Taking Stock of Smart Nation Development in Singapore

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THE ROAD TO HYPER-CONNECTIVITY

In late 2014, Singapore rolled out the Smart Nation initiative – a mega-digitalisation project to transform the city-state into a hyper-connected nation infused with cutting-edge digital and computing technologies. The basic idea is this: harness the power of these technologies to remediate policy problems and by doing so, deliver to citizens tangible improvements in the quality of life. Four years into the Smart Nation, quite a few projects have been implemented. Underlining the vast complexity involved in using modern technology to improve the human condition, roadblocks have also surfaced on the road to hyper-connectivity. To accelerate Smart Nation development, this paper argues that getting citizens to embrace the related technology is crucial. Because privacy is a major concern, smart technology can be made more acceptable through effective product communication and information. Enhancing digital security will also make a difference. It concludes by suggesting that a finer appreciation of the obstacles encountered so far will inform other Smart Nation projects in the pipeline and even the path ahead.

The Smart Nation unpacked

Singapore is undergoing an unprecedented digital transformation into a Smart Nation – a hyper-connected city-state where digital and computing technologies are weaved into everything from public infrastructures and offices to homes and everyday objects. In the years ahead, these cutting-edge technologies will be appropriated ever more to help set the country on a more sustainable development path. Heading into its fifth year, the Smart Nation is well into the implementation phase. But roadblocks have slowed its progress intermittently. With that in mind, this article attempts to shed light on what some of these obstacles are. A stronger

understanding of these impediments will not only reveal possible ways to overcome them but also offer valuable lessons for other Smart Nation projects in the pipeline. But first, it is useful to have a sense of where the Smart Nation, as a mega-digitalisation project, is situated in the broader context.

By all accounts, Singapore was never a stranger to digitalisation, having rolled out quite a few digital masterplans since the early 1980s, just as the digital age was starting.[1] Even so, the Smart Nation does differ from past digitalisation efforts in that its core emphasis is on life in the city-state made better by the pervasive application of digital and computing technology. Gone is the emphasis on an economy elevated by computerisation and related manufacturing. In its place are visions of urban spaces made cleaner, safer and more efficient by modern technologies. In the Smart Nation narrative, the city-state is no longer just a place where technology is produced but a nation where it is taken onboard to enhance the quality of urban living. In other words, insofar as Singapore has been a manufacturer of digital and computing technology, it is now also a beneficiary of its many applications. If anything, the idea of being a receptacle for technology goes to the heart of what a smart city is.[2]

In the last decade, the smart city concept has emerged as the much-sought-after answer to many of the policy problems brought on by rapid urbanisation. As more people flood into cities in search of better economic opportunities, healthcare and education, the overall quality of life has also deteriorated due to, *inter alia*, stressed infrastructures, inadequate housing, rising crime and elevated levels of pollution. With a high availability of digital and computing technology, the smart city has been held up as the panacea to these urban woes. Specifically, through the extensive application of cutting-edge technologies like the Internet-of-Things (IoT), big data and cloud computing, city managers can now have a better sense of the urban problems they face daily, respond to them faster and in some cases, even detect them before they surface.[3] Signs of this high-tech urban future can already be seen as more progressive cities start to line their streets with multi-functional intelligent streetlights, optimise bus routes with crowd-sourced mobile phone data, automate waste collection and recycling, harness video analytics to fight crime, and more.

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[1] Kong, Lily, and Orlando Woods, 2018, "The ideological alignment of smart urbanism in Singapore: Critical reflections on a political paradox," *Urban Studies*, 1-23.

[2] Glasmeier, Amy, and Susan Christopherson, 2015, "Thinking about smart cities," *Cambridge Journal of Regions, Economy and Society* 8, 3-12.

[3] Townsend, Anthony, 2014, *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia*, New York: W. W. Norton & Company.

