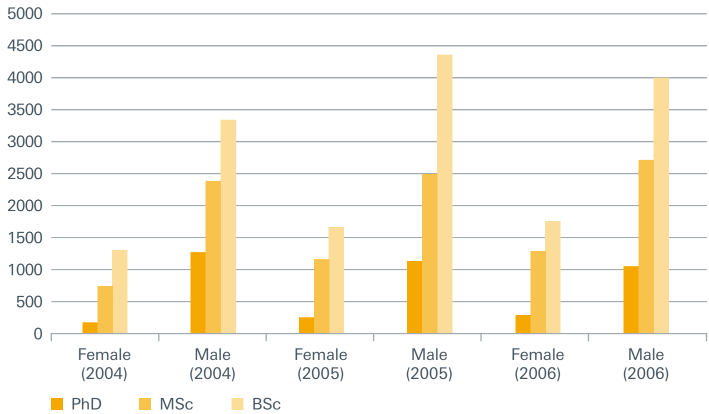
209 Hermawati, W. & Saari, R. (2011). *National assessment on gender equality and the knowledge society: Indonesia,* Centre for Science and Technology Development Studies, Indonesian Institute of Sciences (LIPI): Jakarta, Indonesia.

However, the notion that men and women are equally represented is often anecdotal, says Syamsiah Ahmad, former member of the UN Committee on the Elimination of Discrimination against Women (CEDAW). For example, less than 30% of key decision-makers in Indonesia's major government research institutions are women (see figure 5.1). Even major research institutions rarely disaggregate data on staff gender, which means there is little concrete evidence on how many women attain senior posts, or how much they publish (and how often their work is cited) compared with male peers. "Only by systematically collecting such data will we know how equitable Indonesia's research environment really is," says Ahmad. The data that do exist for government R&D institutions suggest that there is some way to go in achieving equal representation (see figure 5.2).

Figure 5.1 Numbers of men and women in positions of Director, Vice Director, Executive Secretary or Deputy Head, 2012[210]

210 Hermawati, W. & Saari, R. (2011). *National assessment on gender equality and the knowledge society: Indonesia,* Centre for Science and Technology Development Studies, Indonesian Institute of Sciences (LIPI): Jakarta, Indonesia.

Figure 5.2 Numbers of male and female researchers in government R&D institutions according to education level[211]



The idea that women have no trouble being hired as a scientist is widely agreed on; dig below the surface, however, and it is clear that women do face problems when they decide to combine a research career with family life. Female scientists who become mothers have very little childcare support; the traditional societal set-up means that young parents tend to rely on family members for childcare. When many researchers in a city like Jakarta travel 2 or 3 hours each way to their lab, this system doesn't work any more. Although the government has this year introduced policies to create nurseries and crèches in work environments, many institutions are yet to implement it.[212]

The outlook for Indonesia seems positive overall, however. The general consensus among researchers is that women should be encouraged and supported in science careers, and while women are still not as fully represented as they should be, the government has created an enabling policy environment. In 2000, the government incorporated gender mainstreaming into the national development plan, and over the past decade, Indonesia has ratified various covenants – such as the International Covenant on Economic, Social and Cultural Rights – to promote gender equality. In 2013, 19% of parliamentary seats were held by women – higher than the US (18%). In comparison with other Islamic countries, Indonesia's representation of women in parliament far outpaces that of Malaysia (10%), Nigeria (7%), and Iran (3%), though it lags behind Pakistan (21%), Kazakhstan (24%), Senegal (43%) and Iraq (25%).[213]

211 Ministry of Research and Technology (MORT). Survey Report of Governemnt R&D 2004, 2005, 2006. Ministry of Research and Technology: Jakarta, Indonesia.

212 Interview notes from closed workshop with LIPI staff, 28th June 2012, Jakarta, Indonesia.

213 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

Prizes such as the L'Oreal-Unesco Fellowship for Women in Science try to promote female researchers. Yanti, who like many Indonesians goes by one name, a 34-year-old biotechnology researcher at Atmajaya University, and one of three women to be given the L'Oreal award in 2010,[214] believes that women need to be encouraged into science right from high school. "Most high schools in Indonesia do not have good lab facilities, and they only learn subjects theoretically. Women scientists need to be a role model for female high school students to motivate them to learn both life sciences and engineering".

5.3 Social conscience

Indonesian education drives home the concept of community service right from university. Introduced during Suharto's regime, the creation of "good Indonesian citizens" is embedded into the compulsory national curricula of all universities, and forms a substantial part of the study programmes.[215]

Despite how it might seem, this inculcating of national spirit seems to result in a genuine warmth and affection of its citizens for helping to drive development. While the government requires researchers who study abroad to return home for several years, many scientists say they would want to come home anyway. One researcher at UGM said proudly "my blood is red and white (the colours of the Indonesian flag) so that's why I came back to Indonesia".

5.4 The Islamic influence

Indonesia's official ideology, Pancasila, recognizes five official religions including Islam,[216] which is the dominant religion (just over 86% of the population are Muslims).[217]

The role that Islam should play in Indonesian science, how Islam and science should interact (if at all), and how much the country should engage with other Islamic countries is a matter of debate in Indonesia; as is the relationship between science and religion all over the world. From the research conducted for this report, it would appear that many Indonesian scientists perceive science and religion as operating in separate spheres of influence.

Regarding the relationship between science and religion, scientists like Sangot Marzuki claim that if science is neutral, then religion does not come into it. "Indonesia does not place any restrictions on the type of research done, and it has a liberal policy on potentially controversial issues like stem cells" he says.

214 Sabarini, P. (2010). *Yanti and Noryawati Mulyono: Atmajaya's young scientists, 17th December 2010,* Jakarta Post, Jakarta, Indonesia.

215 Nederstigt, W., & Mulder, M. (2011). *Competence based education in Indonesia: evaluating the matrix of competence-based education in Indonesian higher education,* In: Deitmer, L., Gessler, M., Manning, S. (Eds.), *Proceedings of the 2011 ECER VETNET Conference 'Urban Education',* Berlin, Germany.

216 Weatherbee, D. E. (1985). *Indonesia in 1984: Pancasila, Politics, and Power,* Asian Survey, 25, 187-197.

217 Central Intelligence Agency (2012). *The World Factbook: Indonesia,* CIA, Langley, VA, USA.

Professor B J Habibie attempted to initiate a discourse on the "Islamisation of Science" by Indonesian scientists belonging to the Association of Indonesian Islamic Scholars (ICMI) in the 1980s and 1990s,[218] although there is little evidence to suggest it had a major impact on the actual practice of science.

Perhaps any future discourse will centre, as it does elsewhere in the Islamic world, around how the spirit of the 'Golden Age' of Islamic world science, as practiced in the Middle Ages in places such as Baghdad, Cairo and Cordoba, can be channeled into a renaissance of science in the Islamic world, and to further advance the frontiers of learning, curiosity and free enquiry across it.

Many scientists, however, believe that there are some areas of science in which Islamic countries could usefully collaborate. Halal science – the development of products that meet Islamic religious requirements – is a growing industry. The field has tended to focus on food, to ensure that food products are not contaminated with pork or alcohol, but increasingly it is branching out to develop vaccines not made with pig tissue or cells.

Indonesia is starting to venture into halal science, collaborating with neighbours such as Malaysia and Thailand. The Bogor Agricultural University (IPB) established a Halal Science Centre in 2008 to try and develop a halal quality assurance programme to provide a halal stamp of approval on products.

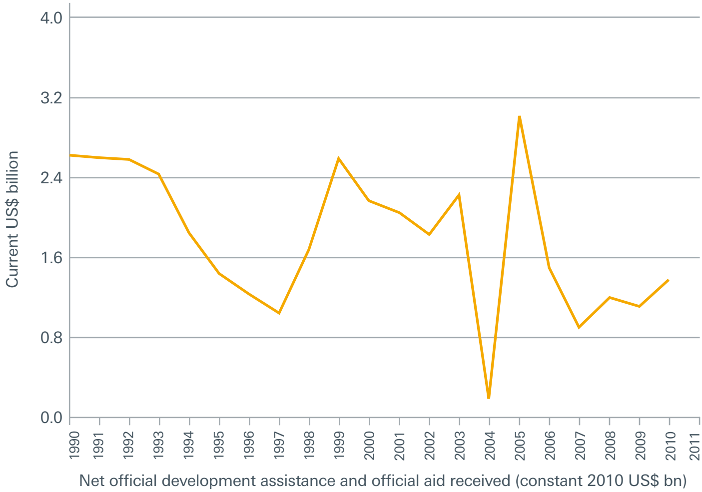
Broadly speaking, Indonesia seems keen to play a larger role in the Muslim world. In February 2013, for instance, it will host the first meeting of the Organization of Islamic Cooperation's (OIC) Human Rights Commission. If the Middle East took a greater leadership role in driving science in Islamic countries, "it would be good for Islam and good for the environment," says Herry Purnomo, a forestry scientist at CIFOR in Bogor.

Indonesia still receives substantial amounts of overseas development assistance and aid. In 2005, it received a staggering US$3 billion in aid, and though that has been steadily reducing, in 2010, it still received US$1.4 billion (see figure 5.3). Some scientists believe that Islamic cooperation would be improved by richer Islamic countries becoming more prominent donors to poorer Islamic nations such as Indonesia, as this would make more sense than continuing to receive aid from countries such as Norway or Spain. While there is very little data on the proportion of Indonesia's total aid that comes from Islamic countries, OECD data does show that the Islamic Development Bank gave US$17.2 million in aid in 2010. Meanwhile, in 2009, the UAE donated US$2.5 million, but this went down to US$0.46m in 2010 and US$0.17m in 2011.[219] The spike in 2009 seems to have been for tsunami-related reconstruction and redevelopment.

218 See http://www.icmi.or.id/

219 Source: OECD Statistics (2012). Organisation for Economic Cooperation and Development:, Paris, France.

Figure 5.3 Net development assistance and aid to Indonesia 1990 – 2010[220]



5.5 Communication

The openness and quality of media such as newspapers, radio and television tend to be good indicators of the transparency of governance. When Indonesia emerged from Suharto's regime in 1998, the heavily government-controlled media was suddenly given an unprecedented level of freedom.

