Building Digital Cities and Digital Nations: Singapore, Thailand, China

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ABSTRACT

Despite critiques of the "smart city," the term has found new life in many parts of the world, morphing from a corporate marketing effort to an "imaginary" of national development. In the mid 2010s, the idea of a "Fourth Industrial Revolution" predicted that the emergence of 5G connectivity and the Internet of Things (IoT) would enable an even greater extraction of data from physical environments and objects. Around this time, three countries compared in this dissertation adopted these ideas into their national development plans: Singapore's Smart Nation (2014), Thailand 4.0 (2016), and Made in China 2025 (2015). These policies also resulted in urban pilot projects including city data platforms, IoT sensor systems, and digital twins. How and why did the "smart city" and "4th IR" resonate with political leaders and national histories in these countries, and how is the trajectory of urban technologies in these contexts co-produced through an interplay between political institutions, culture, and material effects of technologies themselves? This dissertation draws on the perspectives of science and technology studies (STS), political science of late development, and urban theory to understand the implications of these experiments for the future of cities and more broadly, the future of data capitalism.

The dissertation draws on 10 months of fieldwork across three countries involving interviews with key stakeholders, process tracing of policy and project evolution, archival and policy analysis, site visits, and grounded theory development afforded by these different methods. In addition to serving as *testbeds for the nation*, pilot projects examined in each country are *symbolic showcases* shaped by visions of national identity and political dynamics. In Singapore, digital twins and embedding of IoT sensors in biotic environments transform the city into a showroom for the "urban solutions" sector and reinforce its identity as a "city in a garden." In Thailand, the push for digitization of city data is intertwined with questions of sovereignty in a polity long dominated by its capital city and riven by persistent political unrest. Meanwhile in China, the development of Xiong'an New Area and its digital infrastructure is promoted as demonstrating a "new development concept" driven by indigenous innovation, digital urban services, and greater central control over urban development.

The rise of platform capitalism has been predicated on the value of data as an asset monopolized by private firms. Platform companies, eager for greater control over urban data, have tried to build new

digital urban districts, exemplified by Google's Quayside in Toronto, which failed due to citizens' fear of more personal data being surrendered to a corporation. However, in the countries I examine in this dissertation, urban data is increasingly seen as a resource for development and public infrastructure. This leads to an effort by a range of stakeholders to claim sovereignty over that data—from nations passing laws on data sovereignty within their territorial borders, to cities and local leaders deploying data platforms as a resource for municipal governance and local development, to firms that seek to profit from the proliferation of urban data and analytical platforms. Urban data has become a crucial albeit contested domain of state infrastructural power. The dissertation offers a new understanding of the transmutation of urban concepts in diverse contexts, and calls for planners and urban scholars to engage in reimagining alternative urban futures.

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from around the world. I benefited from exposure to anthropological methods from classes with Michael Herzfeld and appreciated his helpful suggestions on navigating Thai language and culture as I began my research in Thailand. In my third year, I was part of Professor Sven Beckert's global history seminar, which offered yet another lens to understand my research. Thanks to Wipa Khampook, who helped start my Thai learning adventure at Harvard and generously brought delicious meals to class each week. I've also benefited from the excellent community of China and Asia-focused scholars in Cambridge, particularly events at Fairbank Center and conversations with Hou Li, Saul Wilson, and Meg Rithmire. Classmates at MIT provided important insights and friendship over the course of my time here including Justin Kollar, Jerik Cruz, Aarthi Janakiraman, Chen Chu, and Alessandra Fabbri.

In Thailand I found a great community of urbanists, researchers and former graduates of Harvard and MIT who introduced me to numerous friends and contacts and shared their wisdom during my fieldwork. This includes Professor Apiwat Ratanawaraha of Chulalongkorn University, Payap (Gob) Pakdeelao, Wan Chantavilasvong, Andrew Gulbrandson, and Saowanee Xie. Mentor and longtime Bangkok resident Jim Stent offered many of his insights and connections in Thailand over lunches and dinners. My incredible group of "wholesome" Bangkok friends made Bangkok feel like a second home during my fieldwork—Justin Henceroth, Weerawat Ricky Runguphan, Pitichoke Chulapamornsi, Chun Kit Ng, Tim Gascoigne, Jai Amornpatchara, and Lee Eu Yang, particularly our weekly "Friday meetings" at the Commons.

Finally, last but certainly not least I want to thank my parents Dan and Jeanne for their unwavering support and encouragement over the years. They've never stopped believing in me, always encouraged me during my darkest moments, and gave me the confidence to follow my curiosity and interests and pursue my own path no matter the adversities. This is for you!

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Prologue: The Elephant in the Room

At a conference hall in Bangkok's True Digital Park innovation complex, Joe Paradiso from MIT's Media Lab is presenting a slide of the globe covered in sensors: "the instrumented earth: the internet of things at planetary scale." Another young researcher with frizzy hair and glasses ascends the stage to outline a utopian vision of "decentralized social networks that are secure, trustworthy, and aligned with human values" and after slick TED-talk style transitions of piped-in music and light displays yet another speaker discusses "hyper-local solutions to global warming through human-scale cities."

The theme of the event is "Beyond the Elephant in the Room." Although the speakers did not explicitly name what the elephant in the room was supposed to be, I was told later that the elephant was conceived of as "humanity's greatest challenges that are often ignored." The conference logo was, of course, an elephant---but not just your typical Indian elephant *Elephas maximus indicus,* an iconic symbol of Thailand. It had been augmented with virtual reality goggles, implanted with a space rocket inside its belly, and it carried a globe atop its back like one of the four elephants thought to hold up the earth in the *Ramayana*, the Hindu epic.

The session topics touched on some of the hottest buzzwords of cutting-edge technology such as "being digital beings, where the digital world merges with the physical and biological worlds", "sustaining cities with smart technologies" and "from artificial intelligence to intelligence amplification." A Thai student from the media lab was dressed in a dinosaur outfit presenting himself as an augmented human, and exclaimed with exuberance that "we're in an era where platforms are making powerful technology accessible, AI is being democratized, and we want to democratize the magic of the media lab and co-create the future with you." The head of the media lab, herself a former NASA administrator, outlined a research program of the center over the next five years for "creating superhumans, 'humans 2.0', connecting the mind and the body, but with an emphasis on wellness and mental health."

Meanwhile, alongside some of the greatest minds from MIT who flew across the world to present their visions for the future are executives of the largest and most influential companies in Thailand: Bangkok Bank, Kasikorn Bank, and True Digital—Thailand's largest telecom company

and a subsidiary of the influential Charoen Pokphand (CP) Group. The CP conglomerate owned by the Chearavanont Family itself is Thailand's largest private business, its owners rank as Asia's fourth-richest family with a net wealth of over 36 billion USD. Pichet Durongkaveroj, former Minister of Science and Technology in the early years of Prayut Chan-Ocha's military government and current Executive Director of Bangkok Bank gave yet another riff on the elephant theme, talking about the creativity of a Thai elephant named Suda, who painted extraordinarily creative artworks with her tusk.

The venue for the event, True Digital Park, is a startup office ecosystem that was developed to be "Southeast Asia's largest startup destination and the place to be for urbanites in the digital era"[1] In the lobby I overhear a young woman in a suit on her phone trying to persuade an investor or partner for funding a startup, pitching her connections with MIT professors and Thai companies alike. That's when the real purpose of the conference becomes clear: a fundraising opportunity for MIT's Media Lab with some of the richest corporations in Thailand (the companies already sponsor fellowships for Thai students to attend the Media Lab) and a roadshow for the Media Lab to wow local business leaders and students with cutting -edge technology and disruptive ideas and raise even more money from the assembled titans of Thailand's business elite.

The Chairman of True Digital, himself a graduate of MIT Sloan's School of Business and member of an influential political family from Chiang Mai, is outlining his company's efforts to create a "connected healthcare ecosystem" connecting patients to virtual doctors, leveraging data analytics, and a "smart farm" system where crops are irrigated by drones and cows wear smart collars that boost artificial insemination and reduce health problems, expanding productivity. The CEO of Kasikorn Bank hails his company's initiative to deliver an "inclusive smart city" through expanding access to digital banking platforms and reducing the bank's carbon footprint. The head of Kasikorn Bank's in-house technology group KTBG plays a cute video of himself as a talking head "AI" asking "how can technology be used to create a more equitable and sustainable economic future for the Southeast Asia Region?"

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[1] https://www.truedigitalpark.com/en/about/about-us

After the two-day showcase of technological solutions to the world's problems, the event closes on a more artistic note. A local dance troupe performs the traditional Thai *khon* dance. it's not your traditional dance performed at the royal Thai court or for tourists. Instead it's a mashup of *khon* with discordant electronic sounds playing in the background which sound to me like knives grating against each other, flashing green lights, and a large background screen of a blinking data dashboard with wires and numbers and a rotating 3D image of a stupa-shaped mask and elephant-head costumes.

The evocative confection of technology and Thainess offers a vision of a future where traditions find new life through cutting-edge technologies, where technology empowers difference to flourish rather than occludes it: a Thai futurist vision. But like the discordant background music this clashes directly with the more universalized technological solutions presented by the speakers moments before: a world covered in sensors, decentralized finance, trust-enhancing social networks that purportedly align with "human values" (not clear precisely whose) along with some of the more mundane money-making schemes that corporate executives have presented.

I left the climate-controlled greenery-adorned office buildings of True Digital Park to walk back to the sky train station above Sukhumvit Road, where the aroma of motorcycle petrol and cacophony of honking horns envelops me. The grittiness of the urban street stood in marked contrast to the glossy technological futures being discussed inside. It was hard to reconcile the optimism of elites from both sides of the Pacific with the lived reality facing most citizens of Bangkok, a metropolis of 14 million people where college graduates earn an average wage of 20,000 baht, or around $500 a month, and where traffic regularly grinds to a crawl turning short commutes into lengthy odysseys, especially during the summer monsoon, with the entire metropolis at risk of being underwater in several decades due to sea-level rise.

I realized then that the real "elephants in the room" were the ones that could not be named, because they were paying for our lunch.

None of the brilliant minds or successful business leaders in the conference were ignorant or would claim not to care about such realities. Many of the speakers were proposing solutions to the very urban, ecological, social, and economic problems that lay just outside the doors of the conference venue. But, I wondered: is it possible for elites who perpetuate a system of global inequality and unequal access to knowledge and capital, a system that underlies many of the ecological, urban, and social crises facing the world today, to also claim to offer the solutions to those problems? Can digital platforms, digital twins, transparent algorithms, and augmented bodies really solve our planetary problems or increase access to opportunities for the world's poor? Or do they simply serve as false idols, their manifest claim to offer a better future obscuring their latent grip on the present?

The story I am about to tell is a story about who gets to create the future. It's also a story about how ideas about the future are developed, transmitted, adopted and adapted around the world. Whose ideas win out and are scaled up, and whose ideas fade away? —the MIT event in Bangkok was just a two-day conference but it was a microcosm of the way ideas and discourses about futurity are exchanged between leading centers of knowledge production in the "West" and global elites in what we now might call the "developing world", or merely the "rest"—many of whom have of course studied and lived in the West and continue to send their kids to attend its most exclusive boarding schools and Ivy League universities. Of course, in the process of my own research flying between Bangkok, Singapore, Beijing, and Boston I also traced similar circuits of global knowledge exchange, and through the relationships, alumni, contacts afforded to me as a researcher from MIT, I had some access to these privileged spaces that others may not have had. Often, the mayors or business leaders I met would expect that coming from MIT I could help them develop some new digital platform or app. They were a bit disappointed when I told them my research examined the social and political factors shaping the deployment of urban technology.

Despite a global pandemic and rising nationalism, ideas travel swiftly and are adopted and adapted more rapidly than ever in this age of "compressed development,"[2] where countries can

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[2] D. Hugh Whittaker et al., *Compressed Development: Time and Timing in Economic and Social Development* (Oxford, New York: Oxford University Press, 2020).

rapidly adopt new technologies and copy or quickly iterate new versions of them in a matter of months or even weeks. Technopoles of the West, whether in Cambridge or Silicon Valley may be at the forefront of cutting-edge technology for now, but they cannot hide their innovations for long. China and smaller middle-income countries like Thailand are home to nascent but vibrant innovation ecosystems of their own, albeit shaped in their own way through dynamic exchanges between centers of knowledge production elsewhere (be they in Cambridge, MA, Cambridge UK, or Shenzhen). The professors and businessmen at the conference, whether American, Thai, Chinese or whomever, are swimming in the same soup of ideas about the future, and many subscribe to similar visions about the role of technology and data in that future. At the same time, this doesn't necessarily mean that the futures being developed in these varied contexts will be identical.

This is not a simple story of unidirectional transmission of ideas from "experts" in the West who impose their hegemonic vision on the rest of the world, or of elites elsewhere who borrow hegemonic discourses and ideas from the metropole, to use postcolonial scholar Bhabha's (2004) concept of "mimicry." Local actors, freely adopting ideas from around the world, transform them to suit local contexts and benefit their own financial or political interests. In doing so they act as agents of translation, taking ideas like "the smart city" and adapting them in a Thai or Chinese, or Singaporean context, such as *meaung achariya*, the common Thai rendering of smart city but more precisely "genius city" which has proliferated in Thai policy and business discourse over the past few years, or *zhihui chengshi*, "city of wisdom", as smart city is translated in Chinese, or the "smart garden", a project to deploy sensors in Singapore's iconic Gardens by the Bay. In each of the cases in this work, technological futures are shaped through an exchange of ideas from abroad, translation into local discourses, institutions and imaginaries of the nation.

Chapter 1

Building Digital Cities and Digital Nations in the Age of Data

"A celestial paradise of science"

After a two-hour drive southeast from Bangkok, turned off the highway. Thick forests, villages, and roadside stands gradually gave way to cleanly manicured lawns and clipped planted tree. A large sign built into the ground proclaimed "Eastern Economic Corridor of Innovation", adorned with the logos of several subsidiaries of state oil company PTT. I passed unobstructed by the security guards sleeping by the entrance, and proceeded along a new road into the heart of Wangchan Valley, the "Eastern Economic Corridor of Innovation", a new campus developed as part of the Thai government's plan to promote local innovation in "S-curve industries." As we drove through the site, my tour guide, a young scientist with Thailand's NSTDA who had moved here from Bangkok to help run the innovation platform, pointed out a drone testing launch pad, an autonomous vehicle proving ground with routes designed to test certain urban driving scenarios, "smart bus stops," and noted that hundreds of sensors were installed throughout the site "to monitor security threats" with data piped into the Intelligent Operations Center, another brand new orange-paneled and glass-clad building at the southern end of the site run by PTT.

"Security threats?" I asked, wondering what security threats would be present all the way out in this idyllic pastoral location.

"Wild elephants."

The "smart bus stops," lining the main road through the site featured screens periodically flashing warnings of encountering wild elephants. "Are there actual elephants here?" I asked my friendly guide, who had moved from Bangkok to this remote location as a researcher for NSTDA, Thailand's national science and innovation research agency. He commuted back to his family on weekends.

"Yes, elephants are a big problem in this area."

This was Wangchan Valley, the first project built as part of the "Eastern Economic Corridor" (EEC), the flagship infrastructure initiative of Prayut Chan-Ocha's military-backed regime, which came to power in the 2014 coup that unseated the elected government of Yingluck Shinawatra. The three provinces of Chaechongsao, Chongburi, and Rayong have been Thailand's industrial hub since the 1980s when Japanese automakers moved much of their production bases here for low labor costs, access to electricity and a nearby port. At that time, the government promoted the region through its Eastern Seaboard policy, helping develop Laem Chaebang port into Thailand's main deep-water harbor and providing tax incentives through the Board of Investment (BOI).

As he showed me around the site, my host explained the strategy and aspirations behind the Wangchan Valley project.

"China has been very smart," he told me. "They required foreign companies operating in China to transfer technology in order to do business in the country. But in Thailand we just let foreign companies come in and do whatever they want. They don't transfer any knowledge or capability to Thai people."

Thailand has for decades successfully cultivated an image as an exotic oriental tourist destination, the "land of smiles" that warmly welcomes everyone. And indeed, there is a great degree of reality to that image. At the same time, upper middle class and business elites often expressed a corollary sentiment of mild resentment and frustration at how these simple stereotypes perpetuated the notion that Thailand was merely a playground for foreign tourists with beautiful beaches, readily available sex, and traditional culture. And while the country had long thrown its doors wide open to foreign investment in addition to tourists, this often did not result in technology transfer or development of local knowledge or capacity. Even though Thailand is usually thought of as a pristine land of tropical beaches and forests, Thailand had over several decades quietly become one of the world's largest manufacturers of automobiles, earning it the once prestigious (now less so) moniker "the Detroit of the East."[3] But most of the factories in

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[3] Rogier Busser, "'Detroit of the East'? Industrial Upgrading, Japanese Car Producers and the Development of the Automotive Industry in Thailand," *Asia Pacific Business Review* 14, no. 1 (January 1, 2008): 29–45.

Thailand are owned by Japanese or foreign car brands. There are no Thai domestic car brands, and most of the research and design is done elsewhere.

In 2017, the military-backed government released its EEC Plan as part of its broader plan to transform Thailand's economy for the digital era known as "Thailand 4.0", inspired by World Economic Forum founder Klaus Schwab's (2017) notion of the "fourth industrial revolution." As with the policies to promote the Eastern Seaboard in the 1980s, the BOI offered new tax incentives for companies investing in so called "s-curve" industries. In 2018, the parliament passed the EEC Act, which set up a new EEC Office directly under the Prime Minister to drive development in the area, and suspending local city planning and zoning regulations in the three municipalities. In addition to continuing the push for foreign investment, the EEC plan also aimed to boost Thailand's domestic innovation capacity. The EEC vision outlined seven new "innovation clusters" along a proposed new high-speed rail corridor that was to link Bangkok with three airports, and connect the cities of Rayong and Chonburi to the capital. The first one to break ground was Wangchan Valley, promoted as "the first new smart city in Thailand," and a base for "clean natural innovation." One reason this project was the first among the seven to break ground is that the site was already owned by deep-pocketed PTT, Thailand's largest company by stock market capitalization.[4]

While the 350-hectare site is owned by PTT, Thailand's national research agency (NSTDA) is developing a portion of the site into the "EECi innovation platform", a series of buildings clustered around a central hall including a pilot plant for new products derived from biomaterials, a robotic manufacturing center for testing new production processes, and an "alternative battery" pilot plant. The thinking behind the "pilot plant" was that small local startups that usually lacked the R&D resources of foreign companies or big corporates could use these facilities to test and develop new products and production processes.

At the entrance of this brand-new complex was an abstract silver sculpture made of three concentric silver rings gleaming in the hot afternoon sun. "This statue is designed to show that

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[4] PTT is 51% owned by Thailand's Ministry of Finance, but operates as a commercial firm with various subsidiaries engaged in both core business of oil exploration and refining as well as new sectors in renewable energy and biofuels

Wangchan Valley will be an innovation amplifier, radiating innovation out from this point throughout the country," he told me.

After the tour of the NSTDA innovation center and the rest of the site, I was taken to see the Wangchan Valley Forest Learning Center, a research forest focused on reforestation and planted with a range of trees including palm and rubber. There were signs bearing the image of Princess Sirindhorn, the sister of the current king and a prominent member of the Thai royal family who was known for being the "academic of the royal family"[5] with her longstanding patronage of the arts, agriculture, and scientific research. Princess Sirindhorn had in fact visited Wangchan Valley on several previous occasions, including presiding over the opening ceremonies for Vidyasirimedhi Institute of Science and Technology (Vistech) which PTT built in 2015 as part of an effort to help translate scientific research into commercial application. The full name of the university is composed of the words *witthaya* for science, *siri* meaning "good luck", and *medhi*, "genius."

At the end of our tour, we drove up to an observatory deck perched at the top of a hill just above the Forest Learning Center. From here, we had a panoramic view of the valley below, the newly-built "innovation district" amidst a flat plain with nearby sites waiting to be cleared for further development, and green forests stretching up to the mountains and away to the edge of the hazy horizon.

What is that structure?" I asked, pointing toward a large newly-designed but classic sloped-roof villa that was perched on the hillside, suspended above the forest canopy. "Oh that's a villa for when the Princess visits, but its only occupied when she is here," my host told me. A sign in Thai read *Vidyapiman*, the name of the villa. Vidya, or Witthaya is a Sanskrit-derived word broadly meaning science, while *piman* means paradise or celestial residence, a term commonly used in parks, palaces, and even apartment buildings. The name of the princess's purpose-built villa, *Vidyapiman* could be translated as a "paradise constructed by science."

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[5] Interview, Chulalongkorn Professor (2023)
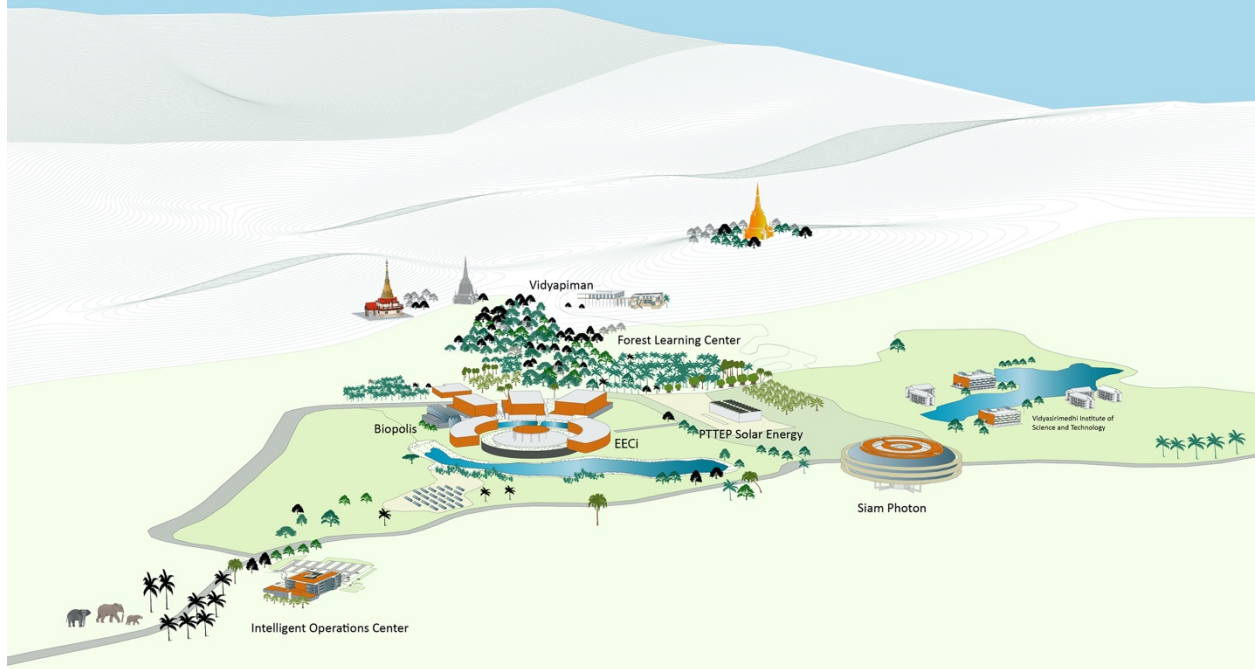
Figure 1. Illustrated Diagram of Wangchan Valley Site (Author, 2024)

Introduction

Located far from the traffic jams and energy of Bangkok, Wangchan Valley is a utopian space, representing aspirations for technological self-sufficiency and a cleaner urban and natural environment under the support of the Thai royal family and a major state-owned enterprise. Whatever the outcome of the project, Wangchan is physically remote from the metropolis of Bangkok and as a self-contained delimited space will not by itself solve Thailand's complex urban challenges nor replace the messy reality of urban life. Nevertheless, Wangchan also exemplifies a core question of this dissertation: how and why are nations developing new spaces (both within existing cities and in new sites) for the test-bedding and trialing of emerging urban technologies like 5G, internet of things, autonomous vehicles, and smart manufacturing seen to be critical to national development objectives? Even if such "pilot" or "showcase" projects are often undertaken for political reasons and are largely symbolic, what effects do such physical projects and technological platforms take on as they are deployed and promoted by various political actors and other stakeholders?

Wangchan Valley is a "showcase" project designed to display futuristic technologies such as internet of things (IoT) sensors, data platforms, and testbeds for robotic manufacturing powered by private 5G networks. In this respect, Wangchan and other similar projects I examine in this study bear resemblance to what Halpern et al., in their analysis of South Korea's "smart city" of Songdo, termed "test-bed urbanism: a form of administration and a redistricting of bodies and information into new global configurations." [6] Songdo, near Seoul's Incheon Airport, was developed through a partnership between South Korean officials, a Boston-based real estate developer, and American technology giant Cisco. Songdo was also considered one of the most ambitious and paradigmatic greenfield "smart city" projects of its time.

The idea of the "smart city" became a popular buzzword since companies like Cisco, IBM, and Siemens began promoting it in the early 2010s. The concept has been widely critiqued as a form of "techno-managerial" governance that reduces citizen agency in favor of control by technical

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[6] Halpern, O., J. LeCavalier, N. Calvillo, and W. Pietsch. "Test-Bed Urbanism." Public Culture 25, no. 2 70 (April 1, 2013): 275

experts and privileges corporate technological solutions over political processes, [7] and are "deeply rooted in seductive and normative visions of the future where digital technology stands as the primary driver for change."[8] These critiques echoed Graham and Marvin's warning about the "splintering" effects of digital infrastructure as previously public infrastructures became unbundled and repackaged as private networks or services.[9] According to Greenfield, "the smart city is predicated on, indeed difficult to imagine outside of a neoliberal political economy."[10] However, the smart city has more recently been embraced not simply as a corporate project but increasingly as an "imaginary" of *national* development. Despite the souring on the "smart city" among academics and public officials in the West, the term has lingered on as a zombie concept, finding new life in other parts of the world, and morphing from a simple corporate marketing effort to sell cities expensive digital infrastructures and control centers to a broader program of national development marshalling resources of nations, cities, and citizens in new and complex ways.

I began this project informed by such critiques of the smart city concept with a similar skepticism of the techno-solutionism and techno-optimism implicit in many such projects, whether or not they are implemented by multinational firms, state agencies, or state-owned enterprises. But as I investigated the ways in which discourses of the "smart city" and "fourth industrial revolution" had found their way into the national strategies of many countries, I realized that previous critiques of the smart city required updating. This dissertation aims to broaden the interpretive and analytic lens through which such projects are understood. This means bringing literature on the smart city and critiques of technological determinism into dialogue with political science of late development. How do such "showcase projects" function both as political and symbolic artifacts in and of themselves, but also as part of broader systems, in particular national

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[7] David Harvey, "From Managerialism to Entrepreneurialism: The Transformation in Urban Governance in Late Capitalism," *Geografiska Annaler. Series B, Human Geography* 71, no. 1 (1989): 3–17; Alberto Vanolo, "Smartmentality: The Smart City as Disciplinary Strategy," *Urban Studies* 51, no. 5 (April 1, 2014): 883–98; Robert G. Hollands, "Critical Interventions into the Corporate Smart City," *Cambridge Journal of Regions, Economy and Society* 8, no. 1 (March 2015): 61–77, 1; Jathan Sadowski and Roy Bendor, "Selling Smartness: Corporate Narratives and the Smart City as a Sociotechnical Imaginary," *Science, Technology, & Human Values* 44, no. 3 (May 1, 2019): 540–63,

[8] Andrés Luque-Ayala and Simon Marvin, "Developing a Critical Understanding of Smart Urbanism," *Urban Studies* 52, no. 12 (September 2015): 2105–16,

[9] Stephen Graham and Simon Marvin, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (Psychology Press, 2001).

[10] Adam Greenfield, *Against the Smart City* (Do projects, 2013).

innovation systems? And how might changing geopolitical dynamics such as the rise of China and the resulting U.S.-China tension and rising protectionism and nationalism across the world affect the development and deployment of "urban technologies" such as city data platforms, the internet of things, 5G, and cloud computing, all of which are increasingly conceived of by many nations and cities as *public digital infrastructure*, critical to national competitiveness in emerging sectors like advanced manufacturing and artificial intelligence (AI)?

Smart Cities: From neoliberal to statist imaginary

At this point, some readers might be wondering: "what else is there new to say about the smart city?" But, in this dissertation I do not take the concept of the "smart city" for granted as a fixed entity. The term is what Gallie called a "contested concept," involving "endless disputes about their proper use."[11] I myself was often asked during many interviews "so what do *you* think a smart city is?" As much as my interviewees expected a PhD candidate from MIT to know, if anyone would, I was typically unable to provide a single cogent articulation without trailing off into endless dependent clauses and qualifications. Soderstrom referred to smart cities as a "normative framing of what the urban should be,"[12] but this normative framing cannot be taken for granted as fixed, either. As my dissertation shows, a term like the "smart city" takes multiple forms and normative meanings shaped by various actors with distinct values and motivations and communicating different messages to international and domestic audiences. Informed by the perspectives of science and technology studies (STS) as well as the political economy tradition of research on "late development" including the "developmental state paradigm," [13] the dissertation asks how the development of urban data platforms and related technologies is "co-produced"[14] alongside specific political and institutional dynamics within each national case. How are visions of future urban technological systems intertwined with particular political and social visions of the actors deploying them?

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[11] W. B. Gallie, "Essentially Contested Concepts," *Proceedings of the Aristotelian Society, New Series* 5 (1956): 167–98.
[12] Ola Söderström, Till Paasche, and Francisco Klauser, "Smart Cities as Corporate Storytelling," *City* 18, 3 (May 4, 2014): 307–20
[13] Alice H. Amsden, "Diffusion of Development: The Late-Industrializing Model and Greater East Asia," *The American Economic Review* 81, no. 2 (1991): 282–86; Peter B. Evans, *Embedded Autonomy: States and Industrial Transformation* (Princeton University Press, 2012); Stephan Haggard, *Developmental States* (Cambridge University Press, 2018).
[14] Sheila Jasanoff, *States of Knowledge: The Co-Production of Science and the Social Order* (New York: Routledge, 2004).

Many critiques of smart cities have focused on the universal sameness of the technological solutions companies offered to cities. Like Koolhaas's notion of the banality of contemporary cityscapes from globalization in his essay "the Generic city," [15] Greenfield argued that the "canonical smart city almost has to be staged in any-space whatever, only by proposing to install generic technologies on generic landscapes in a generic future can advocates avoid running afoul of the knotty complexities that crop up immediately any time actual technologies are deployed in existing places." Greenfield was critiquing the smart city vision ideal type as promoted by corporate marketing literature at the time. This dissertation, meanwhile, sets out to investigate how the deployment of urban technologies is shaped and contoured in real places with histories, shaped by people with particular agendas, political beliefs, and visions of the future. We might consider the "smart city" and other global discourses like "innovation" or the "fourth industrial revolution" as what Latour termed "immutable mobiles"—concepts, objects, or technologies that travel across the world.[16] The academic critique of the "smart city" as a shiny singular object has obscured the "processes of translation" by which the smart city has been rendered into diverse institutional and political contexts. There has been a growing interest in the proliferation of the "smart city" fad around the world, but there has not yet been a proper ethnographic investigation of the *process* of how such technology adoption and implementation plays out, or the political implications of this translation process. Even if the *ideal* of the smart city has often been homogenous, the process of how such ideas unfold on the ground tells a different story.

While there have been many critiques of smart cities, there have been few studies of how the smart city works a discursive object, particularly in contexts of late development. Burns et al. call for "provincializing our understanding of smart cities," calling for more comparative analysis of smart city projects across the Global South and beyond exceptional cities.[17] Recent scholarship on India's 100 Smart Cities Mission[18] and Günel's account of Masdar in the UAE[19] examined how postcolonial nations in the global south have embraced concepts such as "smart cities" for their

[15] Rem Koolhaas, Bruce Mau, and Hans Werlemann, *S M L XL*, 2nd edition (New York, N.Y: The Monacelli Press, 1997).

[16] Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society*, Revised ed. edition (Cambridge Mass, Harvard University Press, 1988)

[17] Ryan Burns et al., "Smart Cities: Between Worlding and Provincialising," *Urban Studies* 58, no. 3 (February 1, 2021): 461–70,

[18] Ayona Datta, "Postcolonial Urban Futures: Imagining and Governing India's Smart Urban Age," *Environment and Planning D: Society and Space* 37, no. 3 (June 1, 2019): 393–410

[19] Gökçe Günel, *Spaceship in the Desert: Energy, Climate Change, and Urban Design in Abu Dhabi*, Illustrated edition (Durham: Duke University Press Books, 2019).

promise of leapfrogging out of poverty, technological dependency, and the chaos of actually existing cities. While adding welcome nuance to understanding the transmutation of the smart city around the world, these accounts have tended to remain siloed within the fields of geography, urban studies and planning. They have generally not engaged with broader literatures around development theory or science and technology studies (STS). And, even as they claim to critique the apparently universal idea of the smart city, the continued use of the term suggests they are still taking it for granted as a coherent thing in itself. Even if productively broadening our view of smart cities, these recent works also tend to narrowly focus on single city case studies of city-level projects or flashy new cities and remain at the level of discourse or state plans. This is understandable given that at the time, many of India's smart city projects had yet to fully break ground, and there is enough material to analyze even if just looking at the discursive meaning of policies, plans, promotional renders, and rhetoric. But there have been few detailed studies to situate urban technology projects contextually within broader national innovation ecosystems or understand how ideas and concepts displayed in such showcase spaces are eventually transformed, adapted, and implemented in other ways by a variety of actors—the smart city as *process*, rather than *thing*.

It is for these reasons that this project adopts a multidisciplinary research approach straddling urban studies and planning, political economy of late development, and science and technology studies (STS). While the "smart city" has been an object of research and critique in the fields of urban studies and planning, this dissertation eschews "methodological city-ist" (city-centric) approaches[20] that have not adequately considered smart city projects within broader *national* development contexts or *international* technological competition. In terms of implications for urban planners and policymakers, this project calls for greater reflexivity and awareness on the part of planners (particularly at the local scale) to consider broader contextual factors and adopt a more proactive approach to planning for digital infrastructure rather than merely reacting or regulating the effects of private-sector digital platforms. The adoption of the smart city as a project of national development means it is crucial to situate this research in the context of scholarship on "late development." While urbanization has generally been seen as an important

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[20] Hillary Angelo and David Wachsmuth, "Urbanizing Urban Political Ecology: A Critique of Methodological Cityism," *International Journal of Urban and Regional Research* 39, no. 1 (2015): 16–27.

prerequisite of development in modernization theory,[21] does the increasing importance of urban data and digital infrastructure complicate existing theorizations of the relationship of urban and national development? This dissertation offers a new theorization of this relationship by analyzing the implications of various digital urban platforms for territorial governance and state power. Finally, those coming from a science and technology studies background take the social and institutional embeddedness of technology as a given. This dissertation considers not only the ways in which different "social factors" shape the trajectory of urban technology but adopts a more symmetrical perspective to examine how the development of digital urban platforms and new forms of urban and national governance are mutually co-constitutive. Building on previous STS work highlighting the role of performance and visualization in establishing technological and scientific consensus in "liberal democratic" contexts, this dissertation considers how "symbolic" pilot projects communicate ideal visions of technology and governance in authoritarian or one-party political systems— both *within* and *across* national borders.

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[21] John Friedmann, *Urbanization, Planning, and National Development* (Sage Publications, 1973); James C. Davis and J.Vernon Henderson, "Evidence on the Political Economy of the Urbanization Process," *Journal of Urban Economics* 53, no. 1 (January 2003): 98–125; Diane E. Davis, "Reflections on the Relations between Development and Urbanization: Past Trajectories and Future Challenges," *International Journal of Urban Sciences* 20, no. 1 (January 2, 2016): 1–14

Figure 2a (above): The Smart City as "generic city": Songdo, South Korea (Author, 2014);
Figure 2b (below): Google's Quayside, Toronto (Heatherwick Studios, 2018)
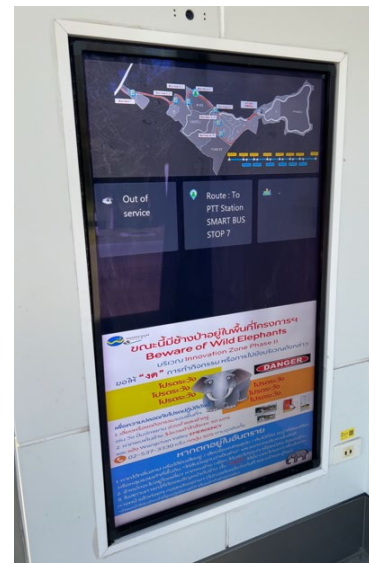
Figures 3a-c: Images of Wangchan Valley: Top(3a): entry pavilion, btm left(3b): Vidhyapiman Villa; Right(3c): "Smart bus stop" sign warning of wild elephants

From Platform Capitalism to the Fourth Industrial Revolution

Another important distinction between this dissertation and earlier work is that I argue that since the advent of smart cities in the early 2000s and subsequent critiques, two shifts have changed the nature and character of urban technologies around data extraction:

1. The first is the growing dominance of an economic model known as "platform capitalism" characterized by monopolistic firms that control social media platforms or urban service sectors and acquire control over urban data in the process.[22] In this model, digital platforms are "intermediaries that sit in the middle of other activities, serve as the infrastructure for capital circulation and extract value by controlling access to assets."[23] The data generated on the consumption and behavior patterns of urban residents from many such urban platforms (whether Uber's data on transportation, Airbnb's data on housing and travel behavior, or Amazon's data on consumption patterns) has become valuable "behavioral surplus"[24] as a derivative of consumers using platforms. Even as they accumulated massive data on cities, most platform firms did not initially consider themselves in the "smart city" business. However, more recently some of these firms (i.e. Google's Sidewalk Labs, discussed in Chapter 4), have tried to extend control over data extraction by building physical urban districts with digital technology embedded from the ground up. But the ownership of urban data by proprietary firms leads to "data siloes," furthering digital divides and hindering utilization for public benefit.

2. The second trend is the advent of what Schwab broadly termed the "4th industrial revolution", predicated on "artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing."[25] The "platform economy" described above

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[22] Nick Srnicek, *Platform Capitalism* (John Wiley & Sons, 2016); Paul Langley and Andrew Leyshon, "Platform Capitalism: The Intermediation and Capitalization of Digital Economic Circulation," *Finance and Society* 3, no. 1 (October 30, 2017): 11–31; K. Sabeel Rahman and Kathleen Thelen, "The Rise of the Platform Business Model and the Transformation of Twenty-First-Century Capitalism," *Politics & Society* 47, no. 2 (June 1, 2019): 177–204,

[23] Paul Langley and Andrew Leyshon, "Platform Capitalism: The Intermediation and Capitalization of Digital Economic Circulation," *Finance and Society* 3, no. 1 (October 30, 2017): 11–31,

[24] Shoshana Zuboff, *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power* (New York: Public Affairs, 2019).

[25] Klaus Schwab, *The Fourth Industrial Revolution* (Crown, 2017).

was "enabled by 4G LTE which cultivated a range of new companies, including Lyft, Uber, Airbnb and cloud-based services."[26] The rise of 5G and IoT was predicted by some like Schwab to open up new industries such as robotic manufacturing precision medicine, autonomous vehicles and AR/VR. The core logic driving this supposed "new era" was to be the integration of digital technologies with the physical world—objects covered in sensors (the so-called internet of things or IoT), intelligent machines, along with all the possibilities that would flow from new data, and new analytical tools to leverage insights from that data. While some of this has not yet been as revolutionary as predicted, nations like South Korea and China developed an early lead in 5G technology and are still piloting use cases and applications to push the technology further.

The platform economy, while having implications for physical space of cities, was enabled primarily by the widespread adoption of mobile phones, 4G speeds, and the growth of third-party applications. Subsequently, platforms generated valuable datasets on cities and their residents. Platform capitalism was an entirely new economic model based on intermediation between consumers and service providers, and subsequent extraction of urban data from monopolizing certain markets. Advances in cloud computing, 5G, artificial intelligence (AI), robotics, and energy storage since the early 2010s have opened up new possibilities for data extraction and aggregation via an even broader application of sensing technologies on national and territorial scales, from smart cities to smart nations, and—if Joe Paradiso, the MIT Media Lab professor, was to be believed "an instrumented earth: the internet of things at planetary scale."

The physical and metabolic implications of "cyberspace" are now widely acknowledged: massive data centers that consume huge amounts of energy, fiber-optic cables crisscrossing the ocean floors, satellites saturating near and far earth orbits. The internet with its data centers and associated digital infrastructures already has a huge environmental footprint.[27] The technologies of the fourth industrial revolution are premised on a further blanketing of physical spaces and objects with digital technology (sensors, cloud computing centers, smart manufacturing, and

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[26] Tarun Chhabra et al., *Global China: Assessing China's Growing Role in the World* (Brookings Institution Press, 2021), 154.
[27] Steven Gonzalez Monserrate, "The Staggering Ecological Impacts of Computation and the Cloud," *Scientific American*, March 1, 2022, https://www.scientificamerican.com/article/the-staggering-ecological-impacts-of-computation-and-the-cloud/.

autonomous vehicles). The implications of this for climate crisis and sustainability could be mixed—IoT devices and digital twins promise more efficient energy systems, for example. But greater amounts of energy will also be required to power the devices, cloud computing centers, and data transmission infrastructure required for these systems. Even as the technologies of the 4th IR are premised on "cyber-physical integration" there has been virtually no systematic exploration of the impacts of the fourth industrial revolution on cities, regions, and territories—in other words, the spatial ramifications.

Additionally, there has not yet been an attempt to grapple with how this "revolution" is reshaping the role of the state in promoting development, and the relationship of cities and the nation. Many of the originators and proponents of the "fourth industrial revolution" did not think much about how the revolution they were forecasting as inevitable would be shaped by the actions of nation states around the world. Such an assumption of the social and institutional embeddedness of technology is a basic premise of science and technology studies. But for techno-evangelists, the "revolution" was a train heading in a single direction that everyone had to get on board or risk being left behind. While concepts like the "smart city" or the "fourth industrial revolution" are often dismissed by many critics as mere marketing concepts and slogans, they have material effects. This is particularly true in contexts of "late development,"—in middle-income countries or countries that have only recently achieved industrialization and reduction of extreme poverty. In these contexts, concepts like the "smart city" and "4th IR" appealed to leaders and elites in late developing countries as visible symbols of modernity and progress.

This dissertation, it should be noted, does not advocate for "rehabilitating" the smart city as a universal solution for urban development. Many of the same critiques of the smart city as "techno-solutionist" could apply equally today in these projects. However, what this dissertation does aim to do is develop deeper understanding of the implications of recent and ongoing state-initiated experiments in implementing urban technology in other parts of the world. Through detailed examination of the situated process of development and relationship between urban and national scales in each context, the project opens up windows into potential alternative pathways of urban technology in a multipolar world with competing visions of the future. For example, particularly in Chapter 4, the dissertation asks whether the experiments in state-

provided urban digital infrastructure challenge the model of private-sector platform capitalism that has become a dominant economic logic over the past decade. In 2015, Google started a new venture called Sidewalk Labs which was to focus on developing technological solutions for cities, and extending the firm's control of search data into control of data collected from the physical environment of cities. To this end it embarked on a project to build a new urban neighborhood from the ground up in Toronto's Quayside redevelopment area. While an heir to the 'smart city' concept, Sidewalk's Quayside Project suggested a new phase whereby technology giants were increasingly interested in not just selling cities systems for managing their infrastructures, but in building cities from scratch for the specific purpose of developing new analytical products and tools from the massive amounts of data that could be collected in them. However, the eventual failure of this project, which stemmed from activists' anger about Google's lack of transparency and questions over Google's ownership of personal data, suggests that Google lacked the "infrastructural power" to execute its vision.[28] Particularly, Google lacked control over land ownership, local institutions, trust, and ability to shape citizens' own values and aspirations—the messy complexity that makes cities what they are. But what about contexts of state capitalism in which governments or state-owned enterprises control much of the fabric of the city, allowing them to deploy new digital systems at scale on sites or in a new city or district with relative ease?

Testbeds for the Nation

As nations focus development strategies on technologies of the 4th industrial revolution, cities are being remade in line with the newfound focus on data as a resource & public infrastructure. The 4th IR is premised on a tighter integration between infrastructures for data extraction and the physical environment. But the prophets of the coming "revolution" like Schwab paid little attention to the potential for divergent futures as nations or cities went about implementing these technologies in highly differentiated institutional and political contexts. How might the effort to collect urban data play out in contexts where the state is a driving force in urban and economic development, and in contexts of "late development" where the imperative of "catching up" and "leapfrogging" animates not only public policy but also citizens, government officials, and business leaders' sense of themselves, their cities, and of their place in the world?

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[28] Michael Mann, "The Autonomous Power of the State : Its Origins, Mechanisms and Results," *European Journal of Sociology / Archives Européennes de Sociologie* 25, no. 2 (1984): 185–213.

The urban projects that were begun as part of these national programs stemmed directly from goals and policies formulated by national-level leaders. Urban areas and the data generated in them were set to become "objects" and "resources" for national development, not merely sites of consumption or production, as cities have typically been conceived of in literature on national development. Of course, cities are important sources of data because they are also key sites of economic activity such as production and consumption. Development economists have generally seen urbanization as highly correlated if not a *sine non qua* of economic growth.[29] What does this relationship look like in the digital age? This dissertation argues that because of the growing importance of "data capitalism" to the global economy, data generated in cities has become a critical resource for nations. This leads to an effort by a range of stakeholders to exert sovereignty over that data—from nations themselves passing laws on data sovereignty within their territorial borders, to cities and local leaders deploying data platforms as a resource for local development, to national firms seeking to profit from the proliferation of urban data and analytical platforms. The outcomes of these efforts to exert sovereignty over urban data often depend on the specific power balance between national and local entities in particular countries, and between nations and multinational firms, which will be examined across the three national cases in this study.

Wangchan Valley and the other projects in Thailand, Singapore, and China that I examine in this dissertation, are not primarily testbeds for new products and services of multinational technology firms, as in the "first era" of the smart city. Rather, they are *testbeds for the nation*: conceived and undertaken primarily by national agencies or state-owned enterprises as part of nationwide development programs to incubate emerging sectors such as 5G, the internet of things, big data and cloud computing, and more recently artificial intelligence, which can be applied to large datasets and a variety of urban problems. In addition to serving as actual testbeds in the service of national development policies, such projects also become symbolic showcases in reproducing certain imaginations of national identity or ideology.

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[29] James C. Davis and J.Vernon Henderson, "Evidence on the Political Economy of the Urbanization Process," *Journal of Urban Economics* 53, no. 1 (January 2003): 98–125; Diane E. Davis, "Reflections on the Relations between Development and Urbanization: Past Trajectories and Future Challenges," *International Journal of Urban Sciences* 20, no. 1 (January 2, 2016): 1–14,

Thus, the dissertation explores both semiotic and material effects of such "national testbeds" and how *discourses* and physical-digital platforms are transformed as they land in different national contexts and are deployed by a variety of actors *within* nations each with their own goals and agendas. For example, even within Thailand, the "smart city" takes on a multitude of meanings and dispositions depending on who is deploying the concept—Wangchan Valley represents one vision promoted by a corporate and Royal elite, but as we will see in later chapters, there are many "urban solutions" being deployed by various actors within Thailand and elsewhere. Far from unfolding in "generic space and time," as Greenfield suggested, this dissertation interrogates how political and business elites adapt globally circulating concepts to suit different national contexts, and deploy them for a variety of objectives in particular places. This is a process of adaptation and translation both across and within national borders. Despite critiques of the smart city or "data capitalism" as a form of corporate colonialism, this project reveals that actors in late developing countries outside the West increasingly are asserting their agency in shaping the trajectory of technology adoption both *within* their borders, as well as increasingly in the rest of the world. The processes of adoption of concepts like "smart city" examined in this dissertation does not necessarily suggest a hegemonic form of "knowledge-power" centered on the West. Instead, the processes I examine in this dissertation involve selective appropriation of globally circulating concepts but also translation and re-deployment primarily by state actors or other business elites within the countries I examine.

Smart Cities, Geopolitics, and the export of a "China model"

China's rapid development led it to export much of its infrastructural capacity to countries around the world through the "Belt and Road Initiative", and subsequent "Digital Belt and Road Initiative."[30] Huawei's leadership in 5G technology, seen by some as enabling a new era of IoT and robotic manufacturing, led to U.S. national security concerns about its networks being used for Chinese state spying in countries using its hardware, which ultimately led to a 2017 ban on its use in the U.S. and many of its allies.[31] While close U.S. allies have mostly opted not to use

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[30] K.C. Fung et al., "Digital Silk Road, Silicon Valley and Connectivity," *Journal of Chinese Economic and Business Studies* 16, no. 3 (July 3, 2018): 313–36; Jonathan E. Hillman, *The Digital Silk Road: China's Quest to Wire the World and Win the Future* (New York, NY: Harper Business, 2021).

[31] Meg Rithmire and Courtney Han, "The Clean Network and the Future of Global Technology Competition" (Harvard Business School, April 12, 2021).

Chinese telecom vendors for critical infrastructures, many developing countries in Africa and Asia have embraced such companies because they offer advanced technologies at cheaper prices, and also offer fantasies of control and modernization, particularly in non-Democratic contexts. Urban digital infrastructure has become a contested terrain shaped by geopolitics and international competition.

With rising tensions between the U.S. and China and talk of decoupling or even a "Cold War 2.0," some have proposed we are now in a "second cold war,"[32] or "friendshoring."[33] This new geopolitical reality also has implications for the development of cyber-physical systems that are now enmeshed within the race for innovation among nation states. Whatever terminology one chooses, the world is moving out of the period of unquestioned globalization and just-in-time supply chains that accelerated in the 1970s—perhaps not the end of globalization, but a significant reorganization nonetheless. What will be the impact of these broader structural changes on cities? Cities have always been sites of economic activity, production, consumption, and innovation. During the peak decades of globalization, cities were often viewed as nodes in transnational circuits of capital and labor.[34] Today, the data generated by cities has implications for national development strategies and cities are increasingly being planned as laboratories and testbeds for national innovation strategies. Data infrastructure is seen as crucial to emerging sectors such as advanced manufacturing or artificial intelligence. Many of the projects detailed in this dissertation are promoted as cultivating local innovation capacity and local knowledge, rather than simply attracting foreign capital. Earlier 'smart cities' were often marketed to attract international investment. Songdo's full name is the "Songdo International Business District" and one of its selling points was the supposed proximity to Incheon airport offering a three-hour flight to a one third of the world's population.[35] This is not to say earlier smart city projects did not involve the state—Korean state agencies, the Incheon city government, and other state actors all played a role in the development of Songdo, as state actors have in most smart city projects.

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[32] Seth Schindler, Jessica DiCarlo, and Dinesh Paudel, "The New Cold War and the Rise of the 21st-Century Infrastructure State," *Transactions of the Institute of British Geographers* 0 (2021): 1–16,
[33] Günther Maihold, "A New Geopolitics of Supply Chains. The Rise of Friend-Shoring," 2022, 7.
[34] Saskia Sassen, *The Global City: New York, London, Tokyo*, Revised edition edition (Princeton, N.J: Princeton University Press, 1991); Manuel Castells, *The Rise of the Network Society: Information Age: Economy, Society, and Culture v. 1*, 2nd Ed (Malden, MA: Wiley-Blackwell, 2009).
[35] Songdo IBD: About (2015) http://songdo.com/

However, the goals of Songdo were still largely framed through imperatives of attracting international capital, drawing in the best technology from MNCs like Cisco, and serving as a base for internationally minded Koreans and foreign expats. While the results of Songdo have been somewhat underwhelming compared to its hype, it has still managed to attract an office of the U.N. and several international schools.

If the term "smart city" was initially popularized during the heyday of neoliberal globalization led by multinational Western firms, how should we understand its current associations with a turn toward 'state-led' or "infrastructure-centric" approaches to development that has in recent years been associated with the "China model" and China's aim to build infrastructure across much of the developing world?[36] These sorts of questions led me to investigate several nations in the Asia Pacific as part of a broader inquiry into the relationship between digital technology, urban systems, and national development.

The dissertation sets out to examine the interplay between national-level ideas and policies and the trialing of urban testbeds at the local level. The choice of cases (Singapore, Thailand, and China) reflects the contemporary reality that many countries in Asia have embraced the smart city and fourth-industrial revolution with particular zeal. Around the time of Schwab's formulation of the "fourth industrial revolution" as the theme of the World Economic Forum's 2016 meeting, all three of the countries in this dissertation developed national strategies that adopted a variation of the concept. Singapore unveiled its *Smart Nation Program* in 2014, directly translating the smart city into a national development strategy. In 2015, China adopted its *Made in China 2025* plan as part of an ambitious effort to develop self-sufficiency in frontier technologies and reduce dependency and even surpass advanced economies. In 2016, Thailand's military Junta issued *Thailand 4.0* as part of its effort to digitally transform the country and justify its takeover from the popularly elected government of the Pheu-Thai party. Policymakers and business leaders in these places (often the same people) decided that the transformation of urban systems through technology would not only improve cities but also offered a pathway for

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[36] Suisheng Zhao, "The China Model: Can It Replace the Western Model of Modernization?," *Journal of Contemporary China* 19, no. 65 (June 2010): 419–36; Schindler, DiCarlo, and Paudel, "The New Cold War and the Rise of the 21st-Century Infrastructure State"; Mustafa Kemal Bayırbağ et al., *The Rise of the Infrastructure State: How US-China Rivalry Shapes Politics and Place Worldwide*, ed. Seth Schindler and Jessica DiCarlo, First edition (S.l.: Bristol University Press, 2022).

their nations to escape the "middle income trap" and join the ranks of "advanced nations." In each case, a vision of urban technologies improving efficiency of governance and urban life were wedded to particular visions of the role of the state and citizen in society, and a particular relationship of cities to their respective nations. Perhaps not surprisingly, the notion of a smart city optimized by smart technologies was appealing to regimes in each of these three countries, all of which were under some form of one-party rule[37]. The proliferation of CCTV cameras with facial recognition capacity has been a key component of China's smart city projects, as well as a tool in what some have termed a "surveillance state."[38] However, the idea of surveillance and total control in authoritarian states has often overemphasized the idea of an all-powerful all-knowing "state." While not neglecting the role of smart cities in surveillance, this dissertation is more attuned to the multiplicity of actors that make up "the state," finding that the rollout of smart city technologies involves significant inter-elite and inter-state negotiation over who has the authority and privilege to benefit from the extraction of urban data.

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[37] The classification of regime type is a contested matter; while China is most clearly a one-party state and is often termed "authoritarian" by Western scholars, Singapore officially has a Westminster-style parliamentary democracy albeit with one-party rule by the People's Action Party since its independence in 1965; Thailand has a more complex form of democracy but one in which the results of elections have often been nullified by military coups; Throughout this dissertation, the term "authoritarian" will be used but with a note that this term is subjective and does not necessarily apply across all of the cases all of the time

[38] Josh Chin and Liza Lin, *Surveillance State: Inside China's Quest to Launch a New Era of Social Control* (St. Martin's Press, 2022).