At a time when city planners across the world are struggling to cope with today's urban challenges it is no wonder that the smart city concept, with its futuristic vision of a more sustainable urban future, is gaining more appeal globally.[4] From North America to Europe to Asia, municipal governments are eagerly jumping onto the smart city bandwagon. But even as smart cities appear in almost every corner of the world, Singapore is still the sole country to embrace it at the national level. Governments around the world may be scrambling to build smart cities but Singapore is the only one looking to turn the entire country into a mega-smart city. Even Estonia – the former Soviet Republic most often associated with extreme digitalisation – has yet to do so and perhaps, for good reasons. For one thing, the public investment needed for such a mega-project would be massive, not to mention the technical complexity involved.[5] A more digitalised economy is also more vulnerable to cyberattacks, as the Estonians and others have found out over time. That raises the question: why is Singapore embarking on this mega-digital transformation then?

The answer has to do with sustainable development. With few exceptions, the weight of the evidence suggests that the Smart Nation is really a platform to remediate key policy issues of the day. Indeed, post-industrialised Singapore is not without its fair share of challenges – issues that not only cut across different policy domains but also defy easy resolution. Although the country has one of the highest standards of living in the world and regularly tops global rankings in education, safety, life expectancy and so forth, it still faces complex policy issues that, if left untouched, threaten to upend the country's many achievements.[6] The most serious is arguably demographic transition; Singapore is ageing rapidly and to make matters worse, current measures like nursing homes and foreign maids to care for the elderly do not scale very well. While there are certainly other hot-button issues around, demographic ageing is possibly the most severe as it has far-reaching consequences for the country's sustainable development. It is noteworthy that the country has no natural resources whatsoever except its human capital, and an ageing population means that the country will soon find it tougher to sustain economic growth, among other consequences.

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[4] Albino, Vito, Berardi, Umberto, and Dangelico, Rosa M., 2015, "Smart Cities: Definitions, Dimensions, Performance, and Initiatives," *Journal of Urban Technology*, 22:1, 3-21.

[5] The Smart Nation, as a case in point, is expected to cost an estimated US$1 billion each year for the next ten years until it is completed.

[6] Tan, Kenneth P., 2017, *Governing Global-City Singapore: Legacies and futures after Lee Kuan Yew*, New York: Routledge.

DELIVERING SUSTAINABLE DEVELOPMENT

This section explains how the Smart Nation will set Singapore on a more sustainable developmental path. Particularly, it looks into how the initiative tackles an ageing society by harnessing smart technology for senior care. Two enabling technologies form the backbone of this high-tech drive: smart homes and telemedicine.

Smart eldercare

By 2030, one in four Singaporeans will be aged 65 and above; in absolute terms, the country is looking at roughly 900,000 senior citizens in about a decade's time. In 2017, that number stood at just above 516,000.[7] The reasons behind this rapid demographic change are highly complex but it is essentially the by-product of a high life expectancy and a low birth rate. More importantly, the policy implications of this dramatic demographic trend for the country's development will be profound.

At issue is really how to take care of the sheer number of seniors in the coming years without overwhelming the country's eldercare system. Compounding the challenge is the fact that building many more nursing homes to house the aged would not be feasible in the city-state as scarce land must be set aside for other things like housing and industry. One practical solution to this conundrum is ageing-in-place, the idea of senior citizens living out their twilight years in their own homes while drawing on the support of their loved ones and communities. Needless to say, if ageing-in-place works as it should, then there will be less pressure on the country's eldercare system ahead. Moreover, the idea complements the wish of most Singaporeans to stay put as they age. So, for obvious reasons, a major aspect of the Smart Nation is harnessing the power of so-called smart homes to help Singaporeans age-in-place.

Built by the Housing Development Board (HDB), the government agency responsible for public housing in Singapore, smart homes are essentially apartments infused with a gamut of digital sensors and gadgets to make them safer for elderly occupants. They are, for all intents and purposes, public housing designed and built with seniors' wellbeing and safety in mind. For instance, since the elderly are prone to falls, these next-generation homes are outfitted with smart motion sensors that detect prolonged periods of inactivity – as in when the occupant has fainted after falling. But unlike run-of-the-mill motion sensors, these sensors are sophisticated enough to send an alert to caregivers and emergency services when

[7] https://www.population.sg/articles/older-singaporeans-to-double-by-2030, accessed 22 November 2018.

something amiss is detected. Other similar enhancements include portable panic buttons and door-contact sensors to help caregivers better monitor the condition and movement of elderly occupants. The former allows elderly occupants in need of immediate assistance to quickly alert their caregivers by just pressing a portable button. Meanwhile, the latter is designed to automatically alert caregivers when elderly occupants (especially those suffering from dementia) leave their apartments and fail to return after an extended period.

