Innovation Districts in Singapore – Can We Plan for Innovation?

"Silicon Valley" in Singapore

In early 2018, several news reports in Singapore heralded the beginnings of Singapore's own "mini Silicon Valley" in Punggol,[1] a relatively sleepy public housing town in the northeast corner of Singapore. The excitement was over plans announced by the Singapore government to pilot a new "enterprise district" there, which would create 28,000 new jobs in digital and cybersecurity sectors.[2] It was the latest initiative in the government's drive to incubate new economic growth centres throughout the city-state. Known as Punggol Digital District, the masterplan for the 50-hectare district would be rolled out progressively from 2023. It would encompass a business park, the new campus for the Singapore Institute of Technology (SIT) as well as community facilities. By putting complementary users—the SIT campus and business park—next to one another, the idea was that they could share infrastructure such as research labs, incubator spaces and learning facilities, and hopefully catalyse deeper collaboration between industry and academia. Clusters of buildings in the Punggol Digital District could also be fitted with new technologies, such as centralised management systems for waste collection, cooling and logistics.[3]

Industrial park of the future

Two year earlier, the government had launched the 600-hectare Jurong Innovation District in one of the few remaining large greenfield sites in Singapore, adjacent to the Nanyang Technological University (NTU) campus and existing Cleantech Park. A fresh approach to industry development was needed in the era of the so-called fourth industrial revolution, where manufacturing technologies were undergoing a digital transformation, and research, innovation and manufacturing were increasingly intertwined. The Jurong Innovation District was envisaged as an "industrial park of the future" to spur new growth areas in advanced manufacturing, robotics, urban solutions, clean technologies and smart logistics.[4] Expected to be completed by 2022, it would host the entire value chain of activities from learning, research, innovation and production for manufacturing firms in these sectors, and serve as a "living lab" for test-bedding innovations. A new public housing town, Tengah, with a car-free town centre, was also being built next to the innovation district.

Led by JTC Corporation (JTC), a statutory board focused on industrial infrastructure development in Singapore, millions would be invested into developing the two new districts. These initiatives generated much

[1] Linette Lai and Toh Yong Chuan, "Punggol North could be a mini Silicon Valley," *The New Paper*, January 22, 2018, http://www.tnp.sg/news/singapore/punggol-north-could-be-mini-silicon-valley

[2] K. Cheng, "New Punggol Digital District to create 28,000 jobs, open gradually from 2023." *TODAY*, January 21, 2018, https://www.todayonline.com/singapore/new-punggol-digital-district-create-28000-jobs-open-gradually-2023

[3] Linette Lai, "Masterplan for 'digital district' in Punggol North launched; area to generate up to 28,000 tech jobs", *The Straits Times*, January 21, 2018, http://www.straitstimes.com/singapore/masterplan-for-digital-district-in-punggol-north-launched-area-to-generate-up-to-28000

[4] H. H. Ong, "Singapore Budget 2016: Jurong Innovation District to be set up; first phase ready by around 2022," *The Straits Times*, March 24, 2016, http://www.straitstimes.com/business/economy/singapore-budget-2016-new-jurong-innovation-district-to-be-set-up-first-phase-ready; Lee Yen Nee, "Jurong Innovation District to nurture new growth areas in manufacturing," *TODAY*, April 8, 2016, http://www.todayonline.com/business/jurong-innovation-district-nurture-new-growth-areas-manufacturing; Ministry of Trade and Industry, *Factsheet on Jurong Innovation District*, April 7, 2016, https://www.mti.gov.sg/MTIInsights/Documents/Factsheet%20on%20Jurong%20Innovation%20District%20(JID)%20-%207Apr.pdf

This case study was written by Jean Chia under the guidance of Dr Joo Yu Min, Lee Kuan Yew School of Public Policy (LKY School), National University of Singapore. The case does not reflect the views of the sponsoring organization nor is it intended to suggest correct or incorrect handling of the situation depicted. The case is not intended to serve as a primary source of data and is meant solely for class discussion.

Copyright © 2018 by the Lee Kuan Yew School of Public Policy at the National University of Singapore. All rights reserved. This publication can only be used for teaching purposes.

anticipation about Singapore's next phase of economic development. Referring to the planned innovation district in Jurong, a real estate analyst enthused, "The development of the JID [Jurong Innovation District] will see the currently sleepy Jurong West locale transformed into a thriving hub of activity."[5] Some observers however, sounded a more cautious note. At a business seminar held soon after the announcement of the innovation district, a business consultant commented, "I think it is still too early to tell whether it's going to work or not, if it's a wonderful idea or not."[6]

Exhibit 1: An artist's impressions of the Jurong Innovation District (left) and Punggol Digital District (right)

Image credit: Ministry of Trade & Industry and JTC Corporation

Nevertheless, innovation districts were fast gaining popularity globally, particularly with city governments looking to revitalise older or blighted urban districts. Given the high stakes and large public investments poured into developing innovation districts, would they give Singapore a competitive edge in the global economy, or would innovation districts end up with empty spaces and unproductive uses? What was the role of the public sector in spurring innovation, and how these efforts dovetail into the Singapore's overall Smart Nation plans? Were there other implications or trade-offs that had been neglected in the public discourse on developing innovation districts? This case study discusses these issues using one-north as the primary example.

Rise of innovation districts

Countries, especially developed economies facing plateauing growth, were increasingly focusing on knowledge and innovation to drive growth. Density and proximity were prized for fostering knowledge sharing and innovation, leading to the popularity of the idea of innovation districts. Although technological advances and the advent of the Internet had lowered the costs and barriers to information-sharing, the process of sharing knowledge remained fraught. Several studies pointed to the advantages of clustering,[7] and the significance of the proximity effect, geographical and cognitive,[8] in generating beneficial knowledge spillovers and accelerating innovations when institutions and firms were tightly clustered.[9] The benefits were highly localised; in other words, it was "out of sight, out of mind".

---

[5] R. Navaratnarajah, "New Jurong Innovation District to boost property demand." *PropertyGuru*, March 25, 2016, https://www.propertyguru.com.sg/property-management-news/2016/3/120859/new-jurong-innovation-district-to-boost-property-demand

[6] "Will the Jurong Innovation District make a difference?" *Singapore Business Review*, March 28, 2016, http://sbr.com.sg/information-technology/news/will-jurong-innovation-district-make-difference

[7] See M. E. Porter, "Clusters and the New Economics of Competition." *Harvard Business Review*, November-December, 1998.

[8] Referring to knowledge bases that are similar.