Figure 4. Map of Case Study Sites (Note: Songdo, South Korea is included for reference but is not a case study in the dissertation). Author, 2024.

City Design and Technology

In 1995, William Mitchell's *City of Bits* described the rise of "a city unrooted to any definite spot on the surface of the earth, shaped by connectivity and bandwidth constraints rather than be accessibility and land values, largely asynchronous in its operation, and inhabited by disembodied and fragmented subjects who exist as collections of aliases and agents." Mitchell's book described the internet as another type of city. Similarly, the term "cyberspace," popularized in William Gibson's 1984 novel *Neuromancer*, came to articulate the notion of a separate digital realm, a "consensual hallucination experienced daily by billions of legitimate operators, in every nation…A graphic representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the non-space of the mind

clusters and constellations of data. Like city lights, receding."[39] The more recent concepts of virtual twins and the metaverse are an even more radical step towards virtual worlds. But the premise of the 4th industrial revolution is the merging of the physical and digital, including the embedding of digital technology in physical environments. Place (and space) has long mattered in the deployment of digital data infrastructure: data centers, fiber optic cables crisscrossing the world's oceans, or the near-earth orbit littered with satellites.[40] This is also seen in the way that land ownership and physical planning is increasingly important to the deployment of the technologies of the 4th Industrial Revolution, and in the ways digital technology is embedded within particular national ideological repertoires.

While 5G was supposed to usher in a new age of ubiquitous connectivity, so far the reality hasn't quite matched the hype. Countries like China, which had an early lead in 5G deployment, are still piloting use cases through significant investment in 5G (and already 6G) hardware and applications in automated manufacturing, autonomous vehicles, and IoT. To fully realize 5G power requires dense networks of base stations often in campuses or in industrial sites. The internet of things and virtual twins can be more powerful if data collected from the physical environment can be aggregated. Joe Paradiso, the MIT media lab professor who pioneered early sensing technology, noted that "so far, IoT is balkanized,"[41] noting how the rise of proprietary smart home systems owned by different technology companies (Google's Nest or Amazon Alexa, in the U.S) have hindered aggregation of data that could generate more significant insights. Thus, the trajectory of how these technologies develop will unfold differently in different places, shaped by market dynamics (i.e. the dominance of technology firms in the U.S.), or through the Chinese state's predilection for investment in hard infrastructure.

The cases in this dissertation address not only questions of constructing utopian showcases of progress and national development, but also questions of ownership of the valuable resource of urban data. Who gets to operationalize urban data as a resource and for what purposes? What is at stake in the technologies and ideas discussed in this project? What is at stake for the future

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[39] William Gibson, *Neuromancer*, First Edition (New York: Ace, 1984).
[40] Monserrate, "The Staggering Ecological Impacts of Computation and the Cloud."
[41] Interview, Joe Paradiso (2023)

of urban technologies, the future of data, and the future of cities? How is the 4th industrial revolution shaped in different contexts through different national political economies? If data is a resource for development, who determines how this resource is used. What kinds of data will be collected and for whom? Who will benefit from the advances in knowledge and power from the algorithms that will derive insights from this data, and new products and applications developed from them? Finally, what are the implications for the design of cities and buildings: the data platforms, digital twins, citizen apps, and networks of IoT sensors will have their own dispositions and effects, perhaps unintended consequences from the intentions of the engineers, designers and companies deploying them. The imaginary of the globe blanketed in sensors obscures many things: the persistent power of nation states, the uneven access to technology, and the question of why political and business elites continue to believe that more sensors, more data, and more digital platforms can solve complex, "wicked problems"[42] facing nations and cities today.

My own research over the course of two years, aims to offer answers to these questions. This narrative, to a certain degree, has to be told *in media res* with regard to ongoing processes of technological innovation, geopolitical change, and supply chain restructuring of our contemporary moment. While initial assessments of the results of national policies are offered, the work should also be considered a snapshot of a moment in time, of the messiness of urban innovation through fits and starts, failures and successes, and a reminder that the future is not "pre-determined" by some inevitable march toward progress driven by the gods of science and the titans of global finance—although they play a powerful role. This is also a call for re-imagining alternative futures where technology responds to the needs of people rather than the other way around.

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[42] Robert Goodspeed, "Smart Cities: Moving beyond Urban Cybernetics to Tackle Wicked Problems: Figure 1.," *Cambridge Journal of Regions, Economy and Society* 8, no. 1 (March 2015): 79–92

Core Questions

The following questions organize the dissertation project, and also structure the organization of the key chapters:

1. How and why have globally circulating visions of urban technology (i.e. the smart city and 4th industrial revolution) been adopted as national development strategies of several countries in Asia and how does this force us to rethink earlier critiques of the smart city as a neoliberal or corporate imaginary?

2. How does territorial power of the state come to matter in the deployment of urban data technologies (i.e 5G, digital twins, city data platforms, IoT) and how might this new role for the state upend the model of platform capitalism where most urban and spatial data is monopolized as an asset by private firms?

3. How do local actors and stakeholders within countries adopt and transform global concepts and national plans for their own goals, and what are the implications of these varying visions of who gets to control urban data for the changing role of cities in national development strategies?

4. What are the implications for the urban design and planning professions in terms of how cities are being redesigned around future technologies that involve the control, extraction, and analysis of urban data?

Chapter Structure

The dissertation is broadly organized around both national-level comparisons as well as specific cases of digital platforms and new city projects within those nations. Following the introduction that lays out the broad research agenda, the Chapter 2 lays out the mixed method approach used in the study. Chapters 3 and 4 are comparative chapters that draw together material across the national cases. Chapter 3 compares the transplantation of ideas about the smart city and fourth industrial revolution into the national contexts of Singapore, Thailand, and China—suggesting that historical modalities through which foreign technology and infrastructure been adopted in each context shapes contemporary approaches to adopting and showcasing new technologies. Chapter 4 discusses the issue of urban data, situating the current effort by states and cities to "discipline data," with an attention to the evolving role of the state in driving smart city projects

from the corporate vision of the smart city to the rise of "platform capitalism" and finally into the current moment. I suggest that ongoing efforts to discipline urban data as a resource and infrastructure for development have unique applications in a context of late development, positing a typology of "digital developmentalism" that encompasses a variety of state actions from data sovereignty, reciprocity agreements with private firms, new roles for digital transformation agencies, and provision of digital infrastructure—such as through smart city projects, for example. Then, Chapters 5-7 cover the cases in Singapore, Thailand, and China respectively—focusing on the ways in which individual actors and stakeholders in each of the cases responded to the various national-level policies and global discourses through their own initiatives.

While these national cases are comparative, they also represent related but not necessarily equivalent cases of the broader phenomenon I describe as "national testbeds". Each of the chapter-length cases focuses on the development of urban digital data platforms in a national context including both contemporary policies and historical precedents of technology adoption. The Singapore case focuses primarily on two pilot projects of the "Smart Nation Initiative" that sought to develop IoT sensors and digital twins, the Smart Gardens and Punggol Digital District— the projects are examined in terms of how they reflect longstanding institutional approaches to technology governance and national identity. The Thailand case looks at competing approaches to developing "city data platforms" in Thailand through examination of national pilots, corporate platforms, and platforms promoted by local governments. The Thailand case situates these smart city experiments in the context of Thailand's ongoing contested politics and persistent regional inequality. The Junta government of Prayut Chan-Ocha conceived of a vision to digitally transform Thailand (Thailand 4.0), making smart cities a key pillar of this policy. But the actual evolution of urban data platforms in the country reveals how efforts to deploy such platforms are enmeshed in politics of contestation over who gets to benefit from data—local mayors, state-owned enterprises, private conglomerates, or foreign technology companies. Given China's scale, one chapter cannot possibly examine the scope of digital urban technologies across the country. Rather, the chapter focuses primarily on the ongoing policies and efforts by state regulators to assert control over urban data as a resource, using the Xiong'an New Area as a case of a state-centric approach to developing urban technology closely supported by Xi Jinping himself. There

are commonalities across the three cases, but also important distinctions—for example, the case studies of Singapore and China focus more on new urban districts or physical projects, while Thailand is primarily concerned with the deployment of digital platforms' deployment in existing cities and in the overall context of Thailand's local-national relationship. Thailand also embarked on several pilot projects, such as previously mentioned Wangchan Valley, but in general has not undertaken "greenfield" projects at the scale of Singapore or China. Finally, Chapter 8 offers concluding thoughts about the implications of the specific pilot projects for the broader theoretical issues raised in the first three chapters.

1. **Introduction: Building Cities and Digital Nations** Lays out the rationale for the project, the framing questions, and how this dissertation provides a new lens in understanding the evolution of the "smart city concept and its centrality to state-led innovation in a new moment of geopolitical competition. The chapter highlights the contributions of the interdisciplinary project in fields of urban studies and planning, political science of development/development studies, and science and technology studies (STS).

2. **Methodology:** This chapter outlines the methodology, including the process and logic of case selection, the relationship of city-level cases to the national level cases. At the core, the dissertation involved a process of grounded constructivist theory through comparative case studies, whereby grounded fieldwork was used to generate new concepts, situated in the ongoing literature on smart cities, urban data, and the relationship between cities and national development. The three case study chapters are organized according to the national scale. Within each national case there are individual smart city projects chosen to represent particular forms that the concept has taken in that country, or chosen to reveal particular dynamics of local-central state relations. Process tracing through historical and archival analysis traces the interplay between national policies, pilot projects, and subsequent iterations following failures or adoption of specific technologies by other actors. The project used interviews with key stakeholders (one might term "elite-focused" ethnography) to understand the motivations of stakeholders implementing various projects. This was supplemented by site visits and archival analysis of national-level policies.

3. **Cyber-Physical Integration as National Development Imaginary** asks: How were *global imaginaries* such as the "fourth industrial revolution," adopted into the development strategies of states in East and Southeast Asia (Singapore, Thailand, China)? In each case, I show how foreign concepts found resonance with existing traditions of integrating foreign technology into physical infrastructure as a tool of national development. The chapter then highlights particular histories in each national context of using cities and urban infrastructure as tools for communicating political ideology—from a model city intended to showcase a Thai version of democracy built by Thailand's King Rama VI in the early 20th century, to Singapore's imaginary of itself as a "garden city" and "intelligent island," to China's history of using large-scale infrastructure and mobilization to construct cities as models for particular ideologies—including Daqing as a model socialist industrial city in the 1950s and Shenzhen as a model for Deng Xiaoping's "Reform and Opening" in the 1980s and 90s.

4. **From Smart Cities to the Digital Development State:** Data, much of it generated in urban areas is now discussed by some as a new "asset class," "community resource" and "public infrastructure." Whereas platform or data capitalism has been premised on the monopolization of key sectors by privately owned firms and the subsequent extraction of data and related insights and products developed from that data, there has been growing unease with the monopolistic power of such firms worldwide. What are the implications of this for late developing or middle-income countries? How does the legacy of previous state development pathways shape approaches to managing, regulating, and disciplining the flow of urban data? Do the strategies states are deploying to promote "digital sectors" comprise an emerging "*digital developmental state*" by which national agencies trial technology through a combination of strategies to regulate data, testbed technology in specific sites? Finally, how is the exercise of "state digital infrastructure power" both shaped by and how does this power influence particular forms of territorial governance in each national case, such as landownership and fiscal relationships between national and local governments?

5. **Singapore: City as Showroom for the Urban Solutions Sector.** Singapore has become known for its comprehensive urban planning, and identity which has made it a common reference point for nations and cities around the world. The 2014 launch of Smart Nation initiative precipitated several pilot projects to incubate new technologies in specific districts of the city. This chapter focuses on two of those: The "Open Digital Platform", a limited virtual city twin pilot developed by Jurong Town Corporation in the new town of Punggol, and the "Smart Garden" project that sought to deploy internet of things sensors in Singapore's iconic Gardens by the Bay. How have these projects reproduced Singapore's vision of itself as a "city in a garden" and turned the entire island into a "testbed" of new technologies?

6. **Thailand: Urban data as contested infrastructure in an unequal polity.** Beyond the Wangchan Valley "showcase" described in the introduction, Thailand's approach to developing smart cities has largely relied on the deployment of digital data platforms within existing cities. This chapter discusses how digital data platforms have become objects for contestation in terms of which stakeholders benefit from urban data including: national agencies, local mayors and business elites, national conglomerates, and citizens. The deployment of urban data platforms is intertwined with longstanding inequities between Bangkok and the rest of the country, the persistent dominance of oligarchic business groups, and the coexistence of elections for local leaders alongside a "flawed democracy" at the national level characterized by ongoing efforts by military-aligned elites to thwart popularly elected governments.

7. **China: Xiong'an and the Construction of a Digital China.** Many cities in China have embraced "smart city systems," which have benefited from a proliferation of AI-enabled surveillance cameras, including Hangzhou's City Brain developed to optimize traffic management by tech firm Alibaba. This chapter, however, focuses on more recent efforts to more fully exert state control over data and digital governance. Using the case of Xiong'an, a new city under construction outside of Beijing, I discuss an effort to embed technologies within the fabric of a new city and build a simultaneous digital twin alongside the city's physical development. The city itself has taken on symbolism as a representation

of Xi Jinping's "new era", characterized by efforts to impose greater central control of urban development and a larger role for state-owned enterprises after several decades market-oriented reforms and municipal devolution under the "reform and opening" period.

8. **Conclusions** This chapter highlights key insights from the dissertation across the cases, bringing together the insights from the theoretical chapters and the case study chapters. Limitations and ideas for further research agendas are also discussed. Contributions of the research to scholarship and implications of the research for policy, planning, and design are discussed.

Chapter 2. Research Methodology

This dissertation bridges several scales of inquiry: globally circulating discourses, national-level comparison and the relationship between city-level projects and national discourses and policies. The primary research methodology is a grounded theoretical approach based on semi-structured interviews with a variety of stakeholders in each country. Interviews have been supplemented with textual analysis of plans, policies, and project briefs from the various projects. There have been few detailed studies of how different stakeholders within countries use and deploy the concept of the "smart city"—thus, by comparing not merely official plans and policies but also talking to those who shape how concepts and ideas "meet the road" was essential, and *process tracing* to understand how national policies unfold over and are implanted over time by a variety of local actors.

I began the dissertation project with a broad interest in understanding how ideas about digital urbanism were being shaped by the new reality of geopolitical tension, rising nationalism, and growing critiques of platform or data capitalism as monopolized by multinational technology companies. I also wanted to understand whether or not China's growing provision of urban data infrastructure, such as its early dominance in 5G that raised alarm bells of the U.S. national security apparatus, constituted an "alternative model" of urban development for cities in the global south. Such a question became particularly relevant over the past few years as China's Belt and Road Initiative (BRI) has financed a number of infrastructure projects across mostly Africa, Southeast and Central Asia such as high-speed railways, ports, and power stations. China's effort to build digital Infrastructure (such as through 5G and smart cities) has been described as the "Digital Silk Road" Or Digital BRI.[43] I was initially drawn to Thailand as a potential case study because of its planned role as both the hub of what China envisioned as a highspeed rail network radiating from Kunming into Southeast Asia, and for its embrace of Huawei's 5G wireless technology. However, after the initial set of scoping interviews, conducted in the summer of 2022, I realized that viewing dynamics in Thailand primarily through the lens of China's Belt and Road was misleading and not representative of the complexity of local dynamics within Thailand, or

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[43] Hillman, *The Digital Silk Road*.

the country's approach to foreign relations and technology in general. When I returned to Thailand in December 2022 to begin the bulk of interviewing, the project transformed from a study of Chinese infrastructure investments abroad to a more comparative study of digital policy and smart city projects in three countries: Singapore, Thailand, and China. While I was interested in the exchange of ideas about development between countries, I was also interested in the internal central-local and state-business dynamics that were shaping each country's approach to digital innovation in smart-city technologies. I thus limited the project to the relationship between urban data technologies and national development policy, and chose three countries that had made such technologies central to their recent *national-level* development plans.

With this relatively broad set of initial questions in mind, I developed a mixed-method grounded theory approach comprising analysis of plans and policies at the national level, historical contextualization of national technology plans in each of the three countries, semi-structured interviews with key informants in the three countries, and site visits and observation. The project uses a comparative "extended case study" method. Within each national case, semi-structured interviews with key decision makers and experts helped generate the material for further analysis. The purpose of the interviews was not only to learn about the details and development process of each of the urban or digital projects in question, but also to interpret the motivations and values implicit in the visions of stakeholders, thus aiming to answer how the implementation of various technologies was shaped through particular values, ideas, and political or financial agendas of various stakeholders in each country context.
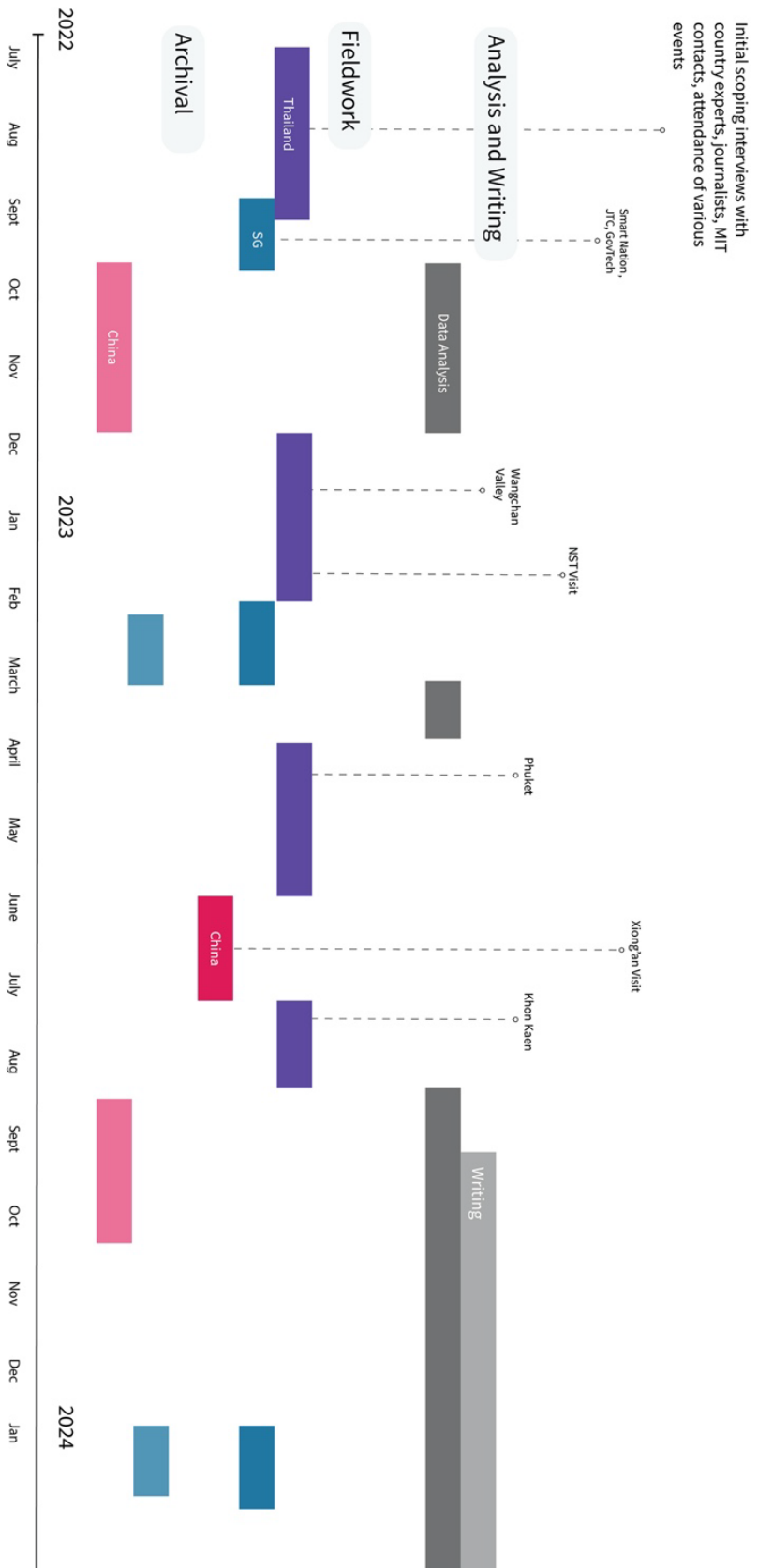
Figure 5. Timeline of Research Process

Grounded Theory

This dissertation is both descriptive but also exploratory, aiming to generate new theory from grounded research, in effect, "grounded theory," as outlined by Glaeser and Straus as "the discovery of theory from data systematically obtained from social research."[44] The core question at my inquiry was: "Why has the smart city been adopted as a policy of *national* development, particularly in countries in Asia over the last few years, and how does this process unfold in variegated ways both *between* national cases and *within* countries?" The methods used to develop a new theory of the smart city as developmentalist project comprise a few methodologies typical of grounded theory: namely, comparative case studies, ethnographic interview analysis, and an iterative process of theory development and empirical analysis that sought to refine concepts generated through fieldwork, archival analysis, and process tracing in each country and city case chosen. The project initially began with the premise that China was becoming a crucial provider of digital infrastructures, particularly in Southeast Asia and thus sought to explore the transfer of ideas between Singapore (a more established reference for urban technology), China as an emerging source of urban technology, and Thailand as a recipient of urban ideas and technological solutions. However, the more time I spent in Thailand led me to develop a different focus for the Thailand case than if I had merely analyzed the country solely through its external relationships. In the Thailand case, I observed how the deployment of digital data platforms was shaped through strong *internal* dynamics such as the longstanding tension between Bangkok-based national agencies, secondary cities, and between a Bangkok-based business elite and grassroots citizens movements. This led me to modify the project's comparative approach so that the case studies were not "equivalent" comparisons but rather offered unique windows into a broader phenomenon.

Case Selection

The cases I chose represent varied points of entry into the broader phenomenon I was interested in: the *adoption of the smart city and 4th IR as strategies for national development*, and also the *relationship of smart city pilot projects to national policies*. The three countries chosen are not the only countries that could have been examined. For example, within the Asia Pacific region,

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[44] Barney G. Glaser and Anselm L. Strauss, *The Discovery of Grounded Theory: Strategies for Qualitative Research* (New York: Routledge, 1967).

South Korea has become a leader in smart city technology deployment. However, if I was interested in the "smart city" as a developmental strategy it would be preferable to examine a middle income or developing country. Both Thailand and Malaysia fit the bill of middle-income countries in Southeast Asia that have adopted a nationwide policy for smart cities.

As Gerring and Cojocaru suggest "descriptive case studies are often selected as typical or diverse."[45] In my case selection, all three countries are "typical" in that they adopted the "smart city" or "4th IR" into their development plan, and are similar politically in the sense of being one-party, or "flawed democratic" political contexts—albeit to varying degrees. However, they differ in the scale and relationship of the city to nation in each context. In each case I was also interested in interrogating the relationship between the city and the nation. While many cities have adopted variations of the "smart city" as it became fashionable in the early 2000s, only certain countries have made smart cities part of their national development plans. In Singapore, the city and the nation are essentially equivalent. In Thailand, the capital city of Bangkok (11 million people) dominates the country of 71 million people in a way few other capital cities do. China, a vast country of 1.4 billion features a centralized state under the control of the Communist Party, but local municipalities have significant autonomy over land leasing and urban development, a situation that developed from China's state ownership of land and "entrepreneurial" approach to local government following introduction of economic reforms in the 1980s. Thus, each country offered a particular lens into the phenomenon of how and why the smart city had been adopted as a strategy of national development, and each case has a unique scalar relationship between the city and nation.

The cases are "diverse" in the sense of each offering a different window into the broader phenomenon. For example, Singapore has become known for its successful urban planning and integration of digital technology and a model for cities in the region and around the world[46], and its "Smart Nation" program in 2014 was one of the first instances of the transmutation of the smart city into a national development strategy. Thailand presented a more variegated case of

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[45] John Gerring and Lee Cojocaru, "Selecting Cases for Intensive Analysis: A Diversity of Goals and Methods," *Sociological Methods & Research* 45, no. 3 (August 2016): 392–423

[46] Beng Huat Chua, "Singapore as Model: Planning Innovations, Knowledge Experts," in *Worlding Cities: Asian Experiments and the Art of Being Global* 31 (2011): 29–54; Choon Piew Pow, "License to Travel," *City* 18, no. 3 (May 4, 2014): 287–306

the smart city as national development imaginary—the concept was a key part of "Thailand 4.0", the military government's economic plan (2016) released two years after they assumed power in the country's second coup in ten years, 2014. The country's openness to foreign technology from the West, Japan, and China made it interesting geopolitically. The longstanding tension between a Bangkok-centered economic and political elite and the rest of the country made the relationship between city and nation particularly relevant. Meanwhile in China, smart cities have been developed through government policy as well as through the efforts of its successful private platform firms like Alibaba, Tencent, and Baidu. China's efforts to export some of these technologies through its "digital belt and road" initiative means it is one of the few countries in the world (in addition to Singapore) that has mobilized its own "smart city imaginary" as a form of economic and international relations. Finally, under Xi Jinping, policies have sought to re-centralize control over municipalities after several decades of devolution in fiscal and economic development policy. This is reflected in the ways national digital development plans increasingly aim to strengthen and coordinate state control over data, and efforts to deploy data as a "factor" of production for the broader economy.

Additionally, the three cases also have important relations to each other. For example, China's leadership has previously looked to Singapore as a model given its successful development combined with a one-party state-capitalist approach. Thailand has long imported advanced technology and ideas from wherever it deemed to be most advanced, beginning with Europe in the 19th century to America in the 20th century. Yet, with the NPCO's discernible realignment to China following the 2014 coup, elites in the country openly expressed admiration and interest in China's technologies. [47] For example, Thailand has quickly become "ASEAN's leader in 5G," partially from adopting technology from Chinese firms Huawei and ZTE. Yet, Thailand has sought to avoid becoming overly dependent on China and still maintains important relationships and openness to capital, technology and ideas from Japan, the U.S. and Europe.

The variation in scale between the cases offers a dimension through which to explore how ideas are translated from national-level to local or city-level in countries of vastly different scales.

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[47] National Council for Peace and Order, name for Thailand's Junta-led government after 2014 coup until 2019 election

Within each country, several "representative" projects were chosen that would illustrate the various ways in which a national policy was adopted by diverse stakeholders. While Singapore is often conceived of as perfectly planned and carefully managed, even here one can observe discrepancies between translation of ideas from national policies into local projects at the scale of a district or neighborhood within the city.

Country	Regime Type	Administrative	Per Capita GDP (USD)	Case Projects
Singapore	Parliamentary/one party	City State	$72,000	Gardens by the Bay, Punggol Digital District
Thailand	Hybrid (military/democratically elected)	Centralized	$7,000	Phuket, EEC Wangchan Valley, Khon Kaen, Nakhon Si Thammarat
China	One party	Centralized, but municipalities have large control over land leasing and urban development	$12,500	Xiong'an New Area, East-West Data Transfer

Table 1: Case Countries and Case Projects

Extended Case Studies

Each country case is an "extended case study", which Burawoy describes as applying "reflexive science to ethnography in order to extract the general from the unique, the move from the "micro" to the "macro" and to connect the present to the past in anticipation of the future, all by building on preexisting theory."[48] In each country I was interested in how the concept of "smart city" or other globally circulating discourses were transformed in their particular contexts by various actors and stakeholders. To do this required engaging with key representative stakeholders across various representative agencies or stakeholders, in essence a process of "theoretical sampling" across key groups. But in reality, the availability of interviews depended also on snowball sampling beginning with existing contacts and networks in each location. In

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[48] Michael Burawoy, "The Extended Case Method," *Sociological Theory* 16, no. 1 (March 1999): 30.

general, I sought to obtain a sample of representative stakeholders from relevant groups including: policymakers in national agencies, private-sector companies, and local officials or those responsible for implementation of national policies. Allen and Davey define the value of what they term "Constructivist Grounded Theory" for research in urban studies: "In urban research, stakeholders typically hold divergent views on the same issue or topic; for example, what is the role of the city and whom should it serve? The grounded theory method allows the researcher to compile a variety of actors' viewpoints without compromising the value of each individual's perspectives.[49] It should be noted that for the China case, availability of interviewees at the national level was limited due to ongoing political and security concerns. In this case I relied more on analysis of national policy, archival analysis of Party leader speeches, writings of academics involved in specific projects, and plans as primary and secondary sources to put projects, national plans and policies in broader ideological context, supplemented with site visits and interviews with key experts where available.

A Note on "Elite Anthropology", Positionality, Access

In general, those selected for interviews in this dissertation can be described as elites, professional experts, and or those with specialized knowledge. The purpose of this was to understand the formulation of policies as being shaped by a process of translation of globally circulating ideas into local discourses, with local elites (politicians, business leaders, etc) playing a key role in this process. These included a governor, mayors, diplomatic staff, directors of companies and government agencies. The interview focus, particularly in Singapore and Thailand, involved a degree of "elite anthropology" to understand the views, ideologies, and positions of key stakeholders shaping national policy and project implementation. While anthropological methods have tended to focus on understanding "subaltern" or "local" populations, elite anthropology is a growing area of interest although presents certain limitations and challenges. One challenge of elite interviews is the possibility that interviewees themselves are highly aware of the risks of revealing classified or sensitive data. As Harvey notes, "many political and business elites receive extensive media training about how to avoid answering questions."[50] I had cases in

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[49] Natalie Allen and Mark Davey, "The Value of Constructivist Grounded Theory for Built Environment Researchers," *Journal of Planning Education and Research* 38, no. 2 (June 2018): 222–32,

[50] William S Harvey, "Strategies for Conducting Elite Interviews," *Qualitative Research* 11, no. 4 (August 1, 2011): 431–41,

which respondents failed to directly answer a question, and made note of this. For example, when asking a director of an innovation park in Thailand about how many startups had signed commitments to invest in the project, he said simply "yes," and thus I took the vagueness to mean he did not want to reveal how many (or few) had actually signed contracts.

Another challenge of elite interviews is that elites often have their own motives in agreeing to an interview, such as believing they could use the platform offered by my research to positively influence perception of their own organization or use the "MIT brand" to boost their own credibility. In one case, I was invited to attend an event with a local mayor in Thailand which showcased his policies and advertised the participation of "experts from MIT" which could be seen as legitimizing the policies of this particular politician. However, I judged the risks of the meeting and the symbolic effect of my attendance to be relatively minimal. Attending this event was a small way of giving "face" and respect, and obtaining greater access to other respondents.

One limitation of elite-focused ethnography is that I could not devote substantial space to understanding how policies and projects are received by ordinary citizens. This was not the focus of my study but is an important area for future research. It should also be noted that as a PhD candidate from MIT, my privileged status coming from a globally known institution influenced both whom I gained access to and how I was perceived by interviewees. Many business and political leaders in Singapore and Thailand have studied in the U.S., some at the same institutions I attended, and this provided the most useful way of obtaining personal introductions to key respondents. I attended MIT and Harvard alumni events in Thailand that provided opportunities to meet key informants that then introduced me to other interviewees. I used my network to locate interviewees. My position and outsider status may have limited some areas of inquiry but provided a useful vantage point for interrogating the role of U.S.-trained elites and their role in translating global discourses into local contexts—one of the topics motivating the study. Some of the people I spoke with had studied in the U.S. and are aware of academic literature on smart cities and current critiques of smart cities and the fourth industrial revolution. Being able to spend time with them and hear how they are thinking about the policies in question was imperative to understanding the process of idea translation on the ground. Of course, this does present a problem of potential bias toward elites trained in the U.S. and those with similar

educational backgrounds as myself. I tried to speak with others outside this initial network, but the MIT name did open up doors to higher-level contacts.

Interviews, Analysis, Coding

The purpose of the interviews was to understand the ideas and motivations of stakeholders involved in the implementation and adoption of various technology platforms. This then led me to conduct around 100 interviews with a broad range across several categories: private-sector firms, public-sector agencies involved in smart city projects and digital transformation, politicians (where available) and selected academics and consultants with knowledge of particular technologies and projects (See Appendix 1). The coding process employed *atlas.ti* software to organize three rounds of coding: first, second, and third-cycles, progressing from simple to gradually more aggregated and abstract concepts. [51] A new feature of ai-enabled coding was useful for "first cycle coding" to make an initial pass through all interview transcripts in order to generate a broad set of initial descriptive codes while minimizing the risk of the analyst (myself) biasing or missing potential categories of analysis. While many of these initial categories were not helpful, it did identify certain affective codes (referring to speaker's tone of voice, i.e. "doubt" or "criticism") which were helpful to identify stakeholders' attitudes to certain projects. The first-cycle coding generated 900 codes, which were edited and consolidated into 145 codes, covering everything from specific countries and organizations to "processes of innovation", "state-business relations", "uncertainty", "discourses of development" and other concepts mentioned in the interviews across the cases related to the initial questions of my project. The coding identified concepts respondents mentioned often, such as "sandbox," "pilot", or "smart city" itself, as well as concepts that were not in my original framing questions but which subsequently became more central to the story. For example, many different respondents across the cases mentioned the challenge of finding "use cases" for technologies and the problem of "tech-led" vs. "solution-led" approaches to technology deployment in cities. This theme became a key element in the "process" tracing" within cases, described in the subsequent section. Finally, a "third cycle" coding of grouping and categorizing the refined second-cycle codes generated meta

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[51] Johnny Saldaña, *The Coding Manual for Qualitative Researchers*, 2nd ed (Los Angeles: Sage, 2013).

categories such as "technologies" "dispositions" "qualities" and "strategies", which encompassed important groupings of the codes generated in the earlier stages (See Table 2).
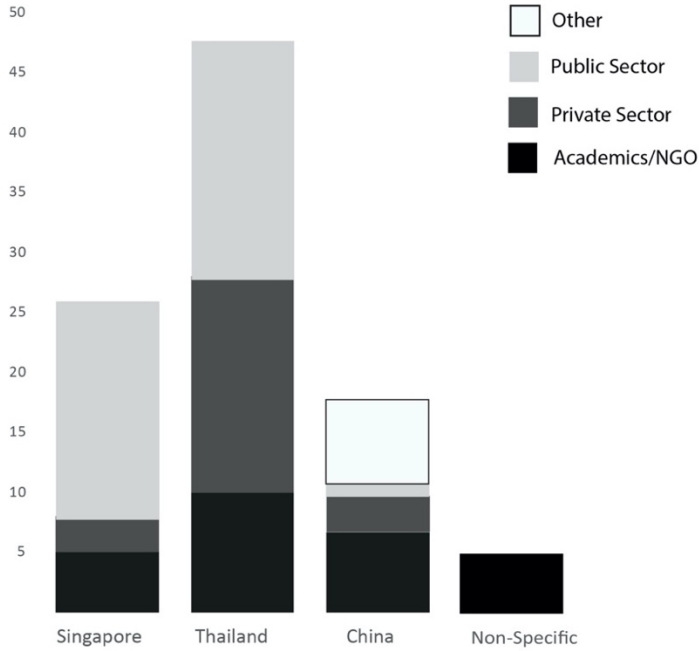
Figure 6. Breakdown of Interviewees by Country/Sector

Meta Categories	Top Codes	Frequency
Qualities	Adaptation/Flexibility	13
	Efficiency	12
	Openness	7
	Hierarchy	5
	Responsibility	5
	Improvement	4
Subjective	Challenges	42
	Discourses of Development	28
	Uncertainty	21
	Networking and Partnerships	20
	Criticism	18
	Comparisons	17
	Leadership	17
	Failure	14

Table 2. Selected Code Categories and Frequency

Process Tracing:

Chapters 5-7 follow the trajectory of digital urban policy and projects in each of the case countries. Thus, the dissertation also makes use of "process tracing" to examine how ideas and policies were implemented in each country. In political science, process tracing has been defined as a form of "within case" analysis that seeks to "uncover what stimuli the actors attend to; the decision process that makes use of these stimuli to arrive at decisions; the actual behavior that then occurs; the effect of various institutional arrangements on attention, processing, and behavior; and the effect of other variables of interest on attention, processing, and behavior."[52] In comparative historical sociology and political science, process tracing can be employed to compare the historical evolution of institutions between countries through analysis of "critical junctures" or "path dependence,"[53] sometimes referred to as "historical institutionalism."[54] A narrative approach to process tracing can help "determine whether there are typical sequences across [cases] … and can explore the causes and consequences of different sequence patterns."[55] Process tracing can sometimes be used to tease out more quantitative "causal inference" between independent and dependent variables. Sorensen has more recently argued for the incorporation of such methods into comparative planning history to understand the *long duree* and temporal evolution of path dependencies and critical junctures shaping cities over time.[56]

In this dissertation, process tracing is primarily employed to trace the evolution of policies *within* national contexts, as well as *between* the national and local scales—for example, even in Singapore, an iterative process was observed in the development of a digital twin beginning with a national pilot and more recently evolving to a project-level scale. In Thailand, national policies on smart cities accelerated in 2016, but local efforts occurred more recently, spurred by individual mayors or governors who used their political position to promote platforms developed in earlier pilots. In China, the development of platform and municipal-driven smart city systems

[52] George, Alexander L., and Timothy J. McKeown. "Case studies and theories of organizational decision making." Advances in information processing in organizations 2, no. 1 (1985): 21-58

[53] James Mahoney, "Path Dependence in Historical Sociology," *Theory and Society* 29, no. 4 (2000): 507–48.

[54] Kathleen Thelen, "Historical Institutionalism in Comparative Politics," *Annual Review of Political Science* 2 (June 1999): 369–404; James Mahoney and Kathleen Thelen, *Explaining Institutional Change: Ambiguity, Agency, and Power* (Cambridge University Press, 2010).

[55] Ronald Aminzade, *Ballots and Barricades: Class Formation and Republican Politics in France, 1830-1871* (Princeton University Press, 1993).

[56] Andre Sorensen, "Taking Path Dependence Seriously: An Historical Institutionalist Research Agenda in Planning History," *Planning Perspectives* 30, no. 1 (January 2, 2015): 17–38,

around 2015-2016 has more recently been superseded by national approaches to coordinate and standardize the development of urban digital infrastructure. Process tracing sought to uncover why the evolution of smart city projects in each country occurred in the way they did, attending to the role of key actors, failures of pilot projects, competition between stakeholders, or policy shifts in national or local governance (see Figure 7). Process tracing sought to explore how the evolution of urban technology *within* national contexts was shaped through political institutions as well as shifts between different scales of national and city-level action.

In Singapore, the initial "Smart Nation Plan" was adopted in 2014, and the chapter traces the development of the city's digital twin and IoT sensor projects from then until 2023. In Thailand, national policies were begun around 2015/2016, and the development period stretches from then until 2023, when my research was done. In China, the chapter focuses primarily on Xiong'an, which was begun in 2017, but also situates the project in relation to earlier smart city projects begun by private sector firms such as Alibaba around 2016. Thus, in each country case there is a parallel iterative process between national and local scales that shaped the evolution of smart city technologies, but the critical factors shaping these pathways differ in each case and have much to do with the translation between national and local actors, as well as shifting political priorities and relative power of specific individuals over time. While the project was not primarily concerned with evaluating "success" of projects in question, process tracing was helpful to identify how projects that may have been described as "failures" in their initial evaluation actually sparked later iterations and adaptations that proved more useful. Process tracing situated projects within historical evolution and elaborated the "process" of innovation over time in each country, involving feedback loops and learning from success or failure of past projects. However, the "critical junctures" for the evolution of technologies often proved to be personal or political—such as Bangkok Governor Chadchart's promotion of Traffy Fondue platform after his election in 2022, whereas the platform was initially developed by the national research agency (NSTDA) as part of the national Phuket smart city pilot in 2016 with limited use cases in the intervening period.
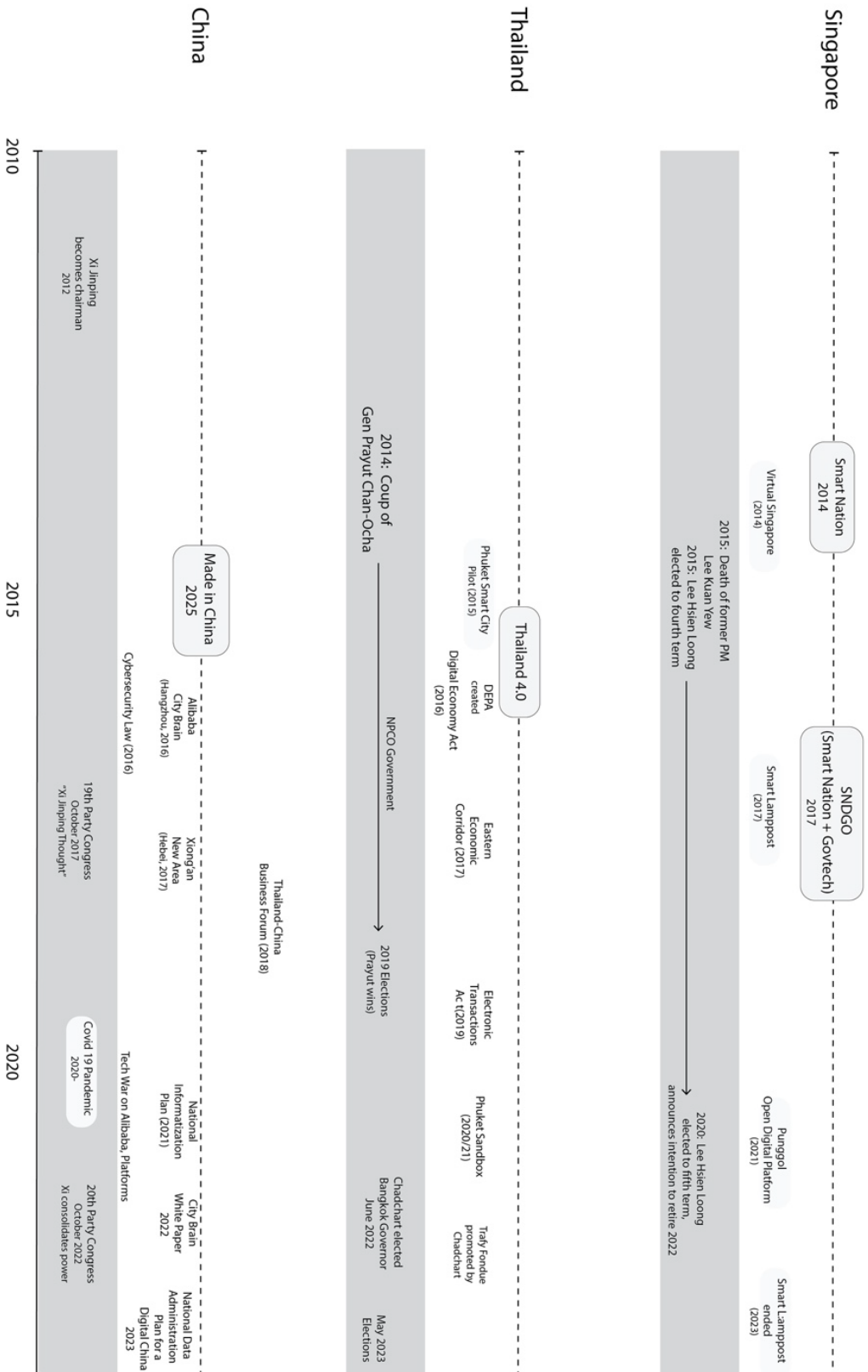
Figure 7. Comparative Timeline of National Policy and Policy Evolution 2014-2023

Site Visits and Analysis

In each of the countries, I focus on the role of "pilot projects" and their function within broader national digital innovation ecosystems. The "elite anthropology" method was geared to learn more about motivations and ideas shaping various projects, while process tracing helped explore the sequencing of how national-level policies were implemented and in what order. Finally, because I was also interested in the symbolic and visual function of such "showpiece projects", it was imperative to actually visit and experience each representative showcase project. Of the three countries, the Thailand case focuses less on the role of buildings and architectural elements, but site visits were essential to understand the symbolic and political meaning of Wangchan Valley in the Eastern Economic Corridor (EEC). Visits to the cities of Nakhon Si Thammarat, Khon Kaen, and Phuket were also essential to see the translation of Thailand's smart city policy into varied local contexts through conversations with local stakeholders. In Singapore, both the "Smart Gardens" and "Punggol Digital District" and Jurong Innovation District are pilot projects, although as Punggol Digital District is still under construction I was only able to visit the Jurong Innovation District, another project of state-owned industrial estate developer JTC, to learn more about the architectural, landscape, and technology elements in each of these spaces and how they help reinforce Singapore's national identity through integration of technology and nature. This included guided tours of the first phase of Jurong Innovation District by a JTC employee and a tour of the "smart" infrastructure of Gardens by the Bay by an employee of the Gardens. Finally the China chapter focuses on the new city of Xiong'an as a lens into evolving relationships between smart city projects, national policies to centralize state control over urban data, and the political function of the city as a showcase for Xi Jinping's political vision. A site visit during June 2023 provided essential observations of architecture, landscape, and planning elements.

Chapter 3. The City as Showroom for the Nation:

Cyber-physical integration and national imaginaries of development

Introduction

In this chapter, I discuss how the countries in this dissertation (Singapore, Thailand, and China) embraced "smart cities" and "cyber-physical" integration as part of their national development strategies. The 4th industrial revolution (4th IR) referred to a supposed package of revolutionary technologies that were to result from the further embedding of digital technologies in objects and the physical environment. Building on core insights of science and technology studies (STS), this chapter is concerned with how and why the concept of the 4th IR and its composite technologies resonated in these countries, all of which can be considered as variations of authoritarian or one-party states. In each of these contexts, the concept of cyber-physical integration was not merely a borrowing of foreign ideas, but resonated with existing institutional and historical approaches to development including a need on the part of state elites to showcase and display advanced technologies for public view and dissemination of new ideas. This chapter explores how cities function as political and ideological communication devices within political systems that are all variations of "one party" rule. The contemporary projects detailed in this dissertation, like their historical antecedents, were built and designed by political or business elites with the intention to communicate ideal visions of technological and political orders from higher-level political leaders to lower ones. Thus, the projects were imagined not only as technological solutions to development problems, but as political and ideological communication devices: reinforcing national identity, offering visions of indigenous technological futures, and communicating ideals of governance to other leaders in each country.

The Fourth Industrial Revolution: an STS Perspective

In 2016 Klaus Schwab, the Chairman of the World Economic Forum (WEF), popularized the notion of the "Fourth Industrial Revolution," which he prophesized would be a fundamental shift with implications for the global economy, governance, and the future of human societies more generally. If the digital revolution followed from advances in personal computers, the rise of the internet, and proliferation of cell phones and digital applications, the essence of this coming

"revolution" would be the blurring of boundaries between the digital and physical, the "*cyber-physical.*" As Schwab wrote:

"The first industrial revolution used water and steam power to mechanize production. The second used electric power to create mass production. The third used electronics and information technology to automate production. Now a fourth industrial revolution is building on the third...It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological sphere."[57]

"Billions of people connected by mobile devices, with unprecedented processing power, storage capacity, and access to knowledge, are unlimited, and these possibilities will be multiplied by emerging technology breakthroughs in fields such as artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing."[58]

By developing an "imaginary" of an inevitable technological revolution sweeping the world that business leaders, politicians, and the public had to embrace, Schwab and others shaped global discourse and policy discussion of these technologies. Schwab himself didn't coin the term "4th IR" out of thin air—in fact, the notion dates to the concept of "Industry 4.0" which was coined in 2011 during the Hanover Fair. In 2013, Germany adopted its own *Industrie 4.0* policy to maintain its formidable manufacturing sector through application of digital technologies.[59] The WEF offered Schwab a global platform for promoting the concept. This chapter shows how the idea was particularly attractive in certain countries where the idea of cyber-physical integration resonated with previous eras of infrastructure-led development and traditions of showcasing and integrating technology through urban models and physical showcases.

In their typical language of technological teleology, a 2020 World Economic Forum report declared that "the Fourth Industrial Revolution and its related emerging technologies will be fully realized through the wide-scale deployment of 5G communication," contributing to $13.2 trillion

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[57] Schwab, *The Fourth Industrial Revolution: A Davos Reader* (Washington DC: Foreign Affairs, 2016)
[58] Ibid.
[59] Nazmul Huda, "The Rise of Industry 4.0 in Germany: A Journey of Innovation and Transformation LinkedIn," February 16, 2023, https://www.linkedin.com/pulse/rise-industry-40-germany-journey-innovation-nazmul-huda/.

of global economic value by 2035.[60] Compared with earlier 4G speeds, 5G offers "lower latency," meaning the "reduced time for data from device to be uploaded and reach its target, "1 ms compared to 50 ms for 4G."[61] Thus, 5G and the broader 4th IR had implications for realizing the vague imaginary of a "smart city—one that can be known and managed in real time and is sentient to some degree," as put by Kitchin and others.[62] A city where physical objects, buildings and environments are embedded with sensors (IoT) streaming back data (via 5G), to cloud servers feeding into urban data platforms and/or digital twins could seemingly create the conditions for an imagined "smart city" that firms like Siemens, IBM, and Cisco proposed in the early 2000s but could not quite realize. In subsequent case study chapters, we will see how the trajectory of these technologies is in fact being shaped on the ground in different ways by engineers, policymakers, and politicians in the countries I examine. Far from being a universal inevitability, there are ongoing debates about the actual impact these technologies will have and what forms they will take.

For example, 5G, has been touted as opening up new possibilities for industrial internet, smart manufacturing or autonomous vehicles, but there is disagreement on how crucial 5G is to allow for the streaming and aggregation of data from multiple devices. China took an early lead in 5G, while the U.S. was initially slow to roll out the spectrum licenses necessary. The *Made in China 2025* program includes the goal of being a global leader in 5G, and significant funding has gone into targeted industries. In Telecom, ZTE and Huawei[63] emerged as "national champions," with Huawei becoming a significant global vendor of 5G hardware and related software and AI platforms and eventually smart city platforms. In 2019, the U.S. National Defense Authorization Act banned use of Huawei hardware in federal deployments seeing it as a security risk. In April of 2020 Secretary of State Mike Pompeo deepened this effort with the Clean Network Initiative, "inviting governments and corporations to 'join a global effort to promote data privacy, security,

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[60] World Economic Forum, "The Impact of 5G: Creating New Value across Industries and Society" (World Economic Forum, January 2020), https://www3.weforum.org/docs/WEF_The_Impact_of_5G_Report.pdf.
[61] Ibid.
[62] M. Batty et al., "Smart Cities of the Future," *The European Physical Journal Special Topics* 214, no. 1 (November 2012): 481–518; Rob Kitchin, "The Real-Time City? Big Data and Smart Urbanism," *GeoJournal* 79, no. 1 (February 2014): 1–14; Anthony M. Townsend, *Smart Cities - Big Data, Civic Hackers, and the Quest for a New Utopia*, Reprint edition (New York: W. W. Norton & Company, 2014).
[63] Huawei has an opaque ownership structure, but was founded by ex PLA member Ren Zhengfei and has close connections with the Chinese government; ZTE is a state-owned enterprise

human rights, and collaboration in communication networks."[64] But there is still disagreement as to how crucial 5G *per se* is to realize such hypothetical use cases. As an engineer working for Singapore's GovTech put it, "usually sensors are low-bandwidth devices, they don't really need a 5G system, if you were to have robotics indoors you would probably be using a WiFi system."[65] A professor of electrical engineering at MIT expressed skepticism that "5G may not be the driving force for the technology that everyone thinks if security becomes the high priority. Edge computing and security becomes a priority. I don't think 5G is necessary for edge computing."[66] One benefit of 5G vs WiFi or local networks is that it can allow for aggregation of data and transfer of data to the cloud from a wider array of sensors. "5G is set up better for the cloud because you get massive amount of data in the cloud, so you can move massive amounts of data fast."[67]

The case of 5G illustrates how the evolution of constituent technologies of smart cities and the 4th IR are contoured differently in certain national contexts, and amidst competition between the U.S. and China. In subsequent chapters, similar contingency and uncertainty is illustrated through examining the evolution of other technologies of the 4th IR such as digital twins, city data platforms and cloud computing.

A basic premise of the field of science and technology studies (STS) is that the development of science and technology is inseparable from its social and institutional contexts. While "social constructivists" showed how technology was shaped by "social" factors like political institutions or culture,[68] other scholars like Langdon Winner have asked if certain objects or technologies have dispositions that lend themselves to particular types of politics or outcomes.[69] For example, in the context of the fourth IR one could ask, "does the internet of things" or "5G" lend itself to authoritarian contexts, or the rise of AI-enabled surveillance cameras *necessarily* imply a form of totalitarian surveillance and social control? Much has been made about the fondness for surveillance technology in authoritarian countries—China's smart city systems feature thousands

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[64] Rithmire and Han, "The Clean Network and the Future of Global Technology Competition."

[65] Interview, Singapore GovTech project engineer (2023)

[66] Interview, Professor of Electrical Engineering, MIT (2023)

[67] Interview, Ibid.

[68] Wiebe E. Bijker, Thomas Parke Hughes, and Trevor Pinch, eds., *The Social Construction of Technological Systems, Anniversary Edition: New Directions in the Sociology and History of Technology*, Anniversary edition (Cambridge, Mass: MIT Press, 1987).

[69] Langdon Winner, "Do Artifacts Have Politics?," *Daedalus* 109, no. 1, (1980): 121–36.

of AI-enabled cameras with facial recognition capabilities have given rise to what some have termed a "surveillance state"[70] At the same time, scholars like Zuboff have argued that Western platform technology firms (i.e. Google, Facebook, Amazon) have created an economic system based on the monopoly and extraction of personal data, what she termed "surveillance capitalism." As Zuboff and others have argued, the advent of surveillance capitalism was not "inevitable" but was shaped in an American political and economic context of shareholder capitalism and deregulation.[71] This is all to say that technologies (including 5G, the internet of things, cloud computing, and autonomous vehicles) do not exist independently of the social context in which they are developed and adopted. Jasanoff's notion of "co-production" takes the view that "the realities of human experience emerge as the joint achievements of scientific, technical and social enterprise: science and society, in a word, are co-produced, each underwriting the other's existence."[72]

This chapter thus adopts this idiom of "co-production" to explore:

1. How and why did the concept of the "fourth industrial revolution" land in different ways in three countries (Singapore, Thailand, China), shaped by particular histories and contemporary moments in which the Fourth IR was seen as providing the way forward to overcome various national crises or blockages

2. How have these countries turned to urban pilot projects to integrate the *cyber* and the *physical* through demonstration projects, and what political and institutional orders might be created through the embedding of digital sensors in a greater array of objects and environments, as well as within processes of governance and state institutions.

3. In what ways have model cities and demonstration projects functioned in the histories of technology adoption within each of the three countries, and what does this say about the techno-politics of visualization and performance in non-democratic contexts?

