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Country Study: Singapore

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Cambridge Industrial Innovation Policy

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Introduction

Stimulating innovation as a policy by the Singapore government is a relatively recent initiative. Singapore has seen the transformation of its economy from a subcontractor or production agent for principals elsewhere in the world into an advanced economy at par with other small industrial economies over a short period of about 50 years. Since its independence in 1965 one can roughly see three major periods in its economic development. From the mid to late sixties onwards till the late eighties of the 20th century it pursued a policy based on open trade, the attraction of foreign direct investment (FDI) in assembly, production and basic services and all this based on low labour cost and a flexible work organisation. This policy reached its limits in the mid-eighties, when Singapore got into an economic downturn, largely based on the loss of competitiveness due to rising labour costs. Since then, Singapore has organised regular (every 6 to 8 years) major reviews of its economic policy framework to determine how to adjust the economy to the changing international environment. These reviews are sometimes triggered by economic shocks or crises.

The major adjustment after the economic downturn of 1986 was to transform Singapore's economy into a knowledge economy. This required a large investment in higher education and R&D[1], a shift in the target companies for FDI, the attraction of 'foreign talent' or foreign employees with higher degrees and knowledge experience, etc. During the late nineties and the first years of the 21st century, there was also a significant shift towards the development of service industries e.g., tourism (with the creation of integrated resorts), trade, financial services (focused on private wealth) and other professional services. It is only in the early 2010s that the government realised that the investment in R&D led to internationally recognised research output, but not to a translation into economically successful innovations. It is then that those policymakers started talking about shifting from a knowledge economy into an innovation economy.

What have been the results in terms of innovation? The economic performance of Singapore has been spectacular. From a fairly lowly developed economy with a GDP of USD 517 in 1965, it is now per capita one of the richest countries in the world with a GDP per capita, estimated for 2021 of USD72,794[2]. But when it comes to innovation the country is probably not yet successful. In a comment published in 2017 in the Straits Times, the main local newspaper, Dr Beh Swan Gin, chairman of Singapore's Economic Development Board, argued that Singapore was able and ready to make the shift from a knowledge-led to an innovation-led economy[3]. Three factors, specifically the rise of Asia as a market, the concentration of dynamic and diverse multinational corporations (MNCs) in Singapore and the availability of private risk capital, but according to him Singapore is in an ideal position to become a significant driver of innovation. Furthermore, the strong scientific base, the growing vibrancy of the start-up ecosystem coupled with Singapore's traditional strengths as a trusted business location and attractiveness to talent and connectedness to the world should enhance Singapore's position as an innovation hub. He used a lot of conditional verbs, which indicates that the senior civil servants know that Singapore is not yet an innovative economy.

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[1] This is extensively documented in De Meyer Arnoud with Jovina Ang. 2022. Building Excellence in Higher Education: Singapore's Experience. Routledge, London (https://www.routledge.com/Building-Excellence-in-Higher-Education-Singapores-Experience/Meyer-Ang/p/book/9780367539160

[2] Source: World Bank, https://www.macrotrends.net/countries/SGP/singapore/gdp-per-capita (accessed: 3 August 2022)

[3] Beh, S. G. 2017. Singapore's long game in innovation. *The Straits Times*, 23 August. [Online] Available at: www.straitstimes.com/opinion/singapores-long-game-in-innovation (Accessed: 27 February 2020).

As I wrote in my book on the development of higher education in Singapore[4]:

> *"In some of the world rankings, Singapore has scored well when it comes to innovation. For example, the 2019 World Global Innovation Index, published by the World Intellectual Property organisation[i], Singapore ranked eighth in the world for innovativeness. [...] Singapore scored exceedingly high in terms of innovation input, where it is at the top of the world rankings, but it is fifteenth in terms of innovative output. Digging deeper into the components of this score, Singapore scored very high with respect to institutions (#1), human capital and research (#5), infrastructure (#7), market sophistication (#5), business sophistication (#4), but not as high in knowledge and technology outputs (#11) or creative outputs (#34). Digging even deeper into the details of this composite ranking, we learn that Singapore's tertiary education which is a component of human capital and research, is ranked first worldwide whereas research output and infrastructure are ranked thirteenth in the world.*
>
> *In another innovation index, published by Bloomberg, Singapore scored third behind Germany and South Korea. [...]. Singapore scored first in tertiary education efficiency which combined factors such as the cohort participation rate, the share of the labour force with an advanced level of education and the annual science, and engineering graduates as a percentage of the total tertiary graduates. Singapore scored second in value-added manufacturing. Relatively speaking, it lagged in high technological (hi-tech) density, defined as the number of domestically domiciled hi-tech companies where it is number seventeen. As for R&D density and researcher concentration, it is ranked number twelve and thirteen respectively. This index suggests a similar result to the WIPO index: despite being highly ranked for government-sponsored input and education, the creation of domestic innovative companies in Singapore is still not yet at the level of the top performers.*
>
> *[...] Why do economic observers remain critical of Singapore's capacity to innovate? The International Monetary Fund[5] identified several reasons for the weakness in innovation in 2017. Two of them stand out. The first reason is culture. Singaporeans' known risk-averse culture could be holding them back from doing and achieving more in innovation. Another reason is the lack of economies of scale as Singapore companies only have access to a relatively small domestic market unlike the companies in Silicon Valley. [...]*
>
> *Lim Chuan Poh was the chairman of A*STAR until early 2019 and was closely involved in R&D and innovation in Singapore. In commenting on the results of the 2016 Global Innovation Index, Lim said that the challenge for Singapore is to enhance the private sector innovation capacity[6]. He mentioned that "although public sector research has grown in intensity and excellence, that of*

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[4] De Meyer and op.cit. Cornell University, INSEAD, and WIPO (2019); *The Global Innovation Index 2019: Creating Healthy Lives—The Future of Medical Innovation,* Ithaca, Fontainebleau, and Geneva. [Online] Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019.pdf, (Accessed: 15 February 2020

[5] International Monetary Fund (2017). *S*taff Report for the 2017 Article IV Consultation with Singapore, *IMF Country Report No 17/240*, July 2017. [Online] Available at: http://www.imf.org/en/Publications/CR/Issues/2017/07/28/Singapore-2017-Article-IV-Consultation-Press-Release-Staff-Report-45144. (Accessed: 15 February 2020)

[6] Lim C.P. (2016). From Research to Innovation to Enterprise: The Case of Singapore, in Cornell University, INSEAD, and WIPO. (2016). *The Global Innovation Index 2016: Winning with Global Innovation*, Ithaca, Fontainebleau, and Geneva

enterprises, especially the local enterprises, has yet to grow at a corresponding rate. The MNCs, by and large, dominate in many R&D-intensive industry clusters, such as electronics, pharmaceuticals and biomedical sciences. In comparison, local enterprises are still relatively modest in their research investments and capabilities although their growth rate appears to have picked up in the last 5 years or so." […]

In an interview with University World News in 2017, [Bertil] Andersson [former president of NTU] added[7]: "Today the big success story in Singapore is research. Innovation has not come that far. Research has to come before innovation and the country has high ambitions to do that. Singapore is a small country, you cannot compare it with Germany, the United States, or the UK. But you can compare Singapore with Sweden, Finland, Switzerland, and Israel – these are what we call small, smart nations. Still, I don't think we have the same culture here in Singapore like Sweden, Switzerland or Israel. Singapore is much more risk-averse, for example. In terms of innovation, I don't think things are going to be radically different in 2020 but maybe in 2025 and 2030. The question is – will the Singapore government, the Singapore taxpayers have the patience to wait for that?"

That said, there have been some successes. Many MNCs have set up innovation centres in Singapore. The often-cited examples are the Visa Innovation Centre, the Philips Health Continuum Space and P&G's Innovation Centre. Our extensive case studies on Schneider's Innovation Hub or Johnson & Johnson's Design Lab[8] illustrate in detail why companies choose Singapore as their innovation hub in Southeast Asia.

The current government is convinced that research plays an important role in building Singapore's future as a smart nation. As explained by then DPM and Chairman of the National Research Foundation Teo Chee Hean in 2020: "R&D is an investment in our future. It's an expression of belief in Singapore and Singapore's future. If we want to be a knowledge-based economy, which thrives on innovation and enterprise, we must build this knowledge base on which we can build the future of Singapore – then R&D is where we have to invest."