[9] See for example, K. Morgan, "The exaggerated death of geography: learning, proximity and territorial innovation systems." *Journal of Economic Geography* 4 (2004): 3–21, doi.org/10.1093/jeg/4.1.3; R. A. Boschma, "Proximity and innovation: a critical assessment." *Regional Studies* 39 (2005), 61-74; K. Buzard, G. A. Carlino, R. M. Hunt, J. K. Carr, and T. E. Smith, "Localized Knowledge Spillovers:

Innovation districts were the "ultimate mash up of entrepreneurs and educational institutions, start-ups and schools, mixed-use development and medical innovations, bike-sharing and bankable investments—all connected by transit, powered by clean energy, wired for digital technology, and fuelled by caffeine."[10] They required the participation of three key stakeholders—research-intensive institutions, industry (ranging from anchor firms to start-ups), and government. Innovation districts also thrived in an environment of "open innovation" in which innovations could move more easily between a firm and its surrounding environment, including other firms, rather than rely primarily on internal research and development (R&D) efforts.[11]

Katz and Wagner identified three development models for innovation districts.[12] While innovation districts varied in size and focus sectors, one common thread was a focus on research-intensive science, technology, engineering, and creative sectors. The "anchor-plus" model was centred on anchor institutions such as a university or research hospital, around which firms and entrepreneurs coalesced. Silicon Valley in the US provided an early prototype in the spatial concentration of entrepreneurs, start-ups and technology firms drawing on talent nurtured in surrounding universities such as Stanford University, albeit in sprawling research and corporate campuses along suburban corridors, rather than downtown hubs. The "re-imagined urban areas" model featured urban industrial pockets, such as historic waterfronts, that were being physically and economically rejuvenated. One often-cited example was 22@Barcelona, which the Barcelona City Council transformed into a new knowledge district out of the decaying manufacturing district of Poblenou. In the "urbanised science park" model, a traditional science park in suburban areas such as the Research Triangle Park in North Carolina was increasingly urbanised through higher density and more mixed use developments.

The growing popularity of innovation districts was evident in the US, where decades of suburbanisation had hallowed out downtown areas, and even bigger cities were struggling after the Great Recession of 2008. The divide between urban and suburban areas, coupled with changing demographics, meant that residents and workers in the US increasingly preferred to live and work in urban, rather than suburban, environments. Emerging firms and talented people were often clustering around underused urban industrial pockets that offered a sweet spot of lower rents, good range of amenities, and transport links within a large and diverse city. This in turn prompted emerging businesses such as high tech start-ups to take an "urban turn" from suburban campuses.[13] Similarly, cities like Berlin, London, Madrid, Tel Aviv, Mumbai, Shanghai and Rio de Janeiro, were the breeding grounds for start-ups.[14]

Innovation districts in Singapore

Clustering, particularly industrial clustering, had been deployed effectively in Singapore, such as in the petrochemicals industry in Jurong Island. It was however, a strategy to create an industrial ecosystem by raising operational efficiencies and holding down costs at an industry level, especially since Singapore offered

---

Evidence from the Spatial Clustering of R&D Labs and Patent Citations," *Federal Reserve Bank of Philadelphia Working Paper No. 17-32*, 2017, https://www.philadelphiafed.org/-/media/research-and-data/publications/working-papers/2017/wp17-32.pdf

[10] B. Katz and J. Wagner, *The Rise of Innovation Districts: A New Geography of Innovation in America* (Washington D.C: Brookings Institution, 2014), 2, https://c24215cec6c97b637db6-9c0895f07c3474f6636f95b6bf3db172.ssl.cf1.rackcdn.com/content/metro-innovation-districts/~/media/programs/metro/images/innovation/innovationdistricts1.pdf

[11] H. W. Chesbrough, "The Era of Open Innovation." *MIT Sloan Management Review*, 44 (2003): 35-41.

[12] Katz and Wagner, *The Rise of Innovation Districts*, 3.

[13] R. Florida, *Startup City – The Urban Shift in Venture Capital and High Technology* (Toronto: Martin Prosperity Institute, 2014), 7.

[14] In a global survey by consulting firm KPMG, Shanghai, New York and Tokyo were ranked as the top three leading technology innovation hubs over the next four years, in addition to Silicon Valley/San Francisco. KPMG, *The changing landscape of disruptive technologies. Part 1: Global technology innovation hubs, 2017*, accessed January 18, 2018, https://info.kpmg.us/content/dam/info/tech-innovation/disruptive-tech-2017-part1.pdf

few natural cost advantages. Even though their key traits of density and proximity fitted well in Singapore's context of a compact and high-density city, developing innovation districts would prove to be vastly different.

Exhibit 2: R&D and innovation clusters in Singapore

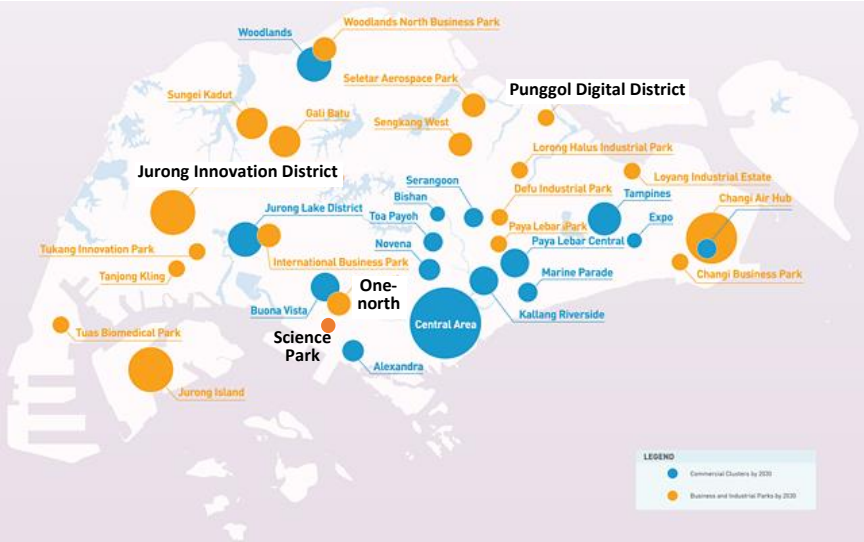


Image credit: Urban Redevelopment Authority

Early forerunner – Singapore Science Park

Although the Jurong Innovation District was the first to be officially labelled an "innovation district" in Singapore, one early forerunner was the Singapore Science Park in the South Buona Vista-Kent Ridge area. First developed in the early 1980s by a subsidiary of JTC, the Science Park was intended to provide infrastructure for the critical manufacturing sector, especially to support applied R&D for multinational corporations and local industries.[15] The period also heralded the beginnings of a national R&D programme[16] (see Exhibit 5); little R&D was conducted in Singapore prior to this. In fact, a Technology Corridor stretching from the Nanyang Technological University in the western end to the Science Park was envisaged in the early 1990s.[17] The Science Park thus marked the government's efforts to make the transition from a labour- and capital-intensive economy into a knowledge-based economy focused on science and technology.

Targeted primarily at high-tech and high-value industries, the park was characterised by government-led directives, mission-oriented research, and a reliance on foreign R&D firms.[18] In a break from earlier industrial estates, the Science Park featured leafy landscaped grounds, relatively generous development plots, and supporting services such as lifestyle amenities and business support facilities. It was located close to the National University of Singapore (NUS), the National University Hospital (NUH) and related research institutions to tap potential linkages with academia. Expanded over three phases, the 65-hectare Science Park hosted more than 300 multinational corporations, local companies and national institutions.[19] With the subsequent establishment of one-north nearby, it also became part of the greater one-north community.