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[70] Chin and Lin, *Surveillance State*. (2022)
[71] Langley and Leyshon, "Platform Capitalism"; Rahman and Thelen, "The Rise of the Platform Business Model and the Transformation of Twenty-First-Century Capitalism."
[72] Jasanoff, *States of Knowledge* (2004)

Fourth IR: From Global Buzzword to National Imaginary

Around the mid 2010s, the countries examined in this study all implemented variations of national innovation plans incorporating ideas of the "fourth industrial revolution" and "smart cities." Both the "smart city" and the "Fourth IR" are an example of what Jasanoff and Kim have referred to as "sociotechnical imaginaries", or "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology."[73] In each of the countries in this dissertation, the adoption of the 4th IR and related notion of the smart city occurred at a particular political moment as well as in places with particular traditions of development. Singapore began its "Smart Nation" initiative in 2014. In 2016, two years after the military came to power in a coup in Thailand, the country released its *Thailand 4.0* plan. China released its *Made in China 2025* plan in 2015, which triggered anxieties in the U.S. and Europe about the stated goals of China to become a global leader in frontier technologies such as AI, quantum computing, and electric vehicles. Developing and developed nations alike have increasingly turned to the vague but alluring goal of "innovation" as a key goal of economic policy.[74] This has often involved a desire to replicate other successful innovation hubs such as Silicon Valley or MIT. As Pfotenhauer and Jasanoff have argued, the adoption of discourses such as the innovation (or by extension *"fourth industrial revolution"*) do not merely involve "policy transfers" or direct adoption, as the literature on policy mobility suggests, but rather involve questions of how "differences in the imagination, implementation and uptake of the model [serve] as windows onto unique social, political and cultural determinants that underwrite innovation policy."[75]

The notion of a "technological revolution" offered countries like China and Thailand the possibility of overcoming the "middle income trap" and finally leaping into the ranks of advanced nations.[76] In China this became particularly clear around 2017 as the country's rapid economic

[73] Sheila Jasanoff and Sang-Hyun Kim, eds., *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, 1st edition (Chicago ; London: University of Chicago Press, 2015), 4.

[74] Calestous Juma and Lee Yee-Cheong, *Innovation: Applying Knowledge in Development* (London: Earthscan, 2005).

[75] Sebastian Pfotenhauer and Sheila Jasanoff, "Panacea or Diagnosis? Imaginaries of Innovation and the 'MIT Model' in Three Political Cultures," *Social Studies of Science* 47, no. 6 (December 1, 2017): 783–810.

[76] Barry Eichengreen, Donghyun Park, and Kwanho Shin, "Growth Slowdowns Redux: New Evidence on the Middle-Income Trap" (Cambridge, MA: National Bureau of Economic Research, January 2013); Richard F. Doner and Ben Ross Schneider, "The Middle-Income Trap: More Politics than Economics," *World Politics* 68, no. 4 (October 2016): 608–44.

growth and growing technological prowess led Xi Jinping to declare that there were "great changes unseen in a century," *bainian bianju*[77] which implied that China would soon overtake the West for global leadership. The technological transformation encapsulated by the "fourth industrial revolution" was seen as part of the broader set of geopolitical and economic changes that would restore China to global primacy. In Thailand, a military-led government promoted *Thailand 4.0* as a new economic plan following ten years of civil strife in between two coups, a signal both to its own populace and the outside world that the country was prioritizing development after a long period of uncertainty. Even as it ascended to become one of the world's wealthiest nations, Singapore has maintained perpetual uncertainty about its place in the world. Becoming a "smart nation" meant adopting the latest technology from abroad and integrating it across government, inculcating a spirit of innovation in the population, and investing in key frontier technologies to stay at the "frontier" of global innovation.

Performance and Demonstration in Authoritarian Contexts
In all of the countries detailed in this study, the fourth IR landed in contexts where the display and showcasing of technology through urban models has been a common feature across different historical periods. The Fourth IR imagined technologies better integrated into physical and natural environments. While STS scholarship has highlighted the importance of public performance and spectacle to the construction of scientific and technological knowledge making in liberal democratic contexts, the function of performance in authoritarian political systems is less well understood.

The public and performative aspect of scientific truthmaking and technological innovation have been key themes in STS scholarship—from Shapin and Schaffer's classic account of how Boyle's air pump performed scientific knowledge in 17th century England[78] to Ezrahi's discussion of the centrality of performance and visualization to democratic forms of knowledge-making. As Ezrahi writes "the cultural construction of politics as a view, together with the validation of the public as the viewer who has the authority to attest and define political reality, furnishes a normative

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[77] Wang Wen, Jia Jinjing, and Liu Yushu, *Bainian bianju* 百年变局 (Beijing: Beijing shifan daxue chubanshe, 2020).
[78] Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton University Press, 2011).

framework for integrating politics as a spectacle with liberal-democratic principle."[79] Ezrahi has argued that in the public culture of liberal democracies "the intention is not to glorify but to attest, record, account, analyze, confirm, disconfirm, explain, or demonstrate by showing and observing examples in a world of public facts. [80] He contrasts this "attestive" mode with so-called monarchical traditions –"a culture of vision "organized to induce wonder and admiration toward the powers and magnificence of authority."[81]

One could simply view contemporary authoritarian modes of visualization as a modern incarnation of Ezrahi's "monarchical culture of vision." The penchant for new urban construction and infrastructure as a tool of political legitimation has certainly been a feature of so-called authoritarian regimes. The term "Potemkin village" was taken from the name of Russian nobleman Grigory Potemkin, who allegedly built fake villages to impress visits of Empress Catherine the Great on her trips to Crimea after it was annexed from the Ottoman Empire. Ding has described some of China's environmental policies as a form of "performative governance," the theatrical deployment of language, symbols, and gestures to foster an impression of good governance among citizens."[82] Such concepts echo anthropologist Geertz's idea of the "theater state" to describe the centrality of ritual and performance to political power, based on ethnographic work in Bali.[83]

However, it would be simplistic to view contemporary forms of authoritarian visualization through urban development as "Potemkin" villages or merely "performative" governance. The countries discussed in this dissertation may be classified by political scientists as non-democratic—albeit each of the three countries defies such simple categorizations in one way or another.[84] Yet, political systems in each of these three variations of "non-democracy" exhibit unique internal processes of feedback and communication between various levels of

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[79] Yaron Ezrahi, *The Descent of Icarus: Science and the Transformation of Contemporary Democracy* (Harvard University Press, 1990).

[80] Ibid., 73

[81] Ibid., 73

[82] Iza Ding, "Performative Governance," *World Politics* 72, no. 4 (October 2020): 525–56,

[83] Clifford Geertz, *The Interpretation Of Cultures* (Basic Books, 1973).

[84] Among the countries, China is most often described as "authoritarian" and indeed has a one-party dictatorship or "Leninist" political system; Singapore has a Westminster-style parliamentary system albeit one in which the ruling People's Action Party (PAP) has been in power since independence; Thailand has alternated between periods of military and democratically elected governments, but in the current period the Military-Royalist coalition has maintained control and influence

governance—between national and local leaders, for example. At least for much of China's past three decades of "Reform and Opening" the country devolved considerable autonomy to leaders of municipalities or *diji shi* (prefecture-level cities) in development, albeit under centrally mandated frameworks or plans. Political scientists have noted the use of "pilots" and experimentation as a key mechanism of policy innovation in China.[85]

For the projects detailed in this dissertation, the creation of pilot or *showcase* districts is part of a *didactic* process—projects were built and designed by political or business elites to communicate ideal visions of technology and governance from higher-level political leaders to lower ones. In this way the notion of "smartness" implicit in rhetorical framings of the smart city describes not only the project's intended effect on cities, but also their intended function as *objects for the dissemination of knowledge*. Many of the stakeholders involved in the creation of such pilot projects know that such models and showcases are often not replicable and will not be followed to the rule in the rest of the country, but they will nonetheless help disseminate ideas about future urban technology to local actors. The didactic impulse can be seen in Singaporean smart districts (Chapter 5), in Thailand's smart city pilots such as Wangchan Valley and Phuket's City Data Platform (Chapter 1 and Chapter 6), and in China's Xiong'an New Area (Chapter 7) which has been called a "template for high-quality development,"[86] a favored ideological term to describe Xi Jinping's priorities for China's "new era" following the 19th party congress in 2017. The didactic intention can be understood through the ways in which stakeholders talk about the projects—something explored in more detail in the case-study chapters. In the case of two local leaders in Thailand, their promotion of digital platforms has become intertwined with their particular discursive claims on the right way to govern, which can be deployed not only by national leaders but charismatic local politicians. Even in so-called "authoritarian" contexts, there is ample room for experimentation and variation as ideas are implemented by other stakeholders and lower-level officials.

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[85] Sebastian Heilmann, "From Local Experiments to National Policy: The Origins of China's Distinctive Policy Process," *The China Journal*, no. 59 (2008): 1–30; Shaoda Wang and David Y Yang, "Policy Experimentation in China: The Political Economy of Policy Learning," *National Bureau of Economic Research* 29402 (2021): 45.

[86] Renmin Ribao, "Jianshe Gaozhiliang Fazhan de Quanguo Yangban-"build a National Template of High-Quality Development"," *Renmin Ribao (People's Daily)*, April 21, 2018, https://www.gov.cn/xinwen/2018-04/21/content_5284632.htm.

Many of the projects (both physical districts and digital platforms) detailed in subsequent chapters are "showrooms" in the sense that they display advanced technology *in situ.* In each case, the purpose and the intended audience of the showcasing differs. In Chapter 5 (Singapore) I discuss how pilot smart city districts are developed as "showrooms" that reproduce Singapore's identity as a testbed of advanced urban solutions which are then marketed by Singaporean companies to developing countries. In Chapter 6 (Thailand), I discuss how idealized notions of the smart city have taken a concrete form displaying a particular vision for the role of technology in improving urban governance and enabling the aspirations of civic leaders in a country beset by structural inequalities. In China's Xiong'an New Area (Chapter 7), a fusion of high technology, ecological landscape design, and Chinese traditional culture are melded to serve as a "national template for a new development concept" in Xi Jinping's China.

II. Cities as Showrooms: Integrating technology, reproducing national identity

This section provides brief accounts of how each of the countries discussed in this dissertation have historically attempted to integrate foreign technology, often through demonstration projects that aim to display new technologies alongside new models of development or governance while also reinforcing particular aspects of national identity. For example, Singapore began cultivating an image of itself as "city in a garden" in the 1960s as a way to attract foreign investment. Its urban planning successes have created a large market for "urban solutions" sold by Singaporean companies abroad. Showcasing new technologies within districts of Singapore helps reproduce Singapore's status as a model of futuristic technologies and a city in a garden. Thailand's history of Royalist-driven modernization beginning with Chulalongkorn's reforms in the 19th century saw the creation of a centralized bureaucratic polity that continues today. The Royal Family and elite embraced foreign technology from many countries as a way to maintain power while also investing in showcases and display of advanced technologies in Thai environments, such as the miniature Dusit Thani city built by King Vajiravudh (1910-1926). Perhaps not coincidentally, Vajiravudh established Siam Cement Group (SCG) as a Royally-owned material company to support the construction industry in Thailand, suggesting the crucial importance of construction to national development aims. The company remains an important conglomerate today and a key piece of the monarchy's portfolio alongside its vast real estate holdings, managed by the Crown Property Bureau. Thailand has also embraced infrastructure aid

as a form of international relations—today signs adorn the Thai-Japan and Thai-Belgium friendship bridges on Central Bangkok's Rama 4 Road, and the *Thanon Mittraphap* or "Friendship Highway" built by U.S. aid in the 1960s still serves as the main highway connecting Bangkok to the country's northeast. More recently, Chinese companies like Huawei have been invited to help build showcases of 5G innovation in various smart city pilot projects. China has a long history of using model cities, villages, and districts to communicate political ideals. In the 1950s, China was exhorted to "learn from Daqing in industry," a city in Northeastern China developed as a production base for a state-owned oil company.[87] Shenzhen became a model special economic zone for other Chinese cities during Deng Xiaoping's "reform and opening up" period. Today, Xi Jinping has similar intentions for Xiong'an New Area, the subject of Chapter 7, to be a template for "high-quality development" in a China moving towards greater technological self-reliance and emphasis on indigenous innovation and traditional culture amidst geopolitical and economic headwinds.

Thus, the idea of a "fourth industrial revolution" landed in countries confronting contemporary development challenges and historical traditions of incorporating and integrating the latest technology from abroad for national development. Each of the national policies formulated during this period embody not only a vision of cities but a vision of the nation, where urban technologies and data are managed, controlled, and harnessed for national development goals. Each of the three countries in this study has historically faced challenges of how to integrate foreign technology while cultivating local or "indigenous" innovation.

The following table summarizes how these contemporary dynamics and historical legacies shape the process of adoption and integration of foreign technologies in the strategies of each country:

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[87] Li Hou, *Building for Oil: Daqing and the Formation of the Chinese Socialist State*, Illustrated edition (Cambridge, Massachusetts: Harvard University Asia Center, 2018).

Country	Historical Legacies	Contemporary Situation
Singapore	Singapore exceptionalism as country that moved from "third world to first", previous national technology plans like National IT Plan, Teleview, Intelligent Island (1985, 2000), "garden city" legacy	Economic success coupled with sense of uncertainty with changing global landscape, transition from Lee Hsien Loong to "4G" leadership, need to stay competitive with rise of regional rivals with cheaper labor markets in ASEAN (Indonesia, Vietnam, Malaysia)
Thailand	Avoiding direct colonization and maintaining sovereignty through relationships with great powers; import of foreign technology by ruling classes	2004, 2014 military coups, entrenched monarchy-military-corporate nexus; growing ties with China under military government
China	Need to embrace technology to maintain national power, focus on physical infrastructure, integration of technology with governance and systems thinking	Slowing economic growth, geopolitical tension with the U.S., Xi Jinping's "new era", desire to surpass the U.S. and restore China's place in the world ("great revival of the Chinese nation").

Table 3. Historical Legacies and Contemporary Dynamics in Each Country Case

Singapore

At the far Northwestern corner of Jurong, the Singapore Discovery Center narrates the history of Singapore's technological development alongside a history of various crises Singapore has faced. The museum is on the grounds of the SAFTI military training institute, not far from Nanyang Technology University and the new Jurong Innovation District. Upon entering the first exhibit hall, visitors bear witness to gruesome depictions of the brief but bloody Japanese occupation from 1942-1945, in which "soldiers rounded up people to be slaughtered at killing sites," but quickly moves to tell a history of the city state's accomplishments following its eviction from Malaysia. A cheery female voice narrates over an animated short: "1965, a time of uncertainty"… [animated greenery blooms across the island]… "a clean and green Singapore attractive for multinational corporations"… [followed by animations of factories popping up and aircraft taking off and landing from Changi Airport]… "We mastered new skills, our economy prospered, but there were setbacks…" [the 1985 recession]… "We changed, we transformed, and showcased Singapore to the World; global events affected our growth, and our way of life, but we stood strong"….[faceless figures donning masks dodge giant floating coronaviruses]…"we found new ways, we forged ahead, to embrace clean technology, to innovate for the future, to become a more self-sufficient city state. [Animations of vertical farming structures popping up across the city]…Imagine Singapore: An Enterprising Modern Nation of the Future."[88] The video keeps

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[88] Visit to Singapore Discovery Center, February 2023

playing on an endless loop but I walk away to visit other parts of the museum. This is a rousing history of Singapore told primarily as a story of technological progress and development, a triumphant narrative of innovation and resilience against adversity.

Even as Singapore became one of the wealthiest nations in the world on a per-capita basis, there is a very real sense among policymakers and the public that if Singapore does not continually innovate it will lose its hard-earned gains. The Committee on the Future Economy (CFE), formed in 2016 to chart the next phase of Singapore's economic growth, has affirmed the importance for Singapore to take the lead in the global digital economy.[89] As Prime Minister Lee Hsien Loong warned during his National Day Rally Speech in 2017, "The world is changing. Unless we change with it, we will fall behind. Singapore must stay with the leaders to attract talent and business, to live up to our own expectations of what we ought to be and can be."[90] Just a few years earlier in 2014, Lee unveiled Singapore's "Smart Nation Program Office," calling for Singapore to become "a smart nation, a nation where people live meaningful and fulfilled lives, enabled seamlessly by technology, offering exciting opportunities for all. We should see it in our daily living where networks of sensors and smart devices enable us to live sustainably and comfortably."[91] In his speech, Lee mentioned a variety of technological initiatives from home monitoring devices to improve elderly care in public housing (HDB) flats to cyber security, to the need to implement a digital payments system to catch up with China, where digital payment platforms were rapidly embraced. Lee also called for integrating these efforts in a "whole of government approach," coordinating action across the country's varied agencies, statutory boards, and companies.

In launching the Smart Nation Initiative, Prime Minister Lee was drawing on the latest technology trends from around the world—in Silicon Valley, China, and beyond. But the Smart Nation Program did not emerge out of a vacuum. It followed upon years of government policy that has aimed to integrate digital technologies in government and promote emerging digital sectors. Smart Nation drew on similar rhetorical themes as in Singapore's earlier digitalization policies: the imperative of catch-up and the need to embrace the latest cutting-edge technologies from

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[89] Singapore's Digital Framework for Action (IMDA, 11)
[90] Lee, Hsien Loong "Prime Minister of Singapore National Day Rally" 2017 (2017, August 20) http://www.pmo.gov.sg/national-day-rally-2017. Accessed on 2018, May 15.
[91] https://www.pmo.gov.sg/Newsroom/transcript-prime-minister-lee-hsien-loongs-speech-smart-nation-launch-24-november

elsewhere in order to remain competitive, the need for national-level integration across agencies and companies, the need to educate citizens about future technologies, and create a culture of innovation within government and among the citizenry.

Singapore set up a National Computer Board (NCB) in 1981. In 1985, a working group issued Singapore's first *National IT Plan*, predicting that "In Singapore, IT will permeate all walks of our lives - work, home, education and leisure - and will have great impact on our society and culture."[92] The prediction of the 1985 report presaged Lee's vision of a Smart Nation in 2014, with a similar didactic tone towards the imperative for Singaporeans to adapt to the new realities of what was then called the information age: "We must mount a total approach to promote a supportive culture to prepare our citizens for their role in the emerging information economy."[93] The plan also proclaimed that "as the backbone or highway of the information age, telecommunications or information communications infrastructure is the enabling facility which interconnects people and machines through voice, text data, and image."[94] Later in the 1980s, Telecommunications Authority of Singapore (TAS)[95] developed Teleview, a videotex system based on using television sets to access a host of Singapore-based services "from news to home banking to interfaces with every Singapore government agency."[96] Based on teletext systems from the 1970s, Teleview was adapted to manage both telephone and television signals, and was built to display Chinese characters. The idea was that "going to the bank, estate agents, or shops can be a thing of the past."[97] By 1991 the program had 7000 subscribers, and grew in popularity until the emergence of the decentralized world-wide web in the mid 1990s overtook this domestic controlled system.

In 1992, the NCB issued the *Vision of an Intelligent Island: the IT2000 Masterplan*, which stated that "Singapore has been preparing itself, since 1986, to exploit advances in information technology (IT) for national competitive advantage," [98] and called for a planned National

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[92] National Computer Board (1992) "Vision of an Intelligent Island: the IT2000 Masterplan"

[93] Ibid., 100

[94] Ibid., 103

[95] TAS would be incorporated as SingTel in 1992 with majority ownership by sovereign wealth fund Temasek

[96] Gregory Clancey, "Intelligent Island to Biopolis: Smart Minds, Sick Bodies and Millennial Turns in Singapore," *Science, Technology and Society* 17, no. 1 (March 1, 2012): 13–35

[97] Trevor Richards and Peter Yuen, "The Interactive Island. Singapore's Teleview System," *IEE Review* 37, no. 7–8 (1991): 259

[98] Ibid., 100

Information Infrastructure (NII) like Teleview. To illustrate the everyday benefits of the NII, a press release entitled, "A Day in the Life of the 'Intelligent Island" was part of the IT2000 report. Set in the near future, it tells the story of one day in the life of the fictional Tay family.[99] As the plan for an "Intelligent Island" expands upon the vision for Teleview:

> "Singapore will be among the first countries in the world with an advanced nation-wide information infrastructure. It will interconnect computers in virtually every home, office, school, and factory. The computer will evolve into an information appliance, combining the functions of the telephone, computer, TV and more. It will provide a wide range of communication modes and access to services. Text, sound, pictures, videos, documents, design and other forms of media can be transferred and shared through this broadband information infrastructure made up of optical fibers reaching to all homes and offices, and a pervasive wireless network working in tandem. The information infrastructure will also permeate our physical infrastructure making mobile telecomputing possible, and our homes, workplaces, airport, seaport and surface transportation systems 'smarter."[100]

Examining the 1992 IT2000 Masterplan suggests how the imaginary of "smartness" and seamless integration of technology presages the more recent concept of the smart city, or even the "cyber-physical" 4th industrial revolution. In announcing Singapore's "Smart Nation Program", Prime Minister Lee drew on decades of Singapore's institutional experience of integrating current technology trends and developing "whole-of-government" strategies for coordination among various agencies. Despite leaps in technologies over three decades, the 1992 and 2014 plans exhibit a strikingly similar tone and rhetoric of the imperative for innovation to national progress, a didactic tone towards the need to educate citizens, and the need for government coordination. As much as technologies change, the continuities with past rhetoric and civic epistemologies[101] of technological adoption are quite apparent.

Another legacy that the Smart Nation Program drew upon was Singapore's longstanding identity as a "city in a garden," which as Yuen has argued, followed from Lee Kuan Yew's decision to make

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[99] Sandy Sandford, "The Intelligent Island," *Wired*, April 1, 1993.
[100] National Computer Board (1992)., 19-20
[101] Sheila Jasanoff, *Designs on Nature: Science and Democracy in Europe and the United States*, 1st edition (Princeton, N.J: Princeton University Press, 2005).

Singapore into a base for multinational capital partially by beautifying the physical environment of the island.[102] In 1967 Prime Minister Lee launched his vision to turn Singapore into a "garden city beautiful with flowers and trees, and as tidy and litterless as can be."[103] As Lee himself emphasized, greenery was mobilized to attract foreign investment: "One arm of my strategy was to make Singapore into an oasis in Southeast Asia, for if we had First World standards then businessmen and tourists would make us a base for their business and tours of the region."[104]

In the cyber-physical era, the possibilities for further integrating sensing technologies into the physical environment of the city drew on Singapore's longstanding practice of improving its physical environment and careful planning of nearly every square foot of the island's limited territory. It's not surprising that some of the first projects under the newly announced Smart Nation Office involved cyber-physical integration such as a "Virtual Singapore….an integrated 3D map of Singapore enriched with layers of data about buildings, land and the environment…a platform to bring the Government, Citizens, Industry and Research Institutions together to solve problems,"[105] and the "Smart Elderly Monitoring and Alert System" in HDB flats. Eventually, Smart Nation Program unveiled other projects that piloted technology in testbed areas, such as the iconic Gardens by the Bay, and in the creation of new "smart districts" like Punggol and Jurong Innovation District, projects in which the new Smart Nation Initiative would help agencies that managed Singapore's physical assets develop new ways to embed digital technology in their daily operations. Various pilot projects of Smart Nation, such as the Smart Gardens, have served not only to promote new applications of digital sensors, but also reinforce particular national identities.

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[102] Belinda Yuen, "Creating the Garden City: The Singapore Experience," *Urban Studies* 33, no. 6 (June 1, 1996): 955–70

[103] The Straits Times, "Singapore to Become Beautiful, Clean City within Three Years," *The Straits Times*, October 20, 1967.

[104] Centre for Liveable Cities, National Parks Board, 2015)

[105] https://www.pmo.gov.sg/Newsroom/transcript-prime-minister-lee-hsien-loongs-speech-smart-nation-launch-24-november
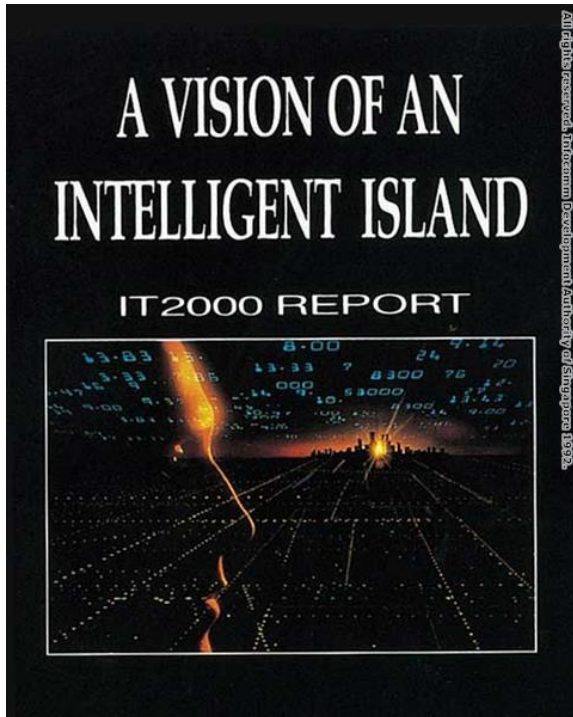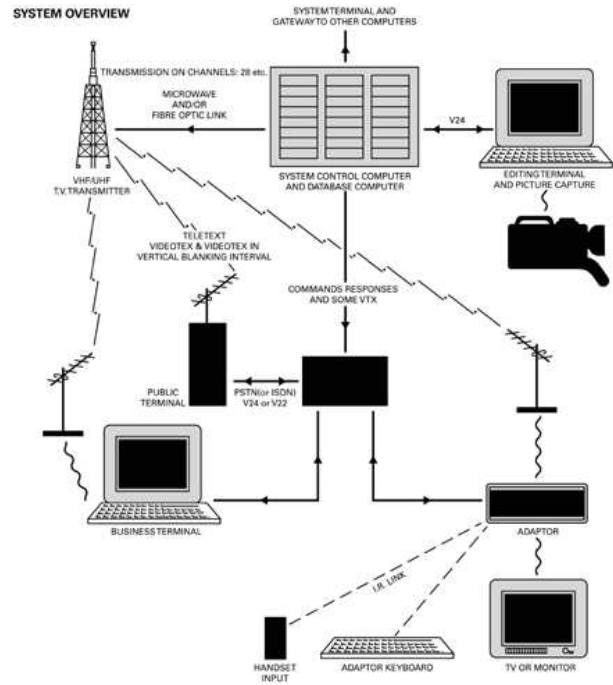
Figures 8a-c   Singapore Imaginaries: Top Left(8a): Lee Kuan Yew plants trees in 1971; Top right(8b): Schematic of Teleview[106]; Bottom(8c): IT2000 Report (National Computer Board, Singapore, 1992)

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[106] Drawing by Dorothy Tang in Hallam, Stevens "Teleview and the Aspirations of the Infrastructural State in Singapore" in Hirsch, Max *Infrastructure and the Remaking of Asia* (Honolulu: University of Hawaii Press, 2022)

Thailand

Since I arrived in Thailand in 2022 as the country was just beginning to re-open to tourists following Covid-19 pandemic, I noticed how the term "smart city" (or *meaung achariya*) was seemingly everywhere. In the 2023 nationwide election, during which the military-led parties that lead the country since the 2014 coup were widely rejected by voters, numerous politicians across the political spectrum promoted "smart cities" or using AI and blockchain to fight corruption or send digital payments to citizens (See Figure 17b). Major corporations picked up on the term to promote a variety of technologies (See Figure 18). True Digital, Thailand's largest telecom provider and a subsidiary of influential Charoen Pokphand (CP) Group, promoted smart city technologies using Huawei's 5G hardware, including monitoring tourists on the island of Phuket in Covid-19 quarantine during its "Phuket sandbox", or CP's "True Digital Cow", which harkened back to CP's origins as an agricultural feed supplier that dominates the country's food sector today. [107] Siam Cement Group (SCG), Thailand's leading conglomerate [108] in building materials and chemicals, promoted its innovations in smart home and building technologies as part of a "smart city metaverse" hybrid exhibition. But how and why had the "smart city" become part of the *zeitgeist* in Thailand over the last few years?

In the term *meaung achariya* are resonances with earlier discourses about modernity and futurity in Thailand, and the relationship between city and polity in Thai history. Translated into Thai, the term "smart city" was rendered in official discourse as *meaung achariya*, with *meaung* the Thai word for city but with broader connotations of the older spiritual notion of the city in Thai as a center of civilization, or "galactic polity,"[109] harkening to the pre-European time when competing city states, or *meuang*, vied for influence and tribute from smaller neighbors across the region. The root *meuang* also finds its way into the word *ganmeaung* or politics, thus suggesting its relation to notions of public affairs and the state more generally. The Thai word *Achariya*, comes from a Sanskrit root that is usually affixed to esteemed scholars or teachers, such as spiritual leaders, and also had connotations of knowledge, connected to the goal of promoting a

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[107] Ownership of 711, Makro/Lotus groceries, agricultural feed companies
[108] SCG is along with Siam Commercial Bank (SCB), one of the major components of the portfolio of the Crown Property Bureau, directly owned by the royal family. (https://scgsmartcity.com/city)
[109] Stanley J. Tambiah, "The Galactic Polity: The Structure of Traditional Kingdoms in Southeast Asia*," *Annals of the New York Academy of Sciences* 293, no. 1 (1977): 69–97.

"knowledge economy" as part of Thailand 4.0. Thus, the Thai translation of the term likely resonated in different ways than the rather innocuous term "smart city" does in an English context. The Thai *meaung achariya* carried with connotations of a higher national and spiritual purpose with it than the English term "smart city," and also has resonances with the earlier search for *siwilai*, or "civilization" under the modernizing reforms of Siam's monarchy in the 19th and early 20th centuries.

During the mid-19th century, the Siamese monarchy began a project of modernization to maintain the kingdom's sovereignty amidst threats of Western colonialism.[110] Siam, along with Japan, was one of the few Asian nations that oversaw a successful indigenous modernization by incorporating foreign technologies and ideas while maintaining traditional forms of social relationships and ideas such as the monarchy and Buddhist practices. Central to this project was the discourse of "civilization," rendered into Thai as *Siwilai*. A parallel term *Charoen*, with etymological origins in Khmer, refers to the "cultivation or accumulation of Merit," as in a Buddhist sense.[111] With the emphasis on attaining civilization that was seen to be emanating from Europe, Siam's kings embarked on various projects of nation building and modernization, with Chulalongkorn's being the most ambitious. During this time, Siam sent officials and students to Europe to study politics, economics and science, while also recruiting Italian architects and engineers to help build the royal family's new villas and palaces in Bangkok.

One unusual experiment during the reign of King Rama VI (1910-1925) serves as an interesting historical precedent for the ways in which imagined utopias blending modernity and the Siamese polity were modeled through a miniature showcase city. In 1918, Rama VI (Vajiravudh) embarked on the construction of Dusit Thani, a miniature model city named after the fourth level of Buddhist heaven. The purpose of the city was to model and experiment with a form of democratic government, albeit limited to the 200 or so mostly male government officials or nobles who were allowed to buy land to build miniature houses in the area around one of the royal palaces, becoming "citizens' of Dusit Thani. The eclectic architecture of the miniature houses ranged from

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[110] Siam was the name of the kingdom until 1932, when the new populist government of Phibun Songkhram changed the country's name to Thailand to emphasize an imagined singular ethnic identity of the nation

[111] Thongchai Winichakul, "The Quest for 'Siwilai': A Geographical Discourse of Civilizational Thinking in the Late Nineteenth and Early Twentieth-Century Siam," *The Journal of Asian Studies* 59, no. 3 (August 2000): 531,

Gothic revival and Second Empire to more indigenous Khmer and Thai forms, some built with new concrete materials and decorated with modern electric lights. Interestingly, Vajiravudh established the Siam Cement Company (SCG) in 1913, which remains in Royal ownership to this day. The city was supposed to model not only modern building materials, but also new forms of democratic governance. As the King said in a speech, "How we run this city is an experiment for what benefits can be derived…The way in which this small city is run is representative of how I wish for Siam to one day be run as well."[112] A constitution was created, as well as a newspaper where "citizens" could express their opinions. As architectural historian Lawrence Chua wrote, "Dusit Thani allowed the court to reimagine their growing empire as a picturesque utopian political community in which an urban-based civilization (*siwilai*) was framed as part of the natural landscape."[113] The experiments of democratic governance were contained within the walls of the miniature city, that is until the 1932 coup that replaced the absolute monarchy with a constitutional monarchy and National Assembly.

When viewed as part of Thailand's long process of elite-initiated modernization, the current zeitgeist of "smart cities" or *meaung achariya* can be seen as the latest iteration of an embrace of modern technology as a substitute for electoral democracy. In the mid 20th century, during a period of American influence and military rule under generals Sarit Thanarat followed by his successor Thanom Kittikachorn, the concept of "development" or *phattana* became the new buzzword. According to Kasetsiri, "Developmentalism gave the new regime legitimacy, diverting attention from a lack of electoral democracy and constitutionalism… It enabled the junta to ward off the opposition and promote their anti-Communist agenda while winning strong support from the monarch and the United States."[114] As part of this developmentalist push, Sarit's government embraced World Bank-funded infrastructure projects, welcomed U.S. aid for both civil and military uses, and established the National Economic Development Board, now called the National Economic and Social Development Board (NESDB). This organization, under the Prime Minister's Office, remains Thailand's formal economic planning agency, responsible for crafting

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[112] Ken Mathis Lohatepanont (2017) "The Story of Thai Democracy: Royal Origins" https://kenlwrites.com/2017/06/21/the-story-of-thai-democracy-1-royal-origins/

[113] Lawrence Chua, Ronald G. Knapp, and Xing Ruan, *Bangkok Utopia: Modern Architecture and Buddhist Felicities, 1910–1973* (Honolulu: University of Hawaii Press, 2021).

[114] Charnvit Kasetsiri, *Thailand: A Struggle for the Nation*, History of Nation Building (Singapore: ISEAS-Yusof Ishak Institute, 2022), 124.

long-term development plans every five years. In 1960, the Board of Investment (BOI) was established to attract foreign investment. King Bhumibol also took on identity as a "developer king" or *kasat nak phattana*. The monarchy has promoted various rural development demonstration projects linked to its vision of a "sufficiency economy."
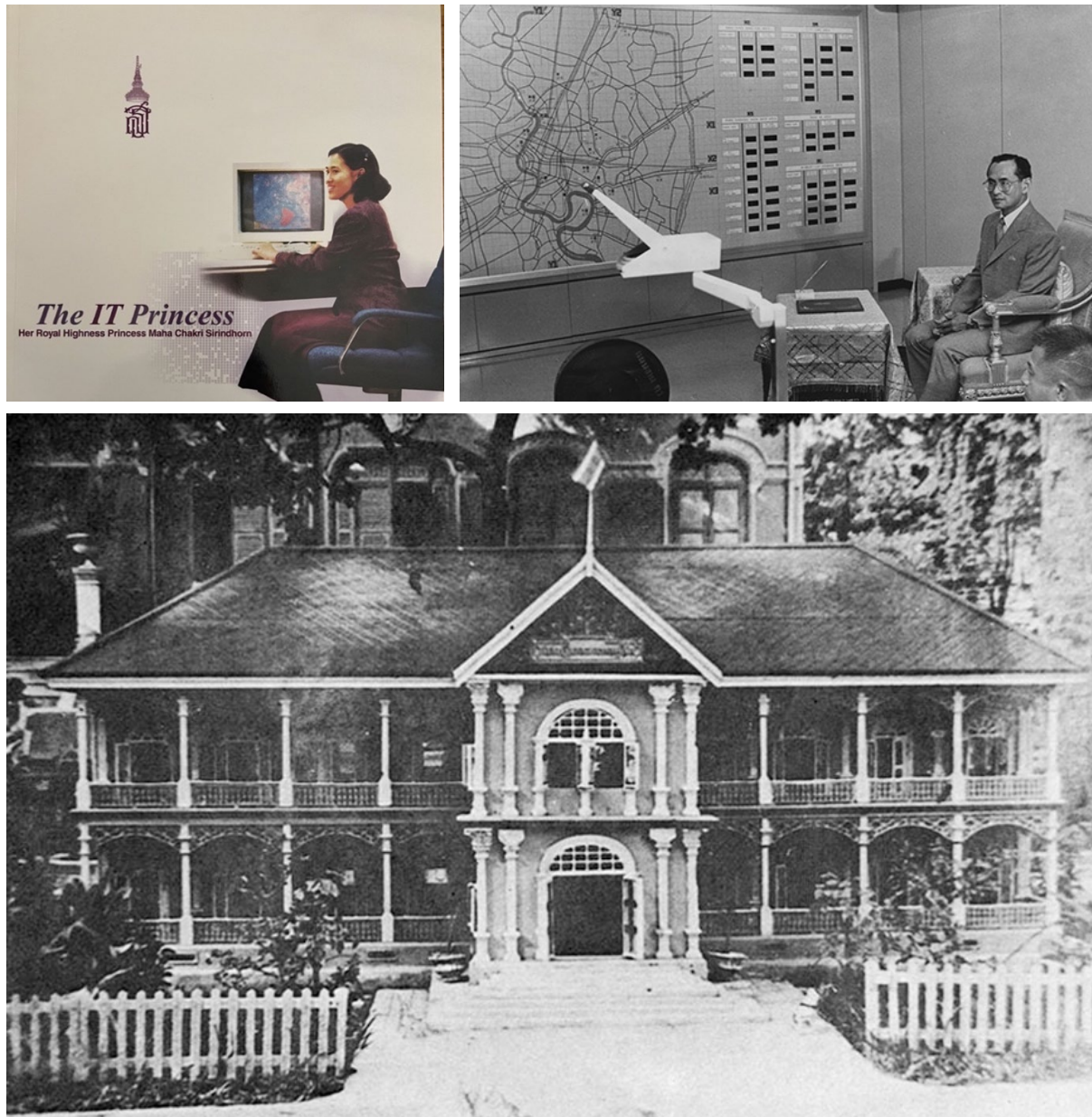
Figures 9a-c: Thai Monarchy as a promoter of science and development; Top left(9a): *The IT Princess* (book); Top Right(9b): King Rama 9 promoting a weather monitoring service for Bangkok; Bottom(9c): Dusit Thani Provincial government hall, model miniature city built by King Rama 6 in 1918 on the grounds of Phaya Thai Palace[115]

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[115] IT Princess: Her Royal Highness Princess Maha Chakri Sirindhorn (Princess Foundation/NECTEC, 2023)

In Chapter 6, I discuss how the proliferation of the smart city policy involved creation of numerous pilot projects and showcases, such as Wangchan Valley, a project primarily initiated by Thailand's PTT state oil company that is intended to become a base for "smart natural innovation." Such pilot projects and showcase cities are utopian models like Dusit Thani, intended to disseminate particular visions of modern technology and urban governance. The embrace of the "smart city" by Thailand's military-led government around 2016 echoes earlier rounds of elite-led modernization that sought to incorporate the latest ideas and technology from abroad, model "civilized" practices and behaviors, and signal to outside investors that Thailand was advancing economically and technologically, if not politically. The Thailand 4.0 Policy released in 2016 aimed to digitally transform government and economy and propel Thailand out of the so-called "middle-income trap."[116] One of the reasons the Junta used to justify the coup was that long-term infrastructure and economic planning had been supposedly neglected under Thaksin's leadership.[117] However the Junta relied on one of Thaksin's key economic advisors, Somkid Jatusripitak, to help devise economic policy.[118] And one of Somkid's key policies was the creation of a new Eastern Economic Corridor (EEC) plan designed to revive the country's industrial core through construction of new infrastructure to promote emerging industries—Wangchan Valley was the first of these to break ground.

Like King Vajiravudh's early attempts at creating a limited model of democratic governance by using modern construction technologies to build a model miniature city, the development of projects like Wangchan Valley can be viewed as "showcases" for a Royalist and Elite-led modernization of Thailand's infrastructure to keep up with the digital economy or global trends like Industry 4.0. An experienced economic steward and technocrat, Somkid was brought into the Junta's National Council for Peace and Order (NCPO) as Deputy Prime Minister to develop policies like Thailand 4.0 and the proposal for a revived EEC regional development plan. The 12th 5 year National Economic and Social Development Plan (2017-2021) was issued in 2017 by the

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[116] Richard F. Doner and Ben Ross Schneider, "The Middle-Income Trap: More Politics than Economics," *World Politics* 68, no. 4 (October 2016): 608–44

[117] EEC Director, Presentation at Foreign Correspondents Club of Thailand (August 2022)

[118] Under Thaksin, Somkid helped devise policies called "Thaksinomics", including village loans schemes and universal healthcare. As a PhD student at Northwestern, Somkid co-wrote a book with his advisor marketing guru Phillip Kotler on "National Marketing", later penning a Thai version *Borisat Prathet Thai*, "Thai Incorporated", which promoted the idea of "nation branding" and national competitiveness.

National Economic and Social Development Board (NESDB), emphasizing the Thailand 4.0 concept that targeted 10 industries: Next-Generation Automotive; Smart Electronics; High-Income Tourism and Medical Tourism; Efficient Agriculture and Biotechnology; and Food Innovation along with five newer sectors: Automation and Robotics; Aerospace; Bio-Energy and Bio-chemicals; Digital; and Medical and Healthcare.[119] The digital economy was seen as a sector in its own right but also as a driver of the other sectors: "Digital transformation is the key driver towards high-income, knowledge-based Thai economy."[120]

Institutional reshufflings were carried out to implement these polices: In September 2016, Ministry of Information and Communication Technology (MICT) was dissolved and replaced by the Ministry of Digital Economy and Society (MODES). A new "Digital Economy Promotion Agency" (DEPA) was set up, replacing the former Software Industry Promotion Agency (SIPA). The Minister of ICT at the time, Dr. Uttayama Savanayana (a close advisor to Minister of Finance Somkid) stayed on to head the new MODES after its reorganization, during which he pushed the "smart city program" as his first policy.[121] Air Chief Marshall Prajin Juntong, who was Minister of Transport from 2014-2015, also promoted the "smart city" concept apparently inspired by a visit to a smart district in Stockholm, and set up a working group to develop a plan to formulate a smart city policy for Thailand.[122] One of DEPA's mandates was to oversee Thailand's Smart City program, a component of Thailand 4.0. This includes helping cities push new digital platforms and services. It was in this national context when the Prayut NCPO administration was attempting to legitimize their rule with new economic policies that the "smart city" term was diffused, and the push for digitalization of government services accelerated.[123]

If Singapore has cultivated a reputation for successful urban planning and fast uptake of futuristic technologies, Thailand has a much different image in the global imagination—as an exotic tropical tourist destination. The government has long cultivated this image as part of a purposeful

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[119] Thailand Board of Investment "Thailand 4.0 means Opportunity Thailand" (*Thailand Investment Review*, January 2017)

[120] Digital Roadmap for Aging Society, Agriculture, Tourism White Paper, (Feb 2017, 9)

[121] Interview, DEPA Phuket Representative (2023)

[122] Pechladda Pechpakdee, "Secondary Cities and Smart Cities: A Case Study of Khon Kaen, Thailand," *Social Science Asia* 6, no. 4 (November 6, 2020): 73–89.

[123] National Council for Peace and Order, the body that was set up following the 2014 coup to formalize Prayut's rule but also incorporate some members from previous Pheu-Thai governments

strategy to attract tourists, dating at least to the 1960s, when the Tourism Authority of Thailand (TAT) was founded. At the time, Thailand became a key rest and relaxation (R&R) destination for American troops fighting in Vietnam, and the wartime influx of American soldiers helped fuel Thailand's early tourism boom, with a rapid construction of hotels and nightlife to cater to soldiers,[124] laying foundations for Bangkok's transformation into a global tourist mecca. Yet, despite the carefully cultivated image of "exotic tropical Orient" projected abroad, there is a desire by many, particularly elites, to propel the country out of the middle-income trap and into the ranks of "developed nations." The almost total disappearance of tourists from the country during the Covid-19 pandemic illuminated more starkly the risky dependence on tourism— tourism accounted for nearly 20% of the country's GDP pre-pandemic.[125] During the pandemic, this source of income almost completely dried up as global tourism ground to a halt.

Thailand is in many ways a developmental "success" story, having graduated to "upper-middle income country" by 2011.[126] Its economy grew rapidly in the 1980s as it attracted an influx of investment from Japanese automakers and other multinationals, earning Bangkok the name the "Detroit of the East"[127] although its economy suffered in the wake of the 1997 Asian Financial Crisis, followed by another period of relatively strong growth under Prime Minister Thaksin Shinawatra. Yet, unlike the other "East Asian tigers" such as South Korea or Taiwan, Thailand has not cultivated "national champions" or moved into higher value-added sectors, struggling with skills upgrading and development of higher value-added industries.[128] The economy is highly unequal,[129] with continued dominance of Sino-Thai family-owned conglomerates. Thaksin came to power promising greater subsidies to the rural poor and delivered on economic growth, but he also created his own networks of patronage and corruption that challenged the Royalist-Military alliance that long dominated the country's politics. Thaksin was deposed in a coup in 2006, followed by a period of military government. Thaksin's sister Yingluck Shinawatra won the

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[124] Porphant Ouyyanont, "The Vietnam War and Tourism in Bangkok's Development, 1960-1970," *Southeast Asian Studies* 39, no. 2 (September 2001): 157–87.

[125] Siriluck Thaicharoen et al., "How Thailand's Tourism Industry Coped with COVID-19 Pandemics: A Lesson from the Pilot Phuket Tourism Sandbox Project," *Journal of Travel Medicine* 30, no. 5 (December 23, 2022): taac151

[126] World Bank Thailand. "Thailand Urban Infrastructure Finance Assessment" (2023)

[127] Rogier Busser, "'Detroit of the East'? Industrial Upgrading, Japanese Car Producers and the Development of the Automotive Industry in Thailand," *Asia Pacific Business Review* 14, no. 1 (January 1, 2008): 29–45

[128] Richard F. Doner, *The Politics of Uneven Development: Thailand's Economic Growth in Comparative Perspective* (Cambridge University Press, 2009).

[129] Pasuk Phongpaichit and Chris Baker, *Unequal Thailand: Aspects of Income, Wealth and Power* (NUS Press, 2015).

2011 election and led the country until 2014, when she was deposed by yet another coup. The second coup led to a period of greater turmoil and violence than the first, with "red shirt" pro-Thaksin protesters from the Northeast facing off against "yellow shirt" Royalists. Eventually the red shirts were met with bloody suppression by the armed forces. Once it solidified its grip on power, the military government or NCPO[130] faced a period of international backlash from the U.S. and Europe. Unsurprisingly, Thai elites began to turn more visibly to China for investment and military ties, a critical shift after decades of being a key U.S. treaty ally in the region.[131]

Constructing China: Idioms of Development from the Physical to the Digital

In China, recent plans for integrating physical infrastructure, developmental policy, and digital technology were motivated both by the tantalizing opportunity the 4th Industrial Revolution presented as an opportunity for China to leap ahead of the West. The plans also reflect longstanding emphasis on constructing large-scale nationwide physical infrastructure as a key lever of development. China's current digital development policies are quite consistent with previous moments in which the country mobilized nationwide infrastructure investment toward the pursuit of national defense goals. In the 1960s, facing both a hostile U.S. in the Cold War and the Sino-Soviet split, Mao undertook a massive program of investment and relocation of defense-related industries to inland areas of China known as the "third front." The plan sought to secure critical industries away from coastal cities that were thought to be vulnerable to foreign invasion. The plan, while wasteful and inefficient in some respects, helped boost development in inland regions like Sha'anxi and Sichuan province.[132] The recently completed North-South Water Transfer *Nanshui Beidiao* is a massive system of aqueducts built to channel water from the Yangzte River and its tributaries to the arid north. Similar projects have been built for natural gas and electricity transmission. Digital infrastructure has now become a national priority amidst China's quest for technological self-reliance and competition with the U.S.

When China's Ministry of Industry and Information Technology (MIIT) released its "Made in China 2025" policy in 2015 as part of the 13th Five Year Plan, it set off alarm bells particularly in the U.S.

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[130] National Council for Peace and Order, which ruled from the 2014 coup until 2019, when Prayut won an election
[131] Benjamin Zawacki, *Thailand: Shifting Ground between the US and a Rising China* (London: Zed Books, 2017).
[132] Covell F. Meyskens, *Mao's Third Front: The Militarization of Cold War China* (Cambridge, UK: Cambridge University Press, 2020).

that the wide-ranging effort aimed to reduce China's reliance on foreign products and technology and signaled China's desire to dominate critical "frontier" technologies. The plan generally aimed to upgrade China's manufacturing sector through application of digital technologies,[133] and also prioritized ten strategic sectors: information technology, robotics, green energy and electric vehicles, aerospace, ocean engineering, railways, power, new materials, medicine and medical devices, and agricultural machinery. China's Made in China 2025 is said to have been inspired by Germany's Industrie 4.0 plan and "is broadly in line with the German and Japanese approaches to economic development and innovation."[134] As mentioned previously, Schwab himself was drawing on Germany's Industrie 4.0 plan in his "Fourth Industrial Revolution" formulation which predated the 2016 WEF gathering by three years.

The idea of the fourth industrial revolution was embraced by top party leaders including Xi, who saw the coming technological revolution as part of a critical period of changes in world history that China had the opportunity to lead. [135] In 2017, Xi used the term "profound changes unseen in a century", or *bainian wei you zhi dabianju* to describe what he viewed dramatic changes in the world order, encompassing technological transformations but also a shift away from a U.S. or Western-led global order. [136] As Jin Canrong, Dean of the School of International Relations at Renmin University, put it in 2019, "after the fourth industrial revolution, the productivity of the East is likely to be ahead of the West, or at least a balance between East and the West will be achieved. This is the most important change among the three changes unseen in a century."[137] Jin goes on to note that "if the 4th industrial revolution is as Schwab described '5G + the internet of things' then China is already leading this revolution, but I tend to be in the camp seeing this as more of a deepening of the 3rd (internet) revolution." Nevertheless, Jin still saw China as having an advantage over the U.S. due to its production capacity. "The U.S. still has the best innovation capabilities, but the hollowing out of industry is a big problem. If you cannot turn innovation into

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[133] Institute for Security and Development Policy, "Made in China 2025," Backgrounder (Institute for Security and Development Policy, June 2018).

[134] (Ibid)

[135] "Di si gongye geming shenmeyang? Xi jinping zheyang miaoshu lantu (What is the Fourth Industrial Revolution? Xi Jinping described the blueprint like this!)" *Qiushi*, July 27, 2018.

[136] Wang, Jia, and Liu, *Bainian bianju* 百年变局.

[137] Jin, Canrong. (2019) Di si gongye geming zhuyao shi zhongmei zhijian de jingzhen er zhongguo sheng suan shi gengda "The Fourth Industrial Revolution is a Struggle Between U.S. and China and China has a better chance of winning." Guanchazhe (Observer, July 29, 2019) https://www.guancha.cn/JinCanRong/2019_07_29_511347_s.shtml

products, it's the same as a piece of waste paper." Thus, Jin viewed manufacturing as a crucial component of China's strength that would allow it to compete with the U.S.

Made in China is focused on maintaining and deepening the country's manufacturing advantages, but deployment of digital infrastructure is a key part of that strategy. The digital economy is a sector in its own right, but data is increasingly conceptualized in China's policy discourse as "factor" of production that is critical to all of the manufacturing sectors highlighted in Made in 2025. Xi Jinping himself publicly described data as a "key factor of production" in 2017, a major theoretical intervention given Marx's theory of the factors of labor, land, and capital is still a "core" of the Party's Marxist-Leninist theoretical base. In 2020, the Central Committee and State Council specified that data was seen as a factor of production. As a researcher with the State Council wrote in 2022, "compared with traditional production factors, data elements have certain characteristics: non-scarcity, massive, and can be re-used, highly mobile, and the speed of data flow is increasing."[138]

In 2023, China's State Council and CCP Central Committee issued the "Plan for an Overall Layout of Building a Digital China" involving the notion of building China into a "cyber superpower" or *wangluo qiangguo*. One of the main components of this is digital infrastructure. The plan calls for "promoting the integration of the digital economy and the material (*shiti*) economy" and "using digitalization to drive changes in production, living, and governance methods."[139] The plan calls for "opening up the main arteries of digital infrastructure: Accelerate the coordinated construction of 5G networks and gigabit optical networks, further promote the large-scale deployment and application of IPv6, promote the comprehensive development of the mobile Internet of Things, and vigorously promote the application of Beidou at scale."[140] A recent article in the *Journal of the Chinese Academy of Sciences* is indicative of current thinking in China on the digital economy, claiming that "digital space has become a new and crucial domain that requires a rethinking of traditional definitions of the state based on monopoly of violence, territory,

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[138] Guangqian Li, "ruhe lijie shuju shi xinxing shengchan yaosu 'how to understand data as a new type of production factor,'" *Jingji ribao (Economic Daily)*, December 19, 2022, http://paper.ce.cn/pc/content/202212/20/content_266006.html.
[139] China State Council (2023) "Plan for the Overall Layout of Building a Digital China"
[140] Ibid; Beidou is China's homegrown alternative to the U.S.-developed global positioning system (GPS)

institutions, and state capacity… As digital space gradually becomes a new battlefield, new types of power based on digital technology are being generated."[141]

The Digital China plan reflects Xi Jinping's increasingly state-centric approach to investment in hard infrastructure, wariness towards the consumer-oriented platform economy, a desire for integration of the digital and "material" economies, and focus on creating a nationwide system of digital governance. Interestingly, the plan also echoes the *Digital Fujian* policy Xi Jinping promoted in 2000 when he was the governor of the southeast coastal province, which included extending telecom to rural villages and digitizing government. As a 2018 article in *Guangming Daily* put it, "General Secretary Xi Jinping's strategic thinking on building an informatized China is consistent, comes from the same source, and is highly related ideologically and conceptually."[142] Whether this is actually the case is beside the point, but from the editorial viewpoint expressed in this state-run newspaper, it was apparently important to emphasize that the "Digital China" policy reflected Xi Jinping's longstanding ideological commitments to remedying poverty and uneven development through investment in digital infrastructure.

One emblematic project that is part of China's nationwide push for a "Digital China" is the "East-West Data project", a plan to bridge the spatial gap between the surplus of cheaper energy in the country's West and the concentration of urban population (and therefore data computing needs) in the country's large Eastern metropolises. The plan calls for a "constructing a nationwide integrated big data center system, which will raise the overall computing power of the nation."[143] The plan aims to build new cloud computing hubs in several inland locations including Guizhou, Inner Mongolia, Zhangjiakou, Hebei and Gansu province. The project can be seen as the latest effort to use infrastructure to redress regional imbalances.

Xiong'an New Area, detailed further in the chapter (7), has taken on symbolic value as a "template of high-quality development," a favorite Party slogan to describe Xi Jinping's "new era"

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[141] Huang, Qisong (2022) shuzi shidai de guojia lilun "Theory of the Nation in the Digital Age." *Journal of the Chinese Academy of Social Sciences* (zhongguo shehui kexue) Vol 10, pg. 60-77

[142] Guangming Daily (2018, April 23) shuzi Fujian shi shuzi zhongguo de sixiang yuantou "Digital Fujian is the ideological source of Digital China"

[143] China Unicom (2022, July). "Dongshu xisuan yaniju baogao- Research Report on the East West Compute"

of cleaner innovation-driven economic growth, adopted at the 19th Party Congress. The city has been conceived of as a "green smart city," featuring a digital twin, IoT sensors, and a digital data center or "city brain" that houses the servers to power the city's digital systems. The city was planned to house state-owned enterprises relocated from Beijing to develop an innovation cluster in renewable energy, smart infrastructure, and other infrastructure-related sectors. Companies that have announced plans to open major headquarters in Xiong'an include China Satellite Communications Company, energy giants State Grid and Huaneng, China Railway, China Telecom, and China Nuclear Power. Thus, the city embodies a push to hardwire digital innovation into the physical infrastructure and governance systems the city, and to use the very construction of the city and its cyber-physical infrastructure systems itself as a generator of innovation.