But what happens when a senior citizen falls ill and requires long-term continuous medical care at home?

Telemedicine, a term referring to medical care delivered remotely with the aid of information and telecommunication technologies, has been taken onboard to address just that. Originally created to treat patients located in rural areas, the medical technology is now being adapted to deliver healthcare to patients in their homes. Thanks to the advent of Internet-enabled medical devices, teleconferencing equipment and wearable health trackers, doctors can now treat and monitor patients round-the-clock remotely. In addition to these high-tech devices, simple home-use medical devices that let patients collect additional medical information at their doctor's request mean that they only visit the hospital when necessary. Apart from convenience, another major advantage of telemedicine is that with fewer non-essential visits to the hospital, the pressure on the healthcare system as a whole will be reduced. With the aid of webcams and video chat apps, physiotherapists can even conduct online therapy sessions for patients in their homes.

The potential for telemedicine to help ease Singapore's ageing pains is tremendous. Seniors who require medical attention can now receive treatments from healthcare professionals without having to set foot in the hospital. Those requiring physiotherapy can now receive it over the Internet. The technology is especially beneficial for bedbound seniors who require regular visits to the hospital. Fewer hospital visits also lower the risks of hospital-acquired infections. Moreover, because telemedicine typically costs less than medical care delivered in a clinical setting, it is expected to keep healthcare affordable as spending jumps in an ageing population.

As futuristic as smart homes and telemedicine may seem, these technologies are now actually in various stages of implementation to help care for the rapidly growing number of senior citizens in Singapore. Coming together under the umbrella of smart eldercare, these technologies will enable more Singaporeans to not only age safely in-place but also receive medical attention in the comfort of their high-tech homes when illnesses strike. One initial concern was that smart homes, with their sophisticated array of sensors and gadgets, would be priced beyond the

reach of most Singaporeans. That worry turned out to be misplaced when a 2015 smart home project actually priced these apartments at about US$20,000 for a two-room unit in a popular housing estate, making them affordable for the average Singaporean.[8]

There is no room here to discuss the Smart Nation's extensive list of digital and computing technologies. But from the discussion above on smart eldercare, the use of technology to remediate policy issues and deliver tangible benefits is clearly visible. If anything, it is a recurring theme in the Smart Nation narrative that harks back to the earlier point about how smart cities are not just urban spaces where modern technology is born but also its receptacles and beneficiaries. That being said, as with previous attempts to use technology on a mega-scale to improve the human condition, vast complexities are involved and, accordingly, unexpected impediments – many of which surface only during the implementation phase – are not uncommon. In that regard, the Smart Nation is no exception.

SMART NATION ROADBLOCKS

This section looks into some of the impediments that have slowed the Smart Nation's progress. As unpleasant as these roadblocks might be, they do offer valuable insights into the complex nature of technology implementation. Indeed, a deeper and more situated understanding of these obstacles can help inform other projects in the pipeline and accelerate the Smart Nation's progress.

Privacy concerns

At the time of writing, it is generally believed that Singaporeans are not exactly embracing smart homes. Suggestive of the level of interest Singaporeans have for the technology, a pilot project that sought to bring it into 3,000 homes in a HDB housing estate had only about 50 sign-ups.[9] This low uptake is even more puzzling given the country's rapidly ageing population. If anything, there should be strong demand for smart homes.

[8] Yeo, Sam Jo, 2015, "First smart HDB homes in Punggol to go for as low as $28,000," *The Straits Times*, 25 May 2018, accessed 2 December 2018, https://www.straitstimes.com/singapore/housing/first-smart-hdb-homes-in-punggol-to-go-for-as-low-as-28000.