---

[15] F. C.C. Koha, W. T.H. Kohb, F. T. Tschanga, "An analytical framework for science parks and technology districts with an application to Singapore," *Journal of Business Venturing*, 20 (2005): 217–239.
[16] S. M. Phillips and H. W. Yeung, "A Place for R&D? The Singapore Science Park," *Urban Studies*, 40 (2003): 714.
[17] B.T.G. Tan, Hock Lim, K.K. Phua, *50 Years of Science in Singapore* (Singapore: World Scientific, 2017), 35.
[18] Phillips and Yeung, "A Place for R&D?"
[19] "About Us." Singapore Science Park, accessed March 1, 2018, https://www.sciencepark.com.sg/en/about-us/

An ambitious science hub – one-north

One-north in Buona Vista was conceptualised in the late 1990s as a science hub to foster entrepreneurial high-tech businesses, and promote start-ups. It became the centrepiece of the government's Technopreneurship 21 initiative to promote "technopreneurship" or technology entrepreneurship in Singapore. The JTC was appointed its master planner in 2000 to realise the science hub with the close involvement of the Economic Development Board (EDB) and the Agency for Science, Technology and Research (ASTAR), Singapore's national R&D agency. In 2002, Phase Z.Ro Technopreneur Park—built from container units for IT start-ups—started as a pilot for the science hub. The container units later made way for the development of the science hub.

The one-north masterplan was unveiled in 2001 and phased over 15 to 20 years at an estimated cost of $15 billion.[20] Conceptualised as an all-encompassing "live-work-play-learn" environment to create a community for research and innovation, one-north comprised several precincts, including three purpose-built hubs– Biopolis (biomedical sciences sector), Fusionopolis (infocomms, media, science and engineering industries), and Mediapolis (digital media cluster).[21] At 200 hectares, one-north was less than a tenth of area of the Research Triangle Park in the US. Like the nearby Science Park, one-north was located close to existing institutes of higher learning and research institutions to facilitate industry-academia collaborations.

By 2016, one-north hosted over 400 companies and organisations with more than 46,000 workers. The occupancy rate for the combined 1.7 million square metres of office space available was reported to be averaging more than 90 per cent.[22] According to a director at JTC, Biopolis had an occupancy rate of more than 80%, while Fusionopolis and Launchpad, where all start-ups were clustered, were well over 90%.[23] There appeared to be agreement among property analysts that the one-north template of having large organisations and corporations act as anchors for small and medium enterprises (SMEs) appeared to be working. One analyst said, "By and large this area has been very successful in not just capturing the multinational companies to set up a strong base… but also researchers, supply chain partners of these large companies and startup companies who are supplying content and services to these large companies… The entire ecosystem is probably matured enough to have this entire science park and industrial estate sustain itself very comfortably."[24] A timeline of the policies and developments at one-north is in the Annex.

Distinct precincts

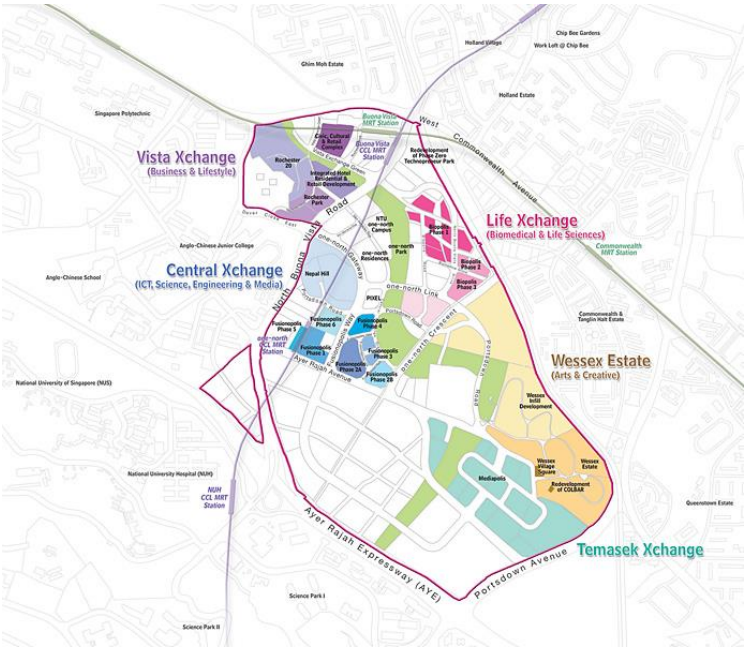
The first precinct to be developed, the 18.5-hectare Biopolis had since become synonymous with the biomedical sector in Singapore. Biopolis was intended to host the entire life sciences R&D value chain from basic drug discovery, clinical development to medical technology research.[25] This was later expanded to include the food and nutrition as well as personal care industries. Developed over five phases, the initial phase was constructed by the JTC and occupied predominantly by ASTAR's biomedical research institutes, while subsequent phases were earmarked for the private sector, such as Proctor & Gamble's Singapore Innovation Centre.[26] The co-location of public sector research institutes and corporate labs was meant to foster a

[20] V. Chong, "$15b global science hub for Buona Vista," *The Business Times*, December 5, 2001, 2.
[21] "Biopolis – one-north." JTC Corporation, accessed March 6, 2018, http://www.jtc.gov.sg/industrial-land-and-space/Pages/biopolis.aspx
[22] Patrick John Lim, "One-north district sees healthy growth but traffic woes persist", Channel NewsAsia, 28 December 2016, https://www.channelnewsasia.com/news/singapore/one-north-district-sees-healthy-growth-but-traffic-woes-persist-7657396
[23] Ibid.
[24] Ibid.
[25] "Biopolis – one-north."
[26] "Biopolis – one-north."

collaborative culture between public and private sector organisations. Researchers could also access ASTAR's state-of-the-art facilities, scientific infrastructure and specialised services, allowing companies to cut R&D costs and accelerate development timelines.

Occupying 30 hectares, Fusionopolis was developed along similar lines, with ASTAR's physical sciences and engineering research institutes serving as anchor tenants, and offering shared facilities such as wet and dry laboratories, clean rooms and vibration-sensitive testbedding facilities. Media firms such as Lucasfilm and ESPN Asia Pacific also established their presence in Fusionopolis. One of the last sectors to be developed, the 19-hectare Mediapolis was envisioned as Singapore's "media epicentre"[27] under the joint stewardship of four government agencies, namely the JTC, EDB, then-Media Development Agency (MDA), and then-Infocomm Development Authority (IDA).[28] Tenants included Singapore's national broadcaster known as Mediacorp, Infinite Studios and STT MediaHub, a collaboration between telco Starhub and STT Telemedia.