[7] Sharma, Y. (2017). The story of how Singapore became a research nation. *University World News*, December 15. [Online] Available at: https://www.universityworldnews.com/post.php?story=20171215122350628 (Accessed: 15 January 2020)

[8] De Meyer A and L Bhattacharya. (2020). *Johnson & Johnson's Choice of regional Headquarters and Innovation Hub: Why Singapore?* SMU case study SMU-20-XXXX. & De Meyer A. and Chan C.W. (2020*). Schneider Electric: Optimising Business Opportunities from its Regional HQ in Singapore.* SMU Case study SMU-20-XXXX.

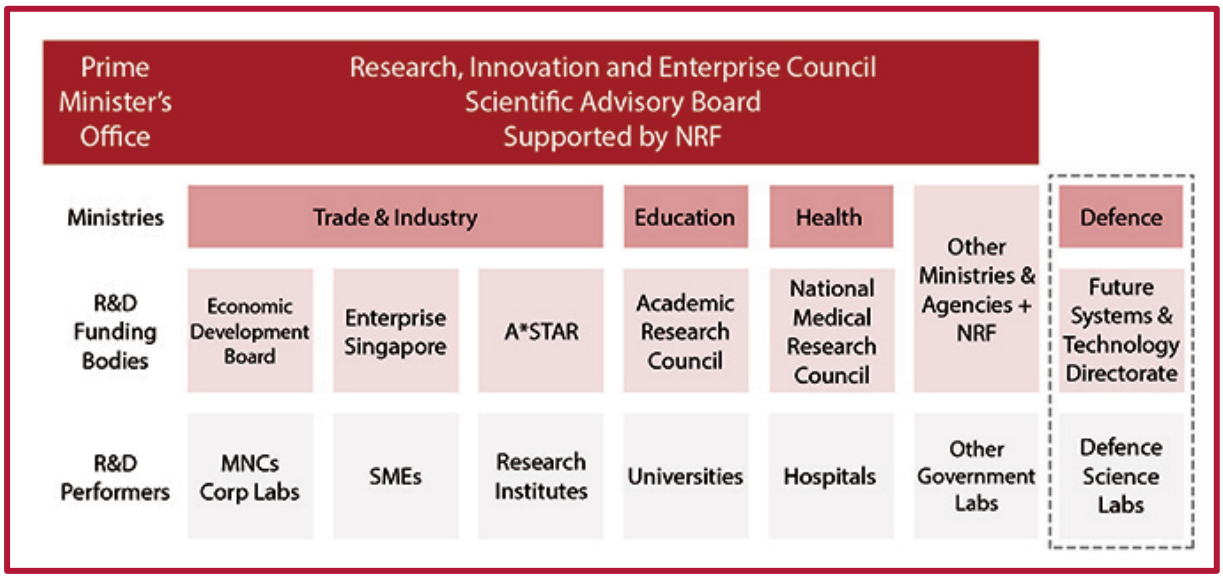
Organisations

Is there an innovation agency? Based on an informal conversation with the Permanent Secretary and the CEO of the NRF (National Research Foundation), which is considered the core organisation in implementing innovation policy, their answer can be summarised as follows (I paraphrase):

> *"Singapore has no Innovation Agency. Innovation is a whole of government effort where several departments and institutions will help in the implementation of the RIE (Research, Innovation and Enterprise Plan). For example, to stimulate the venture departments in MNC's EDB (Economic Development Board) will take this on them. Enterprise Singapore will stimulate innovation in the local SMEs or local start-ups. MOE will support entrepreneurial incubators at universities. As NRF is managing the distribution of the resources, they act as a facilitator. In international G2G interactions with specialised innovation agencies, NRF will be the contact, but they will always bring the relevant organisation along."*

In a recent interview with Deputy Prime Minister Heng Swee Keat, who is chairman of the NRF, he further explained this whole of government also as an evolution from an agency-centred approach to a user-centred approach. In the past, government agencies were sometimes competing with each other in trying to convince users (companies) to accept their support. The real challenge is to come up with specific solutions that combine the support from different agencies and ministries.

On the NRF website, one finds the following diagram of the RIE ecosystem[9]:



The Research, Innovation and Enterprise (RIE) ecosystem in Singapore comprises various ministries, R&D funding bodies and R&D performers. At the top is the Research, Innovation and Enterprise Council (RIEC), chaired by the Prime Minister, which oversees the long-term strategy to transform Singapore into a knowledge-based and innovative society, with strong capabilities in research and technology. The RIEC is supported by the National Research Foundation (NRF) Board, which is responsible for the formulation of 5-year plans and policies to grow Singapore's research capability, support economic growth and meet Singapore's future national challenges.