However, while Indonesian media is no longer censored by the government, the fact that a few powerful players, mostly based in Jakarta, control much of television and radio still means that coverage is skewed to issues affecting Javanese people.[221]

Although the media is largely uncensored now, challenges for communicating science and technology remain. Few people use newspapers or the internet – two key sources of science news. A 2009 survey by the International Republican Institute shows that 82% of people got their information about politics from TV, 42% from friends and family, followed by 26% from the radio, and 23% from newspapers.[222]

220 Source: OECD Statistics (2012). Organisation for Economic Cooperation and Development:, Paris, France.

221 Wagstaff, J. (2010). *Southeast Asian media: patterns of production and consumption,* Open Society Foundations, New York, NY, USA.

222 International Republican Institute (2009). Indonesia overview. International Republican Institute: Washington, DC, USA.

While Indonesia is starting to connect up to the worldwide web, the proportion of the population who use it is low compared with other South-East Asian countries. In 2010, just 9.1% of Indonesians were Internet users,[223] compared with 21.2% of the population in Thailand, 25% in the Philippines, 27.6% in Vietnam, a staggering 55.3% in Malaysia and 70% in Singapore. Most OIC member states have higher proportions of Internet users too – in the same year, there were 26.7% in Egypt, 38% in Jordan, 41% in Saudi Arabia, and 39.8% in Turkey.

5.6.1 Science journalism

"The general public is not science literate", says Ninok Laksono, a veteran Indonesian science journalist, who often engages with government on improving science policy. "It is so regrettable that some Indonesians are happy using gadgets like mobile phones but have no interest in understanding the science and technology of the gadgets they love so much."

Laksono has seen Indonesian media open up dramatically, and seen it change to include coverage of science, where "previously it was dominated by politics, economics, and culture". But in general, he says, science coverage is not especially critical of government policy, nor does it provide any in-depth analysis. "In general, science has not been seen as something important or strategic to help our nation progress".

Ella Syahputri, an editor for Antara News Agency, the government-owned news agency, agrees. "Science news remains the last priority, behind news on issues like law enforcement, politics, election, corruption or scandals. It is almost impossible to find a science story on the front page of a newspaper."

Most media coverage of science is "shallow and superficial, or just reproduced from other international publications such as the BBC," says Harry Surjardi, a science journalist who has been covering environment and technology in Indonesia for 20 years. A former Knight International Journalism fellow, Surjardi wants to engage rural populations in decision-making on science and technology (see Box 5.1).

223 International Telecommunication Union (2010). *Percentage of individuals using the Internet, 2000-2010,* ITU, Geneva, Switzerland. accessed 16 August 2012.

Box 5.1 Spotlight: Engaging the public in science

In developing countries, the voice of rural communities is heard far less often than that of their urban counterparts. Remote regions have little access to the urban hubs where decisions are made, business is done, and the media congregate. News comes to rural areas from big cities, but rarely goes the other way; the lack of communication networks in rural areas often means that news in rural areas can be hard to transmit.

Harry Surjardi is all too aware of the environmental destruction that happens on a daily basis in Indonesia with little punishment or reprisal, having covered these issues for so long for one of the country's main daily newspapers Kompas. In 2007, Surjardi launched a mobile environmental news service for rural Indonesians, in which he trained 150 'citizen journalists' living in remote Kalimantan to send SMS text messages to Ruai TV, a provincial station, on issues such as illegal deforestation or roads that had been damaged by trucks but never repaired.

These messages provided real-time updates on local news that would then show on the station's news ticker. The citizen journalists have already had an effect – a multinational palm oil company was forced by the government to repair roads and property it had damaged and to hire local rather than foreign workers. Surjardi is now launching a bigger SMS service to cover the whole of the country.[224]

224 For more on Harry Surjardi's project see: http://www.icfj.org/about/profiles/harry-surjadi

5.6.2 The language barrier

The English language has become the lingua franca of science and researchers around the world increasingly feel pressured be able to converse in it fluently if they are to be part of the global scientific community. More to the point, most scientists aim to publish in major international English-language journals, which carry a much higher cachet than local journals.[225]

This domination of English has created tensions in much of the developing world, where the language may not be spoken to a high level in much of the population. While the legacy of British rule means that this is not as much of a problem in former colonies such as India, English is not spoken as commonly in other Asian countries such as China, Thailand and Indonesia. Indeed, a major barrier to Indonesian students or scientists studying abroad or collaborating globally is the poor level of English among many students and researchers in Indonesia, says UNESCO's Charaf Ahmimed.

In addition, in Indonesia, much of the information provided by government institutions is in Bahasa Indonesia and English translations are not always guaranteed. This creates a barrier to non-Indonesians who are trying to find information about the country or its institutions. Potential collaborators, such as marine biologist Paul Barber at the Indonesian Biodiversity Research Center (see box 7.2), admit that it is almost impossible to do business in Indonesia without speaking the local language.

The emphasis on achieving a good level of English also presents a dilemma for some researchers, as it unfairly tends to confer better visibility for a scientists' work if they can speak English well. Some scientists resent this bias, saying they would prefer to focus on their research on the basis that international journals will want to publish good science irrespective of the quality of the English the paper is written in. Most, however, are pragmatic and would like postdocs and students to improve their English to allow them to compete internationally, especially travelling abroad to work in other laboratories. Last year, LIPI launched an economic journal – the Review of Indonesian Economic and Business Studies (RIEBS) – in English rather than Indonesian, in a bid to increase its international profile.[226]

However, one scale of English proficiency suggests that Indonesians may not be lagging behind as much as researchers think. The International English Language Testing System (IELTS), jointly owned by British Council, IDP: IELTS Australia, and the University of Cambridge ESOL Examinations (Cambridge ESOL), measures both academic and general level English. Their 2011 data show that Indonesia's English proficiency among academics is actually higher than India, though lower than Malaysia.[227]

225 Meneghini, R., & Packer, A. L. (2007), *Is there science beyond English? Initiatives to increase the quality and visibility of non-English publications might help to break down language barriers in scientific communication,* The EMBO Journal, 8, 112-116.

226 Review of Indonesian Economic and Business Studies, http://www.riebs.org/.

227 International English Language Testing System (2011). IELTS Test takers performance 2011, British Council, London, UK.

Table 5.1 Average scores of English proficiency worldwide[228]

Country	Overall Score
Bangladesh	5.8
Brazil	6.7
China (People's Republic)	5.6
Colombia	6.2
Egypt	6.2
France	6.8
Germany	6.8
Ghana	5.4
Hong Kong	6.4
India	6.1
Indonesia	6.4
Iran	5.9
Iraq	5.7
Japan	5.8
Kenya	6.7

Country	Overall Score
Korea, South	5.9
Kuwait	5.2
Libya	5.4
Malaysia	6.9
Mexico	6.6
Nepal	6.0
Pakistan	5.8
Philippines	6.7
Qatar	4.9
Saudi Arabia	5.1
Taiwan	5.9
Thailand	5.8
United Arab Emirates	5.0
Vietnam	5.9

5.7 From policy to practice

Scientists around the world complain about the difficulties of getting policymakers to make evidence-based decisions, and Indonesian researchers are acutely aware of these issues in their own country. “90% of science policymaking is politics and only 10% is science,” says Ngurah Mahardika, a marine scientist at the IBRC.

Sangkot Marzuki, head of the Indonesian Academy of Sciences, acknowledges the difficulty in getting government to listen to scientists. Marzuki says that the government tends to heed advice on immediate issues that can cause public furores such as stem cells or cloning, or the avian influenza outbreak, but it is harder to be heard on long-term strategic issues, he says.

The lack of policymaking capacity in terms of technical know-how or academic skill is cited as one reason for the disconnect between scientific judgment and decision-making in government.

228 International English Language Testing System (2011). IELTS Test takers performance 2011, British Council, London, UK. Note that the highest score possible is 9.

In 2011, professor Mayling Oey-Gardiner, an economist at the University of Indonesia, and a member of the National Research Council between 2008 and 2011, wrote a scathing review for AusAID of Indonesia's science and technology policy management, in particular looking at the National Research Council's ever-diminishing remit.[229] Oey-Gardiner says that the political leadership relies less and less on research to make decisions or policies. The President solves problems in an ad hoc manner, she says, "ignoring existing institutions in favor of setting up [new] committees. This situation arises from current political conditions where the President rules by a coalition and ministries are shared among political parties instead of having leadership positions assigned to independent professionals. Thus party politics overrules practices of research-based public policy making and [...] research institutes are there to be left alone instead of relied on for advice."

Scientists are not the only important stakeholders in the process of devising policy, however. The public has an important role to play in communicating the research they want their governments and scientists to be engaged in, the type of science they feel is important, and their concerns over controversial issues such as stem cells or GM food.[230]

Despite the fact that Indonesia now routinely imports GM food products such as soya, it has no forum in which the general public can express their views about the type of science being done. The general consensus among scientists interviewed is that the general population either does not care about the type of science being done, or they are not educated enough to have an informed opinion about it. Indeed, although 96% of Indonesians enroll in primary education, for instance, one in five children will not even complete this basic level of education.[231]

While efforts targeted at the public engagement of science do not always guarantee that the population's opinions are given a fair hearing,[232] it is a step towards a more democratic form of science.

229 Oey-Gardiner, M. (2011). *In search of an identity for the DRN,* AusAID, Canberra, Australia.

230 The Wellcome Trust (2009). *Telling Stories: how the public can engage with science,* International Engagement Workshop report, National Centre for Biological Sciences, Bangalore, India.

231 The World Bank (2013). *World Development Indicators,* The World Bank, Washington, DC, USA.

232 Watermeyer, R. (2012). *Measuring the impact values of public engagement in medical contexts,* Science Communication, 34, 752-775.

6. Sustainability

Indonesia is a major world centre for biodiversity. The diversity of both flora and fauna make it a unique habitat that environment researchers the world over come to study. Its extensive reef system is one of the world's richest underwater environments, housing a variety of corals, fish and other reef organisms. The country also holds rich stores of oil, gas, coal, and minerals. Its forests are a major source of timber and other forest products.

However, it is on the verge of losing this great biological wealth. Years of overexploitation – its economy has relied vastly on selling its natural resources – have left it depleted. Much of its biodiversity has eroded, and poor enforcement is threatening to destroy what it has left.[233] This is a 'now or never' moment for Indonesia in preserving its rich environmental heritage.