Exhibit 3: one-north precincts



Source: Economic Development Board

Nurturing start-ups

One-north also featured a 6.5 hectare zone dedicated to start-ups, JTC Launchpad@one-north, which included the well-known Block 71. The Launchpad started in 2011 as Mediapolis Phase Zero, a pilot incubation centre for start-ups and incubators in infocomm and media in what was then an aging industrial estate of flatted factories originally slated for demolition. Its growing popularity as a start-up hub prompted the Economist magazine to dub it "the world's most tightly packed entrepreneurial ecosystem" in 2014.[29] The pilot was expanded to surrounding blocks and to other sectors, including biomedical sciences, electronics and engineering industries, and was offically launched in 2014 as JTC LaunchPad@one-north.

---

[27] "Mediapolis @ one-north: Adding growth to Singapore's Media Ecosystem." Infocomm Media Development Authority, last modified December 10, 2008, https://www.imda.gov.sg/about/newsroom/archived/mda/media-releases/2008/mediapolis--onenorth-adding-growth-to-singapores-media-ecosystem

[28] Parts of MDA and IDA were merged to form the Infocommunications Media Development Authority (IMDA) in January 2016.

[29] "All together now." *The Economist*, January 18, 2014, https://www.economist.com/news/special-report/21593582-what-entrepreneurial-ecosystems-need-flourish-all-together-now

Exhibit 4: JTC Launchpad@one-north

Image credit: JTC Corporation

Flexibility in land use and development

Unlike traditional industrial areas, one-north came under a new "business park-white" land use zoning introduced in 2001 to promote greater flexibility in industrial land use. Targeted at non-pollutive industries engaged in high-tech, high value-added and knowledge-intensive activities, such zoning required at least 85% of gross floor area to be dedicated to business park operations,[30] while up to 15% (or a specified quantum) could be used for "white" or non-industrial uses such as retail, hotels and residential. This flexibility allowed retail shops and services, restaurants, hotels, serviced apartments and condominiums to be incorporated within one-north, creating the sort of mixed-use environment that was thought to appeal to workers of the new knowledge-intensive economy.

At the same time, these districts were not simply a mixed bag of uses and developments. Instead, districts and precincts were differentiated for different sectors that had been identified as important emerging growth areas for Singapore. Within one-north, three precincts were designed to cater to the needs of biomedical sciences, engineering and physical sciences, as well as digital media. JTC was appointed by the government as the master planner and master developer for one-north, giving it greater flexibility to plan and allocate land uses and density at a district level, rather than on a plot-by-plot basis, and stage the timing of developments in response to market conditions.

Encouraging interactions through design

As the master planner and developer for one-north, JTC had more leeway to implement the one-north masterplan. Designed by renowned architect, Zaha Hadid, the masterplan emphasised "integrating heterogeneity" through seamless fluidity, connectivity, and curvilinear patterns that exploited the original undulating geography of the area.[31] This approach was unlike the earlier Science Park that consisted largely of isolated buildings within manicured lawns. In addition to offices and R&D facilities, the Vista precinct within one-north was earmarked as its lifestyle hub. A mix of uses in the form of private residential apartments, serviced apartments, hotels, commercial and retail spaces were distributed throughout one-north to support the development of a vibrant community.

One prominent feature was a network of link-ways, amenities, design features and public spaces that were designed to be pedestrian-friendly and conducive for interactions and cross-pollination of ideas among the

[30] Of this 85% of gross floor area, up to 40% could be used for ancillary and supporting uses.

[31] "One North Masterplan," Zaha Hadid Architects, http://www.zaha-hadid.com/masterplans/one-north-masterplan/

one-north community. Developments at one-north were largely gateless with mandated public thoroughfares while skybridges linked adjacent buildings. These design features provided a high-degree of porosity, allowing public and community spaces to be easily connected. Traffic calming measures such as narrower roads running through the Biopolis sector also created a more pedestrian-friendly environment that could accommodate vibrant street life.

Greening was another major aspect of one-north. Parts of the original vegetation and hilly terrain were retained as a linear park that formed a green spine running through one-north. As a contrast to the densely built-up areas of one-north, the park served as public space and provided visual and physical green relief for one-north's inhabitants. Despite being on development plots, several existing trees were also conserved, while trees that were removed during the construction process had to be replaced.[32]

Singapore's context, constraints and advantages

Despite the government's concerted efforts however, Singapore faced challenges in pursuing new sources of knowledge-driven growth. On the one hand, Singapore's standing as a cosmopolitan and liveable city-state attracted talent to its shores, and the government's readiness to invest in infrastructure and fund R&D helped to attract knowledge-based activities. While it was often hard to gauge how innovative a city or country was, Singapore had scored well according to some rankings. In the 2018 Bloomberg Innovation Index for example, Singapore rose to third from sixth in the previous year, putting it behind Seoul and Sweden but ahead of European countries like Germany, Switzerland and Finland.[33] This resonated with other global studies such as the Global Innovation Index 2017 where Singapore topped Asia and was seventh globally.[34] However Singapore also had to contend with constraints such as limited space, relatively small pool of manpower and expertise, a lack of an open entrepreneurial culture, a relatively small domestic market, and an economy reliant on multi-national corporations. Some of these issues are discussed in the following sections.

Banking on an infrastructure-led approach

Some researchers considered innovation districts unproven with little rigorous analysis of their impacts on a range of cities and cautioned against adopting a "Potemkin village" strategy of ramping up building projects to revitalise the economies of cities.[35] Such an infrastructure-led approach had failed in many cities. A prime example were the so-called "ghost cities" in China, where authorities, in their haste to urbanise, completed construction of buildings and roads, often in poorly connected districts with few inhabitants. To some, innovation districts occurred organically and the idea of authorities trying to develop innovation districts within certain areas ran counter to the essence of innovative and entrepreneurship.[36] In short, "labelling something innovative (did) not make it so".[37]

---

[32] Arthur Aw, "Singapore: The One-North Project", paper presented at 41st ISOCARP Congress, Bilbao, Spain, 2005.

[33] "Singapore ranked third on Innovation Index," The Straits Times, January 24, 2018, https://www.straitstimes.com/business/economy/singapore-ranked-third-on-innovation-index

[34] Priyankar Bhunia, "Singapore ranked 1st in Asia and 7th worldwide in Global Innovation Index," OpenGov, 27 October 2017, https://www.opengovasia.com/articles/7710-singapore-ranked-1st-in-asia-and-7th-worldwide-in-global-innovation-index-2017

[35] Christine Pazzanese, "Renewing urban renewal." *The Harvard Gazette*, July 8, 2014, http://news.harvard.edu/gazette/story/2014/07/renewing-urban-renewal/

[36] Anthony Flint, "Are 'Innovation Districts' Right for Everyone?" *CityLab*, April 29, 2016, https://www.citylab.com/life/2016/04/are-innovation-districts-right-for-every-city/480534/

[37] Bruce Katz, Jennifer S. Vey and Julie Wagner, "One year after: Observations on the rise of innovation districts," *The Brookings Institution*, June 24, 2015, https://www.brookings.edu/research/one-year-after-observations-on-the-rise-of-innovation-districts/

