



Professor Wang Linfa of Duke-NUS Medical School with a Covid-19 test kit – cPass – invented by a team he led. The benefits Singapore has derived from research and development have been substantial, says the writer, with the scaling up of Covid-19 testing capability here owing much to locally developed test kits. PHOTO: DUKE-NUS MEDICAL SCHOOL

By Invitation

Getting more bang for the R&D buck

Singapore's considerable investment in research has brought many tangible benefits, with recent applications such as locally developed Covid-19 test kits and new artificial intelligence programmes. The challenge now is to extract even greater value.



Terence Ho

For *The Straits Times*

Singapore has built up a strong research and development (R&D) base, thanks to sustained investment over many years. A total of \$25 billion will be committed to research, innovation and enterprise (RIE) under the Government's latest five-year plan, or RIE2025, from this year to 2025. The benefits derived from R&D have also been substantial, such as in the national effort to combat Covid-19. The scaling up of Covid-19 testing capability here owes much to locally developed test kits. Diagnostic innovations from Singapore laboratories were quickly translated into clinically validated, mass-manufactured test kits through close collaboration between research institutions, healthcare providers and local medical technology manufacturers.

In the burgeoning field of artificial intelligence (AI), a new public AI programme was launched just this month as part of a concerted effort to harness AI for social and economic good. The National AI Programme in Finance is a collaboration between

Singapore-based banks and local fintech companies that includes an industrywide AI platform – dubbed NovAI – which will help financial institutions assess firms' environmental impact and risks. This is especially relevant in the wake of COP26.

With Singapore's R&D base maturing, the challenge now is to extract greater value from the considerable public investment in R&D.

How can this be achieved? Sustaining a strong foundation in basic research, strengthening pathways to translate research findings into commercial opportunity, and facilitating the deployment of technology and R&D solutions will be critical.

AIMS AND OUTCOMES

Broadly speaking, public R&D spending serves to address national or societal priorities, derive economic gain and enhance scientific or academic reputation. As a small country accounting for a small fraction of global research spending, Singapore cannot excel at everything, and must be selective about its research priorities.

Solutions to national needs may be developed through R&D or purchased from abroad. In deciding whether to "build" or "buy":

- First, does the research address issues particularly important to Singapore, requiring solutions that are not commercially available elsewhere?
- Second, can Singapore realise economic gains from being a first mover, for example, by enabling Singapore firms to capture market share through superior products and services or by licensing intellectual property?
- Third, is Singapore well placed to be a global leader in a particular domain?

Singapore's urban living challenges have impelled development of expertise in urban solutions and sustainability. For

instance, Singapore's water needs have spawned a thriving water industry with 180 companies and more than 20 water research centres. The rapidly ageing population, likewise, has spurred research into ageing, along with the roll-out of products and services catering to seniors. This suggests the possibility of synergies between research excellence and impact in terms of economic and societal outcomes.

Over the years, the research generated by our universities, research institutes and hospitals has grown in volume and quality. Singapore was ranked eighth globally in the 2021 World Intellectual Property Organisation Global Innovation Index and second in the 2021 Bloomberg Innovation Index.

However, the efficiency of Singapore's R&D investments – how much innovation output a country is getting for its inputs – lags behind that of other countries: the Global Innovation Index ranked Singapore first on input but a mere 13th on output. The persistent gap between the Republic's innovation input and output performance has added impetus to get more out of every dollar spent on R&D.

BACK TO BASICS

With the growing emphasis on R&D commercialisation, it is important not to neglect investment in basic research, which underpins Singapore's status as an R&D hub and talent magnet, and can lead to positive spillovers and serendipitous applications.

Basic science is the foundation of the entire value chain in research, innovation and enterprise. Funding excellence in basic research is an investment in talent. Leading scientists in turn attract companies, investment and other research and entrepreneurial talent.

A strong R&D base also increases the absorptive capacity for

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technology, enabling countries and firms to be smart buyers and integrators of technology. So it is appropriate that a third of Singapore's \$25 billion RIE funding has been committed to basic research.

It may, however, take time for value to be realised. In the area of drug discovery, for instance, Singapore is finally seeing results from investments made years ago, with cancer drug candidates now moving into clinical trials and commercialisation.

The journey from scientific discovery to application is often circuitous. It may be difficult at the outset to identify commercial uses, while discoveries made in one domain could find unexpected applications elsewhere.