[9] https://www.nrf.gov.sg/about-nrf/rie-ecosystem (Accessed: 3 August 2022)

The key government agencies involved in the RIE landscape include:

- Ministry of Trade and Industry: focus on policies related to economically oriented and industry R&D
- EDB: provides funding support for companies to conduct R&D
- Enterprise Singapore: grows Singapore companies through innovation, and building a vibrant start-up ecosystem
- A*STAR: performs economically oriented R&D to support companies
- Ministry of Education: oversees policies related to the institutes of higher learning (IHLs) and provides funding support for IHLs to perform R&D and stimulate entrepreneurship among students, faculty and alumni.
- Ministry of Health: oversees policies and provides funding support to the academic medical centres and hospitals, and runs the National Innovation Challenge on Active and Confident Ageing
- Ministry of National Development: runs the National Innovation Challenge on Land and Liveability
- Infocomm Media Development Authority: co-secretariat for the Smart Systems Strategic Research Programme
- Smart Nation Program Office: co-secretariat for the Smart Systems Strategic Research Programme
- PUB (Water Agency): runs the Clean Water Strategic Research Programme
- Energy Market Authority: runs the Clean Energy Strategic Research Programme

Processes

The two main processes that I observe are the whole government effort based on RIE and the development of the Industry Transformation Maps (ITMs), spearheaded by the Ministry of Trade and Industry (MTI)

RIE

For the past 25 years, the investment in research and development by the Singapore government and industry has grown significantly. The current mechanism to guide the investment in R&D is through the Research, Innovation and Enterprise (RIE) 5-year plan. On NRF's website[10] it is described as follows:

> *Singapore's R&D journey started in 1991, with the establishment of the National Science and Technology Board, and the launch of the first five-year National Technology Plan. The aim was to develop high-technology activities that would move us up the economic value chain and build a strong base of scientists, engineers and technologists who would help to drive economic and enterprise transformation. These plans would be refreshed every five years to position Singapore as an innovation-driven, knowledge-based economy.*
>
> *In 2010, Singapore's R&D strategy was expanded to span Research, Innovation and Enterprise (RIE). The RIE2015 and RIE2020 plans included translation, commercialisation and innovation strategies to tap into the growing pipeline of promising research outputs and support our enterprises.*
>
> *Given the rapidly evolving global and technology landscape, RIE plans have also evolved to include White Space funding for unanticipated needs and opportunities. This has enabled Singapore to respond nimbly to new priorities, and seed capabilities in critical, but then-nascent technology areas such as cybersecurity and food.*

This plan is developed by the National Research Foundation (NRF) under the prime minister's office, and in collaboration with economic agencies e.g., the Economic Development Board (EDB) or Enterprise Singapore, as well as broad consultation of the research and business community. In the Research, Innovation and Enterprise (RIE) 2015 Plan, the Singapore Government committed S$16 billion to research, innovation and enterprise in 2011-2015, especially to build Singapore as a global research and development hub. The investment in research was increased to S$19 billion in the RIE 2020 Plan, covering the period from 2016 to 2020 (National Research Foundation, 2020). The current RIE 2025 Plan aims to sustain government investments in research, innovation and enterprise at about 1% of Singapore's GDP. This is about $25B and reflects the Singapore government's sustained, long-term commitment to R&D through economic cycles.

ITMs

The idea of ITMs developed out of the work of the Committee on the Future Economy (CFE), which was convened in January 2016 to guide Singapore's economic strategies for the next 5-10 years. As I mentioned in the introduction such committees are not new to Singapore; the CFE was preceded by many others, including the Committee on Singapore's Competitiveness (1998-2002), Economic Review Committee (2003-09), and the Economic Strategies Committee (2010-16). What made the CFE slightly unusual, however, was that most of these previous committees were typically set up in the aftermath of

[10] https://www.nrf.gov.sg/rie2025-plan (Accessed: 3 August 2022)

an economic crisis such as an oil price shock or the global financial crisis, whereas there was no particular trigger for the CFE. There were, however, some worrying systemic trends – in particular, the slowdown in the global economy, the uptick in protectionist policies in many countries, and the accelerating pace of disruptive technological change – that prompted its formation.

The CFE reported its findings in February 2017. The report made seven key recommendations for the future (see Exhibit 4), one of which was to develop and implement ITMs.