On the other hand, to deal with the scarcity of land and industrialists in the initial years after independence, Singapore had a long history of developing new economic sectors, particularly industrial and manufacturing clusters, through a state-led infrastructure-focused approach. The government had several policy and regulatory levers at its disposal, including a high proportion of state land as well as comprehensive land use planning and development control. Land use planning was carefully calibrated to balance competing land use needs, of which industry was only one of several, through the process of formulating the long-term concept plan and medium-term statutory master plan. Overall, industry and commerce uses occupied 9,700 hectares—about 13% of Singapore's land area, comparable to the 14% for housing—and was expected to expand to 12,800 hectares by 2030.[38]

Industrial infrastructure planning and development were led by JTC, an autonomous statutory board. Its mission was "to develop industrial infrastructure to catalyse the growth of new industries and transform existing enterprises".[39] JTC was responsible for the development of Jurong Industrial Estate, Singapore's first large-scale industrial estate in the 1960s. It also had a longstanding partnership with EDB to plan and develop infrastructural infrastructure suited to the needs of sectors promoted by the latter. JTC was often the first to introduce innovations in industrial infrastructure, which lowered operating costs and raised operating efficiencies for companies, such as specialised industrial parks with shared facilities like Jurong Island and Seletar Aerospace Park. At the same time, it operated on self-financing basis, and recovered its operating expenditures and some development expenditures through its operating surpluses from leasing and other activities. JTC also could seek government funding for projects of strategic national importance, and issue bonds to finance capital spending.

Sitting on state land, one-north—aside from clusters of conserved colonial buildings—was largely built from scratch. As the master planner and developer, JTC exercised substantial control over how and when the district was developed, and could take a long term view, with a development timeline of 15 to 20 years. It adopted a mixed development approach, and directly undertook development of key sites, such as the initial phases of Biopolis, within the one-north precincts to kick-start development with public sector agencies like ASTAR coming in as anchor tenants. JTC also worked closely with EDB and ASTAR to ensure that the requirements of the end-users were met. It leased or sold plots for development by private developers such as Ascendas, and end-user firms such as Proctor & Gamble and GSK. The fact that JTC was the landlord and developer of Launchpad@one-north targeted at start-ups, also meant that rents could be kept affordable.

Although a state-led approach suited earlier generations of industrial development, it was less clear if the same approach would be sufficient to catalyse today's knowledge-intensive ecosystem, which was less reliant on physical capital. Singapore's approach could be compared to innovation districts elsewhere, such as Kendall Square in Cambridge anchored around Massachusetts Institute of Technology (MIT), and the private developer-led model of Knowledge and Innovation Community in Wujiaochang. The experience of 22@Barcelona also illustrates the complications of attracting private investment to build an innovation district (see Box 1).

[38] "Our Land Use Plan", Ministry of National Development, last modified August 24, 2017, https://www.mnd.gov.sg/landuseplan/
[39] JTC Corporation, *Annual Report FY2016,* accessed March 27, 2018, http://jtc.gov.sg/news-and-publications/annual-report/Documents/JTC-AR2016/mobile/index.html#p=1

Box 1: A look at innovation districts elsewhere

Kendall Square, Cambridge

After the Second World War, industries such as distilleries, gas works, rubber factories and soap factories closed in Cambridge, Massachusetts. In the 1960s, large tracts of land were cleared for a NASA research centre, but these were left unoccupied when the plans changed. An urban revival, sparked by the growth in life sciences research in the 1980s anchored around the nearby MIT, transformed Kendall Square into a tightly packed "beating heart of biotech."[40] Biogen, founded by a MIT Nobel laureate set up in Kendall Square in the early 1980s, and more followed suit over the years. The area's reputation as a major hotspot for life sciences research was cemented when large pharmaceutical firms such as Norvatis relocated their global research centres there.[41] Technology titans like Microsoft, Google, Amazon and Facebook also set up operations and research centres at Cambridge. The Cambridge Innovation Center, which housed some 600 start-ups,[42] including many in the tech sector, was started by an entrepreneur who subdivided the office building to create cheap space and collaboration opportunities for entrepreneurs.[43] More recently, MIT launched its Kendall Square Initiative to redevelop car parking lots into new spaces for academic and R&D uses, as well as more retail, dinning, graduate student housing, and open spaces. MIT would also keep 10% of the new space created to cater to start-ups.[44]

Knowledge and Innovation Community in Wujiaochang, Shanghai

Wujiaochang in the Yangpu district, was one of the fastest growing decentralised business districts within the Shanghai municipality. Like Cambridge, Yangpu used to be dominated by heavy industries, which had decanted from the district by the 1990s. The area was also close to several institutes of higher education, including Tongji University, Fudan University and Shanghai University of Finance and Economics, comprising about 130,000 students and faculty, although there was little economic spillover to the district.[45] In the early 2000a, a private developer, Shui On Land, started the development of a 49-hectare Knowledge and Innovation Community (KIC) in the northern section of Wujiaochang in collaboration with the municipal government. Leveraging its proximity to the universities, the concept for KIC was a "knowledge-based community that would integrate three zones of urban office, retail, and mixed-use community, while fostering an 'innovation ecosystem'."[46] The original occupants—small factories, worker dormitories, a stadium and a bus depot—were relocated, and development progressed as plots became available. The area was transformed into four sectors—KIC Plaza/Corporate Avenue (office buildings, R&D centres, exhibition and conference facilities), KIC Village/University Avenue (mixed-use and residences, including live-work units), KIC Venture Park (small and medium-sized companies) and Jiangwan Sports Centre (sports and cultural activities centred on a historic stadium).[47] The northwest corner housed Fudan University School of Management. The Ministry of Science and Technology designated Yangpu as one of the country's first pilot innovation districts in 2010.

22@Barcelona

The experience of 22@Barcelona in Poblenou suggested that an infrastructure-led approach, especially one reliant on private developers, had its limitations. In particular, there was some criticism on how the use of "value capture financing" by the city council to stimulate private sector financing into the innovation district, had instead led to

[40] D. Garde, "Get to know Kendall Square, biotech's booming epicenter of big risks and bright minds," *STAT*, May 5, 2016.
[41] J. Carroll, "Novartis unveils a new global R&D structure, creating centers in Cambridge, MA and Basel." *Endpoints News*, October 5, 2016, https://endpts.com/novartis-unveils-a-new-global-rd-structure-with-new-centers-in-cambridge-ma-and-basel/
[42] A. Dragoon, "Mapping the Changes in Kendall Square," *MIT Technology Review*, August 18, 2015, https://www.technologyreview.com/s/540536/mapping-the-changes-in-kendall-square/
[43] Michael Blanding, "The Past and Future of Kendall Square," *MIT Technology Review*, August 18, 2015, https://www.technologyreview.com/s/540206/the-past-and-future-of-kendall-square/
[44] "Kendall Square Initiative," MIT, accessed January 10, 2018, http://kendallsquare.mit.edu/planning/priorities
[45] Urban Land Institute, *ULI Case Studies: Knowledge and Innovation Community*, accessed March 1, 2018, https://casestudies.uli.org/knowledge-and-innovation-community-shanghai/
[46] Urban Land Institute, *ULI Case Studies.*
[47] Urban Land Institute, *ULI Case Studies.*