6.1 Devastating degradation

Indonesia urgently needs to step up its protection of the environment as the country's natural resources are under dire threat from climate change and human activity. Indonesia has a quarter of the world's mangroves. As well as protecting against natural disasters, mangroves sequester carbon, which helps mitigate climate change, and they stop sediment from swamping coral reefs. Yet Indonesia is losing them at a rate of 6% a year, as locals cut them down for firewood and timber or clear them to plant lucrative oil palm trees,[234] destruction that seems emblematic of the country's powerlessness in protecting its environment. Indonesia has one of the world's worst deforestation rates; in 2011-12 it had the world's largest increase in deforestation, with its annual loss more than doubling to nearly 20,000 square kilometers.[235]

In April 2012, meanwhile, illegal fisherman destroyed the coral reefs in Komodo National Park, a UN World Heritage site, when they bombed the reefs to pieces in order to capture fish.[236] Divers and conservationists say that enforcement has dropped enormously since 2010 when the monitoring of the park was taken from Nature Conservancy, a US NGO, and handed to government officials. Government officials disagree that law enforcement has suffered.

Indonesia's environmental crimes are many. Illegal logging and deforestation (burning for oil palm plantations), illegal poaching, trade in protected species, and illegal and unsustainable fishing, all threaten Indonesia's biodiversity.[237]

233 Fogarty, D. & Creagh, S., (2010) *Indonesia facing crisis over loss of species – scientists,* 20th July 2010, Reuters,London, UK.

234 Kuhn, A. (2012). *Drama amid Indonesia's disappearing mangroves, 30th April 2012,* National Public Radio, Washington, DC, USA.

235 Hansen et al (2012). Global Forest Change. See http://earthenginepartners.appspot.com/science-2013-global-forest University of Maryland: College Park, Maryland, USA. See also Morgan J (2013). Forest change mapped by Google Earth. BBC News Online, 14 November 2013.

236 Herin, J. (2012). *Fisherman blast premier dive sits off Indonesia, 20th April 2012,* Jakarta Post, Jakarta, Indonesia.

237 International Development Law Organization (2006). *Strengthening environmental law compliance and enforcement in Indonesia,* IDLO, Rome, Italy.

6.2 The tsunami's after-effects

Indonesia is highly prone to earthquakes, but the 9.0-magnitude earthquake under the sea near Aceh, north Indonesia, which triggered the 2004 tsunami caused unprecedented devastation. As well as galvanising Asian countries to collaborate to develop an Indian Ocean early-warning system, it also highlighted the importance of environmental conservation. Regions of South India that had dense mangroves, for instance, suffered much less damage than other areas, as they act as environmental buffers.[238]

The tsunami wreaked enormous devastation on the reefs, but there is little evidence that the disaster sparked any major investment in environmental research or reform in environmental protection, says Paul Barber. While the country jointly created the German Indonesian Tsunami Early Warning System,[239] environment scientists say the technology to develop this was largely developed by Germany rather than Indonesia.

6.3 Poor enforcement

Weak enforcement threatens Indonesia's environment. "The Indonesian government felt global pressure to sign up to the Convention on Biological Diversity, but it is really just paperwork," says the IBRC's Ngurah Mahardika.

In theory, Indonesia has ratified most international environment treaties, as well as having signed up to ASEAN working groups on the environment, including the ASEAN Working Group on Multilateral Environmental Agreements and the ASEAN working group on Nature Conservation and Biodiversity. It has also adopted the regional Environmental Education Action Plan (2000-2005).

In practice, very little of its international and regional commitment is translated into domestic action.[240] When examining the reasons for this, one major factor is that the domestic judicial system is not yet set up to favour enforcement of environmental law. For instance, the country has no specialized environmental law courts; government environment officials do not have the authority to investigate environmental violations and these cases must be referred to the police, who may not have the expertise to do so. Indonesia's complicated levels of jurisdiction at district level, a legacy of decentralisation, means that there is enormous uncertainty around who holds the authority to decide on matters of environmental destruction.

6.4 Renewable energy

The demand for natural resources is only going to increase, so maximizing its energy supply from renewable sources could be a significant area of growth for the country. This means exploring not just solar and wind energy, in which

238 Padma, T.V. (2004). Mangrove forests 'can reduce impact of tsunamis', 30th December 2004, SciDev.Net, London, UK.

239 http://www.gitews.org/

240 International Development Law Organization (2006). *Strengthening environmental law compliance and enforcement in Indonesia,* IDLO, Rome, Italy.

technology is now relatively well developed, but also investigating geothermal power, biofuels and biomass.

The potential is huge, according a review by consultancy firm McKinsey, which projects impressive statistics. Renewable energy "could meet up to 20 percent of Indonesia's energy needs by 2030, reducing the country's dependence on oil and coal by almost 15 percent as well as lowering greenhouse gas emissions by almost 10 percent, compared with business as usual. The potential to improve Indonesia's energy efficiency is also significant.

For instance, using more efficient methods to generate power, improving transportation, and retrofitting and constructing more energy-efficient buildings could together reduce 2030 energy demand by as much as 15 percent".

Indonesia has 40% of the world's potential geothermal energy sources, which have the capacity to produce up to 24 terawatt hours a year—about 70% of Jakarta's annual energy consumption. In its medium-term development plan, Indonesia aims to create a 5,000 MW geothermal power plant capacity by 2014.[242] In Box 6.1, we explore efforts to turn to biofuel.

Box 6.1: Pushing for biofuels at FORDA

On a humid day at the end of March 2012, workers all over Jakarta were packing up early, keen to rush out of the office. Soon, the streets were clogged with thousands of protestors objecting to the government's plans to cut fuel subsidies and increase the price of fuel by up to 33%. The protests were ferocious and at times violent.

Since the subsidies made up 20% of government spending in 2011, economic analysts say that getting rid of them is urgently needed to reduce the national deficit and invest in long-term development. Torn between its financial advisors and an angry population, this time at least, the people won.

Indonesia is rich in oil and gas and at one point was a net exporter of oil, but in 2004, consumption had increased so much it switched to being an importer, and resigned from OPEC. A growing population and cheap motor vehicles mean that its consumption is increasing at 7% per year. Combined with the threat to the environment from fossil fuels, it's clear that the country needs to find alternative sources of fuel.

In 2006, conscious of the need to find an alternative to polluting fuels, the government issued a mandate that transport vehicles should use biofuels.[243] They also announced a fund to allow research into developing efficient biofuels

241 Oberman R., Dobbs, R., Budiman, A., Thompson, F., & Rossé, M. (2012). *The archipelago economy: unleashing Indonesia's potential.* McKinsey Global Institute, New York, NY, USA.

242 Indonesian National Development Planning Agency (2010). *The National Medium-Term Development Plan (RPJMN) 2010 – 2014.* BAPPENAS, Jakarta, Indonesia.

243 Obidzinski, K., Andriani, R., Komarudin, H. & Andrianto, A. (2012). *Environmental and social impacts of oil palm plantations and their implications for biofuel production in Indonesia,* Ecology and Society 17 25.

and to provide subsidies so that biofuels are affordable – the cost of renewable energy is a major sticking point.

Government subsidies means gasoline costs R4,500 (about US$ 0.48) per litre. This is draining the economy as fuel subsidies cost the Indonesian government US$ 11 billion in 2008.[244] Under the 2012 measures, subsidies remained in effect only for public transport and motorcycles. Everyone else would pay the unsubsidized price of R8,750. Biofuel can't really compete at the moment; normally priced at about R8,000 per litre, it would still cost 6,000 after subsidy.

The government's target of ensuring that by 2025, 25% of fuel consumed would come from renewable sources seems extremely optimistic given that the interim target of 10% by 2010 has not been met, and the current proportion of renewable energy is just 1-2%.[245] Though the target has already been downsized to 18%, it is clear that significant government action is required, says Putera Parthama, of the Forestry Research and Development Agency of Indonesia (FORDA).

While Indonesia could harvest much more solar and hydro energy than it currently does, the most promising sources of energy lie in its resource-rich land, in the form of geothermal energy and biomass products such as bioethanol, biodiesel and bio-oil. Since forests are crucial in developing these techniques, Parthama is trying to push for the forestry sector's involvement in the development of renewable energy.

He would like to see the government allocate land specially to grow trees (such as acacia) to convert into biomass. Right now, says Parthama, cassava and sugarcane have been experimented on to produce biofuel, but using food crops for fuel is a dangerous road which could easily lead to food insecurity. As well as forests, growing algae in the country's biodiversity-rich Coral Triangle could be a source of biofuel too.[246]

While Parthama is doing his best, the agency is low on expertise. Of about 40 scientists, only two are experts in biofuels, one of whom is about to retire. Parthama's hopes are pinned on a few young scientists who are currently training in Japan and Australia, and who he hopes will kickstart projects when they return with the knowledge they've gained abroad.

The objection to removing fuel subsidies was so strong that "unless an Indonesian president is willing to sacrifice his popularity for the good of the country, it is hard to see how the subsidies will go". Once subsidies are in place, says Parthama, "it is like riding a tiger. If you get off, you'll get eaten".

244 For more on Indonesia's fuel subsidies, see Beaton C and Lontoh L (2010). *Lessons Learned from Indonesia's Attempts to Reform Fossil-Fuel Subsidies.* International Institute for Sustainable Development: Winnipeg, Canada

245 For more on Indonesia's renewable energy policies, see Damuri Y and Atje R (2012). *Investment Incentives for Renewable Energy: Case study of Indonesia.* International Institute for Sustainable Development: Winnipeg, Canada. See also US Department of Commerce (2010). *Renewable Energy Market Assessment Report: Indonesia.* US Department of Commerce: Washington, DC, USA.

246 Silverstein, K. (2012). *Will algae biofuels hit the highway?* 20th June 2012, Forbes, New York, NY, USA.

6.5 Bioprospecting

Indonesia's staggering levels of biodiversity mean that not only is it an important region for conservation, it is also home to thousands of medicinal plants that could be targeted for drug discovery. The country has 10% of the world's plant species, and the WHO estimates that around 900 compounds have been investigated for medicinal properties.[247] The area holds much promise, especially as finding candidate drug compounds in the laboratory is becoming increasingly difficult. Unsurprisingly, companies like Kalbe Farma are "extremely interested" in exploring this area further, says its CEO Johannes Setijono.