The government appeared to be committed to the concept of ITMs even before the tabling of the CFE report. In his budget speech in March 2016, then finance minister Heng Swee Keat (now Deputy Prime Minister) announced that the government would launch a S$4.5 bn Industry Transformation Programme, the key thrusts of which were to (1) support the transformation of individual enterprises; (2) support the transformation of industries; and (3) **provide support for fostering greater innovation in the economy**. He then went on to say:

> *"We will work closely with enterprises and at the industry level to develop transformation maps for each sector … We will take this more integrated and more targeted approach, in partnership with industry and unions, across more than 20 sectors, covering 80% of our GDP".*

As their name suggests, ITMs are intended to be sector-specific road maps to drive industrial transformation. The government defines them as "roadmaps … to address issues within each industry and deepen partnerships between Government, firms, industries, trade associations and chambers".
23 ITMs were eventually introduced. They were launched in a phased manner between 2016-18 as they were finalised. Each ITM was led by a government agency or statutory body that took responsibility for its implementation.

To develop and strengthen synergies between different sectors, operating within related industries, and responding to some criticism that the 23 ITMs were a bit too granular, the 23 ITMs were also clustered. Six ITM clusters were developed: Manufacturing, Built Environment, Trade & Connectivity, Essential Domestic Services, Modern Services, and Lifestyle.

Each ITM aimed to address four central industry needs:

(1) productivity growth,
(2) stimulating industry innovation,
(3) promoting trade and internationalisation, and
(4) upgrading industry jobs & skills.

However, not every ITM addressed every one of these themes in depth but instead focused on the themes of greatest relevance. The aerospace ITM, for instance, did not address trade and internationalisation issues, focusing instead on measures to drive industry innovation, increase productivity, and equip citizens with the necessary skills for the sector. The wholesale trade ITM, on the other hand, prioritised trade and internationalisation, emphasising the need to create digital marketplaces to help Singaporean companies expand their market reach, and attract global players in wholesale markets to anchor their key trading activities in Singapore. But all of them touched to some extent on the need to stimulate innovation. And the ITMs were well integrated with RIE. The advantage was that DPM Heng was at the same time the coordinating minister for the economy and chairman of the NRF.

Content

In terms of priorities and goals RIE 2025 defined four strategic domains:

(1) Manufacturing trade and connectivity
(2) Human health and potential
(3) Urban solutions and sustainability
(4) Smart Nation and Digital Economy

These four areas are supported by three horizontals: academic research, manpower development and stimulating industrial innovation.

Figure 1

Priorities of the 2025 RIE Plan

Where is the money spent? More than 75% of the resources are spent on R&D and talent development. 21% (S$ 5.2 B, or US$ 3.85 B) will be spent on innovation in companies and stimulating entrepreneurship. (See figure 2)