"*rentier* practices to capture monopoly rents" (italics in original).[48] To encourage redevelopment of the 200-hectare area, developers were allowed to intensify developments by building higher, and by having a mix of uses, such as commercial and residential. Despite the project being geared towards "making the district—and the city—a leading node in the global knowledge economy",[49] the results were mixed. While developers were required to set aside 20% of space for knowledge-related activities, the definition of such activities was broad and the threshold set relatively low. Two trends appeared to have emerged—first, many of the firms, attracted by lower office rents, had in fact relocated from other areas in the city centre; second, the new developments catered more to profit-maximising turnkey projects, ignoring the demand for smaller units by knowledge-based SMEs.[50]

Investing in R&D

Alongside the infrastructure-led approach, the government pumped increasing amounts into public sector R&D spending. The National Science and Technology Board (NSTB), set up in 1990 to spearhead Singapore's research efforts, was reorganised into ASTAR in 2002. As the national strategy for R&D grew in importance, the National Research Foundation was set up in 2006 to plan, coordinate and monitor R&D initiatives at national level. From the first $2 billion five-year National Technology Plan in 1991, the public research budget rose to $19 billion in the Research, Innovation and Enterprise (RIE) 2020 Plan for 2016 to 2020.[51] R&D expenditure by the private sector also grew over the years (see Exhibit 5). Overall, gross R&D expenditure as a proportion of GDP rose from 0.8% in 1990 to over 2%,[52] although it lagged that of some developed countries such as Switzerland, Sweden, Israel, Japan and South Korea.

Building up R&D and translating research into innovation took time. Beh Swan Gin, EDB Chairman, called it "Singapore's long game in innovation".[53] The first National Technology Plan focused on upgrading several economically important sectors,[54] namely manufacturing technology, information technology, electronics, materials technology, energy, water, environment and resources, food and agrotechnology, biotechnology, and medical science. While efforts to restructure the Singapore economy towards a knowledge- and innovation-driven one had already started, the global economic environment, such as the rise of China, the internet boom and the 1997 Asian Financial Crisis, made such a transition imperative to stay ahead of global competition. The government adopted a two-pronged approach—expanding and deepening the research capabilities of its universities and research institutes, as well as encouraging technopreneurship and creating a vibrant start-up ecosystem.[55] In particular, the biomedical sciences sector was singled out as a new key growth sector and the development of one-north closely involved ASTAR.

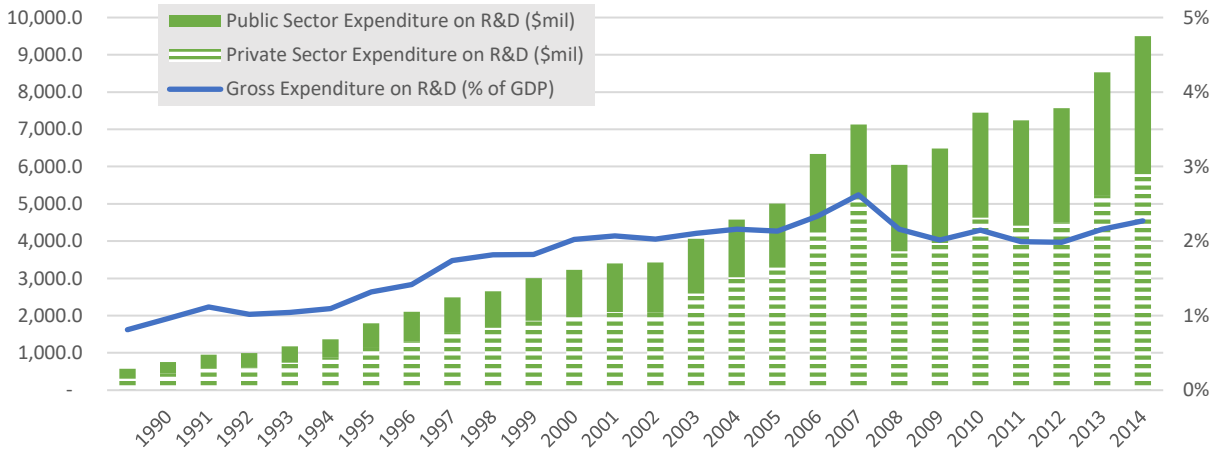
Following the 2008 Global Financial Crisis, the five-year national science and technology plan was revamped into the RIE2020 plan in 2011. The plan prioritised funding in four strategic technology domains—Advanced

[48] Greig Charnock, Thomas F. Purcell and Ramon Ribera-Fumaz, "City of Rents: The limits to the Barcelona model of urban competitiveness," *International Journal of Urban and Regional Research* 38, no. 1 (2014): 198–217, doi:10.1111/1468-2427.12103
[49] Ibid.
[50] Ibid.
[51] Lim Chuan Poh, "From Research to Innovation to Enterprise: The Case of Singapore," in *The Global Innovation Index 2016*, ed. Soumitra Dutta, et al. (Ithaca, Fontainebleau, and Geneva, 2016), 133-140.
[52] "Research and Development Expenditure by Sector, Annual", Data.gov.sg, last modified February 6, 2017, https://data.gov.sg/dataset/public-sector-research-and-development-expenditure
[53] Beh Swan Gin, "Singapore's long game in innovation", The Straits Times, August 23, 2017.
[54] Agency for Science, Technology and Research. *A*STAR: 20 Years of Science and Technology in Singapore* (Singapore: Agency for Science, Technology and Research, 2011), https://www.a-star.edu.sg/Portals/0/aboutastar/2012_Commemorative_Pub_Webv6.pdf
[55] Beh, "Singapore's long game in innovation".

Manufacturing and Engineering,[56] Health and Biomedical Sciences, Urban Solutions and Sustainability, and Services and Digital Economy—to drive future economic growth and address national challenges such as Singapore's transformation into a "Smart Nation".[57] It also adopted differentiated open innovation strategies customised for different segments of the economy,[58] with ASTAR helping to convene research collaboration between private and public sectors. ASTAR reported 1,800 projects with industry partners and deployed over 200 licenses to companies in 2016.[59] These domains would in turn be supported by crosscutting programmes in academic research, manpower, and innovation and enterprise.

The RIE2020 plan also continued efforts to grow a vibrant national innovation system, including targeted support such as co-investment funds to help start-ups scale up, expanding the role of technology transfer offices in public research organisations, encouraging greater industry participation, and funding for domain-specific strategies.[60] More funding was also set aside to encourage public sector researchers to work with industry players. One indicator of Singapore's progress was its top ranking for innovation among Asian countries in the annual Global Innovation Index (GII).[61]

Exhibit 5: Expenditure on R&D in Singapore



Note: Private Sector refers to all business enterprises in the private sector (excluding institutions of higher education); Public Sector refers to all entities in the government sector, higher education sector and public research institutes.