However, hunting for drug compounds in plants – or bioprospecting – is fraught with difficulty. Biodiversity hotspots tend to be concentrated in developing regions, which often have far less rigorous intellectual property laws than the richer countries. By law, biological samples are protected under laws on state resources. The Convention on Biological Diversity states that countries are entitled to a share of the profits from compounds yielded by their flora and fauna.[248] But there have many instances where foreign scientists working on a research permit take hundreds of samples, which they then develop and commercialise, without giving any of the profits to the host country (see Box 6.2).

If carefully planned, however, this could be a key area for collaboration within Indonesia, both between two key science and technology sectors, pharmaceuticals and environment, but also between public and private industry. Environment researchers who are well-trained in sourcing and harvesting species without destroying the ecosystem could partner with scientists working in drug discovery to search for new medicinal compounds. "Bioprospecting is definitely something we have the expertise to help with," says the IBRC's Ngurah Mahardika.

247 World Health Organisation (2001). *Trips, CBD and Traditional Medicines: Concepts and Questions, Report of an ASEAN Workshop on the TRIPS Agreement and Traditional Medicine, Jakarta, 13-15 February 2001,* WHO, Geneva, Switzerland.

248 The Convention on Biological Diversity, http://www.cbd.int/.

Box 6.2 Infringing on Indonesia's traditional knowledge

Bunaken National Park in northern Sulawesi is home to many of the world's endangered species such as dolphins and turtles, as well as the marine life that forms the architecture of the sea – corals and sponges. Over many years, however, hundreds of research groups from all over the world have scoured the area for viable drugs, which has led to two patents on potential anti-cancer and anti-malarial compounds. Foreign scientists own the right to these genetic resources, despite their Indonesian origin.[249]

What's more, foreign scientists in Bunaken have at times far exceeded stipulations on the collection of biological samples. Regulations stipulate that researchers should collect a maximum of 1kg of any species to ensure its preservation, but some scientists have collected as much as 60kg.[250]

Despite its great natural wealth, Indonesia has been slow to protect its natural resources; it only drafted a bill to protect its traditional knowledge in 2011.[251] Moreover, the enforcement of regulations to protect its biodiversity has been poor, with many national parks being plundered for their resources.[252]

249 Balansa, W. (2010). *Big business, big damage, 12th September 2010,* Inside Indonesia, Melbourne, Australia.

250 Balansa, W. (2010). *Big business, big damage, 12th September 2010,* Inside Indonesia, Melbourne, Australia.

251 Wirastomo, R. (2012). *The WTO protection of traditional knowledge and Indonesia's traditional knowledge bill,* Juris Gentium Law Review, 1, 70-83.

252 Campese, J., Sunderland, T., Greiber, T. & Oviedo, G. (eds.) (2009) *Rights-based approaches: exploring issues and opportunities for conservation,* CIFOR and IUCN, Bogor, Indonesia.

Photo: Indonesian Institute of Sciences (LIPI). Credit: Wikimedia Commons (Chongkian).

7. Collaboration

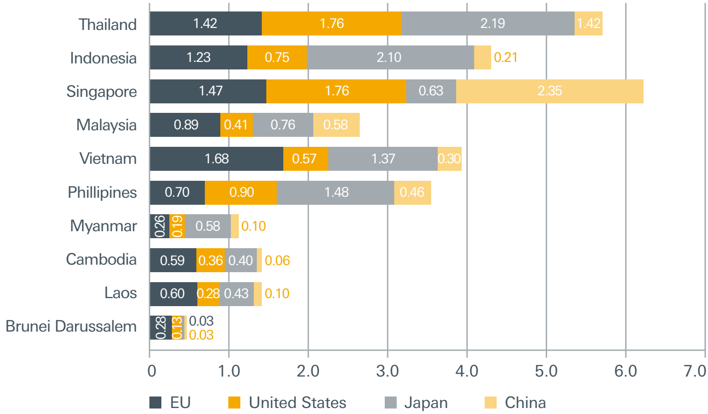
As an enterprise, research naturally lends itself to collaboration. The global scientific community is pushing for more collaboration since this traditionally leads to greater research outputs and citations.[253] Surprisingly, despite the fact that Indonesia collaborates reasonably well with many other countries, these links do not seem not to have increased the number of its citations or publications.

While Indonesia is keen to increase its global collaboration, it compares favourably with neighbours such as Malaysia and the Phillipines on global collaboration with the EU, the United States, and Japan (see figure 7.2).[254]

253 The Royal Society (2011). *Knowledge, networks and nations: Global scientific collaboration in the 21st century,* The Royal Society, London, UK.

254 Ul Hassan, S., Haddawy, P., Kuinkel, P., Degelsegger, A. & Blasy, C. (2012). *A Bibliometric study of research activity in ASEAN related to the EU in FP7 priority areas, Scientometrics,* 91, 1035-51.

Figure 7.1 Number of co-publications between ASEAN countries and major world regions, 2004-2008[255]



7.1 Challenges of international collaboration

International research collaboration is arguably imperative if Indonesia's researchers, universities and public research institutions are to increase their scientific capacity, access new sources of research funding and increase scientific productivity and impact through international publications.[256] However, one major challenge in achieving this is the amount of bureaucracy that researchers need to navigate in order to start work in the country.

Paul Barber, Associate Professor of Ecology and Evolutionary Biology at the University of California Los Angeles and co-founder of the Indonesian Biodiversity Research Center (IBRC, see box 7.2)[257] is passionate about helping to understand and preserve Indonesian biodiversity. As he talks about the difficulties foreign researchers experience when collaborating with their Indonesian counterparts, it is clear that setting up these partnerships requires enormous commitment and time.

"Individual Indonesian scientists are very interested in collaboration. But research permits are not granted by a group of scientists at LIPI anymore, but instead by a group of bureaucrats at RISTEK, and they can deem any issue 'too sensitive' for an outside researcher to be involved with," says Barber. He admits though that the process for research ethics approval has become more streamlined through RISTEK, as you can submit applications online and track progress.

255 Ul Hassan S et al (2012). *Analysing ASEAN-EU research collaboration.* United Nations University: Tokyo, Japan. This ranking uses Salton's measure, which considers publication volumes of both sides to analyse the collaboration strength between the two regions.

256 Lakitan, B., Hidayat, D., & Herlinda, S. (2012). *Scientific productivity and the collaboration intensity of Indonesian universities and public R&D institutions: Are there dependencies on collaborative R&D with foreign institutions?* Technology in Society, 34 227-238

257 Indonesian Biodiversity Research Center, http://www.ibrcbali.org/.

Even making initial contact with Indonesian researchers can be near impossible, he adds, because the system is not set up for it; individual scientists do not have their own webpages and institutions often do not have good communications departments. "If you want to find an Indonesian researcher to collaborate with in your area of expertise, and you don't already have a local contact, then good luck".

"Finding collaborators who can engage as full, equal partners is extraordinarily difficult, simply because a researcher you would want to collaborate with has been on the staff for a long while, but that means they have not been in an environment that encourages an active research profile. So even though they might be enthusiastic, they are probably not going to be at the cutting-edge of their field."

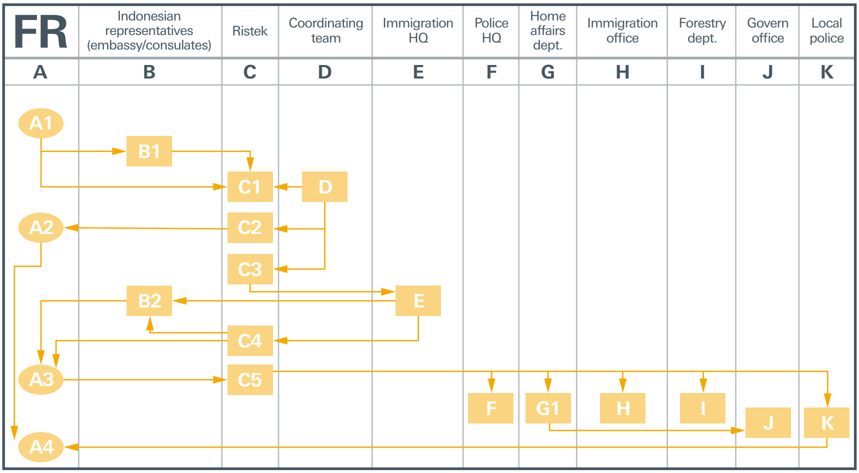
Barber's collaborations in the Philippines were totally different. "The Philippines has a much stronger tradition of basic research and the funding to support that exists. People are actually rewarded for being successful in basic research, whereas that's not quite the case in Indonesia. That was a difficult lesson we learned when we started in Indonesia". Indonesia isn't the only country to suffer this, says Barber, and a major source of frustration for the team was recently having permits granted then inexplicably revoked in Malaysia.

Bureaucracy is another research-killer says Barber. This word crops up in almost any conversation about Indonesian science, but in the case of collaboration, the country's bureaucracy seems set to extinguish any fledgling projects before they even start. The country's extensive decentralisation extends to R&D permits, according to Samantha Cheng, one of the team's key postdoctoral scientists also based both at UCLA and the IBRC. This means that most of a researcher's time in Indonesia is spent chasing permits. Cheng has rapidly learnt Bahasa Indonesia as she goes from one region to another collecting versions of the same permit – required for any research project that might come under the jurisdiction of more than one district. The lack of clarity that has accompanied decentralisation often means that no office is really sure who has the authority to grant a permit and researchers get shunted from one to another.

Box 7.1 explains the long process that foreign researchers need to undergo to work in Indonesia in more detail.[258]

258 Source: RISTEK. Ministry of State for Research and Technology (RISTEK): Jakarta, Indonesia.

Figure 7.2 Research permit procedures for foreign researchers



Box 7.1 The long process to approve overseas researchers in Indonesia

The right of foreign researchers, universities, and other research institutes to conduct research in Indonesia in order to transfer scientific and technological knowledge is enshrined in the Indonesian government's Decree No 41/2006. Exercising this right, however, is far from simple in practice, as Figure 7.3 demonstrates, with the researcher needing to navigate between up to ten separate offices.

The process is described below,[259] and is also outlined in full on RISTEK's website[259], which also offers an online registration system to initiate the process at www.frp.ristek.go.id. It has two major components to be carried out, both before approval, and after the researcher arrives, which he/she is expected to do after the original approval, and to visit RISTEK and other institutions before commencing work. Both parts of the process take around two to two and a half months to complete each, and require reporting to up to ten different institutions. The contrast with many other countries, in which the researcher is only answerable to his or her host institution after permission has been granted (such as Japan), is notable. The lengthy process is laid out in full below, with reference to Figure 7.3 in which each step appears:

259 Ministry of State for Research and Technology (2012). *Research permit procedures for foreign universities, research institutes, enterprises and individual researchers in Indonesia,* RISTEK, Jakarta, Indonesia.