[9] Tham, Irene, 2017, "Untangling the way to a Smart Nation," *The Straits Times*, 26 March 2018, accessed 27 November 2018, https://www.straitstimes.com/singapore/untangling-the-way-to-a-smart-nation.

Based on information obtained exclusively for this article, the low uptake has little if anything to do with the technology itself as earlier trials – albeit at a smaller scale – had demonstrated that it worked exactly as expected. Neither does the level of technological sophistication of Singaporeans explain it. As a matter of fact, Singapore is among the most wired nations in the world with mobile, Internet and social media penetration rates of about 85 percent, 82 percent and 77 percent respectively in 2017.[10] With those figures, it should be obvious that the level of technological sophistication of Singaporeans and, implicitly, their ability to adopt digital and computing technology, cannot fully account for the low uptake. Even assuming that some senior citizens are not tech-savvy enough to take up smart home technology, their often-younger caregivers should be if there is real interest. Then how might one explain the low interest in smart homes?

A crucial factor is evidently trust or more appropriately, the lack of it vis-à-vis the technology. Indeed, there is evidence indicating that people perceive – though erroneously – the technology as a potential violation of their privacy. This was manifested in the behaviour of seniors taking it upon themselves to cover the sensors in their smart homes with towels during trials. Even though the sensors were designed to detect nothing but motion, the common misperception was that they somehow recorded video and images too. That is to say, the concern was that the technology was operating in a way it was never intended to. Consequently, the sensors were covered up and never given the chance to work. And to be clear, the fear was not even about state surveillance, but rather that the sensors were recording occupants as they changed out of their clothes or went to the bathroom. So, it seems that the cultural context in which the technology was situated in also came into play as older Singaporeans are generally more conservative.

Leaving aside the question of why a tech-savvy population like Singapore's would fall for such misguided notions, the effect of this misperception of smart home technology is obvious and tangible. More importantly, unless a way is found to correct these faulty conceptions, smart homes will likely remain confined to the realm of technological imagination in the Smart Nation as citizens continue to shun the technology – for the wrong reason notwithstanding.

[10] https://wearesocial.com/sg/blog/2017/01/digital-in-2017-global-overview, accessed 27 November 2018.

Digital insecurity

Increasingly, it is becoming apparent that smart cities – or more specifically, the extensive array of digital sensors that support them – are vulnerable to cyberattacks and digital manipulations.[11]

Part of the reason is that many of these sensors lack even the most basic protection from malwares. With limited computing, memory and power resources, these so-called resource-constrained devices typically do not come with anti-virus protections, encryptions and firewalls baked into their minimalistic designs. Another reason is that the widespread application of Wi-Fi has exposed these sensors to so-called man-in-the-middle attacks. During such attacks, data flowing between devices can be intercepted and compromised devices can be corrupted into platforms for launching attacks on other systems. It is also entirely possible that the ever-increasing number of Internet-enabled sensors will open up more pathways for malicious hackers to exploit. The worst-case scenario is when hackers wrestle control of critical infrastructures by subverting connected subsystems. As smart infrastructure systems rarely exist in isolation, an attack and subsequent crash in one system could cause a ripple effect and lead to near-simultaneous shutdowns in others.

Since the Smart Nation also utilises a plethora of digital sensors, there are grounds to believe that it too is susceptible to cyberattacks. But exactly how vulnerable the Smart Nation is remains a mystery at this point. One reason is that it is still a work-in-progress with many related projects still in the pipeline and various sensors – to collect real-time data on traffic and environmental conditions, for example – are still not in place. Hence, it is difficult to conclude to what degree the country is vulnerable to large-scale cyberattacks. Furthermore, the government has taken preventive measures like establishing a dedicated cybersecurity agency and air-gapping the entire civil service to better secure the Smart Nation architecture.[12] Even so, the nation got a hint of the pitfalls of extreme digitalisation in July 2018 when it was revealed that the medical records of many patients under SingHealth – the nation's largest healthcare provider – had been stolen by hackers. Indicative of the severity and, to an extent, the sophistication of the attack, the lengthy list of victims included the Singapore Prime Minister himself. Like it or not, the unfortu-

[11] Joo, Yu-Min, and Tan Teck-Boon, 2018, "Smart Cities: A New Age of Digital Insecurity," *Survival*, Vol. 60(2), 91-106.