Source: Agency for Science, Technology and Research, *National Survey of R&D*, various years; Data.gov.sg; Singapore Department of Statistics.

The government also focused on nurturing a diverse research ecosystem, spanning the mission-oriented research of ASTAR's research institutes, universities with their base of fundamental knowledge, academic

[56] Within the Advanced Manufacturing and Engineering domain, eight industry verticals were identified, namely Aerospace, Electronics, Chemicals, Machinery & Systems, Marine & Offshore, Precision Modules & Components, Biologics & Pharmaceutical Manufacturing, and Medical Technology Manufacturing.

[57] Research, Innovation and Enterprise Secretariat. *Research Innovation Enterprise 2020 Plan* (Singapore: Research, Innovation and Enterprise Secretariat, 2016), https://www.nrf.gov.sg/docs/default-source/default-document-library/rie2020-publication-(final-web).pdf

[58] Lim, "From Research to Innovation to Enterprise".

[59] Agency for Science, Technology and Research, *Annual Report April 2016 to March 2016*, (Singapore: Agency for Science, Technology and Research, 2017), 14, https://www.a-star.edu.sg/Portals/81/Data/News%20And%20Events/Publications/Astar%20Yearbook/Files/Astar%20Yearbook/AStar%20Yearbook/ASTAR_Annual_Report_1617.PDF

[60] RIE Secretariat. *Research Innovation Enterprise 2020 Plan*.

[61] Lee Xin En, "S'pore still top in Asia on Global Innovation Index," *The Straits Times*, June 16, 2017.

medical centres and hospitals that concentrated on translational and clinical research, as well as corporate labs. In the early 2000s, research centres of excellence were established within the public universities in Singapore as they were being restructured into more research-intensive institutions. More funding was also channelled into academic research. Over a ten-year period, the pool of R&D workforce in the private and public sectors doubled from about 25,000 in 2005 to more than 50,000 in 2015.[62] In particular for the biomedical sciences sector, the government initially took the approach of attracting top international researchers to Singapore to help kick-start the industry, while building up a local base of expertise by offering PhD scholarships. In the public sector, ASTAR alone had more than 5,000 researchers and support staff in its 18 research institutes involved in fundamental and applied research in two broad categories of biomedical sciences and scientific and engineering.[63]

There had also been apparent misses in implementing Singapore's national R&D plans. For example, a partnership between Singapore and MIT in 2008 was heralded as MIT's first research centre outside of the US. Known as the Singapore-MIT Alliance for Research and Technology (SMART), the tie-up produced research collaborations between Singapore and MIT in areas such as environmental sciences and infectious diseases, future urban mobility, low-energy electronic systems and technologies for the healthcare industry, and created spin-off companies. By April 2017 however, it was announced that the research programmes under SMART would end when their funding from the NRF ran out.[64] In the pharmaceuticals industry, Singapore had also seen the departures of a number of private biomedical research facilities—including Novartis, Eli Lily and Pfizer which were located in Biopolis—as part of a broader industry restructuring.[65]

Conducive environment for research, innovation and entrepreneurship

Katz and Wagner postulated that the full potential of innovation districts required the development of economic assets (firms, institutions and organisations that drive innovation), physical assets (publicly and privately owned buildings and infrastructure that support connectivity and collaboration), and networking assets (relations between individuals, firms and organisations), coupled with a risk-taking culture, to create an innovation ecosystem.[66] Silicon Valley's one key success factor was culture—specifically an open culture of simultaneous competition and collaboration, which accommodated diversity, information exchange, experimentation, and even job-hopping—which was notoriously hard to replicate.[67]

---

[62] Includes researchers, postgraduate students, technicians and support staff. Agency for Science, Technology and Research, *National Survey of R&D in Singapore 2005* (Singapore: Agency for Science, Technology and Research, 2006), https://www.a-star.edu.sg/Portals/81/Data/News%20And%20Events/Publications/National%20Survey%20of%20R&D/Files/RnD_2005.pdf; Agency for Science, Technology and Research, *National Survey of R&D in Singapore 2015* (Singapore: Agency for Science, Technology and Research, 2016), https://www.a-star.edu.sg/Portals/81/Data/News%20And%20Events/Publications/National%20Survey%20of%20R&D/Files/RnD%202015.pdf

[63] Agency for Science, Technology and Research, *Annual Report April 2016 to March 2016* (Singapore: ASTAR, 2017), 13, https://www.a-star.edu.sg/Portals/81/Data/News%20And%20Events/Publications/Astar%20Yearbook/Files/Astar%20Yearbook/AStar%20Yearbook/ASTAR_Annual_Report_1617.PDF

[64] Audrey Tan, "Two Singapore-MIT research programmes to end this year," *The Straits Times*, April 6, 2017, https://www.straitstimes.com/singapore/two-spore-mit-research-programmes-to-end-this-year; Han Fook Hwang, "Singapore's R&D: Expensive lesson or worthwhile investment?", *The Straits Times*, April 16, 2017, https://www.straitstimes.com/singapore/spores-rd-expensive-lesson-or-worthwhile-investment

[65] Chia Yan Min, "Pharma R&D industry in state of flux", *The Straits Times*, October 7, 2016, https://www.straitstimes.com/business/economy/pharma-rd-industry-in-state-of-flux

[66] Katz and Wagner, *The Rise of Innovation Districts*.

[67] Vivek Wadhaw, "Silicon Valley can't be copied," *MIT Technology Review*, July 3, 2013, https://www.technologyreview.com/s/516506/silicon-valley-cant-be-copied/

Criticisms of the Science Park pointed out that the extent of collaboration in R&D among its tenant firms was relatively low, and showed "the urgent need to go beyond science-park-specific (local) factors in assessing the R&D activities of tenant firm because a narrow focus on these factors and conditions *within* such localised territorial ensembles as science parks tend(ed) to overlook the broader linkages and interrelationships cross-cutting different spatial scales of R&D activities."[68]

The government had learnt from its earlier experience in promoting a knowledge-based economy. Besides clustering together industry players, the public sector and academia, one-north was carefully designed to encourage serendipitous interactions among the research community in the hopes of sparking cross-fertilisation of ideas and potentially useful collaborations. At the precinct level, there was a mix of uses including retail and dinning, while spaces were set aside for attractive public plazas and pedestrian-friendly corridors to facilitate interactions. JTC also had to go beyond its traditional role to take on place making and place management for one-north, including organising regular events to create vibrancy and interest in the district.