A1: The foreign researcher (FR) sends or submits his/her research application documents to RISTEK, copying in the Indonesian diplomatic representatives (either in the embassy or nearest consulate) in his/her home country.

B1: The Indonesian diplomatic representatives receive the research application documents, and then issue a recommendation letter which is sent to RISTEK in Jakarta.

C1: RISTEK receives the research application documents from the FR and from the Indonesian representatives, along with the recommendation letter. The secretariat of RISTEK's Foreign Research Permit (FRP) team then prepares a matrix of data from the research application data, and sends it to the bi-monthly meeting of its coordinating team (CT).

D: The CT, at its bi-monthly meeting, evaluates the research application and either approves or declines it.

C2: FRP secretariat sends a formal letter of notification of the CT's decision to approve or decline to the FR or his/her host.

A2: FR receives the notification letter.

C3: If the research application is approved by the CT, the FRP secretariat will prepare a visa 315 application and submit it to Immigration Headquarters (IH) in Jakarta.

E: IH receives and processes the visa application and then issues and sends visa authorisation to Indonesian diplomatic representatives, from whom the FR will collect the visa.

C4: Before the FR collects the visa, RISTEK receives the visa authorisation papers and prepares a letter of request to the Indonesian diplomatic representatives so they can issue the visa for the FR.

B2: Indonesian diplomatic representatives receive the visa authorisation and issue a visa for the FR.

A3: FR brings his/her passport to the Indonesian diplomatic representatives in order to collect the visa. FR can now leave his/her home country for Indonesia.

C5: Having arrived in Indonesia, the FR must now report to the RISTEK office in Jakarta to receive a research permit, a research permit card and other covering letters, before being required to report at a number of other government agencies, including the police, Home Affairs Department, and the Immigration Office.

F: FR goes from RISTEK to the police headquarters with the paperwork he/she received in C5 in order to obtain a travel permit.

G: After receiving the travel permit (Surat Keterangan Jalan), the FR then has to report to the Home Affairs Department(Depdagri), to obtain yet another permit, the SPP.

H: FR now has to report to the Immigration Office and apply for a Limited Stay Permit Card (KITAS).

I: If the FR intends to enter a conservation area (eg a nature reserve, a national park or a wildlife reserve) then he/she now needs to apply for an entrance permit to a conservation area (SIMAKSI) at the Directorate General of Forest Protection and Nature Conservation, Forestry Department (Ditjen PHKA, Departemen Kehutanan).

J: When the FR arrives in the location where he/she plans to undertake the research, the FR then needs to report to the Provincial Government Office (Badan Kesbang Linmas Provinsi).

K: Having obtained the KITAS permit, the FR finally has to report to the Provincial Police Headquarters to apply for a Certificate of Police Registration Card (SKLD).

A4: The FR can finally start work on the research project.

An even bigger time-waster is the requirement that a foreign researcher must be in-country when applying for an Indonesian research permit. Since this can take as long as 4-5 months, especially if the scientist is working on environmental resources, it means that a researcher must be prepared to stay in Indonesia for this duration, waiting to hear whether or not their project has been approved. Clearly, this is an impossibility for most scientists.

All this means that while Indonesia may embark on collaborations at the institutional or country level (see sections 7.4 and 7.5 for more on these), those all-important links between individual scientists are rare. Indonesian scientists themselves are difficult to find from outside Indonesia in any case, says Barber, as many do not have webpages detailing their work on their institutional homepages.

Box 7.2 Spotlight: IBRC: Pioneering collaboration in marine biology

Being a marine biologist in Bali, diving into the turquoise depths teeming with tropical fish, would seem like a dream job to most people. Environmental research in Indonesia can be so complicated, however, that the Indonesian Biodiversity Research Centre only came into being through the enormous dedication and persistence of its two lead researchers, Paul Barber and Ngurah Mahardika, who is also based at Bali's Udayana University.

The IBRC laboratory, which sits amidst the tourist traps of Bali's southern beachfront Sanur, is buzzing with activity as the team prepare for a field trip to the north of the island. In person, Mahardika is a tour de force, and the steely determination that allowed him to set up a highly successful collaborative lab is immediately obvious. "We just don't believe in 'business as usual'. I want my researchers to publish in Nature and in Science – the sky is the limit".

Setting up the IBRC meant overcoming several obstacles, particularly funding. "National funding is very short-term, so we are heavily reliant on international funding and have just received a USAID PEER grant".

As a result of this funding, the IBRC is extremely well equipped, unlike most other research facilities in the country. A testament to the truly collaborative drive of Barber and Mahardika is the fact that the laboratory welcomes researchers from less well-resourced laboratories to use their equipment. Now, the centre has matured to a point where they can actively engage in capacity-building of Indonesian researchers, encouraging them to learn molecular biology techniques and training them to collect samples for phylogenetic analysis.

Mahardika is passionate and engaging when talking about his research, and also refreshingly blunt when talking about the politics of science. Wasting resources distresses him greatly, and though he welcomes US collaborations (one of which is funding his laboratory), he suggests that the amount of money spent on President Obama's visit to Jakarta could have been spent on research instead: "Obama could have just Skyped in," he laughs.

7.2 Familiarity breeding contempt?

"Scientists are not really encouraged to share data between institutions," says Farah Coutrier, a researcher at the Eijkman Institute for Molecular Biology. There is very little networking between institutions too, she adds. One factor is that with little understanding of how to collaborate, especially in terms of sharing credits and patents, "there is a fear of not getting the proper acknowledgement".

The method of collaborating can often be haphazard, Coutrier adds, saying that sometimes universities begin collaborating with industry for instance, and only organize a memorandum of understanding after collaboration has begun. If the two sides are not able to agree on the terms of the agreement, the memorandum is annulled and any collaborative work is rendered pointless. Putting in proper procedures, and following these, is a key step to encouraging collaboration.

In an effort to drive collaboration, the government has developed several Indonesian research consortia in an attempt to push collaboration within the country and between sectors.[260] These include:

- The Indonesian Ganoderma Consortium, a collective of palm oil producers aiming to stop the spread of the Ganoderma disease, which could devastate valuable palm oil plantations. The members of the consortium are drawn from industry, research institutes and the Ministry of Agriculture.
- Indonesian Biotechnology Consortium, a community of research institutes, universities and industries that are developing biotechnological techniques.
- North Sulawesi Mitra Bahari Consortium, a collaboration between government and non-government organisations to optimize the role of various stakeholders in maritime activities.
- National Research Consortium on Vaccines, a network of research centers and private industry, focusing on producing Indonesia's first bird flu vaccine by 2013, and developing vaccines against hepatitis B and C.

7.3 ASEAN connections

Indonesia's collaborations with other ASEAN members remain low, but since ASEAN is due to become a unified economic entity by 2015, it is keen to boost the links between its members. In 2011, the ten members of ASEAN endorsed the Krabi Initiative — a framework for intra-regional cooperation on science, technology and innovation (STI).[261] The framework, which is an extension of the 2007–2011 ASEAN Plan of Action on Science and Technology will focus on eight areas: developing innovations for the world market; a regional digital society; embracing new media and social networking; green technology; food and energy security; water resource management; biodiversity and lifetime scientific learning.

260 Indonesian Institute of Sciences, LIPI (2011). *Study on the status science and technology development in Indonesia,* LIPI, Jakarta, Indonesia.

261 Adriano, J. (2011). *ASEAN countries to boost science and technology collaboration, 7th Jan 2011,* SciDev.Net, London, UK.

The six ASEAN flagship science and technology programmes for 2011-2015 are:

- Early Warning System for Disaster Risk Reduction (EWS-DRR) – Indonesia
- Development and Application of Open Source Software (OSS) – Indonesia
- Biofuel – Malaysia
- Food technology – Thailand
- Health – Singapore
- Climate Change – Philippines

7.4 Colonial ties: Netherlands

Indonesia has a long-standing history of scientific collaboration with the Netherlands. Since 2002, the Scientific Programme Indonesia-Netherlands (SPIN) has run Open Science Meetings to explore links between science and society. The partnership currently has three joint research projects on Food, Non-Food and Water Research; Social and Economic Development; and Infectious Diseases and Health for the period 2012-2016. The Netherlands also joins up with DIKTI in providing several PhD scholarships for study in the Netherlands.

In a bid to encourage "unorthodox thinking", the Netherlands offers one-year Indonesian Challenges Exploration Grants for 100,000 euros on a project in the following areas: Green Commodities; Sustainable Energy and Water Research; Infectious Diseases and Health; or Social and Economic Development.[262]

7.5 Other key bilateral collaborations

Japan is Indonesia's top collaborator in terms of co-publications, and through an agreement on capacity-building signed in 2010, Indonesia is sending several scientists to Japan for training as well as graduate students to undertake masters and doctoral programmes.

Indonesia has collaborated extensively with Germany, especially in environmental issues, most recently developing a tsunami early-warning system in the wake of the 2004 tsunami. The two countries are also working on a project to protect Indonesian coastal marine ecosystems.

In 2010, Indonesia signed an agreement with China to cooperate on herbal medicine, stem cells, energy, biodiversity, space technology, and agriculture. In 2011, Indonesia also signed agreements with Mozambique, India and Iran. Box 7.2 discusses Indonesia's collaboration with the US, which has increased greatly in the past 5 years.

262 For more on these, see http://www.knaw.nl/

Box 7.3 Spotlight: The Obama effect

Indonesia has been on the United States' radar for some time now, as one of the world's largest democracies that also has the largest Muslim population on the planet. "Since 9/11, engagement with the Muslim world has been a priority for the US," says Mark Doyle, a policy adviser, who until September 2012 was based at USAID's Jakarta office.

In May 2010, Dr Bruce Alberts, former President of the National Academy of Sciences, visited Indonesia as one of President Barack Obama's "science envoys" to build science and technology partnerships and capacity in Islamic countries.[263] Then in November 2010, President Obama visited Jakarta, where he himself had lived for a time as a young boy, and signed a comprehensive partnership with President Yudhoyono.[264]

The US-Indonesia partnership has led to the launch of several initiatives, including the Partnerships for Enhanced Engagement in Research (PEER), a joint funding effort between USAID and the US National Science Foundation (NSF).[265] This programme offers scientists in developing countries (such as the IBRC's Ngurah Mahardika) the opportunity to collaborate in research with NSF-funded researchers.