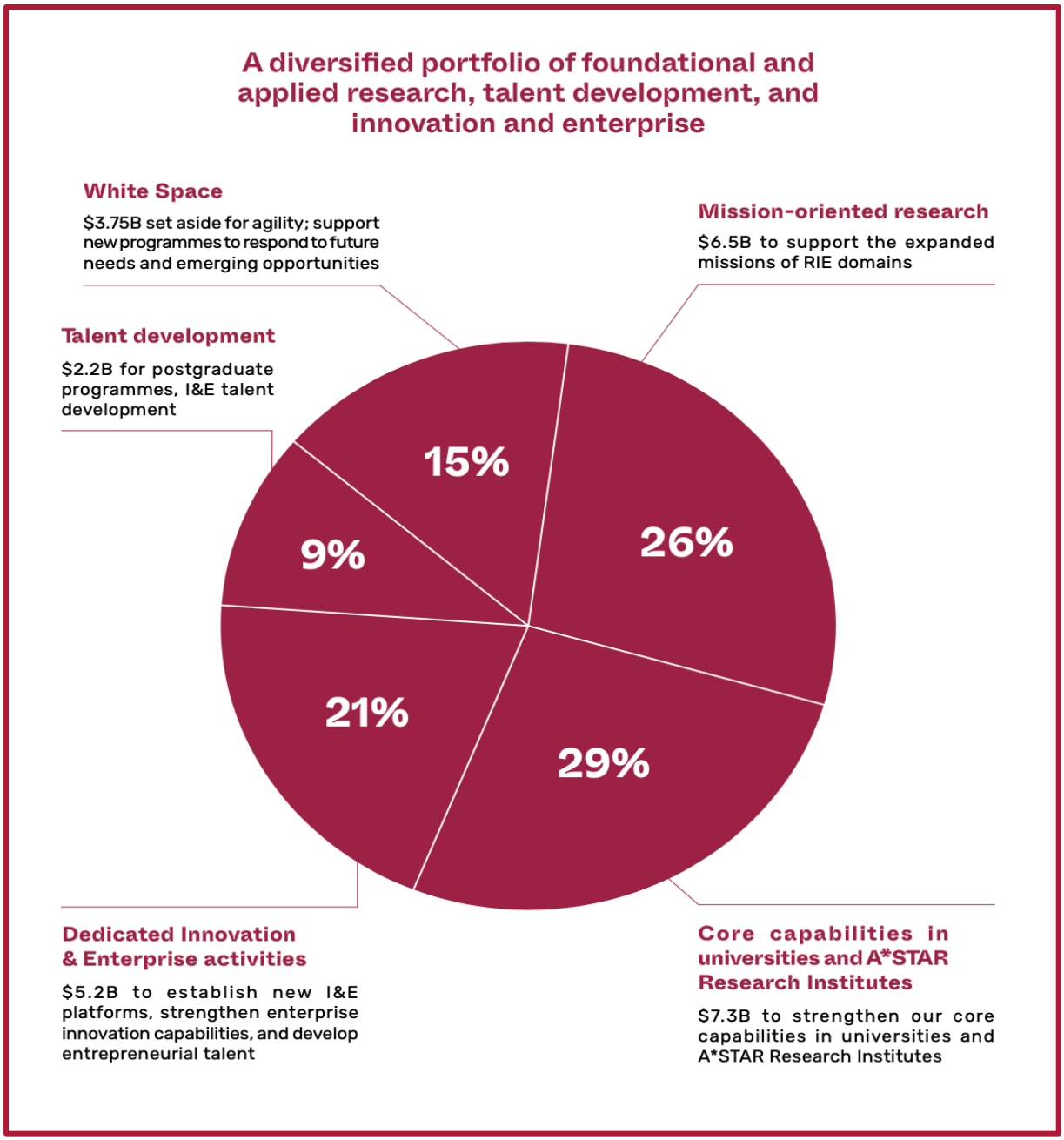


Figure 2: Allocation of the RIE resources

As the name of the RIE plan suggests the investment is both in research (to a large extent at universities and research institutes like A*STAR), and in innovation and entrepreneurship. On the same website of the NRF that I mentioned earlier this shift towards innovation is described as follows:

> *Under the previous RIE plans, we have established I&E platforms that have shown good progress in driving technology translation of public sector S&T and innovation capabilities, to create value for our enterprises. Examples of these platforms include the National Additive Manufacturing*

Innovation Cluster (NAMIC) and the Diagnostic Development (Dodd) Hub, which have driven industry/market adoption of additive manufacturing capabilities and diagnostic devices, respectively. These platforms have strengthened key capabilities at a national level, and also established strong partnerships with companies to catalyse new products.

In RIE2025, we will scale up these I&E platforms to expand our reach and support local enterprises in technology translation and commercialisation. This will accelerate the speed at which companies can translate R&D into market-ready products and solutions. The platforms will also serve as a node to bring together key stakeholders across the R&D community, enterprises, government agencies, and regulators, as a collaborative ecosystem to enhance the cross-pollination of ideas, knowledge, expertise and technology, and catalyse value creation.

We will also build on these platforms to move into high-growth adjacencies. For example, DxD Hub will move into other complementary areas of Medtech, such as integrated medical devices or digital health. We will also further customise our I&E strategies to meet the different needs of various enterprise segments, address industry capability gaps, and strengthen our international networks to enhance our enterprises' access to technology, partners, talent and markets worldwide.