Conclusions

Through brief comparisons of historical legacies of state-led development and modernization in Singapore, Thailand, and China, I have argued that the imaginary of the fourth industrial revolution was particularly attractive to governing classes of these countries. The idea of the 4th industrial revolution found resonance in countries with legacies of late development, colonial or semi-colonialism, and a longstanding desire to overcome technological gaps with the developed world or the "West" through investment in physical infrastructure. The notion of cyber-physical integration was particularly attractive in countries with longstanding histories of pursuing development through large-scale infrastructure and physical engineering projects. The showcasing of technologies in "showcase districts" disseminates ideal visions of integrating technology with governance to lower-level political leaders and other stakeholders in each of these countries. While STS literature has noted the importance of public display of technology and truthmaking to establishing public consensus on scientific facts, I argue that the display of technologies in authoritarian or semi-authoritarian contexts is often motivated by a need of higher officials to perform and display ideals of governance for the rest of the country: truth by example, rather than accountability by witnessing, as Ezrahi described public displays of science in democratic polities. The "physicality" of technologies serves to reinforce their embeddedness within local society and the environment, and transform them from foreign objects into local ones. Whereas King Vajiravudh built a miniature "heavenly city" to model supposed virtues of democratic self-governance, today the smart city or *meaung achariya* became an ideal to which

Thai cities have aspired to as a prerequisite of digital modernity. The "showcase city" of Wangchan Valley is a modern incarnation of Dusit Thani complete even with a villa built for Princess Sirindhorn, a patron of the project, evocatively named *vidyapiman*, or a "paradise constructed by science."

Chapter 4. From Smart Cities to the Digital Developmental State

Urban Data as Infrastructural Power

"Personal data is the new oil of the Internet and the new currency of the digital world."[144]
        -- Meglena Kuneva, European Consumer Commissioner, March 2009

"I'm playing a big role in building the digital infrastructure of Thailand, I'm using a state enterprise's resources, and they would like me to build a big business."
        -- Founder Bedrock Analytics (2023)

Introduction

In this chapter, I discuss how urban data has become a critical asset and also a key object of state developmental policy, particularly in a developing country context. The rise of the platform firms has seen the monopolization of certain urban services by platform companies, who then acquire valuable data that can be further monetized. The chapter briefly explains how and why technology companies set their sights on building actual cities, exemplified by the "failed" case of Sidewalk Labs in Toronto, which revealed conflicting visions of urban data as private commodity vs notions of "data as infrastructure" and "community asset" articulated by opponents of the project. The chapter then pivots to ask, if data and information are a resource, an asset, or an infrastructure, what are the implications of this for developing countries? Data and information is increasingly seen as a resource for development, albeit one that may be contested, between state authorities and platform firms, or between different state actors (agencies, municipalities, or state-owned enterprises). Classic research on late-developing contexts in the mid 20th century suggested the notion of a "developmental state" that sought to discipline private capital to achieve export-oriented manufacturing. Unlike with export-oriented manufacturing, the aims of digital developmental policy can seem unclear—platform economies have been shown to be highly exploitative of precarious work and provide only a small slice of higher-level jobs in engineering or management. Do developmental legacies shape contemporary approaches to digital development in states undergoing digital transformation? If so, what are the various mechanisms through which states are attempting to discipline urban data as a resource for development? The chapter identifies several typologies of "digital developmental actions", including provision of digital infrastructure (5G, testbed zones, data policies), building

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[144] European Commision (2019) "Keynote speech Roundtable on Online Data Collection"

public city data platforms, asserting national data sovereignty, or disciplining private technology firms by requiring data to flow back to the state. The chapter also explores across the cases how the exercise of state infrastructural power over urban data is highly dependent on varied forms of territorial state infrastructural power in each case, encompassing different regimes of land tenure and state ownership (or private ownership), as well as different relationships between central, provincial, and local states.

From Smart Cities to Platform Capitalism

Shoshana Zuboff describes Google as the first company to innovate a new business model of "surveillance capitalism" in which companies generate enormous revenues based off the "surplus" data extracted from users of their platforms. "Surveillance capitalism begins with the discovery of behavioral surplus. More behavioral data are required for service improvements. This surplus feeds machine intelligence—the new means of production—that fabricates predictions of user behavior. These products are sold to business customers in new behavior futures markets."[145] Zuboff describes how Google, initially a free tool for searching and indexing the vast content on the internet, eventually stumbled into a new business model under the pressure of its shareholders. "Google's engineers and scientists were the first to conduct the entire commercial surveillance symphony, integrating a wide range of mechanisms from cookies to proprietary analytics and algorithmic software capabilities in a sweeping new logic that enshrined surveillance and the unilateral expropriation of behavioral data as the basis for a new market form."[146] The company's revenues stemmed from turning the data generated from users' search into valuable information that could be used to show targeted ads to users based on their searches. In 2001, Google turned its first profit, and reached $3.2 billion by 2004, when it went public. By 2016, 89% of the company's revenues of Alphabet derived from targeted advertising. The success of Google was replicated by other "platform firms" like Facebook, which derived its power from the massive amounts of data its users voluntary surrender on their profiles. From these beginnings as social media and online search platforms to online marketplaces, so-called "platform companies" have become the dominant business model of our time. The age of "platform capitalism" has seen a rise of digital technology companies that monopolize markets

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[145] Zuboff, *The Age of Surveillance Capitalism*, 97.
[146] Ibid., 87

by serving as intermediary between consumers and producers or owners of a product or service, extracting vast amounts of data, and leveraging these monopolies to enter other sectors. According to Srnicek "platforms are digital infrastructures that enable two or more groups to interact. They therefore position themselves as intermediaries that bring together customers, advertisers, service providers, producers, suppliers, and even physical objects."[147]

Following the success of Google and Facebook, the platform model has expanded into other sectors such as urban mobility and travel. What Srnicek called "lean platforms" like Airbnb and Uber do not need to own hard assets, but rather assemble cars or apartments owned by others, creating new markets, reshaping city services and in the process extracting valuable data on the markets they end up controlling. Such platforms turn "idle resources into maximally productive assets and commodify latent space in existing places."[148] Even if they do not directly own assets, these companies and the markets they assemble reshaped urban economies and the physical city itself: Uber's control over mobility marketshas challenged public transport and according to some studies led to increases in vehicle traffic,[149] while Airbnb's effect on housing and rent prices has become a contentious issue,[150] particularly in popular tourist cities around the world.

Scholars of "platform urbanism" have grappled with the wide-ranging implications of private-sector platforms and their socioeconomic effects for urban space and urban economies. As Sadowski writes, "digital platforms are an urban phenomenon for many of the same reasons that capital is centralized in cities. Platforms benefit from the population density and spatial proximity of users/workers in cities." [151] But platforms have also transformed urban space, "as platforms become fixed in place, so too do citizens and governments begin to rely on them as fixes for the deficiencies and inefficiencies of cities."[152] Sadowski describes platform urbanism as the "second

[147] Srnicek, *Platform Capitalism* (2016); Langley and Leyshon, "Platform Capitalism"; Rahman and Thelen, "The Rise of the Platform Business Model and the Transformation of Twenty-First-Century Capitalism", *Politics and Society* 43, 2 (2019).

[148] Jathan Sadowski, "Cyberspace and Cityscapes: On the Emergence of Platform Urbanism," *Urban Geography* 41, no. 3 (March 15, 2020): 448–52.

[149] Brishen Rogers, "The Social Costs of Uber," *SSRN Electronic Journal*, 2015.

[150] David Wachsmuth and Alexander Weisler, "Airbnb and the Rent Gap: Gentrification through the Sharing Economy," *Environment and Planning A: Economy and Space* 50, no. 6 (2018): 1147–70; Mara Ferreri and Romola Sanyal, "Platform Economies and Urban Planning: Airbnb and Regulated Deregulation in London," *Urban Studies* 55, no. 15 (November 1, 2018): 3353–68.

[151] Jathan Sadowski, "The Internet of Landlords: Digital Platforms and New Mechanisms of Rentier Capitalism," *Antipode* 52, no. 2 (2020): 450.

[152] Ibid.,

phase" of the urbanization of technology capital. In the first phase, firms like IBM and Cisco acted merely as technology vendors of "smart city" systems for governments. Meanwhile, the second phase of platform urbanism "seeks to construct a new techno-economic infrastructure on which city inhabitants will live."[153]

Given that urban data became "raw material" for value extraction under platform capitalism, it's not surprising platform firms have tried to enter the market of building cities themselves. The entry of technology firms more closely into city building and real estate[154] is seen by Sadowski (2021) as a "third phase" of the urbanization of technology capital. One of the most infamous cautionary tales of a digital technology firm entering the city-building industry is the case of Sidewalk Labs' Toronto Quayside Project, the saga of which is the subject of journalist Josh O'Kanes *Sideways: The City Google Couldn't Buy*. Sidewalk was set up in 2015 as an urban technology venture backed by Google, with an initial investment of around $300 million,[155] with the "potential to extend Google's focus on digital innovation to the physical world." The startup, which would be led by New York City deputy mayor Dan Doctoroff, developed a range of technology for cities, including Wifi "LinkNYC" Kiosks that would provide free WiFi for residents (in the process sucking up data on passersby) in New York City, and apps focused on enhancing mobility data. But ultimately Sidewalk's biggest goal was to develop a prototype digital neighborhood from the ground up. According to O'Kane, "Sidewalk didn't just want to build a city of the future. It wanted to run the city, too. The urbanist ideas and citizen-focused technologies would be there, but executives were slowly building out a vision to prototype a community with many functions run by a private company."[156] Eventually, after for searching for potential locations like the Bay Area or Detroit for a suitable location, Sidewalk settled on a piece of former industrial waterfront land in Toronto, partnering with Waterfront Toronto, a provincial not-for-profit redevelopment agency that was tasked with redeveloping Toronto's former industrial area fronting Lake Ontario.

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[153] Jathan Sadowski, "Who Owns the Future City? Phases of Technological Urbanism and Shifts in Sovereignty," *Urban Studies* 58, no. 8 (June 1, 2021): 1732–44

[154] Joe Shaw, "Platform Real Estate: Theory and Practice of New Urban Real Estate Markets," *Urban Geography* 41, no. 8 (September 13, 2020): 1037–64

[155] Josh O'Kane, *Sideways: The City Google Couldn't Buy* (Toronto: Random House, 2022), 43.

[156] Ibid., 49

Despite the support of powerful real estate backers and city leaders in Toronto who saw the venture as having potential to bring revenue and innovative technologies to the city, opposition to the notion of a private company owning so much personal data became a major political obstacle. "Even as they promised not to collect certain types of data, Sidewalk floated ideas like "tiered access to their own neighborhood based in large part on how much data about themselves they were willing to share. In this regard, data would be a kind of currency: people who chose not to share anything about themselves when they visited a friend's apartment in Project Sidewalk might not get access to its self-driving taxibots, or be able to buy items from certain stores."[157] And Toronto residents could see that the ultimate aim of the project was to generate profit by collecting massive amounts of data and the valuable insights into consumer behavior that could come from it, augmented by emerging Ai technologies, like the AI company DeepMind acquired by Google's parent Alphabet around the same time. "Even though Sidewalk promised to minimize the collection of data that could identify people—and though it promised to take extra steps to remove identifiable information from data that it *did* collect through various sensors—the information the company gathered about the way people lived their lives would still be extraordinarily valuable to its parent company. Alphabet's routine investments in AI made this kind of data processing easier with the passing year."[158]

The eventual collapse of the partnership between Sidewalk and Waterfront Toronto revealed the importance of trust (or trust deficit, in Sidewalk's case) between public agencies, communities, and technology companies, and the issue of transparency over what data would be used for and who would own it, with Sidewalk refusing to agree to de-identify all data at the source and claiming IP rights over any data or analytics generated within the site boundaries, which clashed with Canadian data regulatory laws.[159] The failure of Sidewalk also revealed the nature of urban data as a "contested asset", with one activist proclaiming at a meeting "anything related to data collection in cities should be a civic asset"[160] thus raising critical questions about data ownership and sovereignty—"If Canadians were generating money-making data as they moved around their

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[157] Ibid., 81
[158] Ibid., 123
[159] Ellen P. Goodman and Julia Powles, "Urbanism Under Google: Lessons from Sidewalk Toronto," *SSRN Electronic Journal*, 2019; O'Kane, *Sideways*.
[160] O'Kane, 123

city, Waterfront wanted its three government shareholders to get a cut of the eventual cash". Bianca Wylie, the activist who became one of more visible opponents of the project, articulated this quite well when she said that "we need to think about data infrastructure the way we think about critical physical infrastructure. It cannot be proprietary."[161]

In addition to the narrative of Sidewalk Labs Quayside as a heroic tale of community resistance to corporate domination of urban data, is useful to reflect from the perspectives of the political economy of urban development on other structural factors that may have hindered Sidewalk Lab from realizing its ambitions to develop a digital city from the ground up. Even in their bid for the project, Waterfront Toronto cautioned that the 12-acre site "may have been too small to deploy many of their bolder ideas"[162] such as self-driving taxibots, energy savings systems, or centralized traffic management systems. The initial Quayside Framework Agreement did not explicitly grant land ownership over to Sidewalk even of the small site itself, nor was it clear they would extend rights for Sidewalk to expand the project to the entirety of the larger 880-acre eastern Waterfront where technologies could have been tested at greater scales.

Data as oil? Urban Data as Infrastructure Power

In a 2011 report, the World Economic Forum proclaimed "personal data will be the new 'oil'-a valuable resource of the 21st century. It will emerge as a new asset class touching all aspects of society,[163] ushering in a world "utilizing ubiquitous communications infrastructure, the personal data opportunity will emerge in a world where nearly everyone and everything are connected in real time." The report noted the billions of emails and 95 million tweets sent on an average day, but that "the potential of personal data goes well beyond these promising beginnings to vast untapped wealth creation opportunities."[164] Of course, the technology giants were already aware of the potential of data as a resource and moved to quickly acquire dominance of it before regulations could keep up with the significance of data. As Pentland et al ask, "data is now central to the economy, government, and health systems, so why are data and the AI systems that

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[161] Wylie, Bianca (2018) "My deputation to Toronto's Executive Committee on Sidewalk Toronto" *Medium*. Jan 25.
[162] Ibid., 90
[163] World Economic Forum, "Personal Data: The Emergence of a New Asset Class," *World Economic Forum*, 2011.
[164] Ibid., 7

interpret the data in the hands of so few people? Communities without data about themselves and without the tools to use their data are at the mercy of those with data and AI tools." [165]

But there are key differences between data and traditional assets. As Pentland, et al note "we talk about data as the 'new oil'…but data is still not being fully understood because it is very different from traditional production factors, such as capital, labor, and oil." [166] In contrast to such "traditional" physical or other productive assets, "data is a nonfungible production factor—this means that one unit of data (1MB for example) can contain data about almost anything, some might be useful for an organization but some may not." The authors also note that "data tends to create value when it comes in big volumes," [167] and that "unlike capital and labor, data is nonexclusive in its use, meaning that the same unit of data can be used, for example, by many funds at the same time." The authors, who have advocated for treating data as a public resource, propose "data exchanges" [168] as a solution to the problem of giving users and communities control over personal data while enabling the sorts of data aggregation that can unlock new insights, value, and products—and bring those benefits to communities. They also advocate that instead of data traveling to a centralized hub for processing, the data should remain close to its owners and the algorithms should travel to the data, allowing for insights and analysis while safeguarding data sovereignty and privacy. [169] While these ideas have yet to be implemented on a wide scale, many governments around the world are increasingly treating data as a "public infrastructure," or a "resource" like oil.

Despite Google's ambitions to build, own, and run a city and extract valuable data from it in the process, they lacked certain forms of "infrastructural power" to realize their lofty ambitions. Mann described "infrastructure power" as "the capacity of the state to actually penetrate civil society, and to implement logistically political decisions throughout the realm." [170] In the case of Google and other tech companies, what they had was capital and control over much of the

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[165] Alex Pentland, Alexander Lipton, and Thomas Hardjono, *Building the New Economy: Data as Capital* (Cambridge, Massachusetts: MIT Connection Science & Engineering, 2021).
[166] Ibid
[167] Ibid., 38
[168] Ibid., 40
[169] Thomas Hardjono, David L. Shrier, and Alex Pentland, eds., *Trusted Data, Revised and Expanded Edition: A New Framework for Identity and Data Sharing*, Expanded edition (Cambridge, MA: MIT Connection Science & Engineering, 2019).
[170] Mann, "The Autonomous Power of the State." (1984)

world's "information infrastructures" through monopoly on web searches and other digital sectors. What they lacked was control over territory, and thus the "territorial infrastructural power" to realize their goals of monetizing data from the citizens of Quayside.

In his canonical definition of statehood, Weber defined the modern state as having the "legitimate monopoly of violence within a given territory"[171] Control over territory has often been considered the *sine non qua* of modern statehood, with historians generally dating the demarcation of states with fixed borders to the Westphalian system that emerged in Europe in 1648. The key role of modern states in producing space was recognized by Lefebvre, who wrote that "only the state is capable of taking charge of the management of space on a grand scale", and state's role in shaping territory (materially, socially, symbolically) is a major theme in political geography.[172] As Peter Taylor argues, "the state's capture of politics and much else besides, in the modern world, is premised upon territoriality."[173] James Scott emphasized that control and *visibility* over territory was a key facet of the emergence of the "modern" state: "the modern state increasingly aspired to "take in charge" the physical and human resources of the nation and make them more productive. These more positive ends of statecraft required a much greater knowledge of the society. And an inventory of land, people, incomes, occupations, resources, and deviance was the logical place to begin."[174] Benedict Anderson's famous triad of the "census, map, and museum" as instruments of state power and nationalism in the colonial context, further reflect the centrality of knowledge making (particularly over territory) as intrinsically linked to the formation of modern state power.[175]

The smart city in its early years originated from the efforts of multinational firms to sell city governments data platforms for managing urban infrastructures. In the mid 2010s, the rise of mobile apps led platform firms like Google, Facebook, and Amazon (in the U.S, along with a

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[171] Max Weber *Politik als Beruf* "Politics as a Vocation" (1919)

[172] Neil Brenner, "Beyond State-Centrism? Space, Territoriality, and Geographical Scale in Globalization Studies," *Theory and Society* 28, no. 1 (1999): 39–78; Neil Brenner et al., eds., *State / Space: A Reader*, 1st edition (Malden, MA: Wiley-Blackwell, 2003); Bob Jessop, *State Theory: Putting the Capitalist State in Its Place* (New York: John Wiley & Sons, 2013).

[173] Peter J. Taylor, "The State as Container: Territoriality in the Modern World-System," *Progress in Human Geography* 18, no. 2 (June 1, 1994): 151.

[174] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998).

[175] Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism* (London: Verso, 1983), 163.

variety of equivalents worldwide), to acquire a new form of "digital infrastructural power." The growing power and reach of technology companies like social networks, has led some to compare them to nation states—Mark Zuckerberg declared Facebook would be the 6th largest country in 2016. Social platforms like Facebook have sometimes been compared to Anderson's idea of nations as "imagined communities." In recent years, however, nation states have challenged this power in a variety of ways, re-exerting their own territorial controls over the seemingly borderless informational infrastructural power of digital platforms. This has been seen in periodic most clearly in Europe's 2016 General Data Protection Regulation (GDPR) law on personal data protection, and in China with the 2016 Cybersecurity Law and Xi Jinping subsequent crackdown on China's own domestic platform firms. Not only has it banned most Western social media platforms since around 2010 due to these company's unwillingness to cooperate with Chinese censorship laws,[176] but in 2021 China begun a regulatory crackdown on its own domestic private platform champion firms, aiming to reduce their monopoly power over industries and data, and promote an agenda of "common prosperity." As Collier notes, "platform companies were beginning to assemble large batches of consumer data, including spending patterns, total wealth, and entertainment expenditure. This posed a threat to the Party's political control. For example, Didi Chuxing's geospatial data could track the location of senior officials."[177] China's platform crackdown showed how wary the ruling Communist Party and the Chinese state was becoming toward the growing power and infrastructure of private platform firms.

As mentioned in Chapter 1, a key rationale for this dissertation is to explore the transformation of concepts like the "smart city" from city and corporate project into a project of national state building. This chapter sets out to investigate, through a comparative examination of national policies across the three country cases in this dissertation, how the deployment of urban data platforms, smart cities, and other digital infrastructures are increasingly central to the national development strategies of countries. While Bianca Wylie of Toronto was articulating a notion of data as a "public infrastructure," this notion could have even more relevance and application in contexts where the state plays a dominant role in the economy. Canada may be slightly to the

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[176] For a while, Microsoft owned LinkedIn was one of the few Western social media firms to be allowed to continue operating a separate site in China, although has recently announced plans to exit the country.

[177] Andrew Collier, *China's Technology War* (Singapore: Palgrave Macmillan, 2022)., 7

left of the U.S. in terms of its welfare state and wariness toward monopoly power of private firms. But how are public data platforms and other digital infrastructures being deployed in contexts where the state plays a guiding role in the economy, such as contexts of "state capitalism"?[178] What are the implications of the notion of data as a "infrastructure" or "resource" for an understanding of developmental policy in middle-income or "late developing" countries? The notion of data as a "resource for development" has significant implications for how countries in the "global south" orient their development strategies. The power of platforms derives from their "network effects"—thus their tendency towards monopolizing entire industries, but platform firms employ a small number of skilled engineers or managers, while relying on a vast pool of "contractors" who are typically underpaid and precarious—meaning that the platform model has limited capacity to serve as an engine for broad-based economic prosperity or development. Research has more generally suggested platforms contribute to economic concentration and inequality in developed and developing nations alike. There has been a growing body of research on the relationship between platforms and precarious forms of labor,[179] and their exacerbating socioeconomic and spatial inequality. Thus, the opportunities for skills upgrading and economic growth differ significantly from export-oriented manufacturing, which served as an engine of most countries who were able to move from developing to developed status in the 20th century.

The chapter is also concerned with the spatial implications of the strategies deployed by governments (and other actors) to exert control over data. For example, many countries have now passed some form of data sovereignty laws, which regulate the flow and exchange of data across borders, and on citizens of particular countries. Thus, the traditional territorial sovereignty of states is brought to bear on data and digital flows. But there are other ways in which the provision of digital infrastructure (city data platforms, smart city testbeds, and regulatory sandboxes, for example), are highly dependent on particular forms of territorial authority that straddle nation states, subnational actors, and non-state actors. The country cases provide opportunity to explore this in further detail.

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[178] Ian Bremmer, "State Capitalism Comes of Age: The End of the Free Market?," *Foreign Affairs* 88, no. 3 (2009): 40–55; Joshua Kurlantzick, *State Capitalism: How the Return of Statism Is Transforming the World* (Oxford University Press, 2016).

[179] Juliet B. Schor et al., "Dependence and Precarity in the Platform Economy," *Theory and Society* 49, no. 5 (October 1, 2020): 833–61,

Organizing Questions of the Chapter.

1. How has data morphed from an emerging "asset class" monopolized by private sector platforms to one increasingly seen as a national resource or infrastructure, and what are the implications of this shift for the ways states and cities are regulating urban data?

2. How do actions undertaken in these countries to "discipline data" constitute an emerging form of governance over the digital economy that I term the "digital developmental state", in which data is increasingly conceived of as a public infrastructure, and various policies and agencies are mobilized to develop the digital economy through state intervention, regulation of private platform firms, and provision of digital infrastructure?

3. Given that territoriality is a key aspect of state infrastructural power, how does the deployment of data platforms manifest differently in contexts of varying state territorial power and different central state-local state relations? The cases in this dissertation, while regionally proximate and exemplifying various forms of "single-party" or "authoritarian" governance, represent different scales of the territorial state, and different relationships between the city and the nation. They also have different forms of state land ownership or private property.
   a. Singapore: a city-state (the city and nation are contiguous)
   b. Thailand: a centralized bureaucratic polity dominated by its capital city (Bangkok)
   c. China: a country of 1.4 billion people, that saw a devolution of power to local governments since the 1980s "reform and opening" but is currently implementing policies of provincial and national-led centralization under Xi Jinping in a variety of domains

The three countries in this study offer interesting dimensions along which to compare how urban data gets operationalized as a national resource and how it is contested between different territorial actors (national, provincial, local government), as well as infrastructure companies, state-owned enterprises, and private conglomerates.

Organizationally, the chapter first addresses Question 1 (above) by briefly summarizing the policies undertaken in these three national contexts to promote the digital economy and regulate private digital firms. Then, the chapter argues that the various forms of digital action taken constitute what I term an emerging "digital developmental state."[180] Finally, in the last part of this chapter, I discuss the implications of these emerging policies for exercise of territorial state infrastructural power (Question 3). This compares how and why the differing territorial state structures and institutions in the countries in this dissertation shape the trajectories of actions described in question 2.

I.   Overview of Digital Developmental Policy in Southeast Asia (Singapore, Thailand) and China
In this section, I briefly summarize the nationwide policies unveiled in Singapore, Thailand, and China to promote the digital economy, highlighting the goals and rationales for each of them. In each of these contexts, the imperative of "digital upgrading" was stressed, highlighting not only the need to develop digital sectors *per se*, but also to use digital technology to upgrade older industries, such as manufacturing sectors into an age of robotic intelligent manufacturing. Data is viewed as a "resource" for development—not only for digital industries, but also as an input into a variety of other sectors.

While the countries are all located in Asia and share certain political aspects (one-party, or variations of one-party/quasi-authoritarian rule), they also have crucial differences. These differences offer opportunities for comparison between different "varieties" of digital developmentalism. One obvious difference is scale—Singapore is a city state and China is a vast country of 1.4 billion people. Compared to earlier cases of "developmental states", these countries have largely ended "extreme poverty" but are more accurately classed as "middle income" and in the case of Singapore is already high-income. For countries in the "middle income category", defined by the World Bank as countries with "GNI per capita between $4,046 and $12,535," [181] promoting the growth of high-tech and knowledge-intensive sectors is now

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[180] The Developmental State paradigm refers to a broad body of work in political science that analyzed the state policies of successful "late developers", chiefly Japan and the East Asian Tigers (Some classic works: Chalmers Johnson, *Miti and the Japanese Miracle: The Growth of Industrial Policy, 1925-1975*, Reprint edition (Stanford, Ca: Stanford University Press, 1982); Alice Amsden, *The Rise of" the Rest": Challenges to the West from Late-Industrializing Economies* (Oxford: Oxford University Press, 2001); Haggard, *Developmental States*.
[181] World Bank, "The World Bank in Middle Income Countries" (2022)

embraced as a core goal of state developmental policy. The "middle-income trap" refers to the idea that many successful developing countries have stagnated after they reach a point of middle income, after they have left extreme poverty behind often by pursuing "low-hanging fruit" of development in moving rural workers into urban industrial or advanced sectors, and achieving a certain standard of human development. In the "middle-income trap," countries face challenges in boosting productivity, local innovation, and higher value-added sectors that would allow it to move up into the ranks of "advanced nations."[182] While South Korea is considered a paradigmatic case of a country that rapidly moved from low-income to advanced, many countries continue to facing challenges in moving into the higher value-added knowledge-intensive sectors. The three countries that comprise this project can be considered "advanced" (Singapore), and upper middle-income (Thailand and China).

Many countries facing the middle-income trap have oriented their development policies around promoting the digital economy including centering data as a key resource to be mobilized in pursuit of national development goals. In recent years, many developing countries have also embraced some form of the "smart city" in their national development strategies. India, while not yet considered a "middle-income country" launched an ambitious Smart Cities Mission in 2015, with the goal of building 100 smart cities across the country.[183] At the other end of the spectrum, one of the wealthiest countries in the world Singapore launched its "Smart Nation" program in 2014 with Prime Minister Lee Hsien Loong declaring that "our vision is for Singapore to be a Smart Nation – A nation where people live meaningful and fulfilled lives, enabled seamlessly by technology, offering exciting opportunities for all… where networks of sensors and smart devices enable us to live sustainably and comfortably." [184]

In Southeast Asia, Grab achieved dominance in ride hailing, while Shopee and Lazada have become e-commerce giants.[185] In China, local platforms like Didi (ride hailing) achieved rapid

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[182] Barry Eichengreen, Donghyun Park, and Kwanho Shin, "Growth Slowdowns Redux: New Evidence on the Middle-Income Trap" (Cambridge, MA: National Bureau of Economic Research, January 2013); Richard F. Doner and Ben Ross Schneider, "The Middle-Income Trap More Politics than Economics," *World Politics* 68, no. 4 (2016): 608–44.

[183] Ayona Datta, "New Urban Utopias of Postcolonial India: 'Entrepreneurial Urbanization' in Dholera Smart City, Gujarat," *Dialogues in Human Geography* 5, no. 1 (March 2015): 3–22

[184] https://www.pmo.gov.sg/Newsroom/transcript-prime-minister-lee-hsien-loongs-speech-smart-nation-launch-24-november

[185] Shopee is part of Singapore-based Sea, while Lazada is wholly owned subsidiary of Alibaba.

growth, but drew the scrutiny of a Chinese government increasingly wary of the infrastructural power of private technology platforms, particularly their ownership of vast lucrative and sensitive customer data. Amidst intensifying U.S.-China rivalry, Rolf and Schindler proposed the idea of "state platform capitalism" by which "platforms are rendered increasingly interdependent with states, through lucrative contractual incentives and punitive regulatory interventions"[186] They argue that U.S. and Chinese platforms are now intertwined with states and their geopolitical goals, such as competition with each other for centrality in global networks. While it is true that platforms have become "key infrastructures", both for nations and their major cities, their relationship to the state is tenuous. In China, Xi Jinping began a broad crackdown on private platform firms in 2021, aiming to reduce their monopoly power over industries and data, and promote an agenda of "common prosperity."[187] The most prominent target of this crackdown was Alibaba—CEO Jack Ma criticized China's approach to financial regulation of Alibaba's Ant Financial. Shortly thereafter, Ant had to withdraw its much-anticipated U.S. IPO. Meanwhile, state-owned asset managers took 1% "golden shares" in top technology companies, what Pearson et al. termed "party-state capitalism."[188] Singapore's sovereign wealth fund Temasek also took a minority stake in Grab, the dominant ride hailing platform in Singapore and Southeast Asia. Both China and Singapore have directly intervened in their dominant platforms (Singapore more softly) suggesting states are taking a growing interest in regulating platforms.

However, the scope of state developmental policy toward upgrading digital industries goes beyond regulation of platform firms. The premise of the "4th industrial revolution" was the integration of cyber and physical systems, and the application of digital technologies to a wide range of other industries, such as advanced manufacturing.[189] The various technologies of the 4th IR require further investment in physical infrastructure: 5G hardware, cloud computing centers, better network infrastructure, and standardization for data collection and integration. Investment in cyber-physical infrastructures is therefore a core aspect of state-led digital development policy. In China, Xi has indicated a preference for "hard technologies" like AI and

[186] Steve Rolf and Seth Schindler, "The US–China Rivalry and the Emergence of State Platform Capitalism," *Environment and Planning A: Economy and Space*, January 11, 2023

[187] Collier, *China's Technology War* (London: Palgrave Macmillan, 2022)

[188] Pearson, Margaret, Meg Rithmire, and Kellee S. Tsai. "Party-State Capitalism in China." Current History 120, no. 827 (September 1, 2021): 207–13; So-called "golden shares" were taken through a newly created China Internet Investment Fund

[189] Schwab, *The Fourth Industrial Revolution*.

advanced manufacturing over the supposedly soft consumer-facing platform firms like Baidu, Tencent, and Alibaba.[190] Singapore seeks to retain advanced manufacturing, a focus of its new Jurong Innovation District, aiming to upgrade its original industrial zone for the digital era and retain advanced production in Singapore despite the generally high cost of labor in the wealthy city state.[191] Thailand, while not typically seen as having such high "state capacity" as China or Singapore, has still unveiled a slate of policies and spatial plans to deploy new infrastructure to propel its own digital transformation.

China

In 2015, China's Ministry of Industry and Information Technology unveiled the Made in China 2025 plan, a far-reaching effort to fund innovation and industry to lead in ten emerging sectors, and generally use digital technologies to upgrade existing manufacturing industries. Following this, several cybersecurity laws were passed in 2016 and 2021, giving more power to agencies like Cybersecurity Administration of China (CAC) to regulate platform firms. In 2017, Xi Jinping announced data should be thought of as a "factor" of production, on par with land, labor, and capital—a view formally adopted by the State Council in 2020. Since then, new national plans have been announced such as the 14th Five Year Plan for National Informatization (2021) and Plan for the Overall Structure of a Digital China (2023). In 2023, a new National Data Administration (NDA) was created under the National Development and Reform Commission (NRDC), China's traditional economic planning agency. This indicated the importance with which the Party was placing on data not only as a domain of cybersecurity but as a key aspect of economic planning. The effects of these documents and new institutions are still ongoing. The state has a central role for itself as a guiding hand in the regulation of data, provision of digital infrastructure, and digital governance. But there is still significant negotiation, contestation, and lack of clarity over which parts of the state will take the lead over regulation of various aspects of the digital economy— the formal agencies and ministries under the State Council, or the more opaque internal organs of the Communist Party ultimately accountable to Xi?

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[190] Collier, *China's Technology War* (London: Palgrave Macmillan, 2022)

[191] Richard N. Foster, "Working The S-Curve: Assessing Technological Threats," *Research Management* 29, no. 4 (July 1986): 17–20; Clayton M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, The Management of Innovation and Change Series (Boston, Mass: Harvard Business School Press, 1997).

Singapore

As a successful paragon of development in Southeast Asia, Singapore is now a high-income country. Nevertheless, its institutions and strategies still carry a developmentalist legacy, and there is a sense among policymakers that Singapore's success, however hard-earned, is tenuous. Thus the government has been active to continually invest and coordinate policy to stay ahead of economic and technological trends. In 2014, Singapore unveiled its Smart Nation Plan, in which Prime Minister Lee Hsien Loon called on Singaporeans to become "a nation where people live meaningful and fulfilled lives, enabled seamlessly by technology, offering exciting opportunities for all."[192] The Committee on the Future Economy (CFE) was formed in 2016 to chart the next phase of Singapore's economic growth. Minister of National Development Lawrence Wong spoke of the CFE, "Digitalisation is a mega trend that will impact all industries. Data will be the new economic asset of the future. Just as we have been successful as a container port, we must now strive to be a successful digital and data port in the future. Our infrastructure plans must respond to and keep pace with the digital economy."[193]

Thailand

As a middle-income country, Thailand had success establishing a manufacturing base especially for Japanese automakers in the 1980s, but has struggled to develop local champions and is thus sometimes classed as an "intermediate" developmental state.[194] After ten years of political instability following two coups, the military-led government of Prayut Chan-ocha (2014-2023) advanced its Thailand 4.0 policy of digital upgrading, partially inspired by the need to provide infrastructure to catch up with its regional peers, including Singapore and China. The plan sought to move Thailand out of the "middle income" trap by prioritizing investment in 10 frontier sectors,[195] and through a related spatial policy to attract new investment into the Eastern Economic Corridor (EEC). While some of these infrastructure projects have been slow to

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[192] https://www.pmo.gov.sg/Newsroom/transcript-prime-minister-lee-hsien-loongs-speech-smart-nation-launch-24-november

[193] Speech by Lawrence Wong, Minister for National Development and Second Minister for Finance at the 57th Anniversary Dinner of REDAS (2016, November 17). https:// www.mnd.gov.sg/newsroom/speeches/view/speech-by-minister-lawrence-wong-at-the-57th-anniversary-dinner-of-redas. Accessed on 2018, May 16

[194] Doner, Richard F. *The Politics of Uneven Development: Thailand's Economic Growth in Comparative Perspective*. Cambridge University Press, 2009

[195] Charlie Jones and Paitoon Pimdee, "Innovative Ideas: Thailand 4.0 and the Fourth Industrial Revolution," *Asian International Journal of Social Sciences* 17 (January 1, 2017): 4–35

materialize, Thailand has attracted significant investments in cloud computing centers and electric vehicle and battery manufacturing.

Figures 10a-c: Digital Transformation for the Nation: Thailand 4.0, Made in China 2025, Smart Nation Singapore

II. The Digital Developmental State

This section discusses various forms of state developmental policy, using examples from the national cases, grouped into four spheres of action: data sovereignty, data reciprocity and standard setting, creation of digital agencies, and provision of physical-digital infrastructure. These categories should not be thought of as standalone, but form a systemic approach: states exerting sovereignty over data within state borders can be seen as a *first-order* precondition of further regulatory action, such as setting data ownership policies and requiring sharing between state agencies and private companies, either international or domestic. Accordingly, agencies are established to define and oversee these policies. Finally, infrastructure provision can facilitate and catalyze private investment in certain sectors.

I propose that collectively these actions constitute the emergence of a "digital developmental state" that increasingly aims to discipline data for developmental goals. I specifically draw on classic paradigms of the "developmental state", which sought to explain the success of state-led industrial policy in the economic growth of Japan and subsequent East Asian tigers (South Korea, Taiwan, Singapore, and Hong Kong).

To examine these questions means returning to core issues in the classic developmental state literature—*the relationship between state agencies and private actors, and what role states should play in pursuing general economic development and upgrading of economic sectors*. For example Amsden described a regime of "control mechanisms," in which "recipients [of state capital or other favorable policies] were subject to monitorable performance standards that were redistributive in nature and results-oriented." [196] But what are the goals or performance standards that states seek to impose on digital firms today? Has China's technology crackdown aimed to incentivize developmental objectives, or were they primarily motivated by political concerns? In the platform economy, many large countries (United States, China, Indonesia) host successful platform firms due to their large domestic population, offering economies of scale. It

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[196] Amsden, Alice. H. *The Rise of" the Rest": Challenges to the West from Late-Industrializing Economies.* Oxford: Oxford University Press, 2001, 8.

is less clear, however, whether platforms offer developing countries meaningful opportunities for upgrading of technical capacity.

The question remains—what are the goals of digital disciplinary policies and do they meaningfully promote upgrading and advancement into higher value-added sectors? Do they help achieve income growth for the population at large? This chapter does not offer definitive economic analysis of the results of these policies, as many are too early to fully evaluate. Rather, the chapter aims opens up a broader research agenda and re-engagement with the classic "developmental state" paradigm in the context of contemporary digital sectors and develops a theorization of the relationship between state territorial infrastructural power and digital infrastructural power.

Mechanism	Type	Examples
Asserting state and national sovereignty over data	Regulatory	Data sovereignty policies (China 2016 Cybersecurity Law, 2021 Personal Information Protection Law Data Security Law; Thailand's Personal Data Protection Law 2019; Singapore's Personal Data Protection Act (2012, updated 2020)
Data reciprocity and standard setting	Coordinative	Singapore EV charging hubs, IoT DECADA stack, middleware platforms;
Digital Transformation Agencies as "Hubs" and "Hand-holders"	Administrative	Singapore's SNDGO (Smart Nation/Govtech), Thailand's DEPA,
Provision of Digital Infrastructure	Infrastructure	5G towers, China's East-West transmission line, Singapore's 'smart lamppost', innovation sandboxes, cloud computing centers, pilot districts (Jurong, Punggol, Xiong'an, Eastern Economic Corridor, etc)

Table 4. Typology of Digital Developmental Policies

Today, states are implementing a variety of mechanisms to "discipline" the digital economy, such as exerting regulatory power over data. A number of countries have passed laws on "data sovereignty", with the goal of regulating and controlling data within national territories.[197] The European Union's General Data Protection Regulation (GDPR) established a strong legal framework for the protection of personal data in 2018. Beginning with the 2016 Cybersecurity Law, and followed by the 2021 laws, China has strengthened limitations on data being exported out of the country, and involved efforts to mandate foreign companies operating in China to store data on its Chinese users within China. This was a factor behind the rise of Guizhou province as a cloud computing center in China, where Apple opened a cloud computing data center to offer its iCloud services for mainland Chinese customers while retaining their user data within China. In 2021, the Cyberspace Administration of China (CAC) was given broad authority to regulate digital data through the passage of the Personal Information Protection Law and the Data Security Law.[198] On July 10, CAC proposed revisions of existing law calling for "a cybersecurity review in advance of foreign listings by companies that qualify as critical information infrastructure operators and hold personal information of more than one million people." Ten days later, on July 21, the CAC opened its first cybersecurity review, targeting ride-hailing platform DiDi Chuxing's "unspecified potential data and national security risks", just days after its New York IPO.[199] While the CAC was originally set up in 2014 with a limited mandate to oversee online content, the body has accumulated greater regulatory power as a key instrument of Xi's "technology war"[200] against private platform firms. Under Xi, the Party has grown more wary of the "infrastructural power" private firms have amassed over data, viewing them as a rival to state power.

Singapore and Thailand, while both highly dependent on foreign investment, have also sought with varying degrees to pass their own forms of digital localization and sovereignty laws. Singapore's Personal Data Protection Act (PDPA) passed in 2013 while Thailand passed its

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[197] Finn Dammann and Georg Glasze, "Governing Digital Circulation: The Quest for Data Control and Sovereignty in Germany," *Territory, Politics, Governance*, November 17, 2022, 1–21; Patrik Hummel et al., "Data Sovereignty: A Review," *Big Data & Society* 8, no. 1 (January 1, 2021)

[198] Jamie Horsley, "Behind the Facade of China's Cyber Super-Regulator," *Digichina* (Stanford), August 8, 2022, https://digichina.stanford.edu/work/behind-the-facade-of-chinas-cyber-super-regulator/.

[199] Cyberspace Administration of China (2021 "The Cyberspace Administration of China has decided to issue administrative penalties related to network security review of Didi Global Co http://www.cac.gov.cn/202207/21/c_1660021534306352.htm

[200] Collier, *China's Technology War*. (2022)

Personal Data Protection Act in 2022 largely based off the EU's GDPR but with some additional remit to mandate data collected on any Thailand-based subjects remain in Thailand, whether or not they are located within the country.[201] However, Thailand's PDPA doesn't require total data localization as strictly as does China's policy.[202]

In Singapore, the government uses Amazon Web Services (AWS) as one of its main cloud storage providers. About 66% of Singapore's government systems have been migrated to this so-called Government Commercial Cloud.[203] Singapore has also begun a process of re-classifying data so that "less sensitive data can be stored in the cloud, saving a lot of money."[204] Not surprisingly, multinational technology firms view digital sovereignty policies as clashing with their own aims and technology solutions. As a representative from AWS put it "It's very hard to offer the whole suit of cloud services AWS offers when countries require all data servers be in the country, for example, we need to have redundancy so if one server goes down, data is automatically backed up at other locations."[205] However, such digital sovereignty policies have not necessarily been obstacles to investment, with AWS and other cloud providers announcing new facilities in Thailand and elsewhere.

2. Data Reciprocity and Standard Setting

The other side of discipline is reciprocity, such as subsidies given to private companies to lower the cost of investment and manufacturing. Amsden described such arrangements as a "control mechanism"—the imposition of "discipline" via measurable standards (in order to incentivize the private sector to achieve measurable outcomes i.e. exports). Additionally, having adequate information and data on the economy was seen as pivotal to state agencies ability to make good developmental policy. Evan's notion of "embedded autonomy" proposed state bureaucrats needed sufficient information on the industries and economy they intervene in for their policies

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[201] U.S. Department of Commerce, "Thailand Personal Data Protection Act" (Washington, D.C: International Trade Administration, February 17, 2022), https://www.trade.gov/market-intelligence/thailand-personal-data-protection-act.

[202] Antonio Postigo, "Governing the Digital Economy in Thailand: Domestic Regulations and International Agreements," Perspectives (Singapore: ISEAS Yushok Ishaf Institute, July 24, 2023).

[203] GovTech, "Government Projected to Spend $3.3 Billion on ICT in FY23" (Singapore: GovTech, May 24, 2023), https://www.tech.gov.sg/media/media-releases/2023-05-24-Government-projected-to-spend-on-ICT-in-FY23.

[204] Interview, Singapore Smart Nation (2022)

[205] Interview, AWS Public Policy Representative (2023)

to be successful.[206] In addition to questions of state vs. private power, data regulations also involve notions of reciprocity: what data infrastructures (hardware or software) should states provide, and what data do private firms need to share?

Singapore's rollout of electric vehicle charging stations is a case in point, where as a former employee of the Land Transport Authority (LTA) put it, "the lack of data got us thinking about instituting a regulatory regime, that if you really want to operate in this space you need to give us a certain quality of data to let us plan; we would put data into these regulatory regimes that are quite onerous."[207] The government needed data on location and utilization of EV charging stations to better plan and integrate them into Singapore's overall town planning, whereas private vendors, while initially hesitant, were eventually incentivized to share information. "There was no one centralized platform to look for an EV charger, the market was fragmented…so something we did from the onset is we established partnerships with the major players, saying hey this makes sense in the longer term, you want a centralized platform, if you don't do it now we will eventually be regulating you to do it. We got 5/6 of the major operators to share data."[208]

Singapore's rollout of "middleware" platforms for managing internet of things (IoT) devices is another example of how the government is developing public data platforms to allow data aggregation from multiple private technology vendors. One of SNDGO's projects is the Smart Nation Sensor Platform. As part of this, "GovTech is trying to standardize infrastructure for Singapore so different vendors can navigate within the same space, working with building management infrastructure."[209] As a director with Smart Nation put it, "Understand where government needs to intervene. We believe *middleware* is where we should intervene."[210] Middleware refers to a type of software layer that sits in between devices and the specific applications required for their operation, allows for device management, and for data from multiple devices to be aggregated into a central database. GovTech is developing the DECADA IoT stack, a suite of software applications designed to streamline connected devices and data

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[206] Peter B. Evans, *Embedded Autonomy: States and Industrial Transformation*, Princeton Paperbacks (Princeton, N.J: Princeton University Press, 1995).
[207] Interview, Singapore LTA former employee (October 2023)
[208] Ibid.
[209] Interview GovTech (September 2022)
[210] Interview, Smart Nation (February 2023)

gathering across Singapore. How then are state agencies in Singapore aiming to centralize data within government servers, even as they talk about making data openly accessible or public? As a director with Smart Nation put it, "If you a deploy a sensor, the sensor data will be piped into a centralized database, probably the government owns in a cloud somewhere—the vendor can pull data from the database if they need." Even if Singapore wants to make data available to vendors, to researchers, or to the public, there is still a goal in trying to centralize ownership with the government as much as possible. "When government shares data to researchers, we would also like such processed data to also come back to the government"[211] Thus, Singaporean agencies like Smart Nation aims to retain ownership of data even as they make some of it available for private or third-party use.

3. *Digital Transformation Agencies: Coordinators, "Hubs" or "hand holders"?*
What is the purpose and/or strategy of "innovation" agencies today? In all three countries, digital policy has involved the creation of new agencies to coordinate policy and implement technological solutions across what have been seen as siloed traditional ministries. Some of these agencies resemble the classic "pilot agencies" described in developmental state literature, while others are more peripheral, using limited resources to incubate startups, forge innovation ecosystems by partnering with foreign firms, domestic companies, and other government agencies.

Efforts to centralize Party control over digital technology in China has seen the creation of new "central commissions." The previously mentioned Cyberspace Administration of China (CAC), which oversaw much of the crackdown on platforms in 2021, was moved from an office of the State Council (China's cabinet) to the new Central Cyberspace Affairs Commission.[212] Also in 2023 a new China Internet Investment Fund was set up backed partially by CAC to invest in internet companies. In March 2023 as part of a broader administrative reorganization, China announced the creation of a new Central Science and Technology Commission, with broad responsibility to coordinate policy to help China achieve self-sufficiency in critical technologies in the face of U.S.-

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[211] Interview, Singapore Smart Nation Smart Cities Director (2023)
[212] Commissions, as opposed to formal ministries or offices of the state council, are thought to be part of the Party apparatus, less formal and less transparent than State Council/Ministries, part of the formal "State" system

China competition. The existing Ministry of Industry and Information technology (MIIT) and Ministry of Science and Technology (MOST) remain critical to implementation of China's overall digital development policies, but there have been clear moves to create new policy coordination bodies with greater power over the ministries. In October 2023, China inaugurated the National Data Administration (NDA) under the National Reform and Development Commission, China's economic planning authority. The NDA was given authority over "planning China's digital economy, as well as the sharing and development of the country's data resources, promoting smart cities and the exchange of information resources across industries."[213] The formation of the NDA appeared to shift authority in some areas from the opaque security-focused CAC back to the more institutionalized NRDC with its traditional responsibility for national economic planning.

In Singapore, administrative reorganizations created new bodies to focus on the digital economy. These agencies exhibit aspects of both the classic "pilot agencies" of early development state literature as well as that of peripheral innovation agencies.[214] In 2014, Prime Minister Lee Hsien Loong launched the Smart Nation initiative, calling for Singapore to become "a smart nation…where people live meaningful and fulfilled lives, enabled seamlessly by technology."[215] The Smart Nation and Digital Government Office (SNDGO) was set up under the Prime Minister's Office to drive "whole of government transformation" across agencies in Singapore. The government technology agency or GovTech, with around 3,000 employees currently which had its origins in the older National Computer Board, was moved from Infocomm Media Development Authority (IMDA) into the Smart Nation Group in 2016. The IMDA, the current iteration of Singapore's media and telecom regulator has also expanded into various initiatives to promote the digital economy and oversees Singapore's Personal Data Protection Commission.

Administrative reorganization under Thailand's military government in 2016 renamed the previous Ministry of ICT into the Ministry of Digital Economy and Society (MODES).[216] The existing

[213] Si Ma, "Liu Liehong Appointed Head of National Data Bureau," *China Daily*, July 28, 2023, https://www.chinadaily.com.cn/a/202307/28/WS64c37c4ba31035260b819236.html.

[214] Breznitz, Dan and Darius Ornston, "The Revolutionary Power of Peripheral Agencies: Explaining Radical Policy Innovation in Finland and Israel," *Comparative Political Studies* 46, no. 10 (2013): 1219–45.

[215] https://www.pmo.gov.sg/Newsroom/transcript-prime-minister-lee-hsien-loongs-speech-smart-nation-launch-24-november

[216] Previously called Software Industry Promotion Agency (SIPA)

National Innovation Agency (NIA) remains under the Ministry of Science and Technology. The Digital Development for Economy and Society Act, passed by Thailand's parliament in 2017, created the Digital Economy Promotion Agency (DEPA) under MODES, and created a Digital Economy and Society Development Fund to finance future digital economic development.[217] The subsequent 2019 Electronic Transactions Act set up a framework for regulation of electronic transactions and another new agency, the Electronic Transaction Development Agency (ETDA).

Singapore's SNDGG most closely resembles the sort of "pilot agency" of classic developmental state literature. The 2016 reorganization combined the policy-setting group (Smart Nation) with an implementation agency (GovTech) that had previously been the government's IT department. Yet, SNDGG does not have the broad remit to coordinate overall economic strategy as previous "pilot agencies" did—this responsibility falls to the Economic Development Board (EDB), which was created in 1961 to help propel Singapore's early industrialization efforts.[218] Rather, the remit of Smart Nation is to work with existing agencies to drive adoption of digital technologies across government, but also with capacity to deploy its own technology infrastructures (including "middleware," standards for cloud data storage and collection, IoT device management, etc). A Deputy Director with Smart Nation describes their role as that of a "bridge or connector" between agencies."[219] An employee of GovTech described their role as a "hand holder", in working with statutory boards or ministries in Singapore to develop specific digital applications.[220] For example, GovTech works with NParks, the manager of Singapore's green spaces, to develop sensing technology for collecting data on trees and ecosystems, or with HDB to trial "smart home" sensing systems, or with industrial developer JTC to develop a "digital twin" Open Digital Platform in Punggol, a prototype "smart town" district.

Meanwhile, the capacity and budget of Thailand's agencies remains quite limited: NIA's proposed 2024 budget was 1.2 billion Thb ($33 mn USD), and DEPA's only 900 mn Thb with around 300

[217] Ministry of Digital Economy and Society Thailand, "Digital Development for Economic and Social Act 2017" (2017), https://onde.go.th/view/1/Digital_Development_for_Economic_and_Social_Act_2017/EN-US.
[218] Edgar H. Schein, *Strategic Pragmatism: The Culture of Singapore's Economic Development Board*, Organization Studies 11 (Cambridge, Mass: MIT Press, 1996).
[219] Interview, Singapore Smart Nation (2023)
[220] Interview, GovTech Project Manager (2023)

employees.[221] By its own admission, DEPA is a small agency with limited budget and with a philosophy of "doing less and gaining more to harness the power of startups and other stakeholders to drive the digital economy."[222] DEPA oversees Thailand's Smart City Program, among various other initiatives designed to incubate startups and emerging local companies. "For DEPA we are a hub in the middle, we connect from the National Committee on smart city promotion, then connect to demand side (cities)."[223] DEPA was initially tasked with overseeing Thailand's Smart City Certification program, as a way to help cities obtain central funding for various city-led digital projects. More recently, this approach has evolved to be more entrepreneurial, with DEPA playing a role in helping incubate new startups. For example, DEPA partnered with a small Thai startup called Siam Innocity, which developed citizen communication platforms for a small city of Nakhon Si Thammarat in southern Thailand, to scale to other cities in Thailand and expand internationally. DEPA members also helped create a startup "Refill City," a platform for citizens to find refillable water bottle stations and reduce plastic bottle use.

Despite differences in budget and power, digital agencies in Singapore and in Thailand similarly describe themselves as "hubs" or "connectors", coordinating either across the bureaucracy (Singapore), or bringing together private and public stakeholders to create innovation ecosystems in a country where the economy is dominated by foreign investment or monopolistic domestic conglomerates (Thailand). These initiatives can hardly be called "radical innovation" but they do exemplify a certain approach whereby relatively small-budgeted government agencies serve as "connectors" between local governments, domestic startups, and international funders and agencies. Created in 2003, the NIA describes their approach as "innovation ecosystem integrator,"[224] focused on developing regional innovation systems by partnering with local stakeholders and some of Thailand's large private conglomerates, such as the sugar conglomerate Mittphol. As NIA's Director describes, "our innovation system is more similar to Japan or Korea [in terms of dominance of conglomerates]." He also criticizes the "traditional model" of FDI-promotion, typified by Thailand's Board of Investment (BOI), which played a crucial role in attracting Japanese auto manufacturers to open factories in the 1980s. While this helped

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[221] Digital Economy Promotion Agency Annual Report 2022
[222] Interview, DEPA (2023)
[223] Interview, DEPA (2023)
[224] Interview, National Innovation Agency Director (2023)

jumpstart Thailand's manufacturing base, Thailand has struggled to develop "local champions" or develop local technological capacity and upgrading through foreign investment.[225] Thailand still relies heavily on FDI, including in the Eastern Economic Corridor, a flagship policy of the post-coup Prayut government.