The collaboration is intended to focus on capacity-building, which means more than just funding research. Thus, the US has also committed to spending over US$ 165 million over 5 years to support higher education. US$15 million will be pumped into the Fulbright Indonesia, Research and Technology Program (FIRST), an exchange programme offering scholarships for Indonesian researchers to study in the US and for US researchers to work in Indonesia. The US Department of State also provides US$2.5 million a year for 50 Indonesian students and 18 teaching staff for further study or professional development in US community colleges.[266]

263 Office of Science and Technology Policy (2010). *Science Envoy Bruce Alberts Builds Bridges with Indonesian Counterparts, 19th May 2010,* OSTP, Washington, DC, USA.

264 US Department of State (2013). United States-Indonesia Comprehensive Partnership Fact Sheet. US Department of State: Washington, DC, USA. See also Comprehensive partnership. USAID. http://indonesia.usaid.gov/en/about/comprehensive_partnership, accessed September 14, 2012.

265 For more on PEER, see: www.nationalacademies.org/peer.

266 For more information see *US Department of State (2011). US-Indonesia Educational Cooperation Fact Sheet.* US Department of State: Washington, DC, USA.

7.6 A project-based mentality

A World Bank funded collaborative project between CSIRO, Australia's national science agency, and LIPI was set up in 1998 to strengthen the country's commercial science capacity.[267] A core component of the programme was communication of the scientific knowledge accrued in organisations such as LIPI. This included, says Harry Surjardi, a programme in which LIPI would invite journalists to the organisation for a media briefing. In 2000, Indonesia's parliament also heard its first science briefing to bring parliamentarians up to date on researchers' activities. The briefing on earthquakes and disaster management seems prescient, coming as it did 5 years before the tsunami.

When the project ended in 2001, however, most of these science engagement activities were also discontinued as the organization did not have the resources or the momentum to continue.

Current LIPI staff who were involved in the project remember it revitalising the agency's approach and were disappointed that they never developed the capacity to carry the activities on. "But we cannot take external funding forever," says LIPI researcher Dudi Hidayat. "We really need to be able to implement these sorts of initiatives ourselves".

This lack of absorptive capacity in developing countries to implement international initiatives is not uncommon, but it does require a broader institutional and structural willingness to change processes and practices. In many cases, even a willingness to change may be overpowered by other factors. At the time of the CSIRO project, for instance, Indonesia was still struggling to recover from the Asian financial crash. It seems highly likely, from conversations with LIPI staff, that even though LIPI would have liked a major reform in the way it commercialises research or communicates those findings, the financial resources (from central government) simply were not available to do so.

7.7 Public-private partnerships

The lack of innovation is hampering scientific progress in Indonesia, and to reform this area, the Indonesian government has joined the Triple Helix initiative, which was founded in 1996 to promote linkages between academic, industrial and institutional research centres.[268]

The tenth Triple Helix conference – others have been held in Cambodia, Laos and Malaysia – was held in Bandung, Indonesia in August 2012 to give new impetus to public-private partnerships in Indonesia. The Indonesian government is now working out the details of how to take this initial effort forward.

267 Widyawan, R. & Hartomo, T. S. (2003). *Sharing knowledge: a key to lift up people life through science. Experience of the Indonesian Institute of Sciences (LIPI),* 10th Asia Pacific Special Health and Law Librarians Conference, Adelaide, Australia.

268 See http://www.triplehelixassociation.org/.

7.8 Collaborating with the Islamic world

Indonesia is keen to establish stronger links with other OIC Member Countries. However, OIC Member Countries currently only spend a tenth of that expended by more developed nations, and only produce 5.8% of the world's publications.[269] Hence, driven by pragmatism, Indonesia also needs to focus on engaging with countries that have more resources in terms of science and technology.

Nevertheless, many researchers see potential avenues of collaboration since specific research priorities, in halal science or stem cell technology for instance, are likely to overlap. Some scientists interviewed for this report suggested that the Indonesian public may also be more accepting of the products that come out of collaborative research with Islamic countries.

Other links have already been established, particularly in the field of education, where Indonesia's Al Azhar University has received funding from the home of its namesake, Egypt, and where some senior high schools have also benefited from funding support from the Middle East.

While Indonesia has no specific national strategy or roadmap to promote scientific collaboration with OIC countries, some ad hoc collaborations with OIC institutions have taken place. One such example, a collaboration with the Islamic Development Bank (IDB), whose funds come from, and are distributed to, OIC members, took the form of a project, Metrology Standardisation Testing and Quality Assurance (MSTQ), which ran from 2005 to 2007 and was designed to help strengthen Indonesia's science and technology infrastructure, by improving its base of innovation.[270] Outside the areas of science and technology, there is collaboration on social, political and cultural issues: since 1997, the University of Indonesia has established a Center of Middle Eastern and Islamic Studies which runs master degree programmes on political and international relationships, Islamic studies, Islam and psychology, and Sharia Economy and Finance.[271]

269 Data derived from SESRIC and ISI Web of Knowledge, 2013.

270 Harmes-Liedtke, U. (2010). *The Relevance of Quality Infrastructure to Promote Innovation Systems in Developing Countries,* Physikalisch-Technische Bundesanstalt, Braunshweig, Germany.

271 University of Indonesia, Programme of Middle East and Islamic Studies. See http://www.psktti-ui.com

8. Prognosis

Indonesia is keen to regain its former scientific glory. Its past scientific prowess, encompassing bold and innovative science policies, investment in training scientists, international collaboration, and the development of centres of excellence, prove that this is possible. But picking up where it left off will not be straightforward. The world is considerably different than the 1970s, when Indonesia was last a serious scientific contender. Global political powers have shifted considerably, and its Asian neighbours are now arguably more serious competitors, and in some ways more useful collaborators, than Western countries. South-East Asian countries share many of the same challenges in science and technology and also have similar concerns and needs, suggesting that they could collaborate far more on issues such as infectious disease outbreaks and disaster prediction.

Indonesia has much in its favour. Its enormous environmental wealth could position it as a leader in the most urgent research issues of our time – mitigating climate change, preventing the extinction of species, the development of renewable energy technologies, and improving nutrition and food productivity. This offers exciting research avenues both for Indonesian and international researchers, and could form the basis for many fruitful collaborations.

As the fourth most populous country in the world, with the majority of the population at a productive age, Indonesia is not lacking in human resources to drive its science and technology system, but failings in the way its university education system prepares graduates and in its crumbling research infrastructure mean that it is not using one of its greatest resources to its highest potential.

The country is economically strong, and politically fairly stable, but it will need to tackle the rampant corruption and weighty bureaucracy that is not only stifling domestic progress, but also deterring foreign investors and partners.

This is the time for Indonesia to forge ahead. If it can muster the political and scientific will to put its policies into practice, it could see its scientific star in the ascendant once more.

8.1 Strengths and weaknesses of Indonesian science, technology and innovation

8.1.1 STRENGTHS

8.1.1.1 Ambitious science and technology vision

While Indonesia may not like where it's at, scientifically speaking, it knows where it wants to go. Watching neighbours like Malaysia and Singapore soar ahead has stung Indonesia's national pride considerably, and made it even more determined to succeed. The country's medium and long-term development plan both prioritise science and technology, and its economic masterplan sets science and technology at the core of a new economic drive. This is promising as the country clearly values science as a driver for development. It should also mean that the government makes good on promises to improve science and technology.

8.1.1.2 Economic strength

While many developed countries are struggling considerably in the wake of one of the worst economic recessions in recent memory, Indonesia has managed to remain relatively untouched. Even the major emerging Asian economies of China and India have been rocked by the financial downturn. While opinion varies on just how much Indonesia's GDP can grow over the coming years, the general consensus is that it is in much better shape than many richer countries, whose finances are in tatters.

8.1.1.3 Human resources

The country has a mammoth population with a significant proportion of a productive working age. This is an immense resource for Indonesia, and a robust education and training system will turn these individuals into a strong workforce. The workforce must be able to absorb skilled professionals, however, otherwise it risks creating a highly trained but extremely disillusioned proportion of the population. The country must work to increase the number of jobs available, or make it easier for scientists to travel and work abroad.

8.1.1.4 Women's equality

Indonesia prides itself on having a population in which women stand side by side next to men, with equal rights. Unlike many Western countries, it rarely discusses issues of gender in science, and researchers feel that this is because there is nothing to discuss – women are not discriminated against in any area of science, and increasingly they are holding senior leadership positions. However, not being discriminated against is not the same as being encouraged; women still do not tend to pursue mathematics or engineering (as in many countries) and there are no efforts to encourage them into these fields. The support for female scientists who have children is also not as well implemented as it should be, though there are plans to improve this.

8.1.1.5 Rich biodiversity

The country is richer in natural resources than most others. It has vast reserves of oil, gas and minerals. Being right on the equator, its warm and wet climate has given way to forests abundant in a variety of important plant species that harbour valuable timber and medicinal products. It also has an immense diversity of animal species, as well as rich coral reefs and sealife. This biodiversity is under threat, however, because the degradation of its environment is going largely unchecked.

8.1.1.6 Investment in education

Investing in education is a major national priority, and the government spends a significant chunk of its expenditure on education. It also wants to increase the number of people in tertiary education and rapidly raise the numbers of postgraduates so that the country has many more scientists with masters and doctorates.

8.1.1.7 Social conscience

Indonesia's powerfully patriotic spirit and focus on social development is embodied in the way that its lecturers are required to devote a third of their time to work that helps the community. Researchers too, often cite national development and helping their country as a reason for working in science and technology. Crucially, it is one of the reasons why scientists are not migrating out en masse to richer countries. This patriotic sentiment, which in some countries might only emerge during sports matches, is of massive value to the country as it provides a unifying force.