[12] Air-gapping is a digital security measure that involves isolating work computers from unsecured networks like the Internet.

nate fact is that as a country becomes more digitalised, it also turns into a bigger target for malicious hackers.

Beyond the attention-grabbing headlines, incidents like the SingHealth hack can have a chilling effect on the Smart Nation – particularly, on the speed with which it can be implemented. For one, telemedicine will never be as popular if it were shown to leak revealing medical data of users. It is one thing to have plain information like names, birth dates and contact details stolen; it is another to have stolen images of one hooked up to life-sustaining medical devices posted online for all to see. Since public confidence is a key determinant of technology adoption, citizens must have trust in the technology before they bring it into their lives and telemedicine will not be able to deliver tangible benefits – let alone tackle the problems of an ageing society – if citizens shun it.

ACCELERATING SMART NATION DEVELOPMENT

Since Singapore Prime Minister Lee Hsien Loong's remark last year that the country was not moving as fast as it should to realise the Smart Nation, steps have been taken by the government to accelerate plans for its development.[13] They include the formation of the Smart Nation and Digital Government Group in the Prime Minister's Office to drive Smart Nation development and the launch of new projects like the Smart Nation Sensor Platform to fast-track the deployment of much-needed sensors that would help direct autonomous vehicles and improve traffic flows. But apart from those actions, what more can be done, especially in terms of getting citizens to embrace Smart Nation technology?

For starters, more can be done to address the smart home's low uptake. Since the key factor is a flawed conception of the technology – that the sensors in smart homes are violating the privacy of occupants when they are not – better product communication and marketing should help to dispel that wrongful notion. By underlining the function of these sensors to homeowners and drawing their attention to product-specific details, service providers can help drive home the message that these sensors do not violate privacy in any way. Additionally, it will help if positive user experiences are shared more widely since public confidence plays a vital role in technology adoption.

It is also necessary to enhance digital security for devices used in telemedicine if the technology is to gain broader public acceptance. There is no easy answer to how this can be accomplished, not least because cyberattacks are growing in

[13] Tham, *op. cit*., p. 8.

sophistication as they are becoming common. One way, in light of the SingHealth cyberattack, is to adopt strong encryption. If implemented, medical data would be more secure as it cannot be easily read even when stolen by hackers. But the implication of extensive encryption is that resource-constrained devices can no longer be included in telemedicine. So, a trade-off between convenience and security is expected with across-the-board encryption.

Roadblocks are never pleasant. But in the Smart Nation's case, there is a silver lining to them in that they provide an opportunity to gain valuable insights into the complex nature of using technology to improve the human condition. On a more pragmatic note too, a deeper and more situated understanding of the obstacles encountered during the implementation of smart homes and telemedicine can help inform other Smart Nation projects in the pipeline and ultimately, accelerate Smart Nation development. In that sense, as the Smart Nation heads into its fifth year, it is also beneficial to take stock of the last four.

FINAL THOUGHTS

In the beginning of this article, the globally shared problem of rapid urbanisation was underlined. Searching for a better life, people from the countryside are flooding into cities and their actions have paradoxically led to a deterioration in the quality of urban life. The smart city concept, by promising a solution to the assortment of problems brought on by rapid urbanisation, is embraced globally as a result. Taking the smart city concept further than anyone, Singapore has taken it upon itself to become the world's first smart nation. As a first-mover in the pervasive application of cutting-edge digital and computing technology at the national level, Singapore has positioned itself not just as a leader but also as a model for others. With smart cities rising across the globe, it is not a hyperbole to say that the world is watching the Smart Nation. So, proving that smart technology can deliver tangible benefits is not just about realising a vision but also Singapore's chance to inspire many others. And by developing a more refined understanding of the impediments, the path ahead should become easier.

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