Referring to the next generation work spaces of Jurong Innovation District and Punggol Digital District, David Tan, JTC's assistant chief executive officer explained, "It is about making work environments more enjoyable for the industry, where they are highly liveable, sustainable and connected in order to continue to attract the best talent".[69] The blending of workspaces with community and networking platforms to create innovation spaces was also acknowledged by the 2017 Committee on the Future Economy report—"(t)o strengthen the integration between industry and academia within such districts and to create a vibrant exchange of ideas…we need to inject public spaces, programming and software to facilitate interaction of talent living, working and studying in these areas".[70] Punggol Digital District would push the concept of industry-academia collaboration further by co-locating its business park next door to the SIT campus and community facilities within an integrated district.

The Launchpad@one-north was another initiative by the government to catalyse entrepreneurship and innovation in Singapore. By repurposing an industrial block—Block 71—that was originally scheduled for redevelopment in 2011, MDA started a pilot offering lower rents and community spaces to digital media start-ups which proved to be well-received.[71] With the support of JTC and SPRING, and later the Action Community for Entrepreneurship, the start-up hub expanded to additional blocks and more sectors including science and engineering, biomedical, electronics, infocomm and media. Coupled with access to government subsidies and venture capital funds, this allowed a vibrant start-up community to emerge within one-north, complementing the research and technology-focused activities there. The Launchpad model was also being replicated in Jurong Innovation District.

Supporting the Smart Nation initiative

Innovation districts also appeared to be a natural fit with Singapore's efforts to develop itself as a "Smart Nation". The "smart city" label was often applied to a city that used new information and communications

[68] Su-Ann Mae Phillips and Henry Wai-chung Yeung, "A Place for R&D? The Singapore Science Park," *Urban Studies*, 40 (2003): 710.
[69] Jennifer Eveland, "How would you like to work/learn in future?" *Skyline* 7, 2017, 17.
[70] Committee on the Future Economy, *Report of the Committee on the Future Economy*, February 2017, 94, https://www.gov.sg/~/media/cfe/downloads/mtis_full%20report.pdf
[71] "Singapore: Launchpad@one-north: Helping start-ups to take off," *Urban Solutions*, July 2016, 72, https://www.clc.gov.sg/publications/urban-solutions-issue-9-innovation.htm

technologies (ICT), such as a network of sensors, innovatively to achieve its objectives. Some proponents saw smart cities as information marketplaces or an "ecosystem of products, services, companies, people and society that are working together creatively to foster innovation within the city."[72] On the other hand, many cities struggled to translate smart technologies into implementable and effective policies and programmes that benefited their citizens.

Officially launched in 2014, Singapore's Smart Nation initiative, focused on five domains, namely transport, home and environment, business productivity, health and enabled ageing, as well as public sector service. One-north became an active testbed for smart technologies. For example, it was the first zone opened to autonomous vehicles trials on public roads in Singapore in 2015. In February 2018, one-north was also designated Singapore's first drone estate to allow testing of unmanned aircraft systems in urban environments.[73] At the same time, the government took steps to share data collected by the public sector agencies via online portals like data.gov.sg to encourage the private sector and the public to co-create solutions.

JTC could also test out new urban and environmental technologies, such as district cooling systems[74] in Biopolis and Mediapolis, as well as new urban and transport models such as car-lite infrastructure and centralised systems for waste collection and logistics in the upcoming innovation districts. The Land Transport Authority (LTA), JTC and NTU had jointly developed a test circuit for self-driving vehicles at Jurong Innovation District,[75] while the innovation district and the nearby public housing town of Tengah were expected to see the deployment of self-driving buses and shuttles for daily commutes from 2022.[76] Punggol Digital District's focus on the digital economy, including cyber security and Internet of things, would also contribute in terms of research and innovation to the Smart Nation agenda.

Getting the mix right

Innovation districts were a tangible embodiment of the new economic landscape driven by knowledge and innovation. They have become a key plank of the industrial development strategy pursued by Singapore, and elsewhere. However, the development of physical infrastructure represented only part of the mix, and other ingredients such as creating a conducive environment and cultivating the right talent were needed in attracting the right mix of expertise, entrepreneurs and enterprises for innovation.

---

[72] Ellie Cosgraveab, Kate Arbuthnotb and Theo Tryfonasb, "Living Labs, Innovation Districts and Information Marketplaces: A Systems Approach for Smart Cities," *Procedia Computer Science*, 16 (2013): 669.

[73] Karamjit Kaur, "One-north to be designated as Singapore's first drone estate," *The Straits Times*, February 6, 2018.

[74] A district cooling system has a centrally chilled and hot water processing plant to serve the heating and air-conditioning needs for a cluster of buildings.

[75] Land transport Authority, "Joint News Release by the Land transport Authority (LTA), NTU & JTC – NTU, LTA and JTC unveil Singapore's first autonomous vehicle test centre," November 22, 2017, https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=10ceddae-472a-4920-8d4c-e73babfcecb0

[76] Adrian Lim, "Driverless vehicle rides in three new towns from 2022", *The Straits Times*, November 23, 2017, https://www.straitstimes.com/singapore/transport/driverless-vehicle-rides-in-three-new-towns-from-2022

Discussion Questions

1. How do innovation districts fit into the Singapore's economic development? How are innovation districts shaped by economic, social and demographic trends in Singapore?
2. What are the constraints and opportunities in Singapore vis-à-vis other cities with similar ambitions?
3. What has been Singapore's approach to developing innovation districts, and what are some of the existing policy strategies and tools? What are the advantages or disadvantages of Singapore's approach?
4. What are the trade-offs for Singapore in developing innovation districts? What might be some of the unintended impacts of developing innovation districts?

Annex: Timeline of Government Policies and Developments

Year	Policy and/or Development
1999	· Buona Vista Science Hub (later renamed one-north) announced as key thrust of Technopreneurship 21 initiative.
2000	· JTC appointed the lead agency for the development of Buona Vista science hub.
2001	· Phase Z.Ro Technopreneur Park developed as pilot. · one-north masterplan unveiled; construction work for Biopolis started in December 2001. · URA introduced new "business park-white" land use zoning.
2003	· Biopolis phase 1 opened.
2006	· One-north park launched.
2008	· Fusionopolis phase 1 opened. · Start of Global Financial Crisis.
2009	· Development of Mediapolis started.
2011	· Development of Mediapolis Phase Zero (later renamed JTC LaunchPad@one-north) started. · Vista precinct (entertainment, residential, hotel and business support facilities) started opening in phases. · one-north MRT station on the Circle Line opened.
2013	· Completion of Biopolis phase 4 and 5.
2014	· Launch of JTC LaunchPad@one-north. · Smart Nation initiative launched.
2015	· Fusionopolis Two (Innovis, Kinesis and Synthesis) completed. · Mediacorp, anchor tenant at Mediapolis, moved in. · Autonomous vehicle trials permitted in one-north.
2016	· Research, Innovation & Enterprise Plan 2020 launched with R&D budget of $19 billion. · Jurong Innovation District launched.
2017	· Report of Committee on Future Economy released, highlighting Jurong Innovation District and Punggol as new innovative growth centres. · Opening of first autonomous vehicle test centre at Jurong Innovation District.
2018	· One-north made the first drone estate in Singapore. · Punggol Digital District launched.