8.1.2 WEAKNESSES

8.1.2.1 Underfunded research

One of Indonesia's major, and most visible, barriers to improving research is extremely poor funding. As a proportion of GDP, it spends far less on R&D than many of its neighbouring countries and many in the OIC. Many scientists believe that it has the financial capacity to increase this proportion significantly, especially given its strong economic growth, but question whether the political will to do so genuinely exists, despite lofty government announcements of plans to increase investment many-fold in just a few years. The funding that does exist is also unpredictable and short-term – often for a year at a time – which prevents scientists from having long-term research strategies and from collaborating with others. Funding also needs to be far more merit-based than it currently is – young researchers need to feel that good work is rewarded.

8.1.2.2 Unrewarded scientists

Indonesia pays its researchers particularly badly, which often forces them into taking on lot of extra work to supplement their incomes. The country has been trying to rectify this situation, but researchers' salaries have been extremely slow to rise. Scientists are also deprived of any royalties from patents, leaving them with little incentive to innovate with the private sector in mind.

8.1.2.3 Poor infrastructure

Years of neglect have left Indonesia's infrastructure in a perilous state. Its transport systems are extremely outdated, with cities and highways clogged by cars and buses. Transport hubs like sea ports – important for an archipelago – are poor too. This means that connectivity within the vast country is extremely low, which considerably affects the efficiency of transporting goods and services. Internet connectivity is increasing but is still too poor in key areas such as universities and government buildings; these networks and bandwidth capacities need to be massively improved.

8.1.2.4 Weak implementation and enforcement

Indonesia's intellectual property system does not really work to support science, technology and innovation as things stand. Few researchers patent their research, institutions do not especially support patenting, and there is little awareness of intellectual property rights and the TRIPS agreement. Industry does not collaborate with public sector researchers for this very reason. The lack of awareness of patents in universities and government is strongly tied to a poor understanding of how to commercialise research findings. Patent infringements are rarely pursued or punished either, which adds a greater disincentive to patenting research.

8.1.2.5 Low industry investment in science and technology

Businesses in Indonesia tend to import technology and knowledge from other countries, rather than undertake any research themselves. Inevitably, this means there is little scope for innovation as industries import processes in wholesale. Largely, this is because research is seen as too risky an enterprise and there are still too few incentives for industry to engage in R&D. Since there are also few public-private collaborations, there is a major disconnect between the needs of industry and the research that universities and government organisations produce.

Students need entrepreneurship training to get them in the right mindset, and schools to provide such training are badly needed.

8.1.2.6 Poor communication

Indonesia's internet users may be on the rise, but the country struggles with effective communication. Government organisations (which perform the bulk of research) do not tend to have reports and publications on their websites, making it hard to access this material. Researchers rarely have their own web pages, making it difficult to know in any detail what scientists are working on.

This is exacerbated by the fact that few research organisations have a communications department, and even when one does exist, it doesn't guarantee that outsiders will be able to easily make contact or receive the material they need.

One major issue is a language barrier, and few documents are available in English. This means that much of what is produced in Indonesia is only accessible locally, and is shut off from the rest of the world.

8.2 Recommendations for Indonesia

8.2.1 Launch a national science fund

While Indonesia's low investment in R&D is a major barrier to high-quality research, the inefficiencies in the funding system make the situation even worse. Currently, research budgets are approved by the Ministry of Finance and disbursed to the ministries responsible for science and technology or education. This means that it is largely disbursed by bureaucrats who are separate from science. The creation of a centralised science fund, similar to the US National Science Foundation, would ensure that those active in research are involved in funding decisions, that funding is more sustained and long-term, and that it is coordinated to avoid duplication of research in different parts of the country. The science fund would still function in sync with national economic priorities, but it could potentially make Indonesia's research funding system much more effective.

Since many scientists are doubtful that the government will indeed increase R&D spending as a proportion of GDP by as much as it promises, the best course of action would be to ensure that what money is available is spent wisely. Ultimately what is needed is a competitive, peer-reviewed system to allow the best researchers to get funding, irrespective of age or connections – a merit-based system.

8.2.2 Incentivise innovative research

This needs to happen at the entrepreneurial level – giving grants to start-ups to boost innovation, for instance – and by creating an enabling environment for business. A conducive environment could be created by ensuring that certain goods and services are tax-free. Indonesia could do much to improve both its competitiveness and its regulatory environment – both crucial factors in attracting business. Yet Indonesia's natural resources mean that even without the best business environment, international companies are keen to set up. This gives it a good opportunity to ensure that multinationals do not just use Indonesia as a base of operations; imposing duties for technology and knowledge transfer, for instance, would help encourage this. It could ease the process of doing business by making its processes electronic and centralising business registration, for example, and creating a one-stop shop.

8.2.3 Empowering education for a stronger workforce

The recent reversal of the autonomy of state universities is a blow to Indonesia's education system, and could render a decade of transition redundant. The original driver for making tertiary education more autonomous- ie to make it more transparent, but also commercially sustainable – still stands. Indonesia is watching its neighbours like Malaysia make vast strides in attracting foreign students (also a key source of revenue), while it still attracts very few.

DIKTI in particular needs to look at ways to improve the employability of Indonesian students, which means ensuring that theory and practice are taught as complementary strands, rather than imposing rules on publication requirements before a student can graduate.

8.2.4 Develop infrastructure for better connectivity

Indonesia's vastness is both its strength and its weakness. Years of neglect have left its infrastructure crumbling, turning each region into individual silos with little connection between them. What linkages there are tend to be within Java, and Java is poorly connected with the other islands such as Sulawesi or Kalimantan. Improving infrastructure is a major goal for the country's economic masterplan, and it should ensure that it improves soft infrastructure (knowledge networks, ICT technology) as well as hard infrastructure (roads, buildings, etc). Universities and government institutions need much more funding for their own R&D infrastructure in terms of laboratory facilities. Too often, researchers return from overseas simply unable to carry on their projects because the resources don't exist. This investment is also needed in regional areas, but rather than spreading funds thinly, the ministries should cherry-pick the institutions with the most potential.

8.2.5 Remunerate researchers and offer career progression

An unhappy scientific workforce does not make for a productive scientific system. Researchers are poorly paid, overworked, and if they are in universities, they are torn between teaching, research and community work. Many are out of necessity distracted by the need to earn more than one salary. The low number of researchers is both a function of the lack of incentives to become a researcher, and also the low number of positions in organisations. Since industry has very few research staff, most scientists crowd into government and university buildings.

The incentive structure within organisations would benefit from a review as well. Researchers need to accrue points to progress within the organisation and also for salary bonuses. These might be generated by publication of papers, but is not linked to the application of patents – thus few researchers tend to bother with patents. Creating greater incentives for commercialisation, linked to the individual's own profits (by allowing researchers to benefit from patents), could benefit individual scientists and research institutions alike.

8.2.6 Promote collaboration by reducing bureaucracy

Indonesia's bureaucracy is stifling. While it cannot be reformed overnight, easing the administrative load on a few key areas in science and technology could transform it. International collaborators are deterred by the process of application, which requires them to be in-country for several months, while they wait to hear whether they have been successful. Few scientists have the time to engage in this, and so few individuals or research teams are able to engage with Indonesian scientists. The administrative mess left by decentralisation urgently needs cleaning up. Too often, the lack of clarity of jurisdiction, especially in environmental issues, stalls research and adds further barriers for potential collaborators.

8.2.7 Become a global leader in renewable energy and biodiversity research

With its extensive biodiversity and natural energy reserves, the country has the potential to become a world leader in renewable sources of geothermal energy and biofuels, and in biodiversity research. These are areas in which global research is urgently needed, as they speak to major issues of our time – climate change and species extinction. Indonesia also has the potential to step up to become a world leader in agricultural and food technology, since food shortages are ravaging countries the world over. Devising ways to make crops pest-resistant, and to improve the nutritional value of food crops, would be immensely useful for many other developing countries. To do so, Indonesia needs to partner with organisations and research institutions that have more know-how, but it also needs to seriously improve its enforcement of environmental guidelines and law. If it continues to destroy its own habitat, it will be in no position to be part of the environmental research community.

8.3 Recommendations for international collaborators

Compared with the scientific capacity of other Asian 'Tigers', Indonesia is more of a cub. But it is in theory extremely open to the idea of international collaboration, and eager to learn from more developed science systems. In practice, however, international collaborators may find Indonesia's bureaucracy too unwieldy to navigate. The key seems to be in making contacts on the inside, and building relationships and networks with Indonesian researchers who can then help with the legal tangle that surrounds research in Indonesia.

If foreign scientists are persistent, they will find that few other countries can match Indonesia's natural resources in environment, energy and agriculture. Exploring these research opportunities can only really be done through collaboration.

8.4 Recommendations for the Islamic world

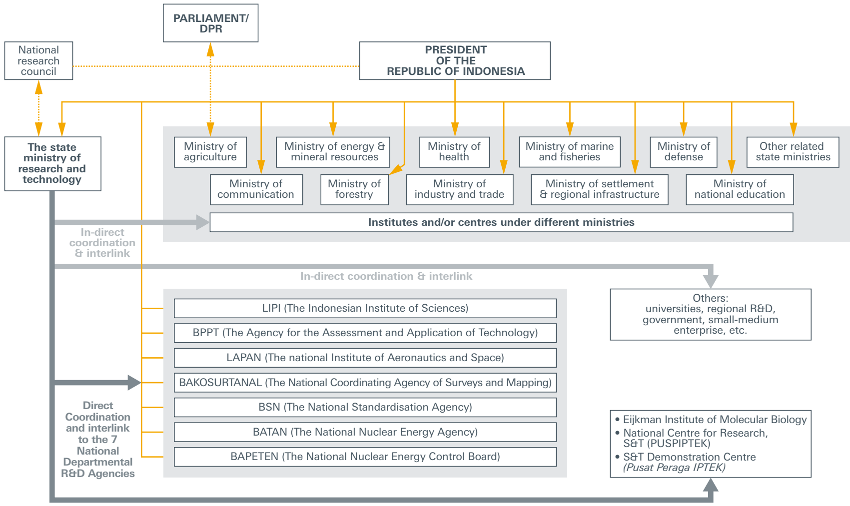
Indonesia is geographically distant from most of the Islamic world, but there is an appetite for building stronger research links. The OIC could "act as a bridge" to the Middle East, hosting conferences designed at getting researchers from both regions together, and also acting as a catalyst for collaborations. Indonesian scientists could also join neighbours such as Malaysia in innovating in areas such as halal science, which could be a useful source of revenue for the country. The Indonesian government encourages increased collaboration between the OIC and other prospective regional fora, such as ASEAN and APEC on trade and investment at the 28th Session of the OIC-COMCEC in Istanbul on 10th October 2012.[272]

The country has an immense capacity to develop significant expertise and know-how on renewable energy, and could share this knowledge and technology with oil and gas-rich countries in the Islamic world, such as Saudi Arabia and Qatar, that need to transition to more sustainable fuel sources. What Indonesia has in natural resources, it often lacks in the ability to fund research; thus, collaborations in which Indonesian research on renewable energy is partly funded by richer Arab countries could be a fruitful collaboration for both sides.