4. *Provision of Digital Infrastructure*

China's ability to develop infrastructure, such as its impressive rollout of the world's largest high speed rail network since 2008, has brought new focus to the role of infrastructure in promoting economic growth. Since 2013, China began its Belt and Road Initiative to export its surplus capacity to build infrastructure across the Global South. Scholars have talked about a shift from a neoliberal Washington consensus to a new era of "infrastructure-led development."[226] Lin proposed the concept of "new structural economics" to argue for investment in infrastructure and supply as a way to jumpstart growth for developing economies.[227] Today, provision of digital infrastructure is increasingly part of the overall "infrastructure power" of states, in addition to "traditional" types of infrastructure like roads, rail, public schools, or other facilities. The internet and mobile telephone networks have long required physical infrastructure such as undersea cables and transmission towers. The merging of cyber and physical worlds, a premise of the 4th IR, requires even further investment in physical infrastructure. China's early rollout of 5G coverage, which required a much higher density of base station and towers compared with 4G coverage, was evidence that the country's infrastructural capacity had implications for rollout of new digital technologies.

In 2023, China's State Council and CCP Central Committee issued the "Plan for an Overall Layout of Building a Digital China intent on building China into a "cyber superpower."[228] One of the main components of this is digital infrastructure. The plan calls for "*opening up the main arteries of digital infrastructure*: Accelerate the coordinated construction of 5G networks and gigabit optical

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[225] Various Interviews (2023)

[226] Seth Schindler, Jessica DiCarlo, and Dinesh Paudel, "The New Cold War and the Rise of the 21st-Century Infrastructure State," *Transactions of the Institute of British Geographers* 0 (2021): 1–16; Seth Schindler and J. Miguel Kanai, "Getting the Territory Right: Infrastructure-Led Development and the Re-Emergence of Spatial Planning Strategies," *Regional Studies* 55, no. 1 (January 2, 2021): 40–51

[227] Justin Yifu Lin, "New Structural Economics: The Third Generation of Development Economics," *Asian Education and Development Studies* 9, no. 3 (December 2, 2019): 279–86.

[228] In Chinese, 网络强国 *wangluo qiangguo*

networks, further promote the large-scale deployment and application of IPv6, promote the comprehensive development of the mobile Internet of Things, and vigorously promote the application of Beidou at scale." [229] One example of large-scale digital infrastructure is the *Dongshu Xisuan* or "Eastern Data Western Transfer," announced in 2021 by the National Reform Development Commission (NRDC). The plan links 4 provinces with high energy production (Guizhou, Gansu, Inner Mongolia, and Ningxia) to China's major urban clusters (Beijing-Tianjin-Hebei, Yangtze River Delta, Pearl River Delta, and Chengdu-Chongqing). Guizhou, which had already emerged as a cloud computing hub, is part of this plan. Apple, which already has a cloud computing center in Guizhou, announced plans to open another facility in Inner Mongolia, seemingly in line with the national E-W plan. The idea is to enhance China's overall "computing power" by building quicker transmission infrastructure for data between Eastern cities and inland areas, where new cloud server hubs will be built. The project follows China's longstanding practice of remedying uneven development through large-scale infrastructure and regional development plans, such as the "open up the West" *Xibu Dakaifa*. The project is described as a "North-South Water Transfer of the digital era," referring to the aqueduct system moving water from China's wet south to the arid North. The first the data functions that would utilize far-flung servers would be ones that don't require low latency, such as "data storage" as well as "national digital governance services."[230] The E-W Data Transfer plan requires coordination with state-owned telecom firms and cloud providers, who also stand to benefit from the policy. Subsidies are provided for data center construction in outlying areas, which may otherwise not have been built without government incentives.

Singapore has long been known for careful urban planning of its limited territory, and what some called an "intrapreneurial" approach to building capacity within the public sector [231] to manage infrastructure through "statutory boards" like Housing Development Board, Jurong Town Corporation, the Urban Redevelopment Authority (URA), and others. Digital infrastructure requires coordination with all of these bodies. One Smart Nation project, "Smart Gardens," deployed IoT sensors in the iconic Gardens by the Bay to test data collection on biotic

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[229] State Council (2023) "Overall Plan for Building a Digital China"

[230] China Unicom (2022) *Dong shu Xi* suan*: zhuanti yanjiu baogao* "East Data West Compute: Professional Research Report"

[231] Julie Tian Miao and Nicholas A. Phelps, "The Intrapreneurial State: Singapore's Emergence in the Smart and Sustainable Urban Solutions Field," *Territory, Politics, Governance* 7, no. 3 (July 3, 2019): 316–35

environments. But scaling this project beyond GovTech has been the responsibility of older agencies that manage the country's physical assets. "The gardens project is a microcosm but I feel that NParks has done it much larger and much faster."[232] NParks has since developed its own digital initiative the "internet of trees"— a virtual twin of Singapore's trees. So, when it comes to deploying digital-physical infrastructure, SNDGG has relatively limited physical infrastructural power—it doesn't manage any physical assets as do Singapore's legacy statutory boards. But it works with them to trial digital systems in limited pilots, and then the boards must scale them up on their own, depending on their own operational needs. The rotation of civil servants from various boards in and out of SNDGG contributes to a system of circulating expertise between Smart Nation and the specific boards. But territoriality and personal ownership of projects is still a factor. One of Smart Nation's early projects involving deployment of physical infrastructure was the Smart Lamppost project, which sought to design a lamppost outfitted with sensors and cameras, envisioned as "lamppost as platform" collecting various data including traffic, weather, and potentially even as part of an autonomous vehicle (AV) communications system. The prototype lamppost was built by ST Engineering,[233] a commercial firm that is majority owned by Temasek, helping develop technical capacity within a firm that could export the product abroad. But the results of the Smart Lamppost project have been underwhelming, with Minister Josephine Teo announcing the end of the initiative in 2023.[234] As a Smart Nation Director noted, "It ended up being a bit tech led, I don't think it was supposed to be that way,"[235] The actual needs of agencies didn't align with the project's goal to develop a fixed lamppost that could collect data for multiple of agencies and purposes. As a project director with GovTech put it, "The demand for sensors is quite low. Only specific agencies. It doesn't make that much sense to provide the same for different agency needs."[236] In the case of Smart Nation, the lack of need for a universal physical infrastructure solution has meant they are now focused more on developing middleware software systems (see previous section on 'Reciprocity').

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[232] Interview, Singapore Smart Nation Director
[233] https://www.stengg.com/en/smart-city/urban-solutions/smart-utilities-and-infrastructure/smart-lighting/agil-smart-lamp-post/
[234] https://www.straitstimes.com/singapore/politics/lights-out-on-plan-for-network-of-smart-lamp-posts-that-detect-speeding-e-scooters-and-unruly-crowds
[235] Interview, Singapore Smart Nation Director
[236] Interview, Singapore Smart Nation Director 2

In 2017 Thailand announced its own spatial development policy to build infrastructure in its Eastern Economic Corridor, which was promoted as linking to China's Belt and Road Initiative. Proposed infrastructure included a high-speed rail link connecting Bangkok and its two airports to a planned aerotropolis industrial zone at U-Tapao Navy airfield in Rayong province. Several other innovation clusters are either in development or planned across the area, including Wangchan Valley, an innovation district built on land owned by state oil giant PTT, and Thailand Digital Valley which is being developed into a tech incubation center DEPA with testbeds for 5G announced with Huawei and Erikson, internet of things, and cloud computing. Interestingly, the site lies on land owned by Thailand's National Telecom (NT), where an important submarine internet cable comes ashore, so site could claim to have the "lowest latency among most locations in Thailand"[237] The infrastructures were conceived to help upgrade the EEC including several regulatory "sandboxes" for autonomous vehicle testing, drone delivery, and 5G. So far however, the most significant investments in the area have been from Chinese battery and EV manufacturers like BYD. The EEC area has also seen investment by cloud data center operators, including Chinese players Tencent, Alibaba, as well as recent investments from Google and AWS.

III. *The Territoriality of State Digital Infrastructure Power*

Country	Land Ownership	Fiscal System	Implications for Digital Infrastructural Power
Singapore	State (90%)	City and state are contiguous	Close integration between deployment of digital infrastructure and state agencies
Thailand	private (%), significant royal family land ownership (Crown Property Bureau)	centralized	Fragmented land ownership makes deploy large-scale infrastructure difficult, local governments have limited authority to generate revenue independent of the center; city data platforms could offer a way to generate additional revenue
China	State with municipality as "representative" and primary decisions over land leasing	Centralized but local state has large control over land revenue	Local governments have autonomy to generate revenue through land leasing/land finance; however, there are efforts underway to reign this in. Digital platforms were often collaboration between local state/private tech firms, now increasing move to standardize control over urban data in SOEs or govt owned enterprises

Table 5. Territoriality and State Infrastructural Power

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[237] Interview, DEPA Executive Director (2023)

Data sovereignty laws are perhaps the simplest and most obvious example of the exercise of territorial sovereignty over the flow of digital information within and between states. However, as the preceding section has shown, states are implementing a variety of other strategies to regulate data, provide software and hardware platforms to standardize and centralize information while facilitating innovation, and deploying various forms of digital infrastructure. Digital transformation agencies must coordinate with entities controlling physical assets in order to realize digital policies. For example, in the city state of Singapore, the Smart Nation Group and GovTech have capacity to rollout policies and even develop in-house software platforms, but they need to partner with "system integrator" firms like ST to develop hardware products like lampposts or connected vehicles.[238] Smart Nation and GovTech also work alongside agencies like JTC, which manages Singapore's industrial parks, to deploy various forms of infrastructure including digital twins, IoT devices, and other systems in physical space. In Thailand, DEPA mainly works as a "networker" to link cities to various private vendors and national funding processes, but it is also developing some of its own infrastructures including a prototype city data platform for Thai cities and Thailand Digital Valley, a site designed to incubate startups in the digital economy in the country's manufacturing hub of the EEC. However, due to the limited budgets of Thai agencies, the private sector (or large SOEs like PTT) remain key players in investment in the digital economy. China has unveiled a host of administrative reshuffling and policies to execute its *Made in China 2025* Plan. But the implementation of these policies still requires the support and cooperation of local governments, private firms (i.e. Tencent or Alibaba), and state-owned enterprises (telecom companies, construction firms).

How then are particular forms of territorial sovereignty in each country intertwined with the rollout of digital policies and infrastructure? Here, I primarily discuss the importance of two dimensions of territorial power—(i.) control over land and physical infrastructure, and (ii.) central-local fiscal relations. Both of these are crucial factors in the trajectory and development of digital developmental policy, including data sovereignty but also in terms of the rollout of specific digital infrastructures and the question of who benefits from the extraction of data from cities and regions. Conversely, the increasing emphasis on data extraction as an engine for

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[238] Interview, ST Engineering (2023)

national development may transform existing dynamics of territorial governance within nations. These themes will be further explored in the subsequent case study chapters.

Land Ownership Systems and the Digital Economy

Singapore's "Smart Nation" may have been one of the first national digital plans to incorporate the smart city. Of course, this wasn't a huge leap to go from a smart city to a smart nation in a city state where the "city" is essentially contiguous with the nation. The rollout of cyber-physical infrastructure is also facilitated by Singapore's state land ownership system—the state has acquired roughly 90% of the country's land. Shatkin called Singapore "the most extreme and influential example of urban planning under state capitalism,"[239] and Haila has similarly termed both Singapore and Hong Kong "property states" in which "real estate has an important role in the functioning of the whole economy."[240] Today, Singapore's land is primarily managed by several Singaporean statutory boards and agencies—public housing, which houses around 80% of Singaporeans by Housing Development Board (HDB); industrial estates by Jurong Town Corporation (JTC) that itself controls 10% of the country's land, green spaces by NParks, and a variety of other land by the Singapore Land Authority. The Urban Redevelopment Authority (URA) is the master planning agency that lays out long-term national land use plans and detailed plans for each of Singapore's planning areas. The Land Transport Authority (LTA) is also a significant player for managing the country's transportation infrastructures. The deployment of cyber-physical infrastructures depends on coordination between digital transformation bodies (i.e. Smart Nation) and the various 'stat boards' that manage the bulk of the city state's land and physical buildings. While Singapore's small size may imply a lack of center-local conflict seen in larger countries, territorial politics is still evident. The relative autonomy of Singapore's stat boards in comparison to the relatively recently created Smart Nation makes these "physical" agencies critical actors in implementing nationwide digital transformation projects.

After China's 1949 Communist revolution, virtually all land was gradually defined as nationally owned. In the planned economy that prevailed until the 1980s, state-owned enterprises were

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[239] Gavin Shatkin, "Reinterpreting the Meaning of the 'Singapore Model': State Capitalism and Urban Planning: The 'Singapore Model' of State Capitalism," *International Journal of Urban and Regional Research* 38, no. 1 (January 2014): 116–37.
[240] Anne Haila, *Urban Land Rent: Singapore as a Property State* (John Wiley & Sons, 2015).

often granted control over urban land, what Hsing termed "socialist land masters."[241] When China initiated reforms to create a housing market, it turned to Hong Kong as a model for how municipalities could use their control over land for development.[242] With the 1988 Land Law, municipalities were formally declared as representatives of the state and given power to lease land to private companies or developers, which began to shift power away from state-owned enterprises or "socialist land masters" to municipal governments for control over urban land.[243] What is now often called *tudi caizheng* "land finance"[244] took off following Zhu Rongji's 1994 tax reforms, which reduced the amount of commercial and business tax revenue available to municipalities. After the reforms, land leasing skyrocketed as a percentage of municipal revenue, considered "off-budget" until 2007 but gradually incorporated into formal budgets. Some have called this a "grand bargain" between center and localities that allowed cities to make up the funding deficit through land leasing.[245] Following the 2008 global financial crisis China's stimulus injected 4 tr RMB ($586 bn), mostly for infrastructure. Local debt increased from 1.7 trillion yuan in 2007 to 6.6 trillion in 2010 and doubled in 2014.[246] A new financialized model began to take shape around this time involving the growing importance of "local government financing vehicles/platforms" LGFV, or *rongzi pingtai*, "entities established by the local governments through injection of land, equity and other types of capital and undertake financing functions for governmental investment projects."[247] The number of LGFVs grew from 306 in 2007 to 8221 in 2009.[248] Local governments were unable to borrow externally until the 2014 Budget Law, but

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[241] You-tien Hsing, *The Great Urban Transformation: Politics of Land and Property in China* (Oxford: Oxford University Press, USA, 2012).

[242] Hong Kong's system of state land ownership dates to the British colonial system of "state leasehold land," whereby the British Crown owned land on Hong Kong island but issued long-term (often 99 year) leases

[243] Meg Rithmire, *Land Bargains and Chinese Capitalism* (New York, NY: Cambridge University Press, 2015); Tao Liu and George C. S. Lin, "New Geography of Land Commodification in Chinese Cities: Uneven Landscape of Urban Land Development under Market Reforms and Globalization," *Applied Geography* 51 (July 1, 2014): 118–30; You-tien Hsing, *The Great Urban Transformation: Politics of Land and Property in China* (Oxford: Oxford University Press, USA, 2012).

[244] Joseph Gyourko et al., "Land Finance in China: Analysis and Review," *China Economic Review* 76 (December 2022): 101868; Dingxi Huang and Roger C.K. Chan, "On 'Land Finance' in Urban China: Theory and Practice," *Habitat International* 75 (May 2018): 96–104.

[245] Adam Y. Liu, Jean C. Oi, and Yi Zhang, "China's Local Government Debt: The Grand Bargain," *The China Journal* 87 (January 1, 2022): 40–71,

[246] Jianyong Fan et al., "Does Government Debt Impede Firm Innovation? Evidence from the Rise of LGFVs in China," *Journal of Banking & Finance* 138 (May 2022): 106475,

[247] State Council, 2010

[248] Fenghua Pan et al., "Developing by Borrowing? Inter-Jurisdictional Competition, Land Finance and Local Debt Accumulation in China," *Urban Studies* 54, no. 4 (March 2017): 897–916,

were encouraged to use LGFVs to seek external financing.[249] Since around 2014, LGFVs have increasingly turned to issuing "urban investment bonds" or *chengtou* bonds as a way to raise money for infrastructure projects.[250] This represented a new phase of land finance turning more to the capital market to raise funds for urban development, although many such bonds are often still backed by municipal land as collateral injected into or purchased by LGFVs. In 2015, the State Council clarified that local governments could issue Local Government Bonds (LGBs). The current rollout of new city data platforms is occurring in a context where the old model of land leasing is reaching limits, and policy makers are turning to "the digital realm" as a potential new engine both of local economic growth and source of generating local government revenues.Thailand has a much more fragmented system of land ownership, where private property rights are more entrenched and in general the state's control of and ability to requisition land for urban redevelopment and infrastructure is much less than in Singapore and China. However, the royal family through the Crown Property Bureau (CPB) remains a large landowner in Bangkok and elsewhere.[251] Besides royal ownership, land ownership is highly concentrated and unequal, with the top 10% of landowners holding about 60% of all titled land in the country.[252] In the words of a professor at Chulalongkorn University "every time a modern road is built in Thailand, high ranking members of the royal family would claim land along the railroad or road, so much prime land is owned by CPB, because they want to develop the land,"[253] or lease land to political allies as a form of patronage. While not equivalent to Singapore's "state land ownership" or China's local-state land finance system, Thailand's royal land ownership comprises a form of state ownership that lies at the center of the monarchy's grip on political patronage networks.[254] The difficulty of acquiring land parcels for development hinders coordinated deployment of physical and digital infrastructure as in Singapore or China. But large private landholders like CPB, ThaiBev, CP Group, and others play a key role in realizing urban megaprojects and other infrastructure, including digital infrastructure projects in the EEC and Bangkok.

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[249] Fulong Wu, "Land Financialisation and the Financing of Urban Development in China," *Land Use Policy* 112 (January 2022): 104412; Yi Feng, Fulong Wu, and Fangzhu Zhang, "Changing Roles of the State in the Financialization of Urban Development through *Chengtou* in China," *Regional Studies* 56, no. 8 (August 3, 2022): 1259–70,
[250] Feng, Wu, and Zhang, "Changing Roles of the State in the Financialization of Urban Development through *Chengtou* in China."
[251] Porphant Ouyyanont, *Crown Property Bureau in Thailand and Its Role in Political Economy*, *Crown Property Bureau in Thailand and Its Role in Political Economy* (ISEAS Publishing, 2015).
[252] Phongpaichit and Baker, *Unequal Thailand*, 33.
[253] Interview, Professor, Chulalongkorn University (2023)
[254] See Appendix 4: "State and Family Capital in Thailand"

Figure 11. State Landownership in central Bangkok: Purple: Royal or formerly royal (Chulalongkorn), Grey: Government; Lines: Military; Selected projects of the Rama 4 Smart City Corridor highlighted along dotted line (Author, 2024)

Figure 12. Map of land in Singapore; JTC-grey; new projects-black; Green: NParks; Tan: HDB (Author, 2024)

State-Local Fiscal Relations

In each of the cases (though, Singapore to a lesser degree), central-local fiscal relations are closely bound up with the deployment of digital infrastructures including city data platforms. Thailand is a mid-sized country that has a highly centralized fiscal and administrative system. The 76 provincial governors are appointed by the Ministry of the Interior in Bangkok, while the Bangkok governor is elected but the Bangkok Metropolitan Administration (BMA) still falls administratively under the Ministry of Interior, constraining the BMA's actual budgetary independence. Local governance is fragmented, with 2441 municipalities in the country, further divided into 5333 sub-district local government authorities. While local governments can raise taxes from land and buildings, in practice, locally levied revenue only makes up 15% of total revenues, while centrally-levied revenue makes up 32%, shared tax 16% and subsidies 37% of the total revenue.[255] Economic development and political power is still overwhelmingly concentrated in Bangkok and vicinity. In this context, national policies pushed by the military-led NPCO government (Thailand 4.0 and the EEC) may further entrench the country's existing economic centers and regional inequality. Control over urban data in Thailand is also enmeshed in the country's particular system of territorial power. Local governments of secondary cities (like Khon Kaen and Phuket) have little autonomy or ability to generate their own revenue or pursue independent infrastructure, and have turned to digital data platforms as one potential option to generate more revenue. However, Thailand's conglomerates are developing their own platforms (like one developed by state-owned oil conglomerate PTT, discussed further in Chapter 5), that if scaled up to serve municipalities across Thailand would help municipalities generate revenue (and charge them a recurring fee for using the platform) by providing a data platform as a service to municipalities. This could help cities generate more revenue from land and property tax through use of AI and other functions to more accurately assess land, building and signboard tax values.

In China, recent nationwide plans like the "Plan for a Digital China", and "National Informatization Plan" call for integrating city-level urban data platforms into a nationwide system designed to liberate "data" as a new factor of production. China's early smart city projects like Hangzhou's City Brain Platform were largely driven by cooperation between the municipal government and

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[255] OECD (2020) "Budgeting in Thailand"

platform firms (in this case with Alibaba, which is based in Hangzhou).[256] However, during Xi Jinping's administration there have been moves toward greater centralization of political power and an effort to reduce the autonomy of municipal governments and curtail the power of technology platforms. Nationwide policies, like the Plan for Construction of a Digital China and the National Information Plan emphasize smart city infrastructure like city data platforms and cloud supercomputing centers as part of nationwide digital governance efforts. The case of Xiong'an, explored in Chapter 7, shows how the project differs from the Hangzhou-Alibaba collaboration in that the city's digital infrastructure is being developed by a subsidiary of the Hebei province-owned LGFV Xiong'an Group, with minority investment from China Telecom, China's state-owned telecom provider.

In Xiong'an, there is emphasis on integrating a city data platform (in this case, a digital twin) with every aspect of the city's planning, management, and governance. This has implications for urban finance, at a time when there is talk in China of transitioning growth away from real estate to high-tech and digital services. Whereas land leasing served as a key source of municipal budgets, now that this source is drying up, there is a need to replace it with a more sustainable form of revenue. A recurring property tax would be an obvious solution, but one that faces political obstacles. As economist Yao Yang of Peking University puts it, "Most of the major reforms were done in the 1990s, and if you want to do a new reform, those reforms are going to touch the core of the Chinese economic and political system; Interest groups are so strong, many people have so many apartments and they are against it, that's probably the main reason."[257] China's current real estate downturn also makes the government wary to put further pressure on real estate sector, which a property tax would likely do. The State Council began authorizing local tax reform pilots in 2021, and China recently unveiled a nationwide property registration system, a full-scale property tax reform remains unlikely in the near term.[258] Current policy discourse in China emphasizes the need to shift from an economy based on land speculation to one driven by technology innovation and digitalization. As the Xiong'an case will explore, the development of

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[256] Federico Caprotti and Dong Liu, "Platform Urbanism and the Chinese Smart City: The Co-Production and Territorialisation of Hangzhou City Brain," *GeoJournal*, November 3, 2020.

[257] Yao Yang, Peking University, Remarks made at Harvard University, October 6, 2023

[258] Global Times, "China Completes Comprehensive Unified Real Estate Registry, a Boon for Sector Development - Global Times," *Global Times*, April 25, 2023, https://www.globaltimes.cn/page/202304/1289779.shtml.

comprehensive digital twins and urban data platforms is also thought to be a driver for a new revenue model in which city governments can derive more sustainable revenues from a range of services including data and digital services, instead of one-time land sales. In the early years of its development Xiong'an was also tasked with finding a new model of urban finance in China, including "breaking the system of land finance" and "making affordable housing a core competitiveness of the new area."[259]

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[259] Ni, Pengfei Xiong'an Xinqu: Zhongguo chengshi fazhan xin moshi de shiyan "Xiong'an New Area: An experiment of a new model of China's urban development" in *Think Tank Reports on Xiong'an* (Beijing: Chinese Academy of Sciences, 2017).

Figure 13. Diagram of Gardens by the Bay showing supertrees, subterranean cooling system, energy generators (Author, 2024)

Introduction: A garden where technology grows alongside the flora

Looking out from the top of the Supertrees at Gardens by the Bay, the first thing one notices are the photovoltaic solar panels that ring each of the massive "trees" that also feature spindly purple rods as "branches." Further out, the Singapore Straits are pockmarked with container ships at anchor in one of the world's busiest shipping channels. The Supertrees are now iconic symbols of Singapore, but they are also functioning pieces of a biomass waste-to-energy generation system. Most of the trees are covered in solar panels, and some of them also funnel exhaust from a facility that converts biomass into energy, built beneath Gardens by the Bay. Buried under the visitor center of the gardens themselves is an underground infrastructure network comprising a facility for processing biowaste from across the island and turning it into heat and cooling. A Singaporean company called Ecowise processes biowaste from across the island, turns it into pellets that can be incinerated at special facilities like the one in Gardens by the Bay. Then, the steam is used to generate electricity which is sent to a substation at another location in the Gardens where it is mixed with energy from the grid. Some of the heat exhaust is used to warm the glass conservatories where tropical and warm climate plants are displayed, while some of the hot water is channeled to an "absorption chiller" where it produces cold water to cool the conservatories housing cold climate flora. As visitors ascend the iconic Supertrees to take selfies and marvel at the collected flora in the cooled greenhouses, most are unaware of the technological testbeds and subterranean infrastructures that are hidden below the lush gardens.

A landscape architect who works for Gardens by the Bay is driving me in a golf cart through the "back of house" operations center, which includes underground staging areas beneath the two glass superdomes and the biomass electricity generation facility. "Previously there was an idea to make the energy generator more 'front of house' and visible for tourists than it currently is."[260] She describes a variety of new initiatives to trial technology in the garden, including a pilot project to deploy sensors that can monitor tree tilt for —each sensor costs around $300 and the data can be aggregated to provide a picture of overall tree health across the gardens. The Gardens has just signed a contract with a local solar panel company to cover selected horizontal surfaces of the gardens, such as greenhouses, with PV solar panels to generate electricity, and with a small

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[260] Interview, Gardens by the Bay landscape architect (January 2024)

local startup company operating drones for a contract to inspect the functioning of the high-tech supertrees and the health of actual trees. "A lot of Singaporean startups want to work with us so they can say 'we deployed our technology in Gardens by the Bay,' and we get some experimental technology for very low cost," she tells me.[261] There is an "ad-hoc" committee of various experts within Gardens by the Bay organization that includes architects, horticulturists, and technologists who come together to recommend new technological innovations for the Gardens.

Gardens by the Bay opened in 2011 and quickly became an iconic tourist destination for the city and anchor of the Marina Bay District built on reclaimed land adjacent to the city's CBD. The idea for Gardens by the Bay emerged from the leadership of Kiat W. Tan, the former director of NParks, the agency that manages Singapore's natural spaces, and who had helped nominate Singapore's older British-colonial era Botanic Gardens for UNESCO world heritage status. Gardens by the Bay served to both reinforce and innovate upon Singapore's longstanding identity as a "city in a garden" a phrase attributed to founding Prime Minister Lee Kuan Yew. In his early years as Prime Minister made beautification of the physical landscape a core part of his strategy for economic development of the former British colonial entrepot.

In 1963, Prime Minister Lee Kuan Yew launched the "Clean and Green Campaign,"[262] involving tree-planting and improving cleanliness across the island. Administratively the National Parks agency was incorporated under the powerful Ministry of National Development.[263] As Belinda Yuen describes, this early push involved a "vigorous developmentalist orientation that emphasizes numbers: to plant as many trees as possible along the major roads and streets, particularly in the Central Area."[264] As Lee Kuan Yew made clear, greenery was mobilized to attract inward investment, "One arm of my strategy was to make Singapore into an oasis in Southeast Asia, for if we had First World standards then businessmen and tourists would make us a base for their business and tours of the region."[265]

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[261] Ibid.
[262] Peter Newman, "Biophilic Urbanism: A Case Study on Singapore," Australian Planner 51, no. 1 (January 2, 2014): 47–65
[263] Ibid., 48
[264] Yuen, "Creating the Garden City," 962.
[265] Centre for Liveable Cities, National Parks Board (2015)

Before Gardens by the Bay there was the Singapore Botanic Gardens, founded in 1859 as a British colonial institution and part of a larger British imperial project of economic botany. The botanic garden was the setting for scientific research, namely the discovery of tropical plants that could be exploited economically in Singapore and in other British colonies in Southeast Asia and beyond. As Henry Murton, an early director of the Singapore Botanic Gardens wrote in 1875, "I shall endeavor to represent, systematically arranged, all the plants yielding economic and medicinal products which are amenable to cultivation in this climate."[266] The Singapore gardens helped cultivate coffee imported from Ceylon, orchids, rubber plants, and many others. Following the British departure, the botanic gardens lost their role as a key node in global scientific enterprise in the 1960s and 1970s and were seen as a relic of colonialism. Eventually they were rehabilitated as part of Prime Minister Lee Kuan Yew's efforts to beautify the city and provide species for citywide planting efforts. When Dr. Tan Wee Kiat assumed the role of Director of the Botanic Gardens in 1983 he expanded the role of the gardens, proclaiming to "Make Singapore our Garden"[267] and would eventually champion and oversee development of the Gardens by the Bay project that was announced in 2005 and completed in 2012. Designed by U.K.-based Grant Associates, the new garden features 1.5 million plants and two of the world's largest greenhouses. The site also features Malay, Chinese, and Indian gardens, in recognition of Singapore's main ethnic groups, and a "Colonial Garden" in recognition of Singapore's colonial history.[268]

Today, the Gardens by the Bay are not only a tourist attraction and symbol of Singapore but also a testbed for new technologies of Singapore's "urban solutions sector". Whereas the colonial-era Botanic Gardens was a testbed for new plants the British hoped to cultivate for economic production across their colonies in Southeast Asia, today Gardens by the Bay is a testbed for new green technologies being developed as part of Singapore's push to become a "smart nation." Gardens by the Bay is perhaps the most iconic but not the only such testbed for technology within Singapore.

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[266] Barnard, Timothy P. *Nature's Colony: Empire, Nation and Environment in the Singapore Botanic Gardens* (NUS Press, 2016).
[267] Ibid., 249.
[268] Peter G. Rowe and Limin Hee, *A City in Blue and Green: The Singapore Story* (Singapore: Springer Singapore, 2019), 91

In this chapter, I explore how various districts within Singapore have become testbeds for urban technologies, many as part of the Smart Nation Project. These projects serve as *"showcases"* in multiple senses of the word—for example, (i.) symbolically the Gardens are showcases of Singapore's identity as a "City in a Garden", (ii.) a showcase for new technology developed under the aegis of government initiatives like the Smart Nation, (iii.) showcases for the senior managers of Singapore's agencies, and (iv.) a showcase for Singaporean companies looking to deploy their new products in high-profile settings, often with the goal of exporting that technology internationally. This is an imperative for most Singaporean companies, given the island's small market size. And while many of the showcase projects within Singapore are developed by government agencies also known as "statutory boards", related technologies are often then exported abroad by commercially-oriented infrastructure firms, most of which are owned by Temasek, Singapore's sovereign wealth fund. Because of the importance of the "urban solutions" sector to Singapore's economy, certain districts and sites are effectively remade into testbeds and showcases for those solutions. Collectively the city has become a showroom.

Smart Nation: A New "Pilot Agency" for Whole of Government Digital Transformation
In 2014, Prime Minister Lee Hsien Loong unveiled the "Smart Nation Program," calling for Singapore to become "a smart nation, a nation where people live meaningful and fulfilled lives, enabled seamlessly by technology, offering exciting opportunities for all. We should see it in our daily living where networks of sensors and smart devices enable us to live sustainably and comfortably." [269] Whereas Singapore had an IT masterplan as early as 1980, Smart Nation involved a more comprehensive "whole of government approach to digitizing various aspects of urban life,"[270] As Lee said during his 2014 speech unveiling the program:

> "To realise this vision, I think we have to pull the pieces together from all over the
> Government. We will set up a Smart Nation Programme Office. Today, the Government
> departments are all variously doing their own thing – LTA, URA, MOM and so on. Our
> research institutes are doing their own things, R&D institutes like A*Star are doing things

[269] Prime Minister's Office Singapore, "PM Lee Hsien Loong at the Smart Nation Launch,", (November 24, 2014), https://www.pmo.gov.sg/Newsroom/transcript-prime-minister-lee-hsien-loongs-speech-smart-nation-launch-24-november.
[270] Smart Nation Programme Office 2016

like helping NLB sort books at night using robotics and sensors, quite interesting programmes, but we need to bring them together. We can go much further if we can put it together, to identify issues, prototype ideas, deploy them effectively to benefit the whole nation."[271]

A few years later in 2017 in response to criticism voiced by Prime Minister Lee himself that "we are really not going as fast as we ought to,"[272] the Smart Nation Program was reorganized. The lean team of Smart Nation Programme Office lacked the technical capacity to develop its initiatives and faced resistance from ministries and agencies with entrenched systems and ways of doing things. In May 2017, the Smart Nation Digital Government Office (SNDGO) was set up under the Prime Minister's office, and GovTech, the statutory board under the Ministry of Communications and Information was placed within SNDGO.[273] GovTech has since grown to be a 3,000-employee in-house software development and technical agency to implement Smart Nation policies. GovTech is the successor to the old National Computing Board, previously under the Infocomm Media Development Authority (IMDA), an agency under the Ministry of Communications and Information (MCI). The SNDGO would be responsible for overseeing many different initiatives including e-government platforms, boosting digital literacy, cybersecurity, streamlining data protocols across government agencies, E-Payments, creating a National Digital Identity (NDI), and the "Smart Nation Sensor Platform" (SNSP) that aims to deploy IoT connected sensors in various domains.

Smart Gardens as a Showcase for the Smart Nation Sensor Program

One of the showcases for the Smart Nation Sensor Platform was the "Smart Garden" project, which sought to deploy various IoT sensors throughout Gardens by the Bay as a testbed for using IoT in biotic environments. According to a project engineer, the project begun in 2020 with a grant from the Smart Nation Fund and the Ministry of National Development, which oversees Gardens by the Bay.[274] "It's SNDGO that came up with it initially, there's probably a mandate to

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[271] Prime Minister's Office Singapore, Ibid.
[272] Belinda Tan and Yimin Zhou, *Technology and the City: Foundation for a Smart Nation*, First edition, Urban Systems Studies (Singapore: Centre for Liveable Cities, 2018). Pg 96
[273] Ibid., pg 96
[274] Gardens by the Bay is a company but overseen through the Ministry of National Development (MND)

work on smart lighting or smart systems, and there was an opportunity to use Gardens by the Bay as a test site for new technologies."[275] The idea was to deploy a variety of sensors to measure things like nitrate levels in the gardens to prevent algae blooms caused by overfertilization, measure visitor levels, and deploy lights that would automatically turn on and off when visitors approach, which could save up to 40% in energy usage. According to an engineer from GovTech who worked on the project, the product they were tasked with developing is a "middleware" platform to manage data from the myriad types of IoT devices that might be deployed. "We're working with the agencies like Gardens by the Bay or NParks to build up applications with them, it's a bit of hand-holding project really. A lot of the use cases for using IoT devices in horticulture haven't been defined yet."[276] The landscape architect with Gardens by the Bay commented that heavy amounts of fertilizer are used to keep the grounds lush throughout the year, in line with visitor expectations. Using sensors to determine more optimal fertilizing requirements could save money and resources and also minimize algae bloom in the water caused by fertilizer runoff.

However, according to a Director with Smart Nation Group, there has been skepticism of the utility of solutions deployed in the Smart Garden project. "I feel like the project was a bit tech-led, it wasn't designed that way, but that's how its evolved."[277] This particular director noted that deploying sensing technology in the gardens might just end up re-allocating labor from service-intensive staff roles to management. The initial idea was to aggregate data from a variety of sensors installed across the park and feed them into a centralized dashboard that management in an operations center would oversee. But as the Smart Nation director noted, "If you don't deploy smart devices smartly, you're just shifting labor around and not making things more efficient." And, he notes that NParks, the agency responsible for managing the much larger entirety of Singapore's green spaces, has gone further than Gardens by the Bay in deploying digital technology. In 2018, NParks, the agency responsible for managing most of Singapore's green spaces, released Trees.sg, an online virtual database of 500,000 trees on the island, with the ultimate aim of plotting every tree in Singapore. "What [NParks] has done is they've asked themselves as a gardener of the city, with 5 million trees, 1.5 are along the roads, if you need to

[275] Interview, Director of Smart Cities, Govtech (2023)
[276] Ibid
[277] Interview, Smart Nation Director of Smart Cities (2023)

make sure the trees are healthy, deploy landscapers to prune the trees, how do you decide, prioritize which to decide, 1.4 million trees, only 8 trees a day, so how do you look after this while controlling the value of labor, cost control, you want to keep natural assets healthy but at the same time we have limited resources; technology allows."[278]

Smart Gardens in Singapore's iconic Gardens by the Bay is a "showroom" project, building on the city's identity as a "city in a garden" to serve as a showcase of how digital technology could be integrated with natural environments. It also serves as a visible showcase for small local startups seeking to test or experiment with technology and use the reputation of Gardens by the Bay to sell their products outside of Singapore. Additionally, it helped test ideas that were later adopted by NParks, the agency that manages the country's green spaces.

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[278] Interview, Ibid
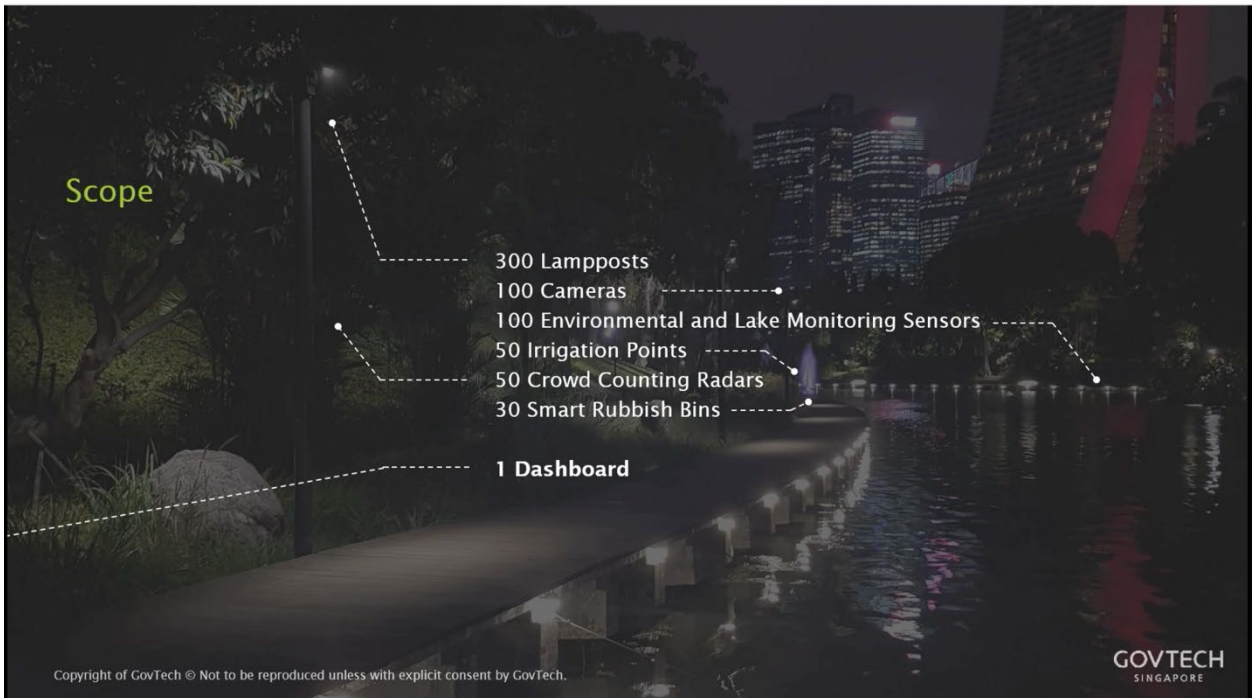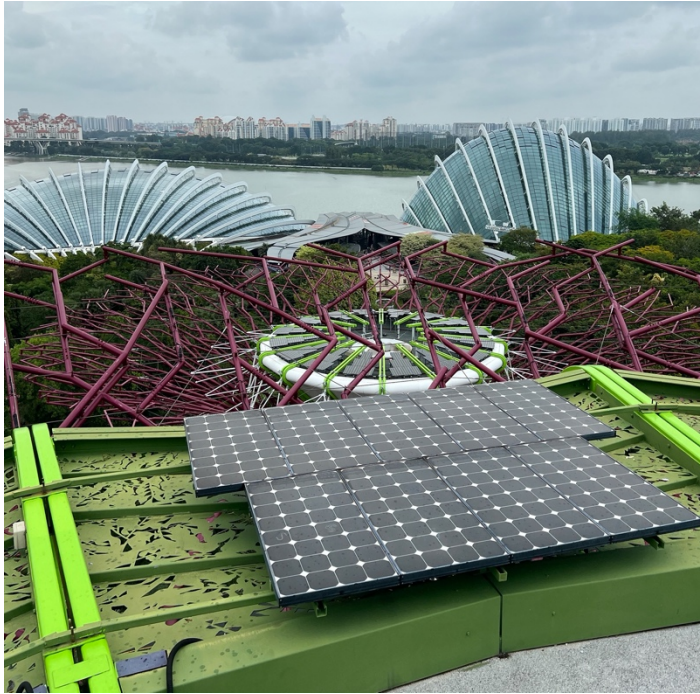
Figures 14 a-c: Above left (a): photovoltaic panels on the supertree viewing decks (Author, 2023); Above right (b): diagram of renewable energy generation system at Gardens by the bay; Bottom (c): Diagram of smart gardens project (GovTech, 2022)

Displayed in Singapore, Exported Abroad: the Case of Smart Lampposts

Another project overseen by SNDGO originated as a way to develop a common platform for sensing technology that could fit sensors for weather, traffic, and even crowds onto a so-called "Smart Connected Lamppost." The idea was part of the Smart Nation Sensor Platform (SNSP), which sought to develop common hardware platforms and software protocols to standardize IoT data and aggregation across Singapore. Initially the "project came about because LTA wanted to switch street lighting to more energy-efficient LED with a remote control and monitoring system" but was then encouraged by the SNPO to "consider exploiting excess power and communication links embedded in the new street lamps to mount additional sensors that could serve other agencies."[279] The idea was for Smart Nation to "collaborate with the Land Transport Authority to leverage its existing lamppost infrastructure to test the feasibility of deploying a shared network for wired and wireless sensors transmitting environmental data such as temperature and humidity."[280]

But the Smart Lamppost failed to gain traction in Singapore largely due its cost and the lack of demand from diverse needs of agencies it was intended to serve. According to an engineer with GovTech, "The demand for sensors was actually quite low and not that even across the board. Only specific agencies. It didn't make that much sense to provide the same system for different agency needs. It was hard to tell at the time if this idea would pan out. Over the years there was a realization there could be a more flexible way of doing this. Mobile posts seem to work better."[281] Another GovTech employee put it more bluntly, telling me that "the Smart lamppost project is almost like a taboo now in Singapore, we don't talk about it."[282] In 2023 the Smart Lamppost project was formally ended by Jacqueline Poh, CEO of GovTech.

Even if the Smart Lamppost failed to gain traction with government agencies in Singapore, that hasn't been the end of the story. ST Engineering is one of Singapore's state-owned infrastructure companies whose core business is defense hardware and system integration.[283] It also operates

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[279] Tan and Zhou "Technology and the City", 95
[280] Smart Nation Factsheet
[281] Interview Smart Nation/GovTech (2023)
[282] Interview, GovTech Engineer (2023)
[283] Majority owned by sovereign wealth fund Temasek, referred to as a GLC, or "government linked corporation"

a growing Urban Solutions business line comprising its proprietary AGIL suite of smart city and IoT solutions, including the AGIL Dashboard for managing IoT devices, and the AGIL Smart Lamppost. The products are designed to be sold as a package of hardware and software solutions for cities: "ST's suite of IoT solutions help smart cities to manage multiple smart city applications on a common platform. Its open architecture design leverages best of breed technologies and standards to facilitate data exchange and analytics, while generating valuable insights to improve quality of city services and enhance operational efficiency."[284]

According to an engineer who worked with ST's Urban Solutions division, "Although the street lighting thing didn't take off in Singapore it did elsewhere, we got lucky overseas [with the smart lamppost project]. Other things did not take off here or elsewhere." Brazil has become a large market for ST's smart lighting solutions. ST has a close working relationship with Singapore's Land Transport Authority (LTA). ST has been working with LTA for decades, we develop a lot of technologies for LTA and we eventually sell overseas; we won a project for traffic management for Abu Dhabi, about four or five times as big as Singapore."[285] The former Chief Executive of the Land Transport Authority Men Leong Chew is currently the head of ST's Urban Solutions business line.

In this way, the legal separation between statutory board and so-called "government-linked corporations" (GLC) allows for state subsidies of initial unproven technologies. But the close cooperation and circulation of managers between LTA and ST, and ST's contracts with LTA blur the boundary between state agency and government-linked corporation. Projects like the smart lamppost originating from national programs like Smart Nation can serve as showcases for technologies that are then exported and sold abroad by commercial firms. These include Temasek-owned firms like ST Engineering, Keppell, and Surbana Jurong. In fact, many of these companies or divisions of them were originally spun off from government agencies themselves. One of the earliest spinoffs was the creation of Jurong Town Corporation (JTC) in 1967 from a division of the Ministry of National Development. JTC has developed and managed the large Jurong Industrial Estate the city's northwest as well as many other industrial and commercial

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[284] ST Urban Solutions Brochure (2022)
[285] Interview, ST Engineer (2023)

properties. In 2001, JTC International was transformed into Jurong International Holdings (JIH), focusing on providing master planning and engineering expertise. In 2003, the building and development division of the HDB was separated and corporatized as HDBCorp, and subsequently acquired by holding company Temasek and rebranded as Surbana. In 2015, Surbana was integrated with JIH and was rebranded as Surbana Jurong. The city's Changi Airport, long rated one of the world's best, was corporatized in 2009 as Changi Airport Group (CAG), which now operates and consults on airport development around the world. The cooling division of Keppel was also previously part of JTC.[286]

By "spinning off" parts of state agencies into commercially oriented firms, the firms can take technology initially developed through state projects within Singapore and sell them abroad, particularly in developing countries. Singapore's "urban solutions sector" has emerged largely due to the island's success at planning its domestic environment, but is now an important export industry in its own right. This ecosystem depends on the interplay between three broad categories of organizations: (i) agencies like the Prime Minister's office which oversees GovTech and Smart Nation and provides guidance for overall technology policy, (ii.) the statutory boards like Housing Development Board (HDB), Jurong Town Corporation (JTC), and NParks that manage the bulk of Singapore's land and built environment, and (iii.) government-linked companies (GLCs) like Surbana Jurong, Keppel, ST Engineering that can sell urban solutions abroad. The development of showcase or pilot projects within Singapore serves as an important site of collaboration between these three types of agencies. While many of the projects are undertaken for symbolic purposes, they also have spinoff products and effects that are often not realized immediately but can pay off at later stages.

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[286] Interview, Keppel Infrastructure (2023)

AGIL Light
SMART LAMP POST

ST Engineering

Figure 15a. (left) Conceptual graphic for Lamppost as Platform (Smart Nation)

Figure 15b (right) Smart Lamppost as Commercial Export (ST Engineering)

Figure 15c. Screenshot of Punggol Digital District's "Open Digital Platform" (JTC, 2023)

Building a Digital Twin: From Nationwide to an "Open Digital Platform"

As I enter the lobby of JTC Summit, the headquarters of Jurong Town Corporation, a friendly-looking robot roving around the lobby watches me as I proceed to an escalator heading up to meet with the CEO Mr. Boon Khai Tan. Later when I'm viewing a virtual representation of the lobby in a demo of JTC's "Open Digital Platform" (ODP) virtual twin, I watch roving robots tracked in real time as they glide around the building, delivering mail, calling elevators and ascending a moving escalator. The robot is able to communicate with the ODP system, allowing it to be tracked as it moves through the building, represented in real time in the ODP. The robot can also talk to the door and elevator systems through WiFi, calling the elevator. The robot calls the elevator, but it still has to wait for an actual human who called the elevator in the normal analog fashion. Sensors installed on the elevator system collect data on the utilization of the elevator, and patterns of use, allowing energy usage to be optimized or reduced during downtimes. This is Singapore's latest effort to build a digital twin.

From the offices of JTC Summit, CEO Boon Khai Tan looks out over the wide expanse of Singapore's original industrial zone stretches out from the emerging second CBD of Jurong East to the offshore petrochemical refinery complex Jurong Island. As Mr. Tan tells me, the government's ability to acquire land, formalized in the 1966 Land Acquisition Act, "made some people very unhappy but ultimately it allowed Singapore to reinvent itself almost on a clean slate,"[287] such as its development of the original Jurong Town and its ongoing efforts to develop new state of the art districts embedded with digital technologies such as Jurong Innovation District (JID) and Punggol Digital District (PDD).The control of physical infrastructure continues to be a key factor in Singapore's ability to allocate new land to specific purposes, such as emerging industries of the future. Control of land and physical infrastructure also allows the test-bedding of technologies such "Open Digital Platform" or ODP on a scale mostly unthinkable in other contexts. Google's Sidewalk Labs was a case of a private technology platform trying to build a digital city from the ground up, but it failed largely due to citizen concerns over data ownership and Google's limited ability to control land development in Toronto, where the project was to be built. When I asked Mr. Tan about the parallels with Sidewalk Lab's failed project in Toronto, he said that "What we're trying to do is the opposite," Mr. Tan tells me, "At the end of the day we

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[287] Interview Boon Khai Tan, JTC (2023

are a facilities management company trying to infuse digital technology into the infrastructure from the very beginning."[288]

In 1968, Jurong Town Corporation was separated from the Economic Development Board to manage Jurong Town, developed to be the independent nation's heavy industrial zone featuring shipbuilding facilities, oil refineries, and numerous factories to attract multinational and local firms. Today, JTC manages 90% of Singapore's industrial land and 10% of its overall land area, and develops new industrial parks in line with strategic national priorities. Two of its most anticipated showpiece "smart districts" are Jurong Innovation District being built on land in the Northwest corner of Singapore near Jurong's original industrial zone, which will focus on "advanced manufacturing," and Punggol Digital District, which is being built in the northeast corner of Singapore in the new town of Punggol. Punggol Digital District is a 50-ha commercial district described by JTC as a "strategic national project" and a "showcase for smart nation initiatives."[289] The new town of Punggol in Singapore's northeast itself houses around 180,000 residents currently. At the core of this is Punggol Digital District, which is expected to provide 28,000 jobs and is envisioned as "Singapore's smart and sustainable business district, housing key companies in key digital growth sectors: AI, fintech, cybersecurity, blockchain, and smart living."[290] Already, a range of companies have announced plans to open offices there, including Chinese firm Wanxiang Blockchain, Germany's Group IB, Boston Dynamics, and Delta Electronics (Taiwan). PDD will co-locate offices next to a campus of Singapore Institute of Technology.

Singapore's first attempt to build a Digital Twin, Virtual Singapore, was begun in 2014 as one of the first projects under the newly-created Smart Nation office. In his announcement of Smart Nation, Prime Minister Lee Hsien Loong declared, "we are going to launch a new project called Virtual Singapore, the idea is to develop an integrated 3D map of Singapore enriched with layers of data about buildings, land and the environment. It will be a platform to bring the Government, Citizens, Industry and Research Institutions together to solve problems, for example to simulate wireless coverage or effects of heavy rain. What that means is to find out where it floods when

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[288] Interview, Boon Khai Tan (2023)
[289] JTC (2023) Punggol Digital District https://www.jtc.gov.sg/find-space/punggol-digital-district
[290] Interview Estates Manager JTC (2023)

it rains." Virtual Singapore was a collaboration between the National Research Foundation (NRF), GovTech, and Singapore Land Authority (SLA). French company Dassault Systems was also brought in as partner to help develop the 3D modelling platform in coordination with NRF. Virtual Singapore was conceived of as the "country's authoritative platform built on topographical as well as real-time dynamic data, an authoritative platform that can be used in simulations and virtual tests of new solutions to urban planning problems."[291] The Singapore digital twin used LiDAR to scan a 3D model of Singapore, as well as integrating geospatial data from various government agencies. Potential use cases were imagined as "simulating the potential and impacts of environmentally sustainable green features such as solar panels, green roofs, LED lights." and allowing communities to "leverage this modeling tool to co-create solutions and make collective decisions to improve their neighborhoods."[292]

Digital twins have become a popular technology concept that can theoretically be used to model any complex system or product. They have been built to model and test performance of jet engines, and in factories to monitor production processes. According to a McKinsey report, "A digital twin is a digital representation of a physical object, person, or process, contextualized in a digital version of its environment. Digital twins can help an organization simulate real situations and their outcomes, ultimately allowing it to make better decisions."[293] According to a report by PwC, "A digital twin can continuously collect information from the built environment via technologies such as sensors, drones and mobile devices to present an up-to-the-second picture. An urban digital twin would receive data from sources including vehicles, buildings, infrastructure and individuals. This is further enhanced with data captured by smart city devices and the Internet of Things (IoT) and additionally augmented by the use of artificial intelligence (AI) and advanced analytics"[294] For example, in the context of a city, data on weather could be fed into data models of transportation, to look at how weather affects transportation patterns, and then automatically adjust traffic lights or subway schedules depending on weather.

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[291] Centre For Liveable Cities "Technology and the City: Foundation for a Smart Nation" *Urban Systems Studies,* 59 (2020)
[292] Ibid, 60
[293] McKinsey, "What Is Digital-Twin Technology?" (McKinsey & Co, July 2023).
[294] PWC "How digital twins can make smart cities better" (PWC, 2022)

In 2011, Joe Paradiso of the MIT Media Lab oversaw the DoppelLab Project that took "streams of data collected by sensors placed throughout an environment and renders the information in graphic form, overlaying it on an architectural computer-aided design (CAD) model of the building."[295] The sensors collected data on sound and audio from microphones, which were muffled to guarantee privacy, but when aggregated could visualize patterns of building activity in real time, and uncover patterns and relationships. The DoppelLab is described as a "reality browser."[296] In essence, an early prototype of a digital twin before the term entered the global discourse. "I've only heard about this concept of 'digital twin' in the last few years," Paradiso told me in his MIT Media Lab office surrounded by various equipment from years of experiments developing sensing technologies. "Back then [with DoppelLab] We weren't doing it for a purpose, we were doing it for an experience, it was purely about that." Paradiso also oversaw another project called the Living Observatory at Tidmarsh Farms, which embedded sensors to collect audio and visual information from a natural environment, a 480-acre cranberry bog wetland managed by the Massachusetts Audubon Society near the historic town of Plymouth. At the time, Paradiso had expressed a less commercial and more poetic vision for how sensing technology might "get our noses off the smartphone screen and back into our environments. They will make us more rather than less present in the world around us."[297] This is an optimistic view of "[sensing technology]..will fold into our existing systems of sensory processing rather than further displacing them."[298] Paradiso and his team were exploring the "digital twin" as a "reality browser," although their application in industrial and corporate settings largely stems from their utility as a tool for modeling and simulation tool. Singapore's efforts to build a digital twin aim to enable more advanced forecasting and modelling of the interconnection between various urban systems. But the desire to build a "replica" of the city state in miniature also seemed to stem from the imaginary of the city state as an island that can be optimized, such as through careful planning and design of its limited land and resources since the 1960s.

However, Virtual Singapore largely failed to live up to the lofty expectations for it. JTC's Boon Kai Tan, who was CEO of SLA from 2015-2020 during the time Virtual Singapore was being developed

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[295] Gershon Dublon and Joseph A. Paradiso, "Extra Sensory Perception," *Scientific American* 311, no. 1 (2014): 36–41.
[296] Ibid.,39
[297] Ibid.,31
[298] Ibid., 41

reflected to me on the experience, "We try not to have a solution looking for a question...we had that problem building the first digital twin under NRF, a beautiful twin was built but it had to go around looking for problems, after a while many of the functions couldn't match the questions they were trying to ask."[299] Sharing of data between agencies, something that a digital twin might facilitate, also proved to be a problem in practice. According to a researcher who consulted on Virtual Singapore, one possible way around this is to try to design a system in which agencies don't have to fully share all of their data but rather "black-box" certain data while sharing only aggregated or de-identified data into the model. "The bus operators have their model, LTA has their model, Grab has their model, you can interlink these models even if each of them is not able to look into the other models."[300] But this leads to fragmented digital twin as opposed to something that could represent the entirety of Singapore and its multiple infrastructure systems.

Singapore's current effort to build a digital twin is the "Open Digital Platform" (ODP), which is a more limited digital twin being co-developed between JTC, GovTech, and ST Engineering (EDB, 2022), although according to James Tan, one of the leaders of the project who was at GovTech and recently moved to JTC, "The original plan was for Govtech, JTC and STE to build this together. However, we took too long to ink an agreement and by the time when we did, JTC and Govtech already completed the backbone of the ODP. In this case STE is now working only on the workflow and asset management."[301] The ODP is part of JTC's new Punggol Digital District, a new innovation district being built in the far Western area of Punggol designed to attract cybersecurity and other digital firms. The ODP will integrate various types of data on building systems within the estate, "mainly centered on facilities management side, the district data center where we collate the usage data, in terms of air conditioning usage, how are the buildings performing in terms of heat gain and loss...so mainly centered on daily operations of the building."[302] Connecting various building systems into one digital platform requires middleware, as GovTech has been developing as part of its focus on creating software platforms that allow various connected devices to talk to each other and aggregate data. "What we are trying to do where each building system is integrated with the ODP once, and then these systems connect to the

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[299] Interview, Boon Khai Tan (2023)
[300] Interview with Engineer, CREATE-ETH Future Resilient Systems (2023)
[301] Personal Communication JT, JTC (2024)
[302] Interview New Estates Manager, JTC (2023)

ODP like a middleware platform, which in turn connects to the district data center. This also gives us the potential to use this data for facility management, use those data and further optimize the operations of the building and so forth, so broadly it's a middleware platform."[303]

In addition to helping reduce energy use and optimize operations of the district, the ODP is also envisioned as a testbed for companies locating in the space develop their own new innovations. The ODP allows modelling of various scenarios. For example, "Using the data we can use it to create a digital twin for test-bedding that can mimic what the output will be on a set of input parameters, if we were going to test a new BMS (building management system), we would run a simulation on the digital twin to see if it enhances or improves the building performance."[304] The idea is that some of the companies locating in PDD will be focused on technologies with direct application to building systems, such as energy saving, security, or lighting. "We are proposing to use the ODP as a platform to plug in building data or to extract certain building data that is available on the platform…So they can input and extract data on this platform so they can run tests for themselves, such as building performance or energy optimization, so that's the current broad arrangement with the leases or tenants…they can restrict what kinds of data they want to share to this platform."[305] According to JTC, legal arrangements of data ownership are still being worked out, but JTC will likely own and operate the platform itself, and tenants would decide which types of data they will provide or choose not to share with the platform and other tenants and researchers.[306]

Because JTC is the owner and operator of the physical infrastructure, in this case, the real estate, they have the ability to deploy the digital twin within the limited scale of Punggol Digital District. As CEO Boon Khai Tan says:

> "We own the real estate, so technically at least you can have a degree of command
> and control over the infrastructure. Many companies don't have the hardware. So
> with GovTech and SmartNation we thought let's give it a go. The team is quite small,
> around 30 people. I think what we have now seen is if you have the ability to get

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[303] Ibid.
[304] Ibid.
[305] Interview CK JTC (2023)
[306] Ibid. (2023)

the fundamentals right, certain standards and features, it will give us a glimpse of the possibilities."[307]

Whether or not the ODB becomes a model for the rest of Singapore remains to be seen. Tan himself is skeptical that it will: "If you ask me if ODP is the mainstay for Singapore my own sense is no, I think different agencies can build their own digital twins, will JTC go the road of being a tech company, our mainstay will be planning and development, but going forward there will be certain baseline features of a smart district, this is how we think about it at the moment, but because tech changes so fast, you need to be able to adapt."[308] James Tan acknowledged that "Govtech is working on deployment of the ODP outside of JTC in very limited numbers. At this point however it is not clear if we will standardize it. Not everybody wants it or needs it."[309]

However, in a demo of the platform released in October 2023, James Tan, who is now Director of JTC's Smart District Division (previously working with GovTech), showcases how the platform can now pipe in various data from sensors and agencies across Singapore. This includes data on all available taxis in Singapore, data on availability and current occupancy of car parks across all of Singapore, all maritime vessels in the Port of Jurong, and live tracking of aircraft taking off and landing at Changi Airport. More details from IoT sensors, such as live feeds from CCTV cameras, are available in JTC-owned properties beyond PDD such as One North. A detailed building-level digital twin testbed is currently being trialed at JTC's headquarters, known as the Summit, while the Punggol Digital District itself is still under construction. Because JTC Summit was built in 2000, implementing a digital twin on an existing site required updating analog building systems to allow most of the building's systems to be hooked up with sensors that feed into the ODP, offering a glimpse of how a digital twin might be deployed in older buildings or industrial estates, not merely a greenfield district like Punggol.

The case of Punggol Digital District and ODP shows how the urban solutions ecosystem of Singapore involves coordination between national agencies like Smart Nation-GovTech, statutory boards like JTC that manage and own physical assets and infrastructure, and technology firms

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[307] Interview, Boon Khai Tan JTC (2023)
[308] Interview, Boon Khai Tan JTC (2023)
[309] Personal communication, JT JTC (2024)

like ST. While the first effort to build a digital twin at the scale of the entire island, Virtual Twin, did not necessarily pan out as intended, the case of ODP shows how some of the initial vision and technologies evolved to the point where a working digital twin is now feasible. Compared to Virtual Singapore, "ODP was conceived by JTC management. They think they have a problem then they look for partners to build it. Therefore, it is indeed more focused,"[310] Whereas the Smart Garden case begun as a small-scale pilot designed to be expanded from Gardens by the Bay to all of the green spaces across Singapore under the purview of NPark, the experience of developing a digital twin has actually moved in the opposite direction, beginning with a much-heralded nation-scale project that found few use cases. Subsequently, a more focused digital twin is now being developed on a more limited scale by GovTech and JTC by creating a middleware platform for integrating building systems within the "smart district" of Punggol by JTC. But the ODP may eventually be scaled up again into a true digital twin for the entirety of Singapore. The process of technology deployment evolves not only through the sharing of expertise and personnel between agencies, statutory boards, and commercial companies, but also through an iterative process moving between scales of the city-state, neighborhood, and project-level.

Middleware: Common Digital Platforms for Cyber-Physical Integration
This chapter has primarily discussed how technology innovation in Singapore has required testing and deployment in physical districts of the city, a fact that benefits from the unique integrated control of much of the city state's land, buildings, and infrastructure by various government agencies such as JTC, HDB, Nparks, and LTA. However, the "cyber" side of cyber-physical integration also requires the development of common software platforms and frameworks to allow integration across the variety of fragmented systems and hardware in physical environments, many of which were developed before the advent of IoT and are managed by independent agencies with preexisting standards and cultures. A current push of GovTech in the Smart Nation Sensor Program has generally evolved from hardware-centric projects like the Smart Lampposts to what is commonly termed middleware. "This is about integrating things and pulling them together. You need to develop capabilities."[311] As another deputy director with Smart Nation tells me, "The building space is the most fragmented and complex space with the

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[310] Personal Communication, JTC (2024)
[311] Interview, EH GovTech (2023)

largest ecosystem of private and public rules and vendors, so we're trying to figure out in terms of the built environment, if or not there should be a common data standard for building protocols."[312]

GovTech has been developing a common IoT software stack called DECADA, which would provide common protocol to allow IoT devices from a variety of vendors to pipe data into centralized database or dashboard systems, allowing for better analytics to explore interaction between different systems. "GovTech is trying to "standardize infrastructure for Singapore so other different vendors who can navigate within the same space, working with building management infrastructure." The use of middleware platforms is actually crucial for allowing meaningful interfaces between the digital and physical. This is seen in the ODP itself, which at its core involves a middleware platform to aggregate data from highly varied physical building systems, such as within an industrial estate but perhaps eventually across the entirety of Singapore. Thus, deployment requires both the technical standards developed by GovTech as well as deployment within actual physical assets such as those managed by Singapore's stat boards.

In addition to allowing data from different hardware or building systems to be integrated into common platforms like the ODP, creating standards also helps centralize storage and control of data within the purview of the government. "In the past, various vendors [of sensor technologies] would own the data. But we would like it if you a deploy a sensor, the sensor data will be piped into a centralized database, probably the government owns in a cloud somewhere—the vendor can pull data from the database if they need it."[313] Even as Singapore has been recently working to de-classify and move large amounts of non-sensitive data to its "government cloud providers," like Amazon Web Services, state agencies like Smart Nation and GovTech are generally aiming to assert state sovereignty over data generated from the growing array of sensors. "What we want is when government provides data, then the data that is created in the research can come back to the government."[314]

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[312] Interview, ST Smart Nation (2022)
[313] Ibid. (2022)
[314] Ibid. (2022)

Prestige Projects: transfer of ideas and leadership between agencies

Despite the formal separation of agencies, statutory boards, and companies like ST Engineering, there is a high degree of interface between them. There is also frequent rotation of leadership and personnel through top positions at Singapore's agencies, which can be easily discerned by looking at the CVs of any of top management. For example, James Tan was previously leading the ODP at GovTech but then moved to lead the project within JTC. The current CEO of JTC Boon Khai Tan led SLA from 2015 to 2020, helping oversee the Virtual Singapore project during his tenure there, which inevitably shaped his efforts to lead the ODP under his watch at JTC. A similar process of senior management transferring their previous initiatives to different agencies could be seen at the Land Transport Authority where the current CEO Ng Lang moved in 2020 after being CEO of JTC, and before that had been CEO of the SLA, which was the main agency involved in Singapore's first digital twin Virtual Singapore. As a former employee of LTA put it to me, "[Ng Lang] was the one who started the digital twin project. So when he moved to LTA he was trying to foster collaborations to get LTA to use the digital twin project, and that's why we ended up collaborating with them to host the charging platforms on [the ODP]. So people move around and try to force collaborations between the agencies they get to make these things happen and force these collaborations that wouldn't otherwise happen."[315] Projects like Punggol or Jurong Innovation District are also not only showcases for the nation but for senior management. "Jurong Innovation District is like JTC's baby, it's a big showcase, it's really an agency proving it is progressive and innovative that they are managing, so it becomes personal, it's not as much about the agency's technical expertise, but it reflects on the agency's senior management how innovative or progressive they can be."[316]

[315] Interview, Former LTA employee (2023)
[316] Ibid. (2023)

Conclusions

Through an investigation of several urban technology projects in Singapore and well as contextualization within Singapore's overall governance model and historical approaches to development, this chapter has proposed the notion of "city as showroom" to illustrate the unique urban technology ecosystem of Singapore. While the city has long been known for its forward-thinking approach to urban planning, this chapter explores how this longstanding focus on improving the physical environment of the city state translates into its approach to developing digital technologies such as IoT sensors, digital twins, and data standardization through "middleware" software platforms. While the projects highlighted in this chapter can be thought of as "showpiece" projects for their symbolic role in reproducing Singapore's identity as a "garden city," even projects that do not have immediate practical implications can eventually be scaled up, or scaled down. Thus, process tracing (such as in the evolution of the smart lamppost project, and the evolution from a nationwide Virtual Singapore digital twin to a more focused platform developed for single commercial district), helps show how pilot projects function in Singapore's overall ecosystem of innovation. The evolution of projects shows even those "symbolic" projects undertaken for political or somewhat superficial purposes can eventually translate into actual innovations that can also be exported abroad. The Singaporean state's tight control of land ownership, coordination among statutory boards, ministries, and state-owned companies, as well as the imperative to seek global markets all shape this approach to using the city's urban space as a testbed for the urban solutions sector. Even in the small city state of Singapore, territorial politics come into play: coordination between different ministries occurs, but individuals and agencies seek to maintain their own interests and "turf". While Singapore's approach to urban development may be unique given its limited scale, it is important to conceptualize because of Singapore's influence as a model, particularly throughout Asia and the developing world. Singapore's early adoption of smart city visions into a nationwide strategy in 2014 prefaced the broader interest by national governments in the region toward incorporating digital infrastructure into national development strategies, as we will see in subsequent chapters.

Chapter 6. Thailand: Urban data platforms as contested infrastructure in an unequal polity

Introduction

This chapter discusses the ways in which the smart city concept has been operationalized by a variety of actors in Thailand, beginning with a national-led effort through the Digital Economy Promotion Agency (DEPA) to develop "smart cities" through piloting urban data platforms, then following several other cases of digital platforms promoted by entrepreneurial local businessmen, state-owned enterprises, mayors and governors. The current initiative on "smart cities" was disseminated as part of national economic policy (Thailand 4.0) formulated in 2016 after the 2014 coup. But the implementation of digital platforms shows how the concept has been seized on by a range of stakeholders to promote multifaceted uses of urban data platforms, each with a different vision for how urban data should be used to deliver benefits for cities. At the heart of this chapter is a question of who gets to own urban data and in (some cases) profit from the data, and who will realize benefits of the data. In his classic *Imagined Communities*, Anderson showed how mapping and visibility over territory through the map and census was an important tool of the power of modernizing nation states.[317] In Thailand, implementation of digital data platforms has direct implications for the contours of state "infrastructural power"[318]—data platforms are being used to bring greater state visibility over particular cities and regions, strengthen the tax collecting ability of local governments, and give local leaders a way to communicate directly with constituents and mobilize scarce resources to address urban problems. In the context of a highly unequal political and economic system that favors a Bangkok-based political and economic elite, some urban data platforms offer a new form of citizen voice in a political system where the results of popular elections have often been ignored or negated by military coups. At the same time, many of the data platforms are also being developed by state agencies and corporate conglomerates themselves. The outcome of urban data platform deployment does not depend entirely on the affordances of the platforms themselves, but on which configurations of actors and platforms come to profit from the extraction and use of Thailand's urban data. This question is intrinsically linked to the contestation of state power between national agencies, economic and political elites, secondary cities, and citizens.

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[317] Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism* (London: Verso, 1983).
[318] Mann, "The Autonomous Power of the State." (1984)

Thailand is an interesting case to examine the interplay between digital platforms and state power. For one, the country has long been dominated by Bangkok. Thus, while the city and nation are not *equivalent* as in Singapore, Bangkok plays an outsize role in Thailand's economic and political life as a paradigmatic primate city.[319] In 2022, out of Thailand's 3.1 trillion Baht ($84bn) national budget, Bangkok receives around 70% of the country's expenditures—when you include the nearby suburb of Nonthaburi that figure climbs to 77% (See Figure 16).[320] The Bangkok Metropolitan Region (BMR) had a total population of nearly 17 million,[321] including Bangkok municipality (11 million) and five adjacent provinces; BMR's share of Thailand's GDP is around 46%. The geographic concentration of resources in Bangkok is intertwined with the concentration of political power in the capital, particularly the dense networks of patronage and clientelism between political elites and business families.[322] Such persistent regional disparity contributed to the political upheaval of the 2006 and 2014 coups—Thaksin's populist base was in the rural northeast, while the Bangkok-based elite supported the military.[323] As Bangkok has sucked in more migrants and economic activity, urban sectors like real estate and infrastructure have become the prime source of wealth for the country's top family-owned conglomerates, whereas agribusiness and industrial sectors had propelled Thailand's wealthy during the 1980s.[324] As Shatkin has noted, "the entrenchment of oligarchic elites in democratized and liberalized political systems has coincided with the urbanization of their economic interests."[325] The growth of digital sectors in Thailand has also followed such monopolistic dynamics. Charoen Pokphand (CP) Group, which originally grew from its dominance of agribusiness and food sectors, now owns True Digital—Thailand's major Telcom provider,[326] and has expanded its efforts to develop property and infrastructure through CP Future City Co. PTT, the state-owned oil conglomerate, has

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[319] Bruce London, "Is the Primate City Parasitic? The Regional Implications of National Decision Making in Thailand," *The Journal of Developing Areas* 12, no. 1 (1977): 49–68.

[320] Thailand Government Spending https://govspending.data.go.th/

[321] Thailand's population was 71.6 million (World Bank, 2021)

[322] Ansil Ramsay and Kevin Hewison, "Bankers and Bureaucrats: Capital and the Role of the State in Thailand.," *Pacific Affairs* 63, no. 4 (1990): 592; Kevin Hewison, "Crazy Rich Thais: Thailand's Capitalist Class, 1980–2019," *Journal of Contemporary Asia* 51, no. 2 (March 15, 2021): 262–77

[323] Jim Glassman, "'The Provinces Elect Governments, Bangkok Overthrows Them': Urbanity, Class and Post-Democracy in Thailand," *Urban Studies* 47, no. 6 (2010): 1301–23.

[324] Kevin Hewison, "Crazy Rich Thais: Thailand's Capitalist Class, 1980–2019," *Journal of Contemporary Asia* 51, no. 2 (March 15, 2021): 262–77

[325] Gavin Shatkin, "Mega-Urban Politics: Analyzing the Infrastructure Turn through the National State Lens," *Environment and Planning A: Economy and Space*, March 16, 2022

[326] Before its merger with DTAC, True was the second-largest mobile telecom provider after AIS.

become a major investor in clean energy and digital technologies through one of its subsidiaries PTT-EP. Conglomerates are using their control over physical infrastructures to advance into digital infrastructures such as "smart city" projects—True began promoting various "smart" applications of its 5G technology after partnering with China's Huawei. CP's ownership of 711s throughout Thailand allows it to deploy its TrueDigital Wallet (digital payments app) as payment at the ubiquitous convenience store, a fixture of Thai urban life.

Analyzing the ways in which the "smart city" is operationalized both in practice and discursively by a range of national and local actors shows the multiple and contested imaginaries of urban data in Thailand. Far from being a corporate or "neoliberal" paradigm or a "neutral" technology of progress, the deployment of urban data platforms in Thailand is intimately enmeshed in questions of state power, particularly relations between the country's existing Bangkok-centered economic and political elite, secondary cities and everyday citizens. The research for this chapter occurred primarily in 2022 and 2023, during the last year of the Prayut Chan-Ocha government leading up to the May 2023 Election that delivered a vocal mandate for change in the victory of the Move Forward Party (MFP). The MFP, whose platform called for "demilitarization, de-monopolization, and decentralization"[327] was ultimately blocked from forming a government by the military-appointed Senate, who used the party's calls to reform the *lese majeste* laws as evidence that the party was anti-Royalist and therefore ineligible to lead the nation.

The national effort to promote a standard city data platform for Thai cities emerged as part of a technocratic policy formulated by the Prayut government called *Thailand 4.0*, which generally sought to digitalize the economy and government and move the country out of the "middle income trap." The assumption of "smart cities" was that digital data management, collection, and open access would facilitate innovation and better urban governance. The island province of Phuket was chosen as the first national smart city pilot back in 2015. The island province of Phuket is itself divided into 18 *thessabon*, or municipalities, hindering standardization and data sharing even within this delimited area. National ministries own significant assets such as land and infrastructures within Thai cities, constraining the power of local governing bodies. While Phuket's data platform was part of a national pilot, it has had limited utility. A variety of

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[327] Move Forward Party Platform (MFP)

alternative platforms are being developed, including some that would be sold as a service for municipalities, helping them boost fiscal power and increase visibility into the value of land and property in cities, allowing them to raise more revenue. Still other platforms are focused on giving citizens a say in bringing urban problems to the attention of government departments with the aim of strengthening citizen voice despite limited resources for infrastructure development in many cities. Entrepreneurial mayors have turned to digital platforms as popular "quick fixes" to potholed *soi* and flooded drains, aiming to boost their own image as problem solvers with urban voters.

The chapter shows that digital platforms do not have singular effects—depending on who is deploying them and for what purpose, they take on highly varied functions and can sometimes have contradictory outcomes—variously enhancing citizen voice, strengthening fiscal capacity of local governments, and increasing power of conglomerates and local business elites. Secondary cities like Phuket and Khon Kaen have turned to city development companies to develop and manage data platforms as a potential source of revenue. Without further decentralizing reforms, these efforts have not significantly changed Thailand's governance system. Whether such data platforms will further entrench the economic and political power of existing elites or galvanize popular demands for better governance is a key question raised in this dissertation. Rather than privileging the technology as determinative, or as merely a reflection of political or economic factors, I take a "co-productionist" approach of science and technology studies[328] to explore how digital data platforms are mobilized by various stakeholders in Thailand. How do the conflicting goals and effects of platforms play out in a context where local politicians are elected and must remain accountable to voters, while national politics continued to be dominated by a Royalist-military-elite conservative coalition? The deployment of digital platforms, while promoted as "solutions" for Thailand's urban problems, are in fact deeply interwoven and implicated within institutional structures.

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[328] Jasanoff, *States of Knowledge* (2004)

Thailand Political and Fiscal *Context*

Thailand has seen alternating periods of democratically elected governments and military-backed rule,[329] with the current military regime in place since the 2014 coup.[330] Despite its developmental successes as one of the "fifth tigers,"[331] the country has long struggled to upgrade local innovation capacity. [332] despite its ability to attract foreign investment and tourism. Thailand's relatively capable bureaucracy has ensured a degree of continuity in policies despite frequent political upheavals, but is also seen to hinder institutional reform. Thailand's "extractive" state capacity remains relatively low in comparison to the so-called East Asian tigers. As of 2019, Thailand collected 17% of GDP in taxes, well below averages for the region and countries of similar income levels.[333] The country's administrative system remains highly centralized,[334] with local governments mostly dependent on fiscal transfers from the central government, and governors (*puwa*) appointed by Bangkok. Locally levied tax revenue accounts for only 15%, with centrally-levied taxes making up 32%, shared tax 16% and subsidies accounting for 37% of revenue.[335] The land and building tax is the main locally administered tax, but rates are set by central authorities, and this constrains how much revenue they can raise. [336]

The roots of Thailand's current centralized administrative system go back at least to 1892. It was during the modernizing reforms of King Chulalongkorn when Prince Damrong Rajanubhab was tasked with overhauling Siam's administrative system. [337] Previously, smaller regional polities were under the influence of Bangkok but had a high degree of autonomy. Motivated by a desire to strengthen central control over outlying regions in the face of incursions on Siam's borders by the French and British, Damrong created what is known now as the *thessapiban* system, whereby

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[329] Chris Baker and Pasuk Phongpaichit, *A History of Thailand,* 3rd edition (Cambridge: Cambridge University Press, 2014).

[330] The 2023 Election of progressive parties Move Forward sent a strong message of change but MFP was ultimately unable to form a government due to opposition of conservative Senators, leading to a Pheu-Thai/military coalition

[331] Robert J. Muscat, *The Fifth Tiger: Study of Thai Development Policy*, 1st Ed (New York: Routledge, 1994).

[332] Richard F. Doner, Bryan K. Ritchie, and Dan Slater, "Systemic Vulnerability and the Origins of Developmental States: Northeast and Southeast Asia in Comparative Perspective," *International Organization* 59, no. 02 (April 2005); Dan Slater, *Ordering Power: Contentious Politics and Authoritarian Leviathans in Southeast Asia*, Illustrated edition (Cambridge: Cambridge University Press, 2011). Doner, *The Politics of Uneven Development* (2011)

[333] World Bank Group *Thailand Public Revenue and Spending Assessment* (June 2023)

[334] Christopher Paik and Jessica Vechbanyongratana, "Path to Centralization and Development: Evidence from Siam," *World Politics* 71, no. 2 (2019): 289–331; Wathana Wongsekiarttirat, "Central—Local Relations in Thailand: Bureaucratic Centralism and Democratization," in *Central-Local Relations in Asia-Pacific: Convergence or Divergence?*, ed. Mark Turner, International Political Economy Series (London: Palgrave Macmillan UK, 1999), 71–96

[335] Thai Budget Bureau, 2019 in *Budgeting in Thailand* (OECD, 2020)

[336] World Bank, "Thailand Urban Infrastructure Finance Assessment" (2023)

[337] Siam was the name of the kingdom until 1939 when "Thailand" was adopted as the country's official name

a new Ministry of the Interior in Bangkok would appoint provincial governors, then called *Monthons*[338], and collect taxes.[339] This essential element of the system continues to this day, with most provincial governors appointed by the Ministry of Interior. A significant proportion of taxes are collected by the Ministry of Interior, which then determines by allocation how much provinces and municipalities receive for city budgets and infrastructure projects. While Prince Damrong's reforms are generally credited with strengthening Siam's "infrastructural capacity" at the time, the lack of local fiscal autonomy limits availability of funds for infrastructure and economic development, and maintains the dominance of Bangkok over the country's politics and economics. This longstanding imbalance was at the heart of the 2006 and 2014 protests—the popularly elected Pheu Thai Party had bases of support in the country's North and Northeast which has lagged behind other regions of the country in terms of development and resources. In the 2023 election, the Move Forward Party (MFP), which garnered support around the country, had advocated for more decentralization to reduce regional disparities, but was unable to form a government due to opposite to their proposed slate of reforms including decentralization, de-monopolization, and demilitarization.[340]

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[338] The *Monthon* or "circuit" system created a layer of administration above local governments, effectively the beginning of what are Thailand's provinces, today called *Jangwadt*

[339] W.J. Siffin, "Prince Damrong Rajanubhab Founder of Modern Thai Public Administration-An Appreciation," *Thai Journal of Development Administration* 27, no. 4 (October 1987).

[340] Interview with Khon Kaen City Development, Move Forward Party spokesperson (2023); While the Move Forward Party under candidate Pita Limjaroenrat received the most votes during the 2023 election, they were blocked from forming a government by the conservative Junta-appointed Senate, and a Pheu-Thai led government that formed a coalition with conservative parties eventually took power under Prime Minister Srettha Thavisin
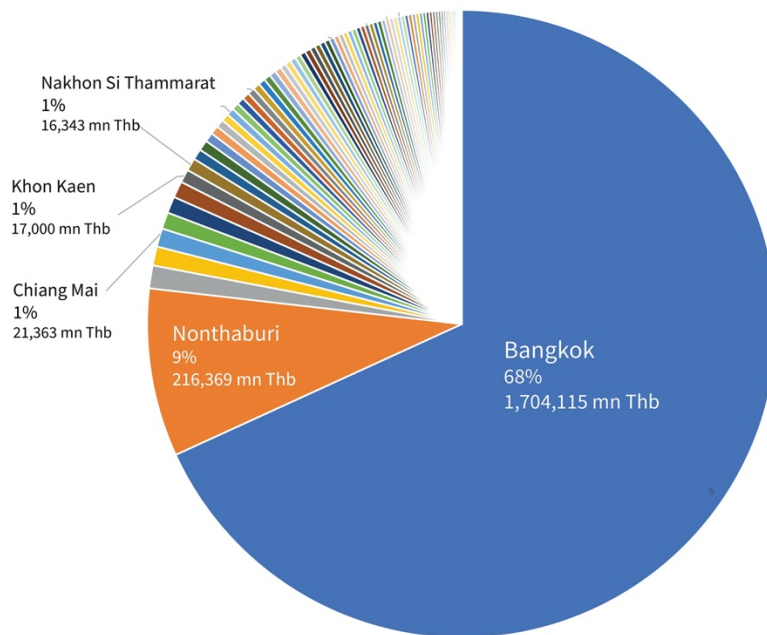
Figure 16. Government Spending by Province (Thailand Government Revenue, 2022)

In this context, amidst a lack of full democratic representation, a centralized administrative structure and low local state capacity, digital platforms have become a tool for local politicians in Thailand to boost fiscal and infrastructural capacity of local governments while also burnishing electoral legitimacy amidst growing popular demands for more accountable and responsive government.

From "Meaung Achariya" to "Meaung Chaladt": Smart cities between utopia and reality
Wangchan Valley was imagined as a "paradise constructed by science," featuring high-tech sensors to detect wild elephants, a smart operations center, smart bus stops, 5G-powered robotic manufacturing—the highest hope for the transformation of Thailand from a middle-income country into a high-income country powered by science and research. But this "paradise" is a world away from the traffic-clogged gritty reality of the sprawling metropolis of Bangkok. Wangchan Valley may not be representative of Thailand, but it nevertheless crystallized a certain aspiration to transform Thailand from its traditional reliance on tourism and low-cost manufacturing into a leader in sustainable innovation. This aspiration was the purported

motivation behind Thailand 4.0, as well as the buzzword of "smart cities" that had suddenly been adopted as part of this government policy.

The new government's push to transform government and economy into the "4.0" era centered on the promotion of 10 "s-curve" industries,[341] as well as digitalizing government services. The "smart city" program, while only one part of the Thailand 4.0 policy, encompassed both goals. The push for smart cities encompassed the immediate goal of digitalizing government services and data, but was also seen as part of an "area-based policy" to build digital infrastructure in specific places that would catalyze private sector innovation and investment in big data, cloud computing, and AI analytics. As the first Minister of Digital Economy and Society Pichet Durongkaveroj noted, "If the strategy for driving the country's digital economy and society can be compared to a large locomotive that carries passenger cars in various sectors of the country towards development projects or activities in information technology under the strategic plan will be as important as each wheel that moves and drives each other."[342]

Many people working in the private sector saw the term "smart cities" as just another trend. As described by an executive managing True Digital Park, the startup-centric office and retail complex developed by CP's True, "Smart cities became a buzzword about five years ago, after the new government drew up their blueprint for Thailand 4.0. But these are just buzzwords, and agencies will use these to get more funding. There are a lot of overlapping results and duties in Thailand and it kind of pisses people off." While not everyone was so dismissive, this was a view I heard often from those in Thailand's private sector, that government policies to promote digital innovation were often uncoordinated, overlapping, or just simply not that effective. Several government agencies had responsibility over various aspects of Thailand 4.0, including the Digital Government Agency (DGA), National Innovation Agency (NIA), and Electronics Transactions Development Agency (ETDA), which was created in 2019 from the Electronic Transactions Act. The National Innovation Agency (NIA) is under the Ministry of Science and Technology, and thus separate from DEPA. The Director of the NIA himself told me that "coordination with DEPA is

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[341] These are: biofuels/biochemicals, digital economy, medicine, automation/robotics, aviation/logistics, biotechnology, smart electronics, next-generation automotive, wellness tourism, and future food. (Thailand Board of Investment, 2017)
[342] Phuket Smart City; Minister of Digital Economy & Society Pichet Durongkaveroj later became a Bangkok Bank executive

difficult since we are under different agencies, we tried to work together but it is not possible."[343] According to a planner who consults on many urban projects in Thailand, "There's a lot of rivalry between the agencies. NIA works more with private sector and cities, Digital Government Association is doing work on e-government and stuff like that."[344] Of course, such inter-agency competition is not unique to Thailand, nor does it mean the efforts were without result.

By its own admission, DEPA is a small agency with limited budget and with a philosophy of "doing less and gaining more to harness the power of startups and other stakeholders to drive the digital economy" [345] With regard to smart cities, DEPA developed a framework for smart cities encompassing "7 smarts of Smart Mobility, Living, People, Energy, Economy, and Governance, and Environment."[346] DEPA has little funding capacity on its own, but its main role is to lend its seal of approval to city or projects as meeting their criteria for smart cities, which can help in securing funding. When cities develop their smart city plan they must include specific projects or aspects across each of the seven "smart" categories in DEPA's framework. "There are a few things the endorsement does: it gives incentives for investment, can get more tax holidays from the BOI, for example."[347] Thailand's famous tourist destination Phuket was chosen as one of Thailand's first pilot "smart cities" back in 2015, two years before DEPA itself was created. In 2018, seven cities were chosen as "smart city pilots", expanded to 27 by 2019, and in 2020, 12 more cities and districts were recognized as "smart city promotional zones," including the Wangchan Valley project of PTT. As of 2020, there were 47 smart city zones in Thailand, meaning nearly every major city in the country had been labeled as a smart city.[348]

Despite the appropriation of "smart cities" as a marketing concept, DEPA's own staff recognize that the term itself and its associations with "failed" projects means the term needs to be revised, especially in the context of Thailand. On my first meeting with Dr. Non Arkaraprasertkul, one of DEPA's directors for international engagement with a PhD in anthropology from Harvard, opened his presentation with a synopsis of smart city projects around the world that failed to consider

[343] Interview, Director of National Innovation Agency (2023)
[344] Interview Thai urban planning consultant (2023)
[345] Interview DEPA Director (2023)
[346] According to DEPA, this typology was borrowed directly from Boyd Cohen's "smart city wheel" concept.
[347] Interview, DEPA Director (2023)
[348] DEPA Smart City Handbook (2021)

what citizens actually wanted and pushed expensive but unnecessary technology including South Korea's Songdo, Masdar in the UAE, and Singapore. Dr. Non claimed that, "What we are doing is very different from other countries, we ask the cities themselves to come up with a vision, what do they want to be, DEPA helps with incubation and technology matching, when the proposals are mature we deliver to the Smart City Committee who will endorse the concept."

The DEPA certification has even been granted to districts or specific megaprojects. For example, Bangkok's Samyan area, which sits on land owned by Chulalongkorn University has been chosen as a "smart district," along with the nearby One Bangkok, a $4 billion megadevelopment of luxury retail, hotels, and residences facing Bangkok's Lumpini Park being developed by ThaiBev, an influential Thai conglomerate.[349] While acknowledging that OneBangkok is mostly a private megaproject with little public benefit, DEPA maintains that they "endorse a project as smart city, insofar as there are benefits to ordinary citizens, maybe open spaces for public use, green areas that contribute to oxygen footprint."[350] A planner working with a community nonprofit pointed to the influential role of Chulalongkorn University pulling together these stakeholders along Rama IV Road, calling it an "upper market view of what the city should be for the upper classes." Chulalongkorn is a major landholder in central Bangkok, controlling 1153 *rai* (455 acres) of prime land in the heart of the capital. The university set up a special company PCMU to manage its landholdings and develop commercial property on land adjacent to its main campus, particularly in the centrally-located Siam Square and Samyan areas. The current governor of Bangkok, Chadchart Sittipunt, was himself previously the director of this company following his time as a Professor at Chulalongkorn University.

At a February 2023 event in the northern city of Chiang Mai that Dr. Non invited me to, I heard him speak about DEPA's vision for smart cities in Thailand. The first part of his presentation he noted that the term "smart cities" in Thailand was usually translated as "*achariya*" a rather elegant Sanskrit-derived word that was closer to "brilliant" or "genius" than the more commonly used term for smart in Thai, "*chaladt*"[351] Thus, if the idea of "brilliant cities" or *meuang achariya*

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[349] Frasers Property is a Singaporean-listed company but was wholly purchased by ThaiBev in 2013; ThaiBev leased the land from The Crown Property Bureau (CPB)

[350] Interview, DEPA International Director (2023)

[351] Remarks at DEPA Conference on Smart Cities, Chiang Mai (Feburary 2023)

was the officially endorsed ideal, a "paradise built by science", the actual translation of the abstract notion of smart cities into reality involved more mundane piecemeal efforts to improve urban management, address problems of urban flooding, inadequate infrastructure, and social inequality. In the view of Dr. Non, this more scrappy ad-hoc attitude towards improving cities meant that "smart cities" should be translated into Thai as *meaung chaladt*, a more down-to-earth smart city. Thus, even within DEPA, Dr. Non was aiming to redefine the meaning of the smart city in the Thai context, away from the utopian tech-led ideal to something more suitable for Thailand's context.

Data Platform	Developer/Owner	Type	Other Details
Phuket City Data Platform	DEPA/Phuket City Development Company	Data Aggregation and Storage	Built as national pilot, collaboration with local university, combines multiple types of data in one platform
Bedrock	PTT/ARV	Data platform as Proprietary service	*Plaform-as-service* model, sold to municipalities or other clients, intended to generate additional tax revenue for local governments
Traffy Fondue	NSTDA-NECTEC	Citizen feedback platform	Allows citizens to report problems in their neighborhood, requires follow up by various government agencies
NakhonCity	Siam Innocity, Line Govtech, DEPA	Citizen feedback platform	Built on Line Open API, citizen reporting functions, flood camera monitoring open access for citizens

Table 6. Digital Platforms and Urban Governance in Thailand: Varying Approaches

Within Thailand, "city data platforms" are a key part of DEPA's smart city framework. One of the early efforts to develop such a platform was Phuket's City Data Platform, which was initially built through partnership between DEPA, the Phuket government, and other local stakeholders including Prince of Songkhla University, and the Phuket City Development Company (PKCD).[352] Yet, even as DEPA promoted the Phuket City Data Platform as a national model, there are a variety of other urban data platforms under development Thailand: proprietary platforms with investment from large corporate groups and small relatively simple apps being championed by individual mayors. There are also a growing number of Thai startups in the data and AI space

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[352] Phuket City Development Company is a registered company founded by local businessmen in Phuket.

more generally, and some of them have promoted themselves as providing products and services to cities and other public-sector agencies.[353]

In this section, I look at the development of city data platforms in Thailand and how they are shaped through the interests of a variety of stakeholders including city leaders (mayors), national agencies, large corporate groups, and entrepreneurs. While most recognize the benefits of better geospatial data, there is little consensus on what specific platform should be adopted by the nearly 7000 local governments in Thailand.[354] There is general consensus on the value of data as a resource. But there are crucial obstacles to digitizing data that cannot be addressed through technology platforms alone, most obviously that reams of data are still maintained in analog formats with different standards, and kept siloed within different ministries, agencies, or city departments. Even with the potential of digital data platforms to facilitate common data standards and more open transparent data, there is little consensus on where data should be stored, who should have ownership of urban data, which entities (cities themselves, proprietary firms?) are best suited to performing more complex analytic functions, and to whom the benefits of the data and the analysis of that data should accrue. Finally, the development of urban data platforms in Thailand is embedded in a complex interplay between local, national and private conglomerates, in a country that maintains a strongly centralized administrative and fiscal system that dates to the modernizing reforms of Chulalongkorn in the 19th century.

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[353] Thai startup 5GCT partnered with NT on a 5G smart city project in Ban Chang, in Eastern Economic Corridor https://www.bangkokpost.com/thailand/pr/2348498

[354] There are 7852 local administrative organizations (LAOs) in Thailand (comprising 76 provinces, 2 special areas Bangkok & Pattaya, 2441 municipalities, and 5333 sub-district level organizations (OECD, 2020).

Figure 17a (above left): Rally for Move Forward Party Bangkok (Author, May 2023)
Figure 17b (above right): campaign posters promote technology to fight corruption (Author, May 2023)

Figure 18 (above): Kasikorn Bank's President presents his vision for smart cities at an MIT Media Lab Conference in Bangkok (Author, 2022)

Phuket: From tourist island to a National "sandbox" for smart city technology

The island of Phuket has become almost synonymous with beaches and tourism, but "smart cities" seem a far cry from the idyllic beach resorts and rowdy bar streets that characterize the tourist concept of the island. While Phuket has long been marketed as a tropical paradise, the unregulated development of tourism also brought negative effects such as traffic, crime and a growing waste management problem particularly in the densely developed nightlife zone of Patong Beach. Efforts to turn Phuket into a "pilot" for Thailand's smart city goals largely began in 2015, when Software Industry Promotion Agency (the predecessor agency of DEPA) unveiled its roadmap for Phuket to become "The Tourism Island of Sustainable growth by enhancing Creative Economy to provide Happiness for all"[355] As Minister of ICT in 2015, Dr. Uttama Savanayana's "first policy is the smart city policy and Phuket was chosen as one of the smart city pilots at the time, along with Chiang Mai."[356] With problems stemming from the oversaturation of tourism, the early Phuket Smart City concepts includes visions of a "smart beach" with AI-enabled cameras to monitor the number of swimmers at specific beaches on the island, and a system for tracking boats around the island, as well as plans for collecting more detailed information on tourist arrivals and travel around the island, which would help hotels and other tourist-dependent businesses market products and services to tourists, and also help the government know where to provide more public services, like waste management.

Other factors may have made Phuket an ideal choice as Thailand's first smart city pilot. As Dr. Saran Samritdetkajorn, Director of the Technology Center National Electronics and Computers (NECTEC-NSTDA) put it "Phuket is a province that is not large, it's interesting in terms of geography and has a certain level of infrastructure, so it's worth a try and if successful it might be expanded to other provinces."[357] Such a sentiment was also expressed by Minister Uttama, saying "Phuket is a province with potential, especially in the field of tourism, and this is a high-value industry that can be further developed."[358] The political context of Phuket may have also played a role in its being chosen as a national pilot. Phuket had been a reliable base of support for the ruling military party and in 2019 voted for the ruling military-led Palang Pracharath Party

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[355] SIPA Presentation (2015)
[356] Interview, DEPA Phuket Representative, 2023
[357] "Smart Phuket" NECTEC (2017)
[358] Ibid.

of Prayut Chan-Ocha, whereas northern cities like Chiang Mai and Khon Kaen were strongholds of the opposition Pheu Thai Party.

Phuket's initial smart city project began with incremental investment mainly focused on developing better telecom coverage and WiFi internet hot spots across the island. The budget for first year of the plan was around 386 Mn Thb ($9.4 Mn at the time), with funding for improved WiFi coverage, smart tourism and maritime safety projects, but most of the funding at the time was provided by the Ministry of ICT for free public WiFi coverage.[359] By comparison, according to those involved in Phuket's smart city projects, they were told when they met with city officials in Busan, South Korea that smart city projects had received around $250 million in funding, leveraging investment from private sector companies like Samsung and Sk Telecom.[360] Phuket's funding was small by comparison. The Phuket Smart City Innovation Park, hosting office space for startups and located on the campus of Prince of Songkhla University, was opened in September 2016, just before Phuket was selected as the first pilot under the newly reorganized Ministry of Digital Economy and Society's Smart city plan.[361]

Data Platforms as Local Resource—the role of "city development companies"
While national ministries helped jumpstart Phuket's early smart city projects, local stakeholders also played a significant role. In 2016, a group of local businessmen mostly in the hotel industry came together to form the Phuket City Development Company (PKCD). Inspired by a similar group founded in Khon Kaen, PKCD was set up to compensate for the lack of adequate funding for infrastructure from the central government. A plan for a light rail train connecting the airport to Phuket's main urban center remains unfinished, still awaiting approval from the Ministry of Transportation. As in other Thai provinces, the governor or *puwa* is appointed in Bangkok but there is also an elected provincial representative (*abbojaw)*. In Phuket, this elected governor has a small discretionary budget of around 8 million baht ($200,000) out of a total city budget of 168 million baht ($4.5 mn).[362] Phuket generates around 20% of tourist revenue in Thailand,[363] but the

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[359] 240 Million baht provided by ICT for high speed free public wifi
[360] Interview DEPA Phuket Representative, 2023
[361] Earlier efforts in Phuket may have begun around 2015, check this timeline
[362] Interview, Phuket City Development Company (2023)
[363] Phuket generated 13 bn USD in tourism revenue; Thailand received 62 bn USD in tourism revenue in 2019 (CEIC Data)

province is 65th out of 77 in budget transfer it receives from the central government. To address this discrepancy, local businessman created a company that would undertake development of public infrastructure, operating "like a social enterprise", but legally set up as a private company, due to differing tax regulations.[364] The two main projects of PKCD are the Phuket Smart Bus, a bus line serving the west side of the island; the second is the City Data Analytics, founded as a subsidiary company of PKCD, which oversees development of Phuket's city data platform.

The decision to develop a local data platform also came after Phuket had been approached by multinational firms, including Cisco which ran a workshop in Phuket. While the relationship with these companies helped spark ideas, local leaders largely opted not to buy their expensive systems. "Sometimes the technology from big companies is useless. It's better to give funding to a local company to create some products. The first time we heard from IBM the city data platform, they tried to sell us their platform for 20-30 million baht, but we have no data at the time, so why should we spend the money."[365] The decision to create a locally-designed and operated city data platform emerged from the partnership between DEPA, PKCD, and Prince of Songhkla University in Phuket. "At first we do the co-research with DEPA, the first version we got funding from DEPA, then we work with Prince of Songkla University to develop the platform."[366] The platform was first trialed in Wichit Municipality, which is part of the urbanized area of Phuket Town, and later in Patong Beach on the West side of Phuket. Phuket's approach suggests an openness to learn from international firms with a focus on developing local capacity and ownership of the platform.

The architecture of the Phuket data platform aimed to integrate a few different types of data, including static government base layer data, data from wireless hot spots which were initially developed through funding from CAT, Thailand's state telecom provider,[367] data from various sensors or cameras such as those that can track the number of tourists arrivals and departures at the airport or at ferry piers.[368] Data is held in various places depending on the owner. For example, 14 sensors around the island collecting data on weather and climate are owned by DEPA

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[364] Interview, Phuket City Development Company (2023)
[365] Interview, DEPA Phuket (2023)
[366] Interview, Phuket City Development Company (2023)
[367] Communications Authority of Thailand (CAT) was subsequently merged into National Telecom (NT) in 2021
[368] Sricho (2021) "Phuket Smart City Data Platform, the most advanced intelligent data system!" *Greenery*.

and stored in a cloud operated by CAT; meanwhile the Disaster Command Center of Phuket captures footage from 300 cameras with optical character recognition (OCR) capability but does not keep the data for more than 30 days.[369] The data platform design required a "data ingestion framework" that would bring data in from the various sources, store the data, clean the data into useable formats or pipe it into a comprehensive dashboard, and clarifying which "consumers" or end users (such as the public, or specific persons at PKCD data oversight responsibility) have the right to access various types of data.

A few years into the development of these projects, the emergence of Covid-19 in 2020 brought an almost complete halt to tourism, a key source of revenue for Thailand. Nowhere was more affected than Phuket. In 2019, tourism brought in $13bn USD in income to Phuket, accounting for 90% of the island's GDP, and 20% of Thailand's tourism revenue.[370] The Covid-19 pandemic disrupted the island's lifeblood but also offered an opportunity to trial new technologies for tourism monitoring. The crisis also convinced city and business leaders for the need to diversity the island's economy away from reliance on tourism, such as attracting startups and digital nomads, and promoting Phuket as a center for gastronomy and wellness.

In October 2021, Thailand approved the "Phuket sandbox," which allowed tourists to enter Phuket, stay at approved hotels, undergo covid testing, and eventually be cleared for travel to the rest of the country if they tested negative. While the program provided much needed revenue for the island before Thailand decided to completely re-open, it also became a "technology sandbox" for testing new technology for tracking and monitoring tourists. Some tourists who failed to report to their designated hotels or were found to have left their hotels before the end of their designated quarantine time were detained for violation of the program. True Digital partnered with Phuket to promote its "smart tourist" technology such as 5G-enabled robots serving food to guests in quarantine, or a wristband for tracking tourist arrivals and

[369] Aziz Nanthaamornphong, Jeffrey Holmes, and Pracha Asawateera, "A Case Study: Phuket City Data Platform," in *2020 17th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)* (2020 17th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON), Phuket, Thailand: IEEE, 2020), 717–22,

[370] Siriluck Thaicharoen et al., "How Thailand's Tourism Industry Coped with COVID-19 Pandemics: A Lesson from the Pilot Phuket Tourism Sandbox Project," *Journal of Travel Medicine* 30, no. 5 (December 23, 2022): taac151

departures on boats to nearby islands.[371] By 2023, most of these sandbox ideas were no longer in use in Phuket except for facial recognition technology at the airport, which the police could use to monitor arrivals or catch potential criminals. "After covid is gone, we deleted all the data," according to DEPA's southern director, based in Phuket. "But the Phuket Sandbox did teach us a lot on how to use the data."[372] A local businessman from PKCD involved with Phuket's smart city projects expressed a more skeptical attitude toward Phuket's 5G pilots. When I asked him about the 5G pilot projects, he said with a wry smile, "you want to know the truth or not? To be honest, there haven't been that many results, the main thing we did is to integrate wireless 5G information with CDP to view traffic flow data."[373]

Although Phuket's data platform has been driven and is in the ownership of local stakeholders, the fragmented nature of Thailand's local administrative system has hindered adoption of the platform across Phuket Province, which is itself divided into 18 *thessabon*, or municipalities. Only three out of the 18 are currently using the CDA platform as of 2023.[374] "Even if the mayor of Phuket wants to, he doesn't have full authority to tell various departments to share data."[375] For example, management and operation of CCTV cameras is the responsibility of the police department or the individual municipalities, depending on their function. There are already 1600 CCTV cameras are operating with a planned expansion to around 4000. But management and maintenance is also a burden. "It isn't just about buying technology but also maintenance, many people think in terms of technology projects, in terms of three years its obsolete." According to a PKCD representative, the company has proposed operating the cameras island-wide and renting or selling this as a "service" to the government. This would reduce the maintenance and management burden of various municipalities across Phuket and allow for better data integration, but talks are still ongoing.

The Phuket CDA came about through joint efforts of national ministries, local businessmen, and input from outside experts. DEPA promoted its "city data platform framework" based largely off

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[371] Komsan Tortermvasan, "True Launches Smart City Tech for Phuket," *Bangkok Post*, November 23, 2021, https://www.bangkokpost.com/business/general/2208567/true-launches-smart-city-tech-for-phuket.

[372] Interview, Phuket DEPA Southern Director (2023)

[373] Interview, Phuket City Development Corporation (2023)

[374] Interview, Phuket DEPA Southern Director (2023)

[375] Interview, Phuket City Development Corporation (2023)

the experience of Phuket. The Phuket CDA hopes to expand to other cities in Thailand, in effect partnering with local municipalities to replicate the model elsewhere. But so far this has not occurred. And even within Phuket, the use cases for the platform have been relatively limited. Even though the CDA is one of the earliest city data platforms in Thailand, its utility and value are less proven. While the idea of collecting many types of urban data is reasonable, the use cases of the data are limited and the company does not yet generate much revenue. DEPA published a Framework for City Data Platforms based on the experience of Phuket,[376] but even a DEPA staff acknowledged that "our city data platform is a bit of a joke, we need to create it in order to show the city that minimum viable product (MVP) of city data platform but its really not helping anyone at the moment beyond that."[377]

While Phuket's city data platform has had limited uptake by other cities, Phuket's City Development Company (*borisat phattana meuang)* has become an increasingly attractive model for local businessmen in secondary cities. Khon Kaen, in Thailand's northeast, is generally thought to be one of the earliest and most advanced examples. In Khon Kaen, the driving force behind the creation of the Khon Kaen Think Tank in 2015 is a charismatic local businessmen named Suradech Taweesaengsakulthai, who runs a large truck manufacturing company based in the city. A major impetus for KKTT was to help build a light-rail transit system for the city. The company is also seeking to acquire a piece of land for transit-oriented development that lies next to the city's railways station and would be the hub of the tram system. A parallel joint stock holding company has been set up with ownership of six municipalities in Khon Kaen to run the proposed transport system. But the plan has been stalled, allegedly due to the Ministry of Interior requesting additional payments and delaying procedures before relinquishing control over the centrally located plot—currently a rice paddy.[378] As a well-placed observer told me, the creation of such companies has generally been driven by local elites with interests in property—"Phuket picks up this model a bit, oh they think we could do like this too, and then Rayong follows, Chiang Mai couldn't do so as much; most of the rich people in Chiang Mai live elsewhere, but in Khon Kaen, the people who are rich and powerful have to rely on value capture, Rayong is the same."[379] The

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[376] Digital Economy Promotion Agency (2022) "Building the City Data Platform: A step-by-step Guide"
[377] Personal communication (September 2023)
[378] Interview (2023)
[379] Interview, Thailand World Bank Associate (2023)

KKTT has pursued other development projects, such as a "metaverse" platform, a small-scale city data platform pilot in collaboration with Khon Kaen University and other local stakeholders.[380] While most of these ideas have yet to bear fruit, they show how local stakeholders have tried to develop their own city data platforms separate from the DEPA-led effort. However, creating actual value from these projects remains a distant dream.

Figure 19. Graphic of True's system of 5G-enabled services during the Phuket covid-19 Sandbox (True Digital)

Figure 20. (Btm Left): DEPA's City Data Platform Guide;
Figure 21. (Btm Right): DEPA's DR. Non gives a presentation on smart cities in Thailand at a conference in Chiang Mai (Author, January 2023)

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[380] Interview, Khon Kaen University (2023)

Private Sector Companies--Bedrock

While national agencies like DEPA and city-based organizations have tried to create city data platforms as a public resource, there are also privately funded commercial ventures trying to develop their own proprietary platforms to sell to municipalities or other public agencies. PTT, the state-owned oil company behind Wangchan Valley, also invested in an early-stage geospatial data platform called Bedrock, through its venture capital arm AI and Robotics Ventures (ARV). The firm ARV has also invested in frontier technologies such as drones for "smart farming", an underwater inspection robot, and digital healthcare platforms. Some of these are related to PTT's core oil exploration and refining business. But PTT has also pushed to diversify into sustainable energy such as biofuels, renewables, and other natural products. As the founder of Bedrock notes, "What we are trying to do is building a digital and data infrastructure for the whole country, and the company."[381] The product is currently geared toward public sector clients like cities and state agencies, but could also be of broader use for its parent company. According to the founder of the company, the brand and financial backing of PTT helps him sell the product to potential clients, and the long-term investment horizon of the company allows the company to invest for the long term: "People talk a lot about digital twins or smart cities, but first you need data infrastructure in Thailand, and you need a company like PTT to sponsor it."[382]

The basic product of the company is a data platform comprising 250 data layers, some collected from existing sources but others generated through remote sensing, drone imaging, and AI. The business model would be "freemium plus," with some functions available for free, and bespoke customizations available on a pay-per-service basis. The product is conceived of by its founder as "an app store for municipalities. We don't own the apps but own the infrastructure." Public-sector clients such as cities and public agencies are the main clients, but the platform may target private sector clients in the future. Because the platform is being developed as a commercial service, the use-cases need to help generate revenue for clients (cities or ministries) to justify their purchasing the product. "I am very realistic about this, my job is to find money, and so without use cases and revenue streams, a data platform is just a lab experiment." The founder criticized the ongoing government-backed data platforms in Thailand like Phuket's saying that

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[381] Interview, Founder Bedrock.ai (2023)
[382] Ibid.

they haven't delivered significant value to cities yet. "Without digital applications or analytic functions, data is meaningless, like a storage warehouse but it goes nowhere, it doesn't mean anything."[383]

Two of the use cases presented are geared towards helping cities collect tax revenue. One of the functions being developed uses AI to generate more detailed and up-to-date information on the ownership and accurate valuation of land parcels and commercial signboards in a city. According to the founder, Bangkok collects less than 50% of what it could in terms of land and property taxes. Another use case is collecting revenue from billboards, which again Bangkok collects less than 30% of what it could. Although they also admitted cities don't always have a baseline number of their maximum potential tax base.[384] In Thailand, most land and property taxes are directly collected by local governments, while value-added tax and commercial taxes must first go to national ministries before being redistributed. Building and land taxes make up the largest share of local government revenue, followed by the signboards tax.[385] These are two use cases targeted by Bedrock's Ai platform. If municipalities can increase their revenue collection by using the platform, the cost of purchasing the service would easily pay for itself in increased local tax revenue.

> "My job is to make money, for instance I am selling a platform as a service, charge them 80k a month, they can afford it, on a yearly basis I can earn 1 million Baht from one municipality, there are 8,000 municipality. Recurring revenue would be 8 million baht/year for the city sector—when you talk about city sector, municipality just part of the city sector."[386]

According to the founder of Bedrock, he is also approaching national ministries like the Ministry of Transportation, which manage huge numbers of physical infrastructure assets. Despite the

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[383] Ibid.

[384] These figures were provided to me by Bedrock and couldn't be independently verified, but other sources confirm the basic point that cities are not fully collecting the tax revenue they could due to inaccurate or out of date assessment information or lack of enforcement.

[385] Jirawat Metasuttirat and Ratthasirin Wangkanond, "The Development of New Revenue Structure of Local Government in Thailand," *International Journal of Crime, Law and Social Issues* 4, no. 2 (2017): 129–40.

[386] Interview, Founder Bedrock.ai (2023)

potential of the Bedrock platform, so far the company has mostly signed nonbinding MOUs with municipalities, with a trial pilot in the southern city of Yala. Bedrock also approached the City of Nakhon Si Thammarat to develop a digital twin model by using drones and LIDAR technology to scan buildings and other physical features.[387] The Mayor of NST is not paying anything for this project since Bedrock, backed by the resources of its corporate parent PTT, has the capital and incentive to spend some money on such public-sector CSR initiatives and potentially use the city as a showcase for their technology. From Bedrock's point of view, smaller cities that lack resources to develop their own platforms would benefit most from the platform. "Not every municipality can develop their own platforms, like Phuket has done. Local governments do not all need to invest tremendous resources to develop their own city data platforms; in Phuket I think they already spend 1-3 million USD to develop the platform."[388] So while Phuket's officials trumpeted building up local capacity and ownership of data, in Bedrock's model individual cities would surrender some form of control to Bedrock's data platform, particularly for analytic functions.

Platform Governance: Citizen Platforms and Entrepreneurial Mayors

What does platform governance look like in Southeast Asia? Thailand provides an interesting context to explore this question. At the national level, Thailand was under a military-led coalition since the 2014 coup until recently. However, local mayors are elected and thus must cultivate popular support to win elections. Yet, once in power, mayors are hampered by a centralized fiscal system in which provincial governors (*puwa*) are appointed by the Ministry of Interior and local budgets are constrained by regulations, a legacy of centralizing administrative reforms introduced by Prince Damrong in the late 19th century. In 2022, the Bangkok Metropolitan Administration (BMA), the provincial-level body responsible for managing the nation's capital, received 81% of its budget by central transfers.[389] In this context, digital platforms have been embraced as one way to "do more with less": platforms offer both real and discursive power for local officials, as a way to communicate with constituents and also to allocate scarce resources in cities.

[387] Interview, Mayor of Nakhon Si Thammarat (2023)
[388] Interview, Chief Software Engineer, Bedrock (2023)
[389] Chartchai Parasuk, "City Hall Needs a Much Larger Budget," *Bangkok Post*, June 30, 2022, https://www.bangkokpost.com/opinion/opinion/2336748/city-hall-needs-a-much-larger-budget.

In 2022, Chadchart Sittipunt was elected as Bangkok's first elected governor since the military coup, sweeping all of Bangkok's districts. Running as an independent (though he had previously served as transport minister in Yingluck Shinawatra's government) Chadchart presented himself as an earnest technocrat solving the Thai capital's urban problems through technology and citizen engagement. As he reflected, "our task is to restore trust and confidence in the democratic system, in the last 10 years people lose faith, many people feel like the system is corrupt, our job is to bring trust back."[390] Chadchart had already become an internet phenomenon in Thailand during his time as transport minister through his adept use of social media--internet meme of him when he was declared the "world's strongest minister". He has continued this publicity strategy as governor with livestreaming early morning jogs and impromptu conversations with city residents.[391]

Despite the hopes invested in Chadchart by those desiring progressive change, there is also recognition by many experts that his ability to implement changes would be inherently limited by the Bangkok Metropolitan Area's (BMA) structural and fiscal power. Chadchart, while he may be a technocrat, is no revolutionary. As one Thai academic put it, "the best quality of Chadchart is that he is acceptable with the elite and so the royalist middle class."[392] While Bangkok dominates Thailand, the Bangkok Municipal Authority (BMA) itself lacks complete authority over the city's infrastructure. Many arterial roads are owned and operated by the Ministry of Interior, electric lines are managed by the Metropolitan Electricity Authority, for example.[393] After a year in office, he has faced growing criticism that he has been unable to make progress on key challenges facing the city such as traffic and periodic flooding especially during the summer monsoon.[394] In his campaign, Chadchart called for solving "capillary problems," noting how services and infrastructure in the Bangkok's narrow *soi* and informal communities have long been neglected in favor of large-scale infrastructure projects along arterial roads or major transportation corridors near tourist areas.

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[390] Chadchart Sittipunt, Presentation at Harvard GSD (November 2022)
[391] Pirongrong Ramasoota "The Chadchart Phenomenon" *Bangkok Post* February 8, 2014 https://www.bangkokpost.com/opinion/opinion/393863/the-chadchart-online-phenomenon
[392] Interview, Chulalongkorn Professor (2023)
[393] Interview (2022)
[394] Various interviews and conversations (2023)

Nevertheless, one success the governor touts is the digital platform Traffy Fondue, an application that allows citizens to report problems in their neighborhood, which may then be addressed by relevant government agencies. Traffy Fondue was originally developed by National Electronic Technology Center (NECTEC), a division of the national science agency NSTDA.[395] The city of Phuket was the first city to implement Traffy in 2018 for the limited purpose of monitoring waste collection in the island that had often faced a refuse problem from overdevelopment and unregulated tourism. But it was Chadchart's order to implement it in Bangkok upon his accession as governor in 2022 that brought the platform into greater use and public attention. "I used this when I was a candidate, I knew the developer, its free, developed by the government, it has been used and tested. The idea is to do this public service thing. But I think the platform by itself cannot provide solutions. When we launched the platform, there were only 1000 people reporting, when I became governor 20,000 complaints on the first day."[396] Chadchart noted how because it was developed by national agency NSTDA, using it was much cheaper and faster than if the BMA would have procured a new product from a private company.

According to the BMA, the platform has received 366,000 complaints in the first 14 months of operation, with 267,000 (72%) being handled or responded to directly.[397] The governor cities this as a benefit of the platform concept, "no gatekeepers, everyone is equal, no friction it can scale fast." According to the Governor, the platform reduced the time it takes to handle complaints from 788 hours to 38 hours when using Trafy. "I don't have to order anything, the people responsible come to the platform and solve the problems, and report back if the problem is fixed."

When applied to governance, the *platform logic* can theoretically achieve goals of using the BMA's limited fiscal resources more efficiently while relying less on top-down commands or traditional communication channels. The use of a platform like Traffy Fondue can also aid in monitoring of government efficacy across the Bangkok Metropolitan Area, which is itself divided into 50 districts, or *khet*.[398] Neither the governor himself nor top-level deputies of BMA

[395] Mr. Wasan Phattharathikom, chief developer
[396] Interview Chadchart Sittipunt, August 2023
[397] Bangkok Metropolitan Administration, 2023
[398] The 1972 Bangkok Metropolitan Area reform transformed Bangkok into special administration area equivalent to a province, divided into 50 districts *khet* and currently about 180 subdistricts *khwaeng*

departments need respond directly to complaints reported on Traffy, but the system can provide data and visibility into which divisions and departments are responding to problems submitted by citizens. The platform is thus turned into a disciplinary tool to monitor performance of lower-level bureaucrats. There is also talk of expanding the platforms' use in other national agencies and ministries. "I went to talk to the head of police, water, electric, now they adopt Traffy, success leads to more expansion."[399]

The Governor frames this as an issue of trust when he speaks about it. He reflects that "the application was there for four years to allow people to report to the city but nobody used it, because I think they don't trust the report would be used to improve the situation, but once they see it being used, they will have more trust." It's clear from Chadchart's public statements on Traffy that he views the platform concept as aiding in democratic representation and improving trust of citizens in government. "On the digital platform everyone is equal, you don't need to have an election, everybody's problem is treated equally, so people feel empowered."[400]
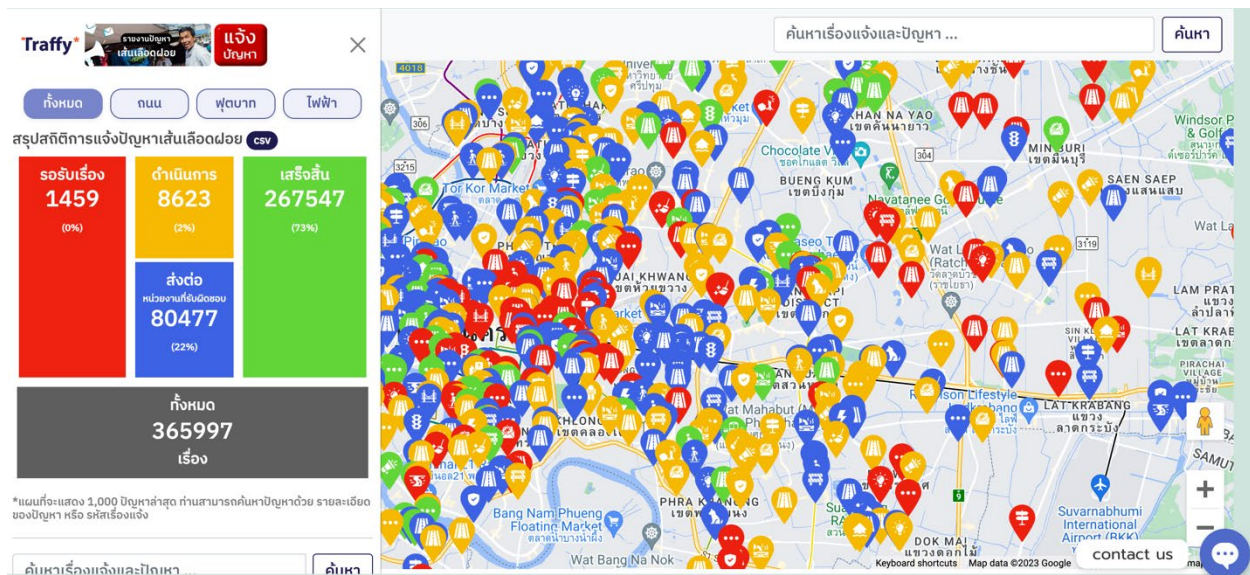

Figure 22. Screenshot of Traffy Fondue Platform showing problems reported (BMA, 2023)

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[399] Interview, Chadchart Sittipunt, August 2023
[400] Chadchart Sittipunt, Harvard GSD Presentation, 2022

Figure 23 (Top): Smart City Expo of Bangkok Metropolitan Administration (Author, 2023)
Figure 24 (Bottom): Meeting with Chadchart Sittipunt, governor of Bangkok (Author, 2023)

Nakhon Si Thammarat: A human-Centered Smart City

An hour south of Bangkok by flight, Nakhon Si Thammarat is a sleepy town of 100,000 on a low-lying flood plain fronting the Gulf of Thailand. Formerly known as Ligor in ancient times and important center for Buddhism in the past, Nakhon Si Thammarat (NST) is far off the typical tourist circuit but is known locally for its famous temple from the 13th century Phra Mahathat Woramahawihan. The current Mayor, Dr. Kanop Ketchart, has overseen a set of initiatives to turn NST into what he calls a "human-centric smart city," promoting technology in local schools and using a citizen engagement platform resembling Traffy Fondue. A small Thai startup called Siam Innocity developed the "smart city platform on Line," leveraging the API of the Japan-based messaging app that is also commonly used in Thailand and Taiwan. According to the developer of the app, he modeled the platform on a similar application using Line in Fukuoka, Japan. Line has a GovTech division with operations in Thailand that promotes public-sector customization and use of its platform. The core interface for this platform is a Line channel @Nakhoncity, which anyone with a Line account can register and follow.

According the developer of the platform, which uses Line's API, the mayor "first didn't work on smart cities, he wanted to fix the problem of flooding in the city. Every year we have flooding, so he asked me to work with him on this problem first."[401] The platform connected sensors and cameras to monitor water levels at dams upriver from the city, which can then send out alerts to citizens in advance of floodwaters arriving in the city. Later, the platform expanded to include the function of citizen complaint reporting similar to how Traffy has been used in Bangkok. The benefits of Nakhon's Line channel compared to Traffy or other platforms is that citizens don't need to download a standalone app but can simply follow the NakhonCity Line channel.[402] This has resulted in 44,000 or 40% of the citizens using the platform.[403] The channel allows users to report complaints but also has additional functions: citizens can view live feeds of traffic cameras and submit documents for approval by the city. On the city side of the application, the data aggregated from citizen reports is displayed in a dashboard interface with maps showing the location of complaints, and summary data generated.

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[401] Interview with InnoCity Founder (Feb 2023)
[402] Interview with Non, NST (Feb 2023)
[403] Interview, Mayor Dr. Kanop Ketchart (February 2023)

The Mayor describes how the platform idea he implemented reflects his modest philosophy of governance, whereby "I am not a leader. They put me in a position so I can allocate the resources. But I follow the people. Whatever they want it's the right thing to benefit them I just follow them… like a flock of birds, that fly together, the strong bird in front weak one in back, small kids with no parents we are the same flock."[404] The mayor also points to the urgency of solving problems raised by citizens, noting that the biggest challenge facing the system is the first 48 hours. "If the problem is not fixed, you are the last bucket. It stops at the mayor. Because people elect you. You do whatever you have to. No one there, you go there with a truck to clean it." Previously, submitting complaints the analog way citizens may have had to wait up to 15 days or longer to receive. Response. According to statistics, the platform has saved the city 10 million baht in operations ($300,000).[405]

A key factor in the success of the project, according to the Mayor, is starting small and building support. "That's why you have to start with the small project; four categories: running water, streetlight, traffic. Four categories You balance the problems with the resources. Once you're confident then you can expand." The mayor's reflections on his implementation of the platform suggest that, like with Chadchart's promotion of Traffy Fondue, the rollout of the digital platform has been linked with the charismatic leadership of particular local politicians. Both Governor Chadchart and Mayor Khenop talk about the platforms as enabling a certain vision of citizenship and of mayor-citizen relations. Chadchart emphasizes the aspects of trust and equality, while Khenop talks about his modest role as a facilitator and servant of the citizenry. Even if digital platforms cannot fully solve urban problems or deliver full accountability, the digital platform has already taken on symbolic and discursive properties by representing the charismatic leadership of local politicians and their concern for solving citizens' problems in a fair, equal, and just process. The "platform" has been transformed from a proprietary logic into a governing logic.

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[404] Ibid
[405] In FY 2023, the budget of the municipality was estimated at $29 mn (Municipality of Nakhon Si Thammarat, "Voluntary Local Review 2022: The Implementation of the UN Sustainable Development Goals in Nakhon Si Thammarat City Municipality," (2023)

Figure 25. Mayor Kanop Ketchart (left) and DEPA's Dr. Non (right) presents at a meeting with DEPA, JICA consultants, and myself (Author, February 2023)

Figure 26. Tommy, head of Siam InnoCity (right) with members of DEPA staff in Nakhon Si Thammarat's control center (Author, February 2023)

Conclusions

This chapter has argued that data platforms, while often conceptualized as neutral solutions for aggregating various types of public data, are directly molded and shaped by the variety of stakeholders who have sought to deploy them for particular ends. Thailand, with its hybrid form of government is an interesting setting in which to analyze the multifaceted dispositions of urban data platforms. While the development of city data platforms was initially promoted by national agencies as part of the national Thailand 4.0 plan for transforming the country through smart cities, the implementation of digital platforms has been highly decentralized. But the process is nevertheless embedded within Thailand's centralized fiscal and political structure in which provinces and municipalities lack autonomy over tax collection, budgeting or infrastructure investment. This has made digital data platforms appealing to local leaders for a number of reasons—as seen in all of the cases. For example, even as the Phuket City Data Platform was developed as a national pilot by DEPA, the company created to manage it (CDA) was created from the efforts and capital of local business people in Phuket who viewed the platform as part of local infrastructure along with new transportation investments. For Bedrock, the startup backed by national oil conglomerate PTT, they saw a market opportunity in creating a data platform as service that municipalities would find cost-effective if it helped them raise more revenue from local taxes, like building and sign board taxes. Finally, local mayors and the governor of Bangkok have embraced citizen participation platforms as a way to both boost their popularity and electoral legitimacy, while making better use of the limited funds they have available for discretionary funding.

The typical view of smart cities has suggested they have often been embraced in developing countries as symbols of modernity, and as a form of "entrepreneurial governance". The varied adoption of urban data platforms *within* Thailand show that smart city has taken on multiple forms and meanings even within one country. Far from being associated with the neoliberal retrenchment of state power in favor of the market, as was thought to be the case in U.S. or European experience and academic depiction of smart cities, in Thailand such platforms are being used to strengthen or enhance state capacity, particularly with regard to fiscal power, often seen as a core part of state "infrastructural power." The citizen platforms promoted in Bangkok and Nakhon Si Thammarat have the potential to both enhance the power of local governments and

mayors but also empower citizens. Whether such platforms enable a more responsive government, or encourage further popular demands for political changes is an open question with implications for the country's political future. With the 2023 election that saw a groundswell of popular support for the MFP followed by subsequent failure of the party to form a government in the face of conservative opposition, one has to wonder how and through what channels future popular politics will be channeled. Will demands for "decentralization, de-monopolization, and demilitarization," –the platform of MFP—be met with technocratic policy responses, or will further street protests and unrest be required for any meaningful political change? What is the role of digital platforms in spurring or obviating energy for more confrontational politics? That is a question that the next few years may provide some answers for.

At the very least, the emergence of the smart city as a discursive field, along with subsequent efforts to build digital data platforms in Thailand suggests that the deployment of data platforms has become intertwined with and is increasingly pivotal to competing visions for urban and national governance and the different visions of how data should be used to empower state power writ large as well as specific interests of national companies, local governments, and citizens.

Chapter 7.

Xiong'an and the Construction of a Digital China

Figure 27. Diagram of Xiong'an's Rongdong District (Author, 2024)

Introduction

This chapter examines the city of Xiong'an New Area as a lens into Xi Jinping's vision of a "new development concept", or *xin fazhan linian.*[406] In general this involves moving away from market reforms and devolution of urban autonomy to a more centrally guided urbanization model involving greater role of central, provincial, and state-owned enterprises at the expense of municipal autonomy. Following from the discussion of China's national digital developmental policies in Chapters 2 and 3, this chapter focuses on the city of Xiong'an as a lens into how these efforts are playing out in a specific new city project. Xiong'an aims to be both "green" and a "smart city", and ambitious efforts are underway to build digital infrastructure into the city from the ground up including an autonomous driving system, a digital twin of the city combining 3D models and 2D data with real time IoT sensors to facilitate both planning, design, and "operations" of the city in the future. Whereas private technology platforms like Alibaba, Baidu, and Tencent have been active in developing smart city systems elsewhere in China, Xiong'an's smart city development is being guided almost entirely by a consortia of state-owned telecom and infrastructure companies. This reflects Xi Jinping's ongoing efforts to ensure control of data resources in the hands of the party state. The project also reflects the recent effort of constructing a "Digital China"—a nationwide policy unveiled in 2023 that aims to deploy physical and digital infrastructure, boost digital governance, and leverage "data as a production factor," a phrasing that suggests a reconceptualization of data as not merely an economic asset for private profit but also a critical resource for national development. Xiong'an, like some of the other cases in this project, is a national showcase: described in official media as a "national template" for "high quality development" the current favored term to describe China's shift to a clean and innovative development model. Whether or not the city itself can be a model for other Chinese cities remains to be seen, but given the full backing and close personal investment of Xi Jinping, the "Xiong'an experiment" will likely have implications for the rest of the country.

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[406] In 2017, "Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era" was incorporated into China's constitution at the 19th Party Congress; also at this time, the idea of "high-quality development" *gaozhiliang fazhan*, and "new development concept" *xin fazhan linian*; these rather general slogans all call for shifting China's growth model away from low-cost manufacturing/real estate to cleaner and high-tech innovation, and emphasize "quality" over speed or absolute quantity of economic growth

The "City Brain": The Nerve Center of Xiong'an's Digital Infrastructure

In the hot dry June sun of Hebei province, a shallow reflecting pool glistens in front of the Xiong'an Cloud Supercomputing Center, a rectangular slab-like structure covered in cream-colored granite housing the computers and servers that will power the city's digital infrastructure. I recognized it instantly from the renders I had seen of the project online, which depicted the building floating almost like a mirage above the glassy water, a temple to the city's data. In Xiong'an and in other cities in China, cloud data centers are increasingly designed not merely as functional repositories of servers, but as icons of technological progress and futurity. The data center has become the new incarnation of the *chenghuang miao* or "city god temples" in Imperial China, which housed deities that were thought to protect cities and ensure their prosperity. Today, the new god of urban development is digital data, which must be housed in shimmering homes designed to cool energy intensive servers and showcase their role in building a "digital China" and a *keji qiangguo* or, "technologically strong nation."

When it opened in November of 2022 the "Xiong'an City Brain" was billed in media reports as the "first ever data center to incorporate ecological energy saving features." The 1bn Yuan ($140 Mn USD) investment into the city brain is a joint venture between Xiong'an Digital City Company (51%), a subsidiary of Xiong'an Group--the Hebei province-owned corporation responsible for building much of the city's infrastructure, and 49% investment from China Telecom. [407] Consultants from Alibaba, Tsinghua University, and China's Academy of Urban Planning and Design also worked on the project. [408] Buried deep within the structure are 3600 server bays, which will "satisfy Xiong'an Digital twin city's demand for computing power by 2035," when the city is to reach the first milestone of development. Burying the servers underground mitigates servers' overheating and reduces energy usage, purportedly making the center one of the first to achieve a power usage effectiveness (PUE) ratio below 1.1. The green roof of the building folds down to the ground into the Yuerong Park behind it, dotted with traditional Chinese landscaping features like pagodas, pavilions, and traditional music piped in from speakers hidden in the foliage. Described as "the core of the ecological city, a perfect integration of digital and ecological" and the "first data center built into the earth, with Chinese landscaping features," the data center

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[407] Wirescreen Database: Xiong'an Group, China Telecom (Accessed 2023).
[408] CAUPD is a division under China's Ministry of Housing and Urban Rural Development (MOHURD)

has both practical and symbolic functions: powering the city's digital systems while also communicating a fusion of high technology, ecology, and Chinese landscaping traditions.

The Party Secretary of Xiong'an Digital City Company Company has called the structure an "important carrier of Xiong'an digital twin city's operations and service." The building will house computing platforms that power "four systems in one," including an Internet of things (IoT) platform, city information management (CIM) platform, a platform of live-video camera feeds from the city. A digital twin of Xiong'an is being built alongside the city's physical construction. The digital platform powering the city integrates building information management and geographic information systems, along with dynamic data from sensors and cameras around the city, the so-called internet of things.

In a separate exhibit on the planning of the city "Xiong'an Impression" a few blocks away in Power China Science City, a development built by a large state-owned infrastructure company Power China,[409] a multimedia display showcases futuristic elements of the city's digital systems. A concept mentioned often in press reports and in the exhibit is that the city is conceptualized as "three cities" *san zuo cheng*: "the city underground, the actual city on the ground, and the city in the cloud." The city underground refers to massive underground utility corridors or *dixia guanlang*, that are being constructed beneath most of the city's arterial roads. These will house utility mains, electric systems, and potentially a level for automatic delivery of logistics and parcels. In the initial concept for Xiong'an, "they were going to put all the transportation underground, but Xi thought this was too impractical, too expensive, and the planners were fooling him. So they asked them to do it again."[410] The winning master plan concept of Xiong'an was delivered by the storied American firm SOM. But the detailed planning and design was turned over to a collection of state-owned planning and research institutes including Tsinghua, Central Academy of Urban Planning and Design, Shenzhen Institute of Planning and Design, and Tongji. In the words of one planner with knowledge of the process, "They brought up a lot of people from Shanghai and other institutes because they were concerned things weren't going well." The mobilization of all of these institutes and state-owned enterprises from around the

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[409] Power Construction Corporation of China or *Dianjian* is a state-owned enterprise formed 2009 from the merger of Sinohydro and invests in hydroelectric power projects and infrastructure around the world. They are developing Power China Science City within Xiong'an's Rongdong District, where the exhibit is hosted.
[410] Interview, planner from Shanghai (2022)

country indicates Xiong'an really is a "thousand-year plan of national significance" or *qian nian daji, guojia dashi*, the eight-character slogan routinely used to describe the city and printed on red banners hanging from lightposts on almost every street in Xiong'an.

Back in Beijing, I'm meeting with Yang Tao, a Professor at Tsinghua University who helped develop Xiong'an's digital planning platform. In a Starbucks just outside Tsinghua's Beijing campus, he explains explains the vision behind the Xiong'an City Brain:

> "The real unique part of what is being done in Xiong'an is to combine the planning, architectural design, and management and governance into one integrated platform, and to do this at the scale of the entire city."

Yang Tao notes the project is still under construction and thus future use cases are still being developed. But he mentions the potential for the system to allow for dynamic adjustment of service provision. "If population increases, then the service levels, say of public transport can be adjusted in real time—this is another potential use." [411] Such real-time adjustment follows longstanding imaginaries of the smart city as what Kitchin terms "one that can be known and managed in real-time and is sentient to some degree." [412] Another more immediate use has been standardizing geospatial platforms for coordination between the various companies and design units planning and building the city, something which Yang Tao says could be continued to standardizing data between government ministries or departments once the city is operational. Such inter-agency (or lack of) coordination is an issue in many cities, and whether Xiong'an's digital platform can improve those issues where others before it failed remains to be seen.

I asked Yang Tao, who has a Ph.D. from University College in London and is familiar with global smart city projects, how significant Xiong'an's platform was in his perspective:

> "The Xiong'an Digital twin is probably the most ambitious and comprehensive project of its kind in China right now. Other cities like Shenzhen and Hangzhou are

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[411] Interview, 2023

[412] Michael Batty, "Smart Cities, Big Data," *Environment and Planning B: Planning and Design* 39, no. 2 (April 1, 2012): 191–93; Kitchin, "The Real-Time City?"

experimenting with similar projects, but Xiong'an is the only one to begin from the ground up, as the city was built."[413]

The "city in the cloud" refers to the digital city construction. A "digital twin city" is being constructed alongside the city's physical construction. As each building is built, a virtual copy of every piece of rebar, piping, and other building systems are constructed on a new platform that incorporates GIS, Building Information Management (BIM), and is to be augmented by IoT sensors feeding real-time information to a digital dashboard. Each "element" such as a piece of material in a building, has a unique digital ID tag. In the "Xiong'an Impression" exhibit, a massive screen shows a digital dashboard with a 3D model of Xiong'an, with data from the city's various systems being fed real-time into the platform. The platform design comprises three layers, a "spatial layer, a model layer, and a perception layer." The Space Layer uses 3D GIS software to "build a virtual twin city that is completely mapped to the real world based on the relationship between locations, units, and attributes." The modelling layer will be used for simulations of planning scenarios, and the perception layer will integrate real-time information from the city's network of traffic cameras, underground utility corridors, ecological areas, air quality, and other aspects.[414]

In a paper written by Yang Tao and Yang Baojun, the head of China's Central Academy of Urban Planning and Design and one of the chief planners of Xiong'an, they describe the six main functions of Xiong'an's City Information Management Platform as: 1. Aggregation of data; 2, "intelligent approval" (such as automating approval of planning or construction permits), 3. "Monitoring and early warning," 4. Assisted decision making, 5. Assessment and governance to "conduct high-frequency real-time assessments on city operations to make the city more resilient," and lastly, 6, "promote the digital economy, by taking urban planning and design scenarios as the engine, integrating new information infrastructure such as 5G and IoT, cultivating a new digital economic model for the city's full life cycle development."

On a giant screen in the "Xiong'an Impression" exhibit, a simulation of one scenario shows how the "monitoring and early warning" aspect might work in practice: A fire in a building flashes red

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[413] Interview Tsinghua Professor/Formerly CAUPD (June 2023)
[414] Yang, Baojun; Yang, Tao, Feng; Zhenhua ; Zhou, Qin; He, Qian; "Digital Planing Platform: A new mode to facilitate the future urban planning and design" *Chengshi Guihua* (City Planning Review) 2022. 46, 9, Sept 2022.7-12

on the screen and fire engines race to the location, notified through automatic sensors that detect the fire and alert authorities automatically. A deep male voice narrates over simulations of the platform, "Intelligent life is created through intelligent Party building, intelligent public service, intelligent office park management." Smart operations functions include "security of industrial parks, analysis of industrial zones, and smart management operations." The screen zooms in on the 3D model of an office building which immediately displays information about the number of employees, production, and companies operating there.

Whether the construction of Xiong'an's digital infrastructure can be a model for other Chinese new cities or existing cities is an open question. But that's certainly the hope expressed by Chief Engineer from Xiong'an Group's Digital City Technology Company Gui Yong, "we hope the example of Xiong'an's digital development can make a contribution to other cities around the country that can use Xiong'an as a reference."[415] In 2022, a research institute[416] under the Ministry of Industry and Information Technology (MIIT) released its "City Brain Development White Paper," which notes that, "with the advent of the digital age, comprehensively promoting digital transformation and building a modern governance system and capabilities that are compatible with urban digital development have become key tasks in promoting the construction of new smart cities and digital China." Thus, the development of city brains systems is seen as integral to the broader national effort now called as *Shuzi Zhongguo*, or "Digital China," the goals and origins of which were discussed in Chapter 2 and further implications of which are discussed at the end of this chapter. The report, which synthesized opinions from government researchers, academics, and industry, collects national best practices and standards for what have hitherto mostly been municipality-led projects. "In recent years, various localities have actively explored and promoted the construction of urban brains based on their own development needs…but in order to establish a unified understanding of the urban brain from all walks of life, systematically analyze the development status, problems and trends of urban brains and provide suggestions for the healthy development of the urban brain."[417] Xiong'an's City Brain is included as a case along with 34 other similar projects. Six of those projects are within Hangzhou itself, reflecting

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[415] CCTV Documentary *Chuangxin de liliang* "The power of Innovation", Episode 8. Aired June 21, 2023
[416] The Working Group on Smart City Standards, within the National Information and Standards Committee
[417] China National Information and Standards Committee, "Chengshi Danao Fazhan Baipi Shu (City Brain Development White Paper)," (Beijing: China National Information and Standards Committee, January 2022).

its early lead in pioneering the City Brain idea through its 2014 partnership with Alibaba. Some are piloted by City-level authorities while others are only piloted by specific districts within cities.

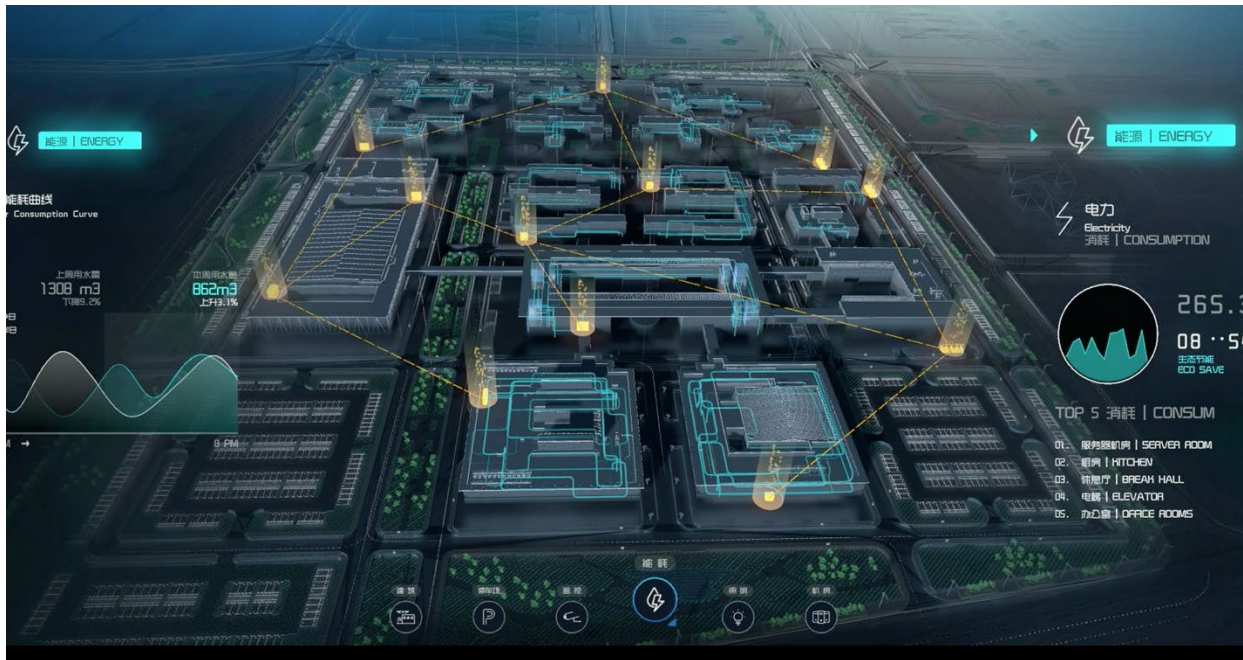Figure 28. Façade View of the Xiong'an Cloud Supercomputing Center (Author, June 2023)

Figure 29a. Screenshot of Xiong'an Digital Twin of Building Energy Systems in the Citizen Service Center (Xiong'an Group Website)

Figure 29b. Rendering of Power China Intelligent City Operations Center "City Brain" (Author, 2023)

Another aspect of Xiong'an's digital infrastructure is the creation of an autonomous transportation system. Many countries and companies are experimenting with autonomous vehicle development, such as Google's Waymo in the U.S. But in China, the development of autonomous transportation systems is not being developed only by vehicle companies, but also by telecom providers and infrastructure developers. In Xiong'an, the plan for autonomous transport relies not only on vehicles equipped with onboard cameras and sensors but an extensive digital infrastructure built into the city itself. Digital buses and cars would communicate with this "embedded digital infrastructure" such as 5G base stations, cameras, and other sensing devices built along roads. As a former Baidu employee described, "There was this idea when I was at Baidu that Andrew Ng [former chief scientist of Baidu] was pushing for-- rather than having autonomous vehicles independent of infrastructure you can build sensors into the infrastructure to train the terrain not just cars."[418]

Shortly after Xiong'an was declared in 2017, China's tech platform Baidu announced intention to help develop its Apollo autonomous driving system in Xiong'an[419] However, since the announcement in 2017, most of Xiong'an's digital development has been undertaken either by Xiong'an Group or various state-owned enterprises like China Telecom. As a former employee for a developer who worked in Xiong'an for two years told me, "At the beginning private technology companies (i.e. Baidu and Alibaba) announced some partnerships but gradually a lot of these projects were begun by Xiong'an Group, which at first didn't have those capacities but they've gradually started their own subsidiaries to do these various digital projects."[420] The project's name "City Brain" itself comes from Alibaba's proprietary City Brain Platform, first trialed in its home city of Hangzhou. That system used an extensive network of AI-enabled cameras feeding data into data centers, where algorithms process real-time traffic flow to manage the city's traffic lights and allow more efficient traffic flow as well as opportunities for enabling emergency response vehicles to bypass normal traffic lights, as well as facial recognition for tracking of criminals.

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[418] Personal Communication, Former Baidu Executive (2023)
[419] Xinhua (2017) "Xiong'an New Area, Baidu to develop AI city program" December 21, 2017
[420] Interview with former employee of CR Land Xiong'an (2022)

The next day in Xiong'an, a driver brings me on a tour of Qidong District, the central business district of the city already under construction just south of the already completed Rongdong District where the City Brain is located. Driving across a vast flat plain of construction sites, I can see the various smart lampposts, cameras, and other equipment hanging from gantries straddling the area's main roads that have already been built. An official post describes these "information poles like pairs of eyes and guards standing on the streets working tirelessly to provide data to the city brain."[421] Already in Rongdong District, 7,500 such poles have been erected, and will "provide digital test scenarios for technological research on intelligent transportation and vehicle-road collaboration."[422] The construction of Xiong'an's IoT network depends not only on the city brain supercomputing center and sensors distributed across lampposts, but also on a system of intermediate edge computing "macro stations" distributed throughout each District, and located at community center facilities or in basement of office buildings. In Rongdong District, planned to house about 170,000 residents, six substations would perform intermediate edge computing functions, collect data from mobile sensors, and funnel data to the city brain. Standards call for one or two such "collection base stations" per *shequ*, or community."[423] In this way, the digital infrastructure of Xiong'an is highly integrated into the city's hierarchical community structure, composed of communities *shequ* and sub-neighborhoods *jiedao*. Xiong'an's development reflects a greater effort to control the city's digital data, with the city's digital development now firmly in the hands of state-owned enterprises—although Baidu and Alibaba are still involved as consultants on some of these projects. Xi's "technology war" which targeted the growing power of privately owned technology giants like Alibaba applied state regulatory and often minority ownership controls over the private sector. As Collier notes, "platform companies were beginning to assemble large batches of consumer data, including spending patterns, total wealth, and entertainment expenditure. This was a huge advantage to these firms but also posed a threat to the Party's political control. For example, Didi Chuxing's geospatial data could track the location of senior officials."[424]

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[421] Buyiyang de dianxian gan cangzhe xiongan de zhineng mima (A different kind of electric pole: hidden code of intelligent Xiong'an) "*Hebei Ribao (Hebei Daily)* November 23, 2023 http://he.people.com.cn/n2/2023/1123/c192235-40651305.html
[422] Ibid
[423] Liu, Xiaoqing, He, Rui (2022) "Planning of City Information Infrastructure: Xiong'an Exploration as Example" *Urban Planning Forum*. 2022. 5. Pg 271
[424] Andrew Collier, *China's Technology War*, (Singapore: Palgrave Macmillan, 2022).

Figure 30. Plan of Rongdong District showing distribution of "edge computing macro stations" and sensing poles (Liu et al 2022)

Figure 31. Gantry-mounted cameras and 5G-enabled sensors mounted on lampposts line the newly finished roads of Qidong District (Author, 2023)

While most enterprises and their employees have yet to relocate to Xiong'an, much of the digital infrastructure is already in place. In fact, one of the first batch of research centers to open in Xiong'an are located in the "Smart Industry Office Park," which consists of research offices developed by each of the country's three state owned telecom companies; China Telecom, which is a partner in the city brain project (See Figure 32a), as well as China Mobile and China Unicom. In this way, the construction of the city's smart infrastructure itself becomes an economic sector in its own right, not unlike the development of Singapore's "urban solutions" sector. Beyond the "smart city research parks" opened by China's telecom firms, the main office complexes under construction include a high-rise headquarters of energy SOE Huaneng, a low-rise star-shaped curvilinear complex that will be home to China Satellite Communications Group, and a pagoda-shaped tower that will house the headquarters of Sinochem (Zhonghua), a large state-owned chemical company. China Communications Group is Developing "China Communications Future City" project next to the city's high-speed rail station. PowerChina, a massive SOE that builds power generation facilities and harbor engineering in China and around the world, is building Power China Science City as an integrated office/research/retail complex (See Figure 32b). China Rail, the state-owned engineering company developing China's high-speed rail system, has announced plans to invest in an R&D complex in Xiong'an. Thus, Xiong'an is due to become a city of "infrastructure innovation" driven almost entirely by state capital and state-owned enterprises primarily in the sectors of infrastructure, IT, energy, and defense-related technology.

Figure 32a. (above) China Telecom Smart City Research Park under construction, Xiong'an (Author, July 2023)

Figure 32b. (below) Power China Science City, Xiong'an (Author, July 2023)
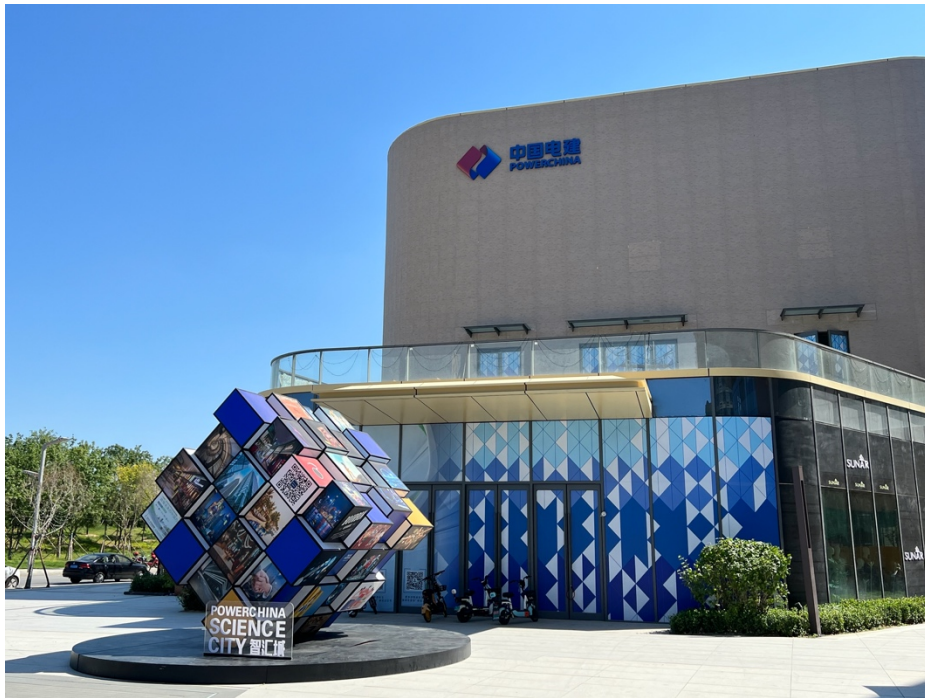
Figure 33. Infrastructures of Xiong'an: Top-section of street-level sensing hardware and subterranean *dixia guanlang*, underground utility channels; Below: Section of City Brain Building (Author, 2024)

Xiong'an as a New Development Concept and Model of "High-quality development"
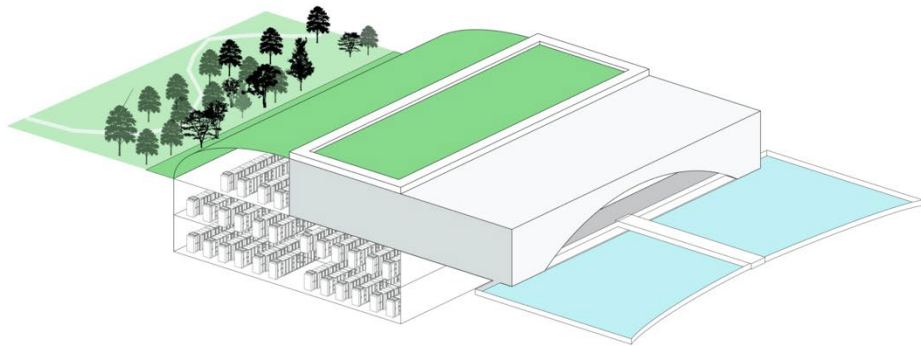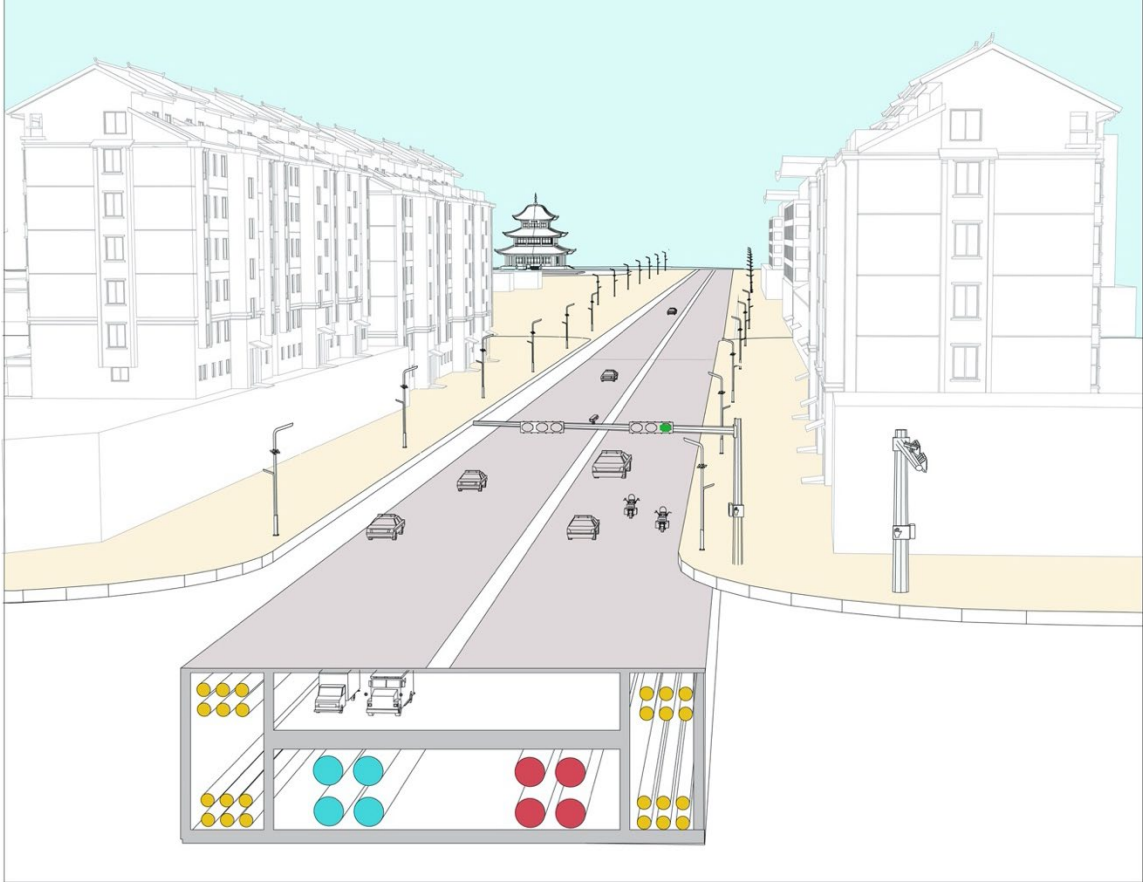
How did Xiong'an New Area become a testbed for a "new development concept" that generally sees a greater role for the state and a more controlled approach to urban development? In 2015 the state council formally adopted the "Plan for the Coordinated Regional Development of Beijing-Tianjin-Hebei" which generally sought to strengthen transport and economic linkages between the three jurisdictions.[425] The "coordinated development" idea was one aspect of the New Type Urbanization Plan released in 2014, which generally sought to strengthen central control over the excesses of China's municipal-driven, chaotic rush toward urbanization, emphasizing urban-rural linkages and central control over spatial planning.[426] Megapolitan regional development had also become a core concept of national economic planning, with the declaration of Greater Bay Area, Yangzte River Belt, and *Jing Jin Ji*, among others.[427] But the concept of a Jing-Jin-Ji region was not new. Since the 1980s market-oriented economic reforms, coastal cities surged ahead of inland industrial centers that had been favored during the planned economy. In the 1950s planned economy, rail hubs and industrial centers were established throughout Hebei such as the new provincial capital Shijiazhuang, Baoding, Xingtai, and Tangshan. During Deng's market-oriented reforms of the 1980s, coastal cities like Tianjin were again favored, leaving older industrial centers behind. It was during this period that policy discourse returned to the need to better integrate Hebei into what was termed a "capital circle" or *shoudu juan*.[428] Spatial planning and policy coordination would aim to tie these cities into an economic belt better integrated with Beijing and Tianjin. In 2011, the idea of a "capital economic circle" was incorporated into the 12th Five Year Plan. After Xi Jinping became President and Party Secretary in 2012, he began driving further development of the idea, including plans for a municipal sub-center in Tongzhou, where Beijing's municipal government offices would be relocated.

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[425] "Plan for Integrated Development of Beiing, Tianjin Hebei Released." *Beijing News.* May 5, 2015

[426] Nick R. Smith, *The End of the Village: Planning the Urbanization of Rural China* (Minneapolis: Univ Of Minnesota Press, 2021).

[427] Eddie C. M. Hui et al., "Deciphering the Spatial Structure of China's Megacity Region: A New Bay Area—The Guangdong-Hong Kong-Macao Greater Bay Area in the Making," *Cities*, October 28, 2018, 102168; Xin Ling, "China's Planned City Clusters Are Bigger than a Megacity," *MIT Technology Review*, April 28, 2021; Minghong Tan, "Uneven Growth of Urban Clusters in Megaregions and Its Policy Implications for New Urbanization in China," *Land Use Policy* 66 (July 2017): 72–79; Fulong Wu, "China's Emergent City-Region Governance: A New Form of State Spatial Selectivity through State-Orchestrated Rescaling," *International Journal of Urban and Regional Research* 40, 6 (2016): 1134–51

[428] Wang (1986) Discussing Beijing's "Capital Circle" Formation and Function" *Beijing Social Science Review*

When Xiong'an New Area was proclaimed on April 1, 2017, the stated aims of the project were straightforward: relocate "non-capital functions" out of Beijing and solve the capital's "urban sickness." Sprawl, pollution, and traffic problems were seen as justifying the need for a satellite city that would take pressure off the capital and remedy longstanding uneven development between Beijing and Hebei province, which surrounds the capital. Two months earlier, on February 23, Xi had made a less publicized visit to the site of the new city, holding a small forum with local officials in Anxin County, one of the three counties that would eventually be amalgamated into Xiong'an New Area. According to a report, he emphasized that "the planning of the Xiong'an New Area would be a deep historically significant choice. Today China is the world's second largest economy, and Xiong'an is necessary choice to propel the economy into a new phase, and build a new growth pole for Northern China."[429]

While the 2015 Jing Jin Ji plan made no mention of Xiong'an, two months after the 2015 Plan for Jing-Jin-Ji was released, Xi emphasized in April of 2015 during another meeting of the Political Bureau of the CCP standing committee that a "suitable location in Hebei should be chosen" to "construct a modern city led by a new development concept" [*xin fazhan linian*].[430] Thus already by 2015, the idea of building a new city emerged as part of the *Jing-Jin-Ji* plan, and this was tied to the much broader aspiration finding a new development model for the country. The idea was to find a location far enough away from Beijing and Tianjin that it would not become simply another suburb, but close enough to allow commuting between the three urban areas. More symbolic elements may have also played a role. As told by Xu Kuangdi, former Mayor of Shanghai who in 2014 was appointed to lead the advisory panel for the Coordinated Development of *Jing-Jin-Ji*, "traditional Chinese culture has the idea of mountains to position city location." As Xu says, "Directly south of Beijing's central axis is Bazhou, but the geological condition there was not suitable for a new city." The three counties chosen for Xiong'an are relatively sparse in population and lies directly south of Tanzhe Temple *Tanzhe si*. This is an ancient temple with origins as far

[429] State Council of China (2017) *Hebei Xiong'an Xinqu Jiedu* (Understanding Hebei Xiong'an New Area) Renmin Chubanshe {People's Press}, Beijing, 36
[430] Ibid. (pg. 9)

as back as the Western Jin Dynasty (307 AD). "Before there was Beijing there was Tanzhe Temple. Relying on this axis, Xiong'an was selected." [431]

It was in October of 2017, six months after the founding of Xiong'an, that "Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era" (or simply, Xi Jinping Thought) was formally adopted into the constitution of China's Communist Party at the 19th Party Congress. This represented a significant elevation of Xi's own power, putting him on par with Mao and Deng. Among the key ideological concepts stressed at the 19th Congress was the notion of *gao zhiliang fazhan*, or "high-quality development." Related to the idea is the adoption of a new "primary contradiction" or *zhuyao maodun*, a Chinese Marxist idea that in every age a primary contradiction exists that the Party State should set about rectifying.[432] In 2017 the principal contradiction was determined to be the contradiction "between unbalanced and inadequate development and the people's ever-growing needs for a better life."[433] The heady excesses of China's rapid boom years also resulted in pollution, corruption, and other externalities that were seen by Xi as mortal threats to the Party-State's legitimacy. In the view of Xi and other party leaders, China's *tudi caizheng* "land finance" system had been partly to blame for some of these excesses. The power of municipalities to lease land for development fueled rapid growth but also fueled local corruption, seizure of farmland from farmers that led to widespread rural unrest, loss of arable farmland, and the development of so-called "ghost cities".[434] This accelerated in the wake of the 2009 stimulus program, much of which was funneled to cities and local government financing vehicles. Xi Jinping, in his speech at the 19th Party Congress, acknowledged the successes of China's reforms that had elevated it to the world's second largest economy, but was also quite critical of the failures of his predecessors to deal with problems that in his view had been building up for years.

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[431] Jingjiao Zeng, "Xiong'an Xinqu fangan 6 yue dishangbao, jiang jian 21 shiji dixia guanlang shi shebei 'Xiong'an New Area will build a 21st century underground corridor infrastructure,'" *Nanfang Doushi (Southern Metropolis)*, June 7, 2017

[432] Angela Stanzel, Jean Christopher Mittelstaedt, and Heike Holbig, "China's 'New Era' with Xi Jinping Characteristics" (Brussels: European Council on Foreign Relations, December 2017).

[433] Report of Xi Jinping to the 19th Party Congress (2017).

[434] Wade Shepard, *Ghost Cities of China: The Story of Cities without People in the World's Most Populated Country* (Bloomsbury Publishing, 2015); Xuefei Ren, "Land Acquisition, Rural Protests, and the Local State in China and India," *Environment and Planning C: Politics and Space* 35, no. 1 (February 1, 2017): 25–41; Nick R. Smith, *The End of the Village: Planning the Urbanization of Rural China* (Minneapolis: Univ of Minnesota Press, 2021).

Xi's own views on the excessive embrace of foreign starchitects during its boom years has also shaped the design of Xiong'an. In 2016 the State Council issued a directive calling for an end to architecture that is "oversized, xenocentric, weird," and devoid of cultural tradition," and also called for an end to gated communities.[435] The design of Xiong'an reflects these priorities, some of which were apparently dictated by aesthetic preferences of Xi himself. Xiong'an's official plan guidelines call for "Chinese-Western fusion, with Chinese as the main style, old and new blending" (Plan, 20). According to a designer who worked on the plan for SOM, "there was pretty clear direction at the beginning that there would be small blocks, land wouldn't be sold en masse to developers, and that things would be state-run."[436] Most buildings in the completed Rongdong District are not overtly "Chinese", but nonetheless reflect a more conservative, classical design ethos. Glass curtain walls were also discouraged, with most buildings clad in some sort of exterior framing of either metal or stone, or wood.

From *Smart Cities" to Building a "Digital China"*

Xiong'an has been described as a "national template for high-quality development," a "thousand-year project of national significance," and a model of a "new development concept." This intended showcase purpose is reflected across many domains: ecological planning, new models for financing urban development that move control away from the municipal level to provincial authorities, central state-owned enterprises, and central banks. In terms of urban technology, Xiong'an also suggests an effort to go beyond what China's private technology firms have already developed and integrate technology more comprehensively into the governance and administration of cities and the nation. This aim is clear in Xiong'an but also reflects national policies such as the recent "Plan for Construction of a Digital China," mentioned in Chapter 3. In this sense, Xiong'an is a microcosm of ideological discourse and state policies in contemporary China that increasingly aim to integrate digital infrastructure across every domain of the "real economy" *shiti jingji*, use data as a "factor" of production for other industries and as a means for strengthening state governance.

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[435] Li, Cao. "China moves to Halt Weird Architecture" *New York Times* February 22, 2016.
[436] Interview, SOM Xiong'an Urban Designer (2021)

While the term "Smart Cities" was incorporated into China's 12th Five Year Plan (2011), the acceleration of China's smart city development didn't take off in earnest until the rise of homegrown technology giants such as Baidu, Alibaba, and Tencent. These platforms, propelled by China's massive market and aided by restrictions on Western platform firms like Facebook and Google from operating in China, helped drive China's digital economy and also helped power its smart cities. After they conquered China's search, payment, and e-commerce markets, they invested some of their massive cash reserves into other technology projects such as smart-city related technology, not unlike Google's creation of Sidewalk Labs as a "urban technology venture" in 2015. The first notable successful case of this was the Hangzhou City Brain, first unveiled in 2016 as a partnership between Hangzhou-based Alibaba and the Hangzhou City government to improve traffic flow deploying 4500 citywide AI-enabled cameras, facial recognition technology, and eventually an AI-powered traffic management software platform.[437] While Alibaba Cloud helped develop the infrastructure for the digital platform and AI capabilities, the system also depended on the city-installed surveillance camera network. In addition to Alibaba, Hangzhou is also home to Hikvision, one of the largest producers of surveillance cameras in China and now worldwide.[438] Alibaba subsequently expanded their City Brain platform to numerous cities around China, as well as in Kuala Lumpur, Malaysia. Huawei, an expanding Chinese telecom and technology firm headquartered in Shenzhen, has also promoted its own smart city services including a city data platform. Huawei also found itself in the crosshairs of Western countries after the U.S. raised concerns about the security of its 5G equipment and the possibility of data traffic across its networks being subject to Chinese state surveillance. Despite being a mostly privately-owned firm, Huawei has close links to the Chinese military and has received significant subsidies and funding from the Chinese government. This led the U.S. administration on a wide-ranging effort known as the "Clean Network" project to persuade allies to abandon Huawei and other Chinese technology providers, fearful that China would eventually control the pipes of information flow in countries around the world, not only in developing countries but in key U.S. allies like the U.K. and Germany.[439] Interestingly, even as Western countries grew alarmed at the potential of China's internet giants to dominate the world's digital infrastructure, China's own

[437] Federico Caprotti and Dong Liu, "Platform Urbanism and the Chinese Smart City: The Co-Production and Territorialisation of Hangzhou City Brain," *GeoJournal*, November 3, 2020
[438] Chin and Lin, *Surveillance State* (2022)
[439] Rithmire and Han, "The Clean Network and the Future of Global Technology Competition."

Communist Party had grown similarly wary of the power amassed by private firms, particularly seen in the last-minute blocking of Alibaba's Ant Financial Launch in 2021 by China's Cybersecurity Administration, and subsequent fines against ride-hailing Didi and Tencent. Meanwhile, Huawei has retained the government's favor as a "national champion", with strong links to military and party leadership.

National policies in China should be taken more as general frameworks rather than detailed plans. Nevertheless, the recent outpouring of national policies related to digitalization, data, and urban data systems suggests that smart city policies are an important part of national efforts to integrate smart city technologies (which includes city data platforms or city brains, e-government projects, and AI/cloud computing facilities) with governance *zhili* across different levels of administration. This fits with an overall push by Xi Jinping over the last few years to centralize control over policy implementation at the national level, whereas the previous decades had seen a trend towards devolution especially to the municipality level. Xi's 2014 call for building China into a "strong cyber power" or *wangluo qiangguo* has been incorporated into subsequent high-level policy documents, and emphasized at the 2017 19th Party Congress.[440] In general, the notion of "strong cyber power" encompassed a push for leading policy and standards creation across a variety of digital domains to accelerate China's effort to become a leading power in digital technologies.

China's 14th Five Year Plan (2021-2025) or *shi si wu* calls for using "digitalization to boost urban and rural development and governance model innovation, build an urban data resource system, and promote the construction of urban data brains."[441] Subsequent policies have followed after the 14th Five Year Plan including the 14th Five Year Plan for National Informatization, which includes plans for a "ubiquitous, intelligent, connected digital infrastructure system", comprising 5G, big data centers, smart networks, for example. This document makes explicit just how such national goals are intertwined with geopolitical competition, declaring that:

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[440] Graham Webster et al., "Lexicon: 网络强国 Wǎngluò Qiángguó," *DigiChina* (blog), 2018, https://digichina.stanford.edu/work/lexicon-网络强国-wangluo-qiangguo/.
[441] State Council of China (2021) "14th Five Year Plan"

"International competition in the digital space is entering a new phase, and national innovation and competitiveness focused on information technology ecosystem advantages, digitization transformation capabilities, and data governance abilities at the core, is currently becoming the focal point of a new round of competition between countries worldwide"[442]

The National Informatization plan also mentions the need for a "new type of high quality *gao zhiliang* smart cities," thus incorporating the "high quality development" concept into the smart cities plan, and calling for "coordinated and effective digital government service system." This can be taken to mean that smart cities need to be closely integrated with governance across multiple levels of the Chinese administrative system:

"Perfect urban information model platforms and operational management and service platforms, explore the construction of digital twin cities, and effectively enhance the broad sensing and smart decision-making capabilities of urban operations and economic operational states, and roll out models for "one map" (*yi zhang tu*) datafied urban management."[443]

The document later mentions improving the "multi-level smart governance overall plan", mentioning not only smart cities but also "smart community *shequ* construction."[444] As one of the lowest rungs in China's administrative system, the *shequ* has been a longstanding focus for Chinese governance—encompassing the Party-state's most common daily interactions with residents.[445] This suggests a further penetration of digital applications at the community level in light with ongoing efforts to rethink the role of the Party-state in everyday community governance.[446]

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[442] State Council of China (2021) "14th Five Year Plan for National Informatization," 8

[443] Ibid, 36

[444] Ibid., 50

[445] David Bray, *Social Space and Governance in Urban China: The Danwei System from Origins to Reform*, 1 edition (Stanford, Calif: Stanford University Press, 2005); Luigi Tomba, *The Government Next Door: Neighborhood Politics in Urban China* (Cornell University Press, 2014).

[446] Zhongping Xie, *chengshi shequ dang de jianshe lilun yu shixian chuangxin (urban community party building: theory and practice innovation)*, 1st edition (Tianjin: Tianjin People's Press, 2014).

More recently, the State Council issued its plan for the "Overall Structural Plan for Construction of a Digital China" emphasizing two main goals of i.) "opening up the main arteries of digital infrastructure" (this includes 5G, ipV6, internet of things, and Beidou—the Chinese alternative to U.S. GPS), as well as ii.) facilitate the circulation of data resources, which involves "aggregation and utilization of public data, build national data resource banks such as in public health, education, and science and technology."[447] The plan emphasizes coordinating and integrating data across various domains, and that in order for the potential of digital technologies to be fully realized, there has to be better coordination across different levels of government and different sectors of society. In a 2023 article, Guo Liang, an engineer with China's Academy of Information and Communications Technology (CAICT), published an article calling for what he termed *suanwang chengshi*, or "computing network cities." As the "bridgehead of developing the digital economy."[448] The development of city brains and cloud computing centers in Chinese cities is linked to national goals of promoting the digital economy and boosting China's overall "computing power" (*suanli*). One implication of these policies for China's smart cities is that the state and state-owned enterprises (like China Telecom) will now play a leading role.

At the national scale, China's NDRC and other agencies announced in 2021 called the "East West Data Transfer" or *dongshu xisuan*.[449] Mentioned briefly in Chapter 3, this project is designed to boost China's overall "computing power" by building new data and cloud computing centers in selected inland regions. The logic behind the plan is that these areas also have greater energy resources (coal, oil, natural gas, as well as renewable energy potential in solar and wind), and are economically lagging and thus could benefit from new investment. Of course, the reason why most cloud centers are located near major metropolitan areas in the country's east is to be as close as possible to customers. Proximity to data centers allows faster data transfer speeds and lower latency, however new technologies could make far-flung cloud centers viable for certain types of computation that do not require ultra-low latency, such as cold storage, experimental computation, and e-governance data—such as that generated in smart city platforms. The

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[447] State Council of China (2023) "Overall Structural Plan for Construction of a Digital China" 《数字中国建设整体布局规划》
[448] Guo, Liang (2023) *tuijin 'suanwang chengshi' jianshe dazao shuzi jingji fazhan 'qiaotoubao'* (promoting network cities is the bridgehead of creating digital economic development" Beijing: China Academy of Information & Communications Technology
[449] National Reform and Development Commission (2021) "National Integrated Big Data Center Coordinated Innovation Computing Power Hub Construction Plan." 《全国一体化大数据中心协同创新体系算力枢纽实施方案》

genesis of this plan can be traced to the successful effort of Gui'an New Area in Guizhou Province to attract cloud computing and data centers to the remote region—Huawei, Tencent as well as Apple have all built data centers in the area. [450] In 2021, a plan was unveiled to create a nationwide network by building seven additional clusters of data centers, including new inland hubs in western provinces (See Figure 34) of Inner Mongolia, Ningxia, and Gansu, while augmenting metropolitan regions with cloud hubs in Chengdu's Tianfu New Area, Wuhu (outside Shanghai), Shaoguan (north of Guangzhou), and Zhangjiakou (north of Beijing). The project is estimated to cost between 4-500 bn Yuan ($55-70 bn), with financing coming from a mix of government and private-sector investment. Local governments are offering financial incentives and other policies to attract investment into purpose-built Big Data Industrial Parks from firms like Huawei, Alibaba, and Tencent. State-owned telecoms China Telecom, China Unicom, and China Mobile are also expected to play a large role in building data centers.

The E-W Data Transfer is also explicitly framed in reference to previous large-scale nationwide infrastructure projects such as the North South Water Transfer *nanshui beidiao* (a system of aqueducts to channel water from south to north China), the Western Gas Transfer *xiqi dongshu* (natural gas pipelines) and the Western Electricity Transfer *xidian dongsong*.

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[450] Kevin Ziyu Liu, "Making the China Data Valley – The National Integrated Big Data Centre System and Local Governance," *Journal of Contemporary Asia* (2024): 1–23
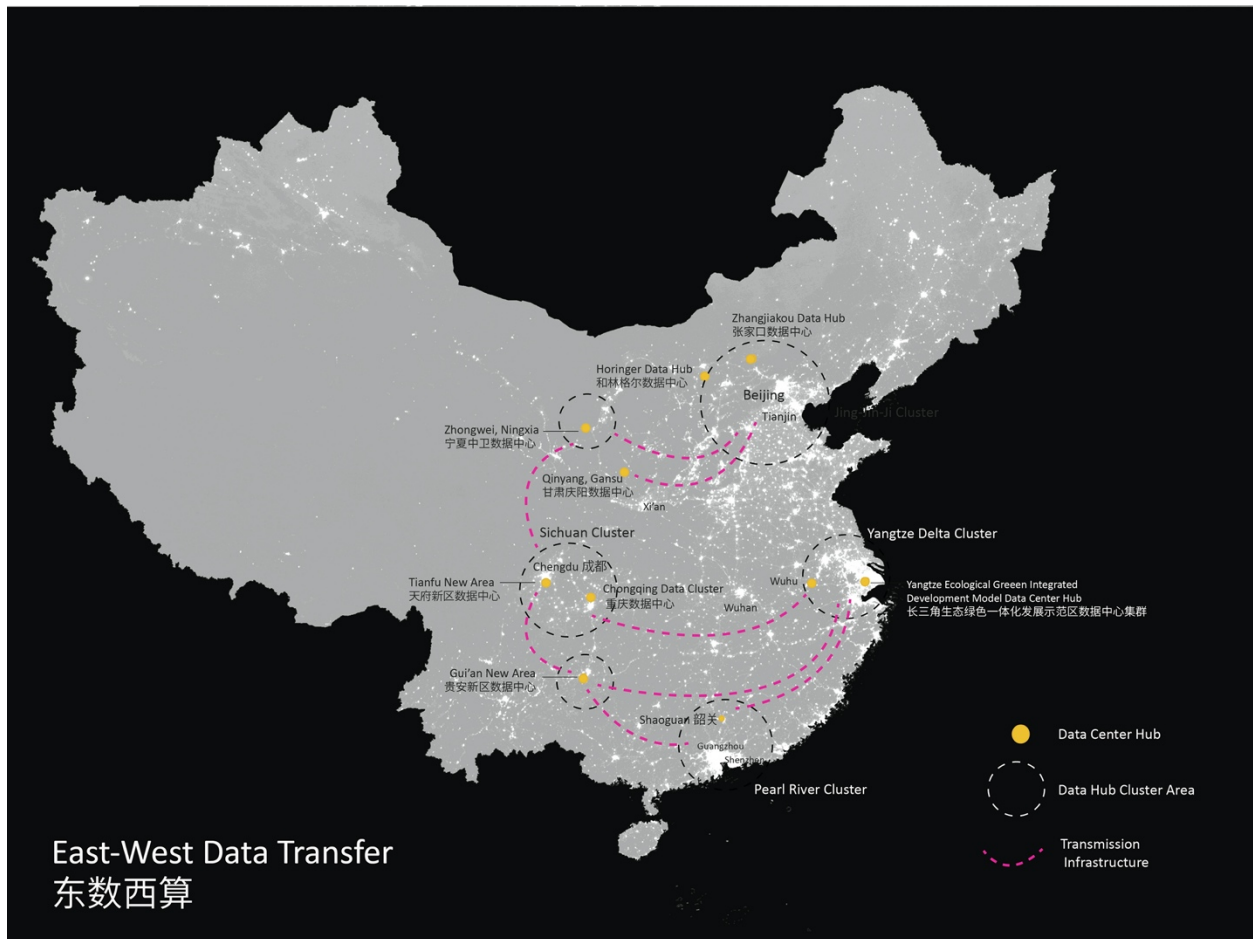
Figure 34. Map of East-West Data Plan overlaid on a nightlights map of urban areas (Author, 2024). Note transmission links are not precise lines but are intended as representation only.

Beyond Regulation: Data as a New Production Factor and Source of Value

Beyond the issue of state-market contestation over who controls data, there is a greater effort underway in China to rethink data as a "new source of value" and as a "production factor" in its own right. As mentioned in Chapter 3, Xi Jinping described data as a new production factor as early as 2017, something that was reiterated by the Central Committee of the Communist Party and State Council in 2020. The vision for data as a factor of production and source of value has implications for municipal finance and local governance. China's current system of land-based finance emerged in the late 1980s and early 1990s as China transitioned from a Socialist planned economy to a market economy. With the 1988 Land Law, municipalities were formally declared as representatives of the state and given power to lease land to private companies or developers, which began to shift power away from state owned enterprises or "socialist land masters" for

control over urban land.[451] What is now often called *tudi caizheng* "land finance"[452] took off in earnest following Zhu Rongji's 1994 tax reforms, which sharply reduced the amount of tax revenue available to municipalities. Some have called this a "grand bargain" between center and localities that allowed cities to make up the funding deficit through land leasing.[453] After the reforms, land leasing skyrocketed as a percentage of municipal revenue, considered "off-budget" until 2007 but gradually incorporated into formal budgets. Following the 2008 global financial crisis China's stimulus injected 4 tr RMN (586 bn USD), mostly for infrastructure. Local debt increased from 1.7 trillion yuan in 2007 to 6.6 trillion in 2010 and doubled in 2014.[454] A new financialized model began to take shape around this time involving the growing importance of "local government financing vehicles/platforms" LGFV, or *rongzi pingtai*, "entities established by the local governments through injection of land, equity and other types of capital and undertake financing functions for governmental investment projects."[455] The number of LGFVs grew from 306 in 2007 to 8221 in 2009.[456] Local governments were unable to borrow externally until the 2014 Budget Law, but were encouraged to use LGFVs to seek external financing.[457] Since around 2014, LGFVs have increasingly turned to issuing "urban investment bonds" or *chengtou* bonds as a way to raise money for infrastructure projects.[458] This represented a new phase of land finance turning more to the capital market to raise funds for urban development, although many such bonds are often still backed by municipal land as collateral injected into or purchased by LGFVs. In 2015, the State Council clarified that local governments could issue Local Government Bonds (LGBs).

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[451] Meg Rithmire, *Land Bargains and Chinese Capitalism* (New York, NY: Cambridge University Press, 2015); Tao Liu and George C. S. Lin, "New Geography of Land Commodification in Chinese Cities: Uneven Landscape of Urban Land Development under Market Reforms and Globalization," *Applied Geography* 51 (July 1, 2014): 118–30; You-tien Hsing, *The Great Urban Transformation: Politics of Land and Property in China* (Oxford: Oxford University Press, USA, 2012).

[452] Dingxi Huang and Roger C.K. Chan, "On 'Land Finance' in Urban China: Theory and Practice," *Habitat International* 75 (May 2018): 96–104; Joseph Gyourko et al., "Land Finance in China: Analysis and Review," *China Economic Review* 76 (December 2022): 101868,

[453] Adam Y. Liu, Jean C. Oi, and Yi Zhang, "China's Local Government Debt: The Grand Bargain," *The China Journal* 87 (January 1, 2022): 40–71,

[454] Jianyong Fan et al., "Does Government Debt Impede Firm Innovation? Evidence from the Rise of LGFVs in China," *Journal of Banking & Finance* 138 (May 2022): 106475,

[455] State Council, 2010

[456] Fenghua Pan et al., "Developing by Borrowing? Inter-Jurisdictional Competition, Land Finance and Local Debt Accumulation in China," *Urban Studies* 54, no. 4 (March 2017): 897–916,

[457] Fulong Wu, "Land Financialisation and the Financing of Urban Development in China," *Land Use Policy* 112 (January 2022): 104412; Yi Feng, Fulong Wu, and Fangzhu Zhang, "Changing Roles of the State in the Financialization of Urban Development through *Chengtou* in China," *Regional Studies* 56, no. 8 (August 3, 2022): 1259–70,

[458] Feng, Wu, and Zhang, "Changing Roles of the State in the Financialization of Urban Development through *Chengtou* in China."

China's system of land-based finance, initially developed as a policy solution to finance urban development and infrastructure, is now widely seen as a risk to local economic development and an impediment to further reform. The system initially served to promote entrepreneurial local development and incentivized local leaders to pursue large-scale urban infrastructure, develop "new areas," and attract both foreign and domestic investment. Yet, the "ownership" of land leasing rights by municipalities led to perverse incentives for corruption, excessive conversion of scarce arable land, and revolts by farmers evicted from rural land. All of this has come under criticism from Xi, particularly following his anti-corruption campaign, and the 2014 New Type Urbanization Plan, which called for coordinated urban-rural development and more human-centered development.

But it has been difficult to wean China's cities off land as a source of revenue. Part of this stems from the policy obstacles to implementing a real estate or land tax, as exists in most countries. As one prominent economist from Peking University put it, "Most of the major reforms were done in the 1990s, and if you want to do a new reform, those reforms are going to touch the core of the Chinese economic and political system; Interest groups are so strong, many people have so many apartments and they are against it, that's probably the main reason."[459] Absent deeper political or institutional reforms, such as a property tax, what are the alternatives?

Xiong'an has been tasked with experimenting with new forms of finance. Early policy documents suggest the city was supposed to "break the original land financing model and transform it into a tax and fiscal model. Specifically, through taxation, income from infrastructure to balance expenditures on infrastructure and public service construction and operations, issue bonds by pledging the future income from infrastructure and future fiscal revenue, implement PPPs, raise development funds, implement construction, so as to achieve benign development."[460] As Yang Tianping of China Merchants Xiong'an, a subsidiary of the large state-owned enterprise, reflected, "The central government's creation of Xiong'an signals the end of the traditional industrial park model. What did the traditional office park model rely on? Everyone knows, land finance. What will the new model rely on? Tax finance…Traditional models relied on buying and selling

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[459] Yao Yang, Peking University, Presentation at Harvard University (October 6, 2023)
[460] Ibid.

(property), the new model will depend on the gathering of innovative resources."[461] Six years into the city's development, the creation of a new financial model in Xiong'an remains an aspiration with unclear results. The city has relied mostly on an infusion of central state capital from central bank loans, Hebei-provincial long-term bonds, and investment from central SOEs themselves.[462] There have been efforts to experiment with new land leasing models in which developers pay a fixed annual land rent fee or *tudi zulin*, instead of up-front fee as has been the norm. This could be seen as a land tax in everything but name, but it is still unclear how the city's long-term financing will develop.

One possibility raised by Yang Tao, the consultant on the city's digital platform, is that "digital elements" could also serve as a new source of value for cities like Xiong'an.

> "Part the impetus for this came from the fact that China's current urbanization model of land-based finance is reaching its limits, so if we can explore new ways of generating value from the digital realm, this could help replace land leasing revenue; could the digital twin become another element (*yaosu*) in the search for new sources of value." [463]

How this would work in practice is still a bit unclear. But discussions with planners from Beijing's Municipal Planning Bureau confirm that other Chinese cities are experimenting with similar efforts to find new value from the integration of physical and digital worlds. During a meeting at the Beijing Municipal Planning office, I was invited to listen to a presentation by a professor of urban planning from Beijing's Capital University of Finance who talks about the challenges facing China's current development model including declining population, geopolitical conflict with the U.S. (I move a bit awkwardly in my chair), but also the shift of China's "land finance" to a new development model driven by data and digitalization.[464] If data, like land, is to be declared a "factor of production," then the regulation and sale of data by municipal governments (or other

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461 Yang, Tianping (2017) *fahui Zhaoshang jituan youhui zhuli Xiong'an xinqu jianshe* "Give fully play to Zhaoshang's strength's, help build Xiong'an New Area" in Think Tank Reports on Xiong'an (Series 1). Economy and Mgmt Publishing House
462 See Appendix 3. "Dataset on Financing of Xiong'an New Area 2017-2023" (Stokols, 2023)
463 Yang Tao, Interview, 2023
464 Presentation at Beijing Municipal Planning Office, June 2023

state entities) could become a new source for state revenue, just as the state leveraged its ownership of land to fund development since the beginning of the reform era.

Conclusions

Xiong'an is still in its infancy. But given the strong political support of Xi Jinping and the desire to make Xiong'an into a new model for Chinese urban development, the system of digital infrastructure including the digital twin, roads embedded with sensing infrastructure, and integration of digital governance systems including blockchain, the digital RMB, and automatic tax payment systems—Xiong'an reflects current national-level policies on "building a Digital China" and "National Informatization" that Xi Jinping and his "techno-industrial" approach to government favor. Xiong'an builds on China's private-led platform-based city brain information systems like Alibaba's Hangzhou City Brain. But in Xiong'an, the state and state-owned enterprises are playing the leading role. The urban development corporation[465] Xiong'an Group controls the subsidiary Xiong'an Digital City Infrastructure Co that will manage and run the digital operations, and in the process centralize control over data and integrate these systems further into the daily administration and governance of the city. Of course, whether this all works out according to plan remains to be seen. Xiong'an is a new city, a "piece of blank paper" as its advertisements have suggested. The experimentation with new models of project financing and affordable housing reinforce the idea of Xiong'an as an experiment reflecting Xi Jinping's "new era." Digital infrastructure and digital governance are embedded in the city's physical buildings, streets, and natural systems, offering an integration across ecological, political, and human systems. Xiong'an embodies the sort of "high-modernist" thinking seen in earlier utopian new cities such as Brasilia and Chandigarh, all of which failed to live up fully to their lofty goals, but did become functioning new cities after several decades. Xiong'an may be an exceptional case within China, given how much it is dependent on the central government and the political support of Xi. But the city reflects the current centralizing trend of governance Xi has promoted, particularly after the 2017 elevation of Xi Jinping Thought into the Party constitution. Xiong'an is a tangible symbol of a vision for a country confident that its system and values can offer a new approach to modernity that diverges from Westernization or universal ideas of urbanity.

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[465] Local government financing vehicle (LGFV) in English or *Chengshi touzi fazhan gongsi* (*chengtou)*
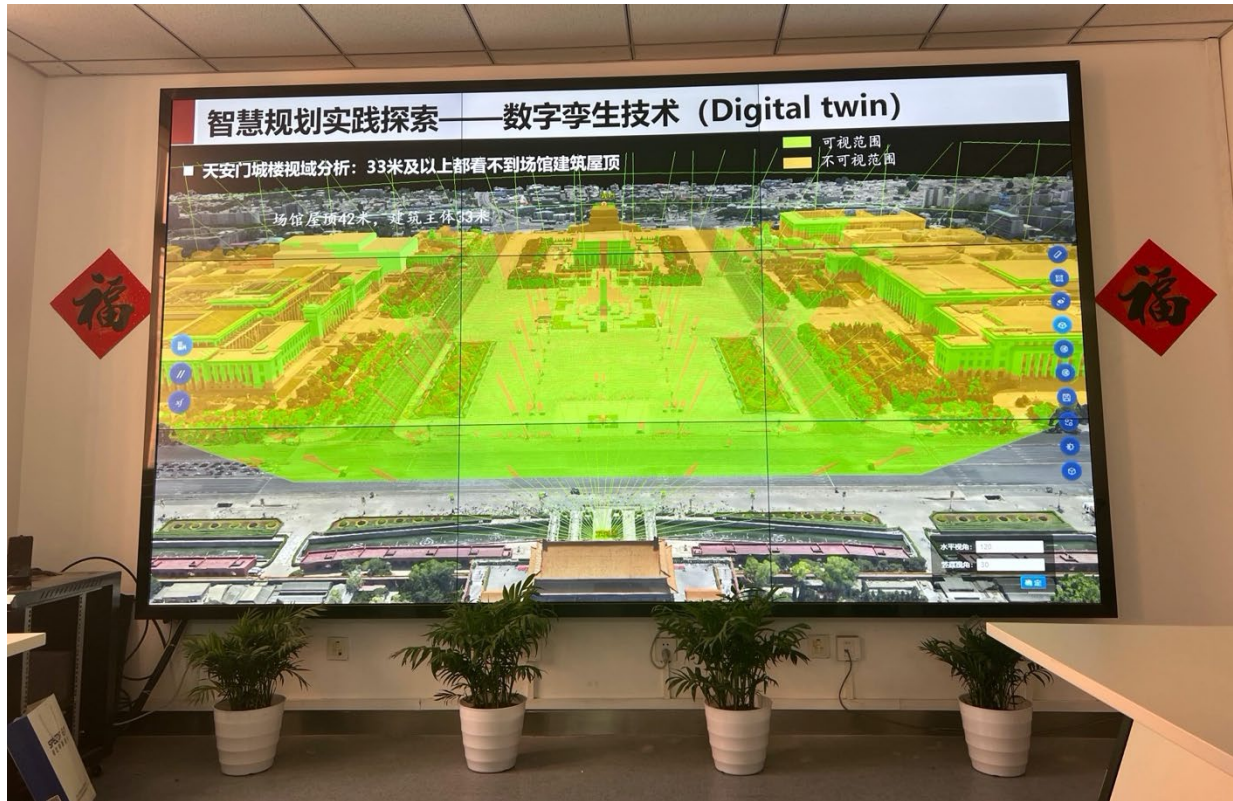
Figure 35. Digital Twin of Tiananmen Square, Beijing Municipal Planning Bureau (Author, 2023)

8. Conclusions

Cities have long been sites for innovation and engines of national development. This dissertation has argued that today, the relationship between the city and the nation is being transformed in the wake of "platform capitalism" and "data capitalism" whereby data, much of it generated in urban or densely populated environments, has become a new asset class—the extraction and utilization of which forms a core logic in contemporary capitalism. The "smart city" emerged as a popular buzzword in planning and beyond in the early 2000s as multinational internet technology firms tried to sell infrastructure to manage various city systems and information to city governments around the world. Some high profile "greenfield" new smart cities were built to "testbed" such technology, including Songdo—a partnership between Cisco and South Korean local authorities, and Masdar in the U.A.E. The smart city has also been adopted as a mode of governance in existing cities, exemplified by the numerous projects around the world to promote open data platforms, greater aggregation of various urban data on city systems, and promote innovation. However, within the scholarly community of urban planning and critical geography, the concept has been widely discredited as a techno-managerial corporate form of governance, linked in the West at least, to state retrenchment, deregulation, and splintering of public infrastructures into privately bundled systems. Many smart city projects have often failed to deliver on their intended aims, even more recent efforts to involve citizens in smart city projects have often fallen flat or been subjected to the same techno-solutionist critique. In the mid 2010s, a new iteration of the smart city emerged in the form of the "fourth industrial revolution" which promised a dramatic technological shift that would occur from the blanketing of sensors across landscapes and into physical objects—the "internet of things," which, coupled with other emerging technologies such as 5G, cloud computing and AI, would fuel smarter more efficient manufacturing, autonomous vehicles, better insights from more and more data. Around this time as well, the idea of the "fourth industrial revolution" as promoted by Klaus Schwab of the World Economic Forum captivated the ears and eyes of elites in developing countries, particularly in Asia. This dissertation traces how the ideas of the "smart city" and "fourth IR" were translated into the *national* and *urban* contexts of three countries: Singapore, Thailand, and China.

I began this project wondering whether the turn to a more-state centric model of infrastructure development inspired by China's rapid economic growth was also leading more broadly to new

paradigms of urban development, particularly in the "global south." In the domain of urban technology, this could be seen in the so-called "digital belt and road" by which the Chinese state and Chinese technology firms like Huawei went out globally to sell digital systems to cities, primarily but not entirely in the developing world. Huawei's dominance in 5G technology raised alarm bells with many in Western national security agencies warning of the possibility of China "owning the wires of war" as one book claimed.[466] In other words, compared to the early era of the "smart city," urban digital technologies had become (i.) key objects of national development policy, and also (ii.) contested domains of international rivalry, particularly between the U.S. and China.

I undertook a cross-national comparison of three countries to understand how the "smart city" and the related "fourth industrial revolution" had become crucial to a new approach of state-centric innovation, and crucial to efforts to exert sovereignty over data. Having previously worked for a research institute on future cities in Singapore, I was familiar with the city state's embrace of futuristic city planning not merely as a means of improving living conditions and making use of its limited territory, but increasingly as an *economic sector* in its own right, the so-called "urban solutions sector." China's embrace of smart city technologies both in domestic governance and export made it a compelling additional case. Thailand offered a slightly more complicated story of urban data platforms as embedded in complex multi-scalar contestation between city and national authorities, and between Bangkok-based conglomerates, local mayors, secondary cities, and citizens. Within these three national comparisons, I traced how the discourses of the smart city or 4th IR were translated and adopted by different domestic stakeholders including local politicians, companies, and other actors. I also showed how they resulted in new city-building projects—both entire new cities and new digital data platforms—sometimes a combination of both.

The dissertation has generated novel theoretical frameworks, such as the "City as Showroom," which describes how the design and planning of cities is being remade due to the emergence of urban infrastructure and "urban solutions" as key sectors in an urbanizing world. This is typified

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[466] Jacob Helberg, *The Wires of War: Technology and the Global Struggle for Power* (New York: Simon & Schuster, 2021).

by Singapore (Ch. 5) but also seen in China and Thailand to some degree. I also trace the historical precedents in each country for showcasing and displaying technology in Chapter 3, which I argue continue to shape how these countries approach technology adoption and display today. Another key concept is the "digital developmental state," which reframes the effort to develop urban digital infrastructure as part of national development strategies for emerging industries.

Below, I summarize the key findings of the dissertation across several related but distinct domains. This project has primarily aimed to generate new theoretical frameworks to explain emergent logics driving urban technologies of data extraction and national development in East and Southeast Asia. But there are also important implications for planning practice and planning scholarship, particularly around adopting more proactive regulation and planning of digital infrastructure (both hardware and software) as a core aspect of the physical design and planning of cities, and the need to critically examine the growing dominance of big-data-based methodologies for understanding urban processes.

Key Findings

 The findings of this dissertation can be summarized across several related yet distinct points:

1. *The imaginaries of the smart city and fourth IR resonated in late developing authoritarian/non-democratic countries with unique histories of display and integration of foreign technology through model cities and projects.*

In each of the countries in this study, I showed in Chapter 3 how the imaginary of "cyber-physical integration" promised by the Fourth Industrial Revolution offered both visions for futures in which these countries (particularly middle-income countries like China and Thailand) could leap ahead of the "West" (China), join the ranks of wealthy nations (Thailand) or maintain their position as a leading global hub for innovation (Singapore) by embracing cutting-edge technology. The imaginary also landed in contexts where improvement of the physical environment has been a key mechanism through which such countries pursued previous rounds of modernization. This can be seen in Singapore's Lee Kuan Yew developing the "clean and green Singapore" program and "city in a garden" identity in the 1960s, and plans from the 1980s and 1990s to build

Singapore into an "intelligent island" through integrating telecommunications systems into everyday life and governance. In Thailand, a tradition of elite and Royalist-led modernization is discussed through the example of the Dusit Thani, a miniature model city built by King Rama VI in 1916 to showcase his vision for a democratic modernized polity. In China, model cities have often been associated with political ideologies of leaders, from Daqing as a model of socialist state-led industrialization to Shenzhen as a model for "reform and opening"—today, Xi Jinping has similar aims for Xiong'an to become a model of a new era of "high-quality development" driven by digital infrastructure, clean advanced manufacturing and innovation.

*2. The concept of "**city as showroom**" articulated in Chapter 3 offers a new interpretation of the performative and visual nature of technology adoption in contexts of authoritarian governance. The notion of "showroom" explains the growing importance of "pilot projects" to showcasing technologies for potential customers of urban solutions (as in Singapore), and the idea of showcasing or communicating ideal assemblages of technology and governance between higher-level authorities and local officials.*

Whereas STS scholars have emphasized the role of witnessing and visualization in the stabilization and uptake of scientific "facts" in democratic public sphere, [467] the role of technological display in authoritarian contexts requires a different conceptualization. There has been a tendency to see all forms of urban construction or large-scale infrastructure in such countries as despotic, echoing longstanding tropes in Western writing such as "Oriental despotism" or "the Asiatic mode of production"[468] where states exercise total control such as through building large-scale infrastructure designed to overwhelm subjects and foreigners in awesome displays of state power. This dissertation avoids such tropes by arguing that projects can be performative and still play a "functional role" in communicating certain ideals of technology integration and governance in governance systems where lower-level leaders have a degree of autonomy but still depend on patronage and support of central authorities. Lower-

[467] Yaron Ezrahi, *The Descent of Icarus: Science and the Transformation of Contemporary Democracy* (1990)

[468] Karl Wittfogel, *The ruling bureaucracy of Oriental despotism: A phenomenon that paralyzed Marx*. Review of Politics 15, 3.;Karl Marx, *Grundrisse (Foundations of the Critique of Political Economy)*. London: Penguin, 1973 (published in Germany, 1953)

level or local leaders use symbolic projects as a way to communicate their own vision and win the attention and favor of higher-level officials or national leaders.

The notion of the "city as showroom" was developed through grounded interviews. There was a tendency by some of my interviewees to describe national pilot projects as "failures," but if one traced the process of subsequent technological adoptions in the years following such pilots, they often built on or incorporated general ideals or goals seen in apparently "failed" pilots. Through their prominence or endorsement of key political leaders, national pilots become templates for other officials. Singapore may be a small city state but there are still gaps between national-level policies and "local implementation" by the so-called statutory boards. For example, Virtual Singapore digital twin was one of the first projects to begin under the aegis of Smart Nation following Prime Minister Lee Hsien Loong's announcement of the program in 2014. It was spearheaded partially by Singapore Land Authority (SLA), the CEO of whom at the time was a man named Boon Khai Tan from 2015-2020. While the first version of the nationwide digital twin largely failed to deliver useful applications, Mr. Tan subsequently has led a more targeted effort to develop a digital twin for use managing JTC's industrial estates after he assumed the CEO position of Jurong Town Corporation, which manages almost all of the city state's industrial land. Mr. Boon's project was in line with the national *Smart Nation* policy, but his promotion of each project has undoubtedly served his advancement within the Singaporean civil service.

Phuket was declared as Thailand's first national smart city pilot from around 2015, and subsequently rolled out a template "city data platform" and other testbeds for 5G, particularly during the so-called "Phuket Sandbox" during Covid 19. While many of these initial pilots have not been considered 'successful', they did spawn certain more useful platforms. For example, an app called Traffy Fondue was initially developed for tracking waste management in Phuket by the national research agency NSTDA-NESTEC. This app was obscure until Bangkok Governor Chadchart Sittipunt promoted it as a form of citizen-led governance upon his election in 2022, the first elected Bangkok governor since the 2014 coup. Chadchart linked the digital platform to his philosophy of solving small-scale "capillary problems" that were often neglected. Thus Chadchart was using a digital platform to promote his political stature, within the aegis and framework of a national effort to develop smart cities, which had begun under the NCPO

government. While Chadchart had been part of the Pheu-Thai government, he ran as an independent and stated his intention to work with the Prayut government to get things done.

China is generally thought of as highly centralized, but "entrepreneurial local governance" has been a feature of the Chinese system at least since the beginnings of Deng Xiaoping's "Reform and Opening Up." Local governments and technology companies were instrumental in some of China's first large-scale smart city platforms such as Alibaba's "City Brain" in Hangzhou. Now, under Xi Jinping's "new era" there is a turn toward greater centralization in an effort to reign in corruption, land speculation, and rising housing prices that characterized the era of municipal devolution. Xiong'an is a "national template for high quality development," a favored slogan of China's leadership in recent years. The city is intended as a model for a more restrained and planned urbanism, putting digital governance and data back in the hands of the state.

3. Urban data as state infrastructural power
A key goal of this project was to understand the implications of state-led urban digital development for the trajectory of digital capitalism globally, one of which is the extension of "state territorial sovereignty" over the extraction and generation of urban data. Chapter three began by discussing the evolution of smart cities and the failure of Google's efforts to build a digital district in Toronto. While this dissertation focuses on the East and Southeast Asian context, there are implications of my findings for the future trajectory of data capitalism worldwide. While projects like Sidewalk Labs failed in Toronto due to Google's lack of "infrastructural power," the projects in this dissertation largely comprise a more integrated approach where the state or various state actors play a leading role in land ownership, technology policy, and spatial development. Of course, each of these cases varies in terms of how urban data and territorial governance are interwoven. In Chapter 4, I argue that emerging forms of digital developmental policy are both territorially and institutionally embedded—highly dependent on relations between national-level authorities, and in particular fiscal relationships between local and national authorities (particularly in Thailand and China). One of the issues at stake is an ideological and material battle over the definition of data—is it a private "asset" as the story

Zuboff tells of extracting "behavioral surplus,"[469] or is it a "public infrastructure" as articulated by Toronto activist Bianca Wylie, who led opposition to Google's project in her city, or is it as Xi Jinping and Chinese officials increasingly refer to data as a "factor of production" or one of the so-called "new productive forces."[470] All of these varying definitions have implications for how data is regulated by the state.

The three country cases offer a comparative framework for understanding the sometimes contradictory and divergent effects digital platforms can have depending on the particular dynamics of local-central governance relations. In early literature on smart cities, the rise of a global telecommunications networks was seen as creating a "space of flows" in which "global cities" were key nodes of command and control of the global economy, commanding the levers of financial flows as well as flows of information.[471] In this view, both the nation state as a whole as well as secondary cities (such as industrial cities of Detroit, Manchester, and Osaka) lost status to "primate cities" like New York, London, or Tokyo. In the cases I examine, urban digital infrastructure is increasingly coordinated by national-level authorities. But the implications of this trend for urban-national governance are not straightforward or entirely clear. On the one hand, the growing importance of urban data would seem to suggest a further concentration of national resources in the largest cities, which are also the largest generators of urban data. On the other hand, new digital platforms could offer smaller city governments the chance to assert their own sovereignty and agency over their own citizens' data.

Thailand and China present a fruitful comparison in this regard. As discussed in Chapter 6, Thailand has maintained a highly centralized administrative system with roots in early modernizing reforms under King Rama V (Chulalongkorn) in the late 19th century. Fiscally, Thailand's Ministry of the Interior maintains control over appointment of provincial governors and Ministry of Revenue and Finance over budgeting, constraining local governments in terms of

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[469] Shoshana Zuboff, *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power* (New York: Public Affairs, 2019).

[470] "Xi Jinping Emphasizes Accelerating the Development of New Qualitative Productive Forces to Solidly Promote High-Quality Development during the Eleventh Collective Study Session of the CCP Central Committee Politburo [习近平在中共中央政治局第十一次集体学习时强调 加快发展新质生产力 扎实推进高质量发展]", CSIS Interpret: China, original work published in Xinhua News Agency [新华社], January 31, 2024

[471] Manuel Castells, *The Informational City: Economic Restructuring and Urban Development*, 1st edition (Oxford: Wiley-Blackwell, 1989); Sassen, *The Global City*.

how they generate local revenues through land or property taxes. Today, calls for greater decentralization are at the core of longstanding political divides that have fueled ongoing political instability. The Thailand 4.0 policy unveiled by the military government sought to boost the country's digital infrastructure and improve delivery of urban services and citizen accountability. However, most cities have not received adequate resources to carry such initiatives out. In the cases of Phuket and Khon Kaen, local businessmen have become central players in efforts to shape development in their cities by creating "city development companies" that have taken ownership of data platforms as well as new transport systems. However the bulk of Thai cities lack capacity or expertise to develop their own platforms. This is where national conglomerates like PTT come into the picture—the deep pockets of Thailand's largest state-owned enterprise have backed a platform that would be sold as a recurring service to municipalities across Thailand. In exchange for this, cities could theoretically generate additional revenue and gain more agency over their own development. It is still early in the deployment of city digital platforms in Thailand, but initial appraisals suggest that deep-pocketed national conglomerates have greater resources to develop analytic tools that can generate revenue, but that some of the larger secondary cities (i.e. Phuket, Khon Kaen) can benefit if they have well-resourced and organized civil and business communities. If companies like PTT's Bedrock win out as favored providers of digital infrastructure for Thai cities, this could boost a national conglomerate's control over data and analytics, while some secondary cities may see incidental benefits of increased fiscal capacity.

Meanwhile China had already devolved significant control over development through the granting of municipalities large leeway to generate revenue through land leasing, particularly after the 1994 tax reforms that centralized industrial tax revenue with central authorities. This paradoxical recentralizing and decentralizing is seen by some as the "grand bargain" between the center and municipalities that propelled China's economic growth.[472] However Xi Jinping has taken a more critical view of devolution, seeing diminished central control as enabling corruption, loss of arable land and eviction of farmers from their homes for urban growth. What is the role of digital platforms in this ongoing tension? In Xiong'an, we can see how control over urban digital platforms is at the heart of new initiatives to build a "Digital China," a rather vague campaign

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[472] Jean C. Oi, Adam Y. Liu, and Yi Zhang, "China's Local Government Debt: The Grand Bargain," *The China Journal* 87 (January 20, 2022).

formalized in 2023 encompassing everything from boosting e-governance, strengthening 5G coverage, and investing in data centers to boost China's overall computing power. China's early smart city projects, such as Hangzhou's "City Brain" platform, were driven primarily through municipal-private sector partnerships. Alibaba, headquartered in Hangzhou, played a key role in that city's digital efforts. However, given the Party's crackdown on technology platforms such as Alibaba, efforts are now underway to more fully embed control over data in the hands of state authorities. Xiong'an's digital infrastructure project is being driven by the Hebei province backed Xiong'an Group[473] as well as China Telecom, the state-owned telecom company. As China's land-leading system slows, local governments are trying to develop alternative sources of value and revenue. Digital data is seen by some as one potential source of new value—and digital data platforms would then be critical to cities generating new value through data. However, the mechanisms of how this would work are still rather inchoate.

The comparison of these cases does not offer definitive evidence that digital platforms *necessarily* boost primate cities, strengthen or weaken provincial or national governments, or enhance citizen agency. This is consistent with a "social constructivist" framework that views technology as shaped by social and political factors, rather than a technological determinist framework. Nevertheless in each context, the deployment of digital platforms is bound up with whatever political agenda or politician is dominant at a particular moment. For example, in Thailand digital platforms have been seized upon by secondary cities and mayors as tools for furthering decentralization and citizen voice. But in China, the trend towards greater centralization under Xi has mobilized digital platforms for greater central and provincial control at the expense of municipalities and platform firms. At first glance, Singapore lacks the territorial complexity of Thailand or China. But even in the city state of Singapore, deployment of digital platforms has strengthened the "infrastructural power" of statutory boards that control the country's physical infrastructure. Whereas Smart Nation Initiative was unveiled with the goal of *coordinating* across the bureaucracy, in fact the deployment of digital platforms has been driven by individual agencies and their executives. Given the small size and frequent exchange of leadership and personnel between agencies, information and ideas do not stay siloed for long.

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[473] Xiong'an Group is a LGFV or "urban development corporation"—while many Chinese cities set up such entities to undertake urban development, Xiong'an Group is relatively unique in being 100% owned by the province

This means successful "experiments" can easily be scaled up. But not always—the case of the first Digital Twin pilot in 2014 and subsequent embrace by Jurong Town Corporation on a more limited scale suggests that agencies have taken initiative on their own to develop more focused use cases based on their own need, a *scaling down* of projects. Rather than magically leading to greater centralization, the push for "whole of government" digital transformation has paradoxically enabled greater autonomy by the city's agencies—in certain respects. However, the story is more complex. Some of Smart Nation's project such as Trace Together and Digital Payments systems have indeed brought greater centralization of data and digital infrastructure. But in the realm of IoT sensors and digital twins, the key role of "physical assets" to these projects means owners of those assets are going to have an easier time deploying digital solutions than agencies without control over physical assets (see the following finding below).

Mechanism	Examples	Possible Implications for Governance
City data platforms	Phuket City Data Platform	Increased data sharing between agencies, greater revenue or resources for secondary cities
AI analytical tools/platform as service	Bedrock.ai	Boost municipal tax revenue, increase revenues for PTT (state owned enterprise)
Citizen Platforms	Traffy Fondue, NakhonCity	Enhance citizen voice, more efficient deployment of city budget
Embedded Sensors (IoT)	Singapore's Smart Gardens, Xiong'an digital systems	Energy savings, strengthen role of agencies
Digital Twins	Singapore ODP, Xiong'an	Energy savings, better analytic capacity for adjusting service levels

Table 7. The Effects of Various Digital Infrastructures on State Power

4. This dissertation offers a novel conceptualization of **"*cyber-physical infrastructural power*"** as conjoined digital and physical territorial power. *Because the technologies of "cyber-physical integration" require coordination between physical and digital, extraction of urban data is shaped by patterns of land ownership and property development; owners of physical capital and physical assets have advantages in deploying these technologies at scale, thus providing a means of translating physical or real estate capital (what might be termed fixed assets) into digital capital.*

A core concept underpinning the 4th IR is the notion of *cyber-physical systems* defined by Lee in 2008 as "integrations of computation and physical processes."[474] This notion also underpinned the idea of the fourth industrial revolution, which would not emerge until a few years later, disseminated by boosters like Schwab at the World Economic Forum. But the notion of "embedded systems" had also been around for some time to describe "engineered systems that combine physical processes with computing" such as in aircraft control systems or home appliances. Lee goes on in this 2008 article to note that "the radical transformation we envision comes from networking these devices, which poses considerable technical challenges." As this dissertation has shown, the blanketing of cities, nations, and perhaps eventually the earth with embedded sensors and other cyber-physical systems is not merely a technical challenge. In addition to being "embedded" within physical processes and objects, such cyber-physical integration is also deeply embedded institutionally and territorially. The contexts examined in this dissertation illustrate how the evolution and development of cyber-physical systems is shaped through institutional and cultural systems. This is captured by the notion of a "sociotechnical system" that emerged in organizational sociology in the 1950s and 1960s.[475] While the basic premise of "sociotechnical systems" is seen across the fields of STS, systems, theory, and other domains, there has been no detailed study of how the emergence of technologies of urban data extraction are shaped through specific territorial dynamics of state power such as land ownership, or fiscal regimes.

Singapore presents possibly the clearest case of the importance of state land ownership to the deployment of cyber-physical technologies. While the Smart Nation Group (comprising both policy teams and GovTech software agency) is formally a pilot agency under the Prime Minister's Office, in reality it must partner with Singapore's statutory boards in order to realize many of their ideas. Singapore's various boards control most of the city's key infrastructures: Housing Development Board (public housing), Jurong Town Corporation (commercial office parks), NParks (open space), Land Transportation Authority (roads and rail infrastructure), and Singapore Land

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[474] Edward A. Lee, "Cyber Physical Systems: Design Challenges," in *2008 11th IEEE International Symposium on Object and Component-Oriented Real-Time Distributed Computing (ISORC)*, 2008, 363–69,

[475] E. L. Trist and K. W. Bamforth, "Some Social and Psychological Consequences of the Longwall Method of Coal-Getting: An Examination of the Psychological Situation and Defences of a Work Group in Relation to the Social Structure and Technological Content of the Work System," *Human Relations* 4, no. 1 (February 1, 1951): 3–38,

Authority (other public lands). These agencies play a lead role in development of cyber physical technologies.

Thailand, meanwhile, lacks the strong state land ownership seen in Singapore or China. However, if we consider the Thai Royal Family through the Crown Property Bureau (CPB), which owns by some estimates around 30% of the land area in Bangkok,[476] then Thailand starts to resemble a context of state land ownership to some degree (See pg. 125, Figure 11). And this figure increases if we consider additional land owned by the armed forces, various ministries, and temples— which receive a degree of support from the government and monarchy. The CPB does rent some of its extensive holdings to small businesses and low-income families, but it also has monetized its most valuable pieces of land by leasing them to development companies, such as Thai Bev, Siam Piwat, others who have built Bangkok's leading malls and hotels. The CPB's power to grant land leases to these families and their conglomerates is a core aspect of Thailand's patronage system. Some of these same family-owned conglomerates are also investing in digital technologies and use their control over infrastructure and land to enter into emerging sectors. We also see this with state-owned enterprise PTT, which is developing a range of digital innovations through its venture subsidiary AI Robotics Ventures (ARV) which is developing the Bedrock spatial data platform. We can also see the transmutation of physical into digital capital in the case of CP Group—the conglomerate that franchises 711s, which are ubiquitous in Thai cities. CP also promotes use of True Digital Wallet, part of its True Digital subsidiary, for payment in 711s.

In China, municipalities were declared representatives of the state in the right to make plans and lease land, beginning with the 1988 Land Law. In 1994, tax reforms centralized commercial and industrial tax, while allowing cities to generate revenue through land leasing, a key factor in China's domestic developmental model. However, this model is now coming under strain as China's property market has tanked, and the central government asserts more authority over local governments. Urban digital infrastructure is increasingly seen as part of national "new type infrastructure" or *xinxing jichu sheshe*, including data centers, 5G towers, smart city platforms.

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[476] Porphant Ouyyanont, *Crown Property Bureau in Thailand and Its Role in Political Economy*, *Crown Property Bureau in Thailand and Its Role in Political Economy* (ISEAS Publishing, 2015)

5. *Urban Design and Planning Process as a Generator of the Urban Solutions Sector*

It is a rather tedious truism that cities have long been sites of innovation. However, the rise of the "urban solutions sector"—essentially the rise of a new sector based on the construction and provision of services to an urbanizing world—has become a new engine of innovation in its own right. Singapore is the progenitor of this—with a host of Singaporean state agencies including the Economic Development Board, Centre for Liveable Cities, Enterprise SG, and state-owned companies like Surbana Jurong and ST Engineering promoting "urban solutions" as a new sector.[477] I argue in Chapter 5 that in order for Singapore to continue reproducing itself as model and therefore exporter of urban solutions, it has to continually remake its urban fabric to testbed new technologies—both merely as a form of internal governmentality but also because they then can be exported abroad as commercial products—ST Engineering's success selling the Smart Lamppost Abroad after it failed to gain traction in Singapore is a case in point.

China has become known for its ability to build large-scale modern infrastructure, typified by new cities, the world's longest nationwide high-speed rail network in 10 years. Through the Belt and Road it has sought to export its "infrastructural capacity" through its large state-owned construction firms. These firms are now the chief companies being tasked to build Xiong'an into a model city for futuristic urban technologies. Thus, Xiong'an may ultimately serve as the showcase for China's infrastructural capacity, both in the innovations developed there and also literally by the state-owned infrastructure companies that are set to relocate there, including in energy, telecom, construction, rail and other sectors. Thailand differs from Singapore in that the state has generally lower capacity and private conglomerates dominate most industries. However, even in Thailand, a host of companies have entered "smart cities" businesses including major Telecom True Digital (owned by CP Group), materials conglomerate Siam Cement Group (owned by the royal family), and PTT (owned by the Ministry of Finance). Two of these can be considered state-owned enterprises (PTT and SCG), while CP as a major conglomerate has close ties to Thailand's political elite. The urban solutions sector in Thailand is commercially oriented, but still remains dependent on state patronage and support.

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[477] ST Engineering (2023) "Urban Solutions" https://www.stengg.com/en/smart-city/urban-solutions/ and Enterprise Singapore (2023) "Urban Solutions"https://www.enterprisesg.gov.sg/industries/urban-solutions/key-markets

6. Rethinking the relationship of urban design and planning to digital platforms and infrastructure

This dissertation has focused primarily on understanding the emerging logics underpinning new forms of state cyber-physical infrastructures. These logics have significant implications for planners, designers, policymakers and others shaping the built environment. While the "smart city" has been a buzzword in the field for many years now, there is still a gap between the traditional focus of planners on zoning, land use, and design guidelines and the dizzying growth of new digital platforms and technologies that are transforming cities faster than planners or regulators can keep up. While many cities have created "digital planning" units or incorporated digital mapping or citizen feedback platforms into their operations, this doesn't come close to grappling with the broader impacts of digital infrastructure affecting cities. At least in the Americas and Europe, early critiques of smart cities have given way to recognition of the need for "participatory digital governance" such as open data initiatives, citizen complaint or 311 platforms, or participatory budgeting processes, as has been adopted widely in Brazil. [478] However, while these "participatory fixes" address some critiques of the top-down corporate smart city, they do not account for the ways in which even any technological platform is always embedded within specific institutional contexts. In Chapter 6, we