Thus, Singapore needs to be embedded in upstream and downstream research in various focus areas to have the best chance of making timely discoveries and capturing value.

NO LONGER LOST IN TRANSLATION

The potential for economic value capture is greater if there are pathways to translate research discoveries into commercial applications.

There is scope to bring to market more of the research done in Singapore's universities and research institutes. The Experimental Drug Development Centre, opened in 2019, offers a conduit for high-potential drug candidates to realise commercial as well as clinical outcomes, with a focus on diseases prevalent in Asia. Also launched in 2019, the Target Translation Consortium coordinates early-stage drug discovery efforts across academic institutions, healthcare institutions and government agencies.

Where innovation is industry-led, there is a high likelihood of successful commercial applications. Last month, ST Engineering announced a new research collaboration model (Research Translation @ ST Engineering) that brings together engineers and researchers from the company, universities and the Agency for Science, Technology and Research, or A*Star, in a common collaborative space. Its aim is to spur customer-centric R&D, translating laboratory research into prototype development and the roll-out of commercial products.

Singapore's start-up ecosystem, too, is playing a growing part in demand-pull innovation. For instance, start-ups have been working with larger corporates to develop market solutions under thematic open innovation calls, in partnership with public agencies and research outfits. While the start-up space has been dominated by consumer-facing enterprises, "deep technology" start-ups in areas such as advanced manufacturing, health and

sustainability are emerging, with strong potential to leverage R&D and intellectual property for competitive advantage.

PUBLIC SECTOR'S ROLE IN TECH DEPLOYMENT

Besides the private sector, the public sector may also generate demand for R&D. This requires sufficient focus on technology and innovation within public agencies, notwithstanding the many pressing issues vying for management attention. Innovation, after all, could yield solutions to public sector challenges such as sustainability, productivity and safety.

There may be a place for "big, hairy, audacious goals", such as to lower the ambient temperature in residential areas to a target range, or to achieve energy self-sufficiency in wastewater treatment by a set date. A clearly articulated target could serve to mobilise R&D efforts across a range of research domains and institutions.

To be able to deploy technology in operations effectively, public agencies must also develop "ops-tech" capability. One way is by recruiting and developing scientists and engineers, not just for in-house R&D, but also as smart buyers and technology "brokers" who can advise management on how to develop, procure and implement technological solutions.

Recent years have seen efforts to strengthen public sector engineering expertise and build capabilities in emerging technologies. In particular, the Government Technology Agency is spearheading the transformation of public service delivery through technologies such as AI and machine learning, along with data science and analytics. This entails working closely with public agencies, citizens and businesses to understand user needs and how best to address them.

Sometimes, regulations may pose a barrier to the deployment of new technology. The challenge for regulators is how to manage risk while giving sufficient leeway for the testing of new technologies and business models.

In the area of financial technology, for example, the Monetary Authority of Singapore's "regulatory sandbox" allows for experimentation with innovative financial products and services. Financial institutions or fintech players can market test innovations within a well-defined space and duration. Safeguards are in place to contain the consequences of failure and preserve the integrity of the financial system.

The proof of the pudding is in whether regulatory frameworks permit the timely deployment of new technologies at scale, so that the full benefits of innovation can be reaped. It is, of course, possible to wait for a technology to be fully mature before allowing its adoption, but Singapore may then miss out on first-mover advantage, or even fall behind the curve.

Innovators may require a degree of regulatory certainty before proceeding to the next stage in developing a new technology or product. What may be helpful is for regulatory agencies to articulate clear targets and obligations, such as a commitment to allow autonomous vehicles on the roads when the accident rate in trials is below half the human driver rate. This could open the door to faster innovation at scale.

CAPTURING GREATER VALUE

Over successive national science plans, public expenditure on R&D has grown substantially, in tandem with economic growth. The \$25 billion budget for RIE2025 is up from \$19 billion for RIE2020 and \$16 billion for RIE2015. Public R&D spending has been pegged at around 1 per cent of gross domestic product, putting Singapore on a par with other small advanced economies such as Denmark and Sweden.

While Singapore's research, innovation and enterprise ecosystem has already generated considerable economic and social impact, there is scope to capture greater value still from public investment in R&D.

Harnessing the full potential of our R&D talent, infrastructure and institutions will be central to Singapore's efforts to survive and thrive in the post-pandemic world.

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