272 Cabinet Secretary to Indonesia (2012). *Cabinet Secretary Alam invites OIC members to enhance collaboration with Growing Regions, 12th October 2012,* Cabinet Secretary, Jakarta, Indonesia.

Appendix 1.

Structure of Indonesia's science and technology system[273]



273 Source: RISTEK. Ministry of State for Research and Technology (RISTEK): Jakarta, Indonesia.

Appendix 2.

List of organisations interviewed

USAID Indonesia

UNESCO Indonesia

Indonesian Academy of Sciences (AIPI)

Eijkman Institute of Molecular Biology

Indonesian Institute of Science (LIPI)

University of Atmajaya

British Council, Indonesia

Soegijapranata Catholic University

Muhammadiyah Surakarta University

Universitas Pembangunan Nasional Veteran Yogyakarta

Gadjah Mada University

Bandung Institute of Technology (ITB)

Indonesian Biodiversity Research Center

IAARD (Indonesian Agency for Agricultural Research and Development)

ICALRRD (Indonesian Center for Agricultural Land Resources Research and Development)

IVETRI (Indonesian Research Center for Veterinary Sciences)

ICASRD (Indonesian Center for Animal Science Research and Development)

ICABIOGRAD (Indonesian Center for Agricultural Biotechnology and Genetic Resource Research and Development)

ISMCRI (Indonesian Spice and Medicinal Crops Research Institute)

IRIAP (Indonesian Research Institute for Animal Production)

ICECRD (Indonesian Center for Estate Crops Research and Development)

ICAPOSTRD
(Indonesian Center for Agricultural Post Harvest Research and Development)

Udayana University

Cornell University

University of California, Los Angeles (UCLA)

Diponegoro University

Universitas Negiri Papua

DIKTI

RISTEK

BPPT (The Agency for the Assessment and Application of Technology)

PAPPIPTEK-LIPI

CIFOR

University of Indonesia

IPB Bogor

Forestry Research and Development Agency of Indonesia (FORDA)

World Bank, Indonesia

Puspiptek Centre of Science and Technology Research

Kalbe Farma

Appendix 3.

List of Acronyms

ADB	Asian Development Bank
AIPI	Akademi Ilmu Pengetahuan Indonesia – Indonesian Academy of Sciences
APA	Algemeene Proefstation der AVROS
APEC	Asia–Pacific Economic Cooperation
APTISI	Asosiasi Perguruan Tinggi Swasta Indonesia – Association of Indonesian Private Universities
ASEAN	Association of Southeast Asian Nations
AusAID	Australian Agency for International Development
AVROS	Algemeene Vereeniging van Rubberplanters ter Oostkust van Sumatra
BAPATEN	Badan Pengawas Tenaga Nuklir – Nuclear Energy Regulatory Agency
BAPPENAS	Badan Perencanaan Pembangunan Nasional – State Ministry of National Development Planning
BATAN	Badan Tenaga Nuklir Nasional – National Nuclear Energy Agency
BBG	Bogor Botanical Garden
BIC	Business Innovation Centre
BKMG	Badan Meteorologi, Klimatologi, dan Geofisika – Indonesian Agency for Meteorological, Climatological and Geophysics
BKPM	Badan Koordinasi Penanaman Modal – Indonesia Investment Coordinating Board
BoP	Balance of payments
BPPT	Badan Pengkajian dan Penerapan Teknologi – Agency for the Assessment and Application of Technology (BPPT)
BSN	Badan Standardisasi Nasional – National Standardisation Agency of Indonesia
CEDAW	Convention on the Elimination of All Forms of Discrimination against Women
CEDS	Centre for Entrepreneurship Development and Studies
CEO	Chief Executive Officer
CIFOR	Centre for International Forestry Research
COMCEC	Standing Committee for Economic and Commercial Cooperation of the Organization of the Islamic Conference
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CT	Coordinating team
DIKTI	Direktorat Jenderal Pendidikan Tinggi – Directorate General of Higher Education
DRN	Dewan Riset Nasional (DRN) – National Research Council

ESOL	English for Speakers of Other Languages
EWS-DRR	Early warning system for disaster risk reduction
FDI	Foreign Direct Investment
FIRST	Fulbright Indonesia Research and Technology Programme
FORDA	Forestry Research and Development Agency
ForMemRS	Foreign Member of the Royal Society
FR	Foreign researcher
FRP	Foreign research permit
FRS	Fellow of the Royal Society
GDP	Gross domestic product
GEPI	Global Entrepreneurship Program Indonesia
GERD	Gross expenditure on research and development
GM	Genetically modified
HDP	Human Development Plan
HELTS	Higher Education Long Term Strategy 2003-2010
IBRC	Indonesian Biodiversity Research Centre
ICES	International Cooperation on Education about Standardisation
ICMI	Ikatan Cendekiawan Muslim Indonesia – Association of Indonesian Islamic Scholars
ICT	Information and Communication Technologies
IDB	Islamic Development Bank
IELTS	International English Language Testing System
IH	Immigration headquarters
ILO	International Labour Organisation
INS	Indonesische Nederland School
IPB	Institut Pertanian Bogor – Bogor Agricultural University
IQF	Indonesian Qualification Framework
ISRA	Indonesian Sea Radar
ITB	Institut Teknologi Bandung – Bandung Institute of Technology
KITAS	Kartu Ijin Tinggal Sementara – Temporary Residence Permit
LAPAN	Lembaga Penerbangan dan Antariksa Nasional – National Institute of Aeronautics and Space
LIPI	Lembaga Ilmu Pengetahuan Indonesia – Indonesian Institute of Sciences
LPNK	Lembaga Pemerintah Non Kementerian
MP3EI	Masterplan for Acceleration and Expansion of Indonesia's Economic Development
MQF	Malaysian Qualification Framework
MSTQ	Metrology Standardisation Testing and Quality Assurance
BAKOSURTANAL	Badan Informasi Geospasial – National Coordinating Agency for Surveys and Mapping
NGO	Non-governmental organisation
NIS	National Innovation System
NRC	National Research Council
NSF	National Science Foundation (USA)

OECD	Organisation for Economic Cooperation and Development
OIC	Organisation of Islamic Cooperation
OPEC	Organization of the Petroleum Exporting Countries
OSS	Open Source Software
P3GI	Pusat Penelitian Perkebunan Gula Indonesia – Indonesian Sugar Research Institute
PAPPIPTEK-LIPI	Pusat Penelitian Perkembangan Ilmu Pengetahuan dan Teknologi – Lembaga Ilmu Pengetahuan Indonesia / Centre for Science and Technology Development Studies – Indonesian Institute of Sciences
PBPLN	Overseas Postgraduate Scholarship Program
PEER	Partnerships for Enhanced Engagement in Research
POJ	Het Proefstation Oost Java
PPKS	Pusat Penelitian Kelapa Sawit – Palm Oil Research Centre
PPP	Purchasing power parity
PUSPIPTEK	Pusat Penelitian Ilmu Pengetahuan dan Teknologi – The Research Centre for Science and Technology
R&D	Research and development
RIEBS	Review of Indonesian Economic and Business Studies
RISTEK	Kementerian Riset dan Teknologi – State Ministry of Research and Technology
RPJMN	Rencana Pembangunan Jangka Menengah Nasional – The 2010-2014 National Medium-Term Development Plan
S&T	Science and technology
SESRIC	The Statistical, Economic and Social Research and Training Centre for Islamic Countries
SIMAKSI	Surat Izin Masuk Kawasan Konservasi – Permit to enter protected area
SKLD	Surat Keterengan lapor Diri – Certificate of Police Registration Card
SMS	Short Message Service
SPIN	Scientific Programme Indonesia-Netherlands
SPP	Surat Pemberitahuan Penelitian – Notification of Research
STI	Science, technology and innovation
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
UAE	United Arab Emirates
UCLA	University of California, Los Angeles
UGM	Universitas Gadjah Mada – Gadjah Mada University
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USAID	United States Agency for International Development
USD	US dollars
USPTO	US Patent and Trademark Office
WHO	World Health Organisation
WIGSAT	Women in Global Science and Technology

Acknowledgements

We would like to thank the following individuals who reviewed this report prior to publication:

- Professor Satryo Soemantri Brodjonegoro, Bandung Institute of Technology (ITB)
- Professor Bruce Alberts CBE ForMemRS, Professor Emeritus, Department of Biochemistry and Biophysics, University of California, San Francisco
- Dr. Sonny Yuliar, Bandung Institute of Technology (ITB).
- Dr Triarko Nurlambang, Chairman of the Centre for Applied Geography, University of Indonesia.
- Dr. Tusy Adibroto, Principal Engineer, Agency for the Assessment and Application of Technology (BPPT)
- Professor Atta ur Rahman FRS, President, Pakistan Academy of Sciences and President, Network of Academies of Sciences of Islamic Countries

The reviewers were not asked to endorse the conclusions or recommendations of the report.

Indonesia has much to offer the world. Its rich biodiversity could allow it, for example, to pioneer cutting-edge research into pressing issues such as the effect of climate change on forests and oceans. Its geothermal stores allow for experimentation with generating renewable energy from the earth as well as through solar and wind sources. With food insecurity on the rise, Indonesia could also pioneer agricultural techniques that improve food productivity and nutrition.

Once, Indonesia had the potential to emerge as a global scientific powerhouse, yet decades of neglect have left its infrastructure still too weak to build a robust R&D system. For now, the country needs to invest in the basics, ensuring that the foundation for good scientific practice is strong. It will also need the right people to make this happen, and it must focus on producing and rewarding high-quality researchers who are adept at critical thinking rather than just churning out high numbers of graduates.

The research for this report was conducted as part of the *Atlas of Islamic World Science and Innovation* project. Bringing together partners from across the Islamic world, Europe and North America, it aims to explore the changing landscape of science and innovation across a diverse selection of countries with large Muslim populations.

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