*To grow the pool of talent in Singapore who can help bring nascent technologies to market, and enhance the innovative capacities of our enterprises, RIE manpower schemes will be enhanced to gather and nurture 'bilingual' talent who have both technological and business expertise. Opportunities for on-the-job-training through internships and traineeships in A*STAR Research Institutes and corporate laboratories sited in our autonomous universities will further develop their knowledge and skills, and facilitate strong networks across industry, academia and government.*

Turning to the 23 ITMs these set very specific quantitative targets to be achieved for each of these sectors, and the particular metrics they prioritised. Figure 2 lists the baseline statistics and quantitative targets detailed in the ITM press releases for each sector. As the figure indicates, several ITMs specified quantitative targets for industry value added (VA), jobs, or both. With respect to jobs, while some ITMs simply specified the desired increase in the total number of jobs, several others specified that they aimed to increase the number of "good" jobs or Professional, Managerial, Executive and Technical (PMET) jobs, reflecting the importance placed on increasing the proportion of more productive and highly-skilled jobs in targeted industries. Some ITMs, on the other hand, explicitly targeted zero job growth. This was the case in the food services and retail ITMs, both sectors that accounted for a much larger proportion of the labour force relative to their contribution to total GDP. Accordingly, the ITMs for these two sectors included specific quantitative targets for productivity growth, as did some other ITMs such as air transport, financial services, and food manufacturing.

Figure 3: Baseline statistics and quantitative targets by ITM sector

ITM sector	Baseline statistics	Value-added (VA) target	Productivity target	Employment target	Other target
Aerospace	In 2016: ➢ $3.35 bn VA ➢ 21,000 jobs Average VA growth rate of 7% p.a.	$4 bn by 2020		Add 1,000 jobs by 2020	
Electronics	In 2016: ➢ $90 bn manufacturing output 70,000 workers	$22.2 bn by 2020		Add 2,100 PMET jobs by 2020	
Energy & chemicals	In 2015: ➢ $78 bn total output > 28,400 jobs	$12.7 bn by 2025		Add 1,400 jobs by 2025	
Marine & offshore	In 2016: ➢ $12.3 bn manufacturing output > 23,000 jobs	$5.8 bn by 2025		Add 1,500 jobs by 2025	
Precision engineering	In 2014: ➢ $8.8 bn VA 94,000 jobs	$14 bn in 2020		Add 3,000 PMET jobs by 2020	
Construction					8,000 workers trained in DfMA, IDD and green building capabilities by 2025
Environmental services	In 2017: > 78,000 jobs				Make 30,000 jobs higher VA by 2025
Real estate					
Security	In 2018: ➢ 240 security agencies ➢ 600 security service providers 47,000 active security officers				
Air transport		Increase by 16% from 2015-2020	Increase by 3-4% p.a.	Add >8,000 good jobs by 2025	
Land transport	In 2018: 123,000 jobs			Add 8,000 public transport jobs by 2030	
Logistics		$8.3 bn by 2020		Add 2,000 PMET jobs by 2020	
Sea transport	In 2018: ➢ 7% of GDP > 170,000 jobs	Add $4.5 bn by 2025		Add 5,000 good jobs by 2025	
Wholesale trade	In 2016: ➢ 12% of GDP > 325,000 jobs			Add 10,000 jobs by 2020	
Early childhood education	17,000 educators in 2018			Add 1,000 more senior professional positions	Expand provision of Malay and Tamil language education to 350 centres

Training & adult education				
Healthcare				
Financial services		Increase by 4.3% p.a.	Increase by 2.4% p.a.	Add 3,000 net jobs in financial services, plus 1,000 net jobs in FinTech
ICT & media		Increase by 6% p.a.		Add 16,000 jobs, of which 13,000 are PMET jobs, by 2020
Professional services	In 2016: ➢ 6.5% of GDP ➢ $25 bn VA > 230,000 jobs	$31 bn by 2020		Add 5,500 PMET jobs per year
Food manufacturing	In 2015: ➢ $3.7 bn GDP 40,000 jobs		Compound annual growth rate of 4.5%	Add 2,000 PMET jobs by 2020
Food services	In 2016: ➢ 0.8% of GDP ➢ 160,000 jobs 4.5% of workforce		Increase by 2% p.a.	No increase in jobs
Hotels	In 2016: 33,000 jobs			
Retail	In 2016: ➢ 1.4% of GDP ➢ 21,000 retail establishments ➢ $35 bn operating receipts 3% of workforce		Increase by 1% p.a.	No increase in jobs

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About us

Cambridge Industrial Innovation Policy (CIIP) is a global, not-for-profit policy group based at the Institute for Manufacturing (IfM), University of Cambridge. CIIP works with governments and global organisations to promote industrial competitiveness and technological innovation. We offer new evidence, insights and tools based on the latest academic thinking and international best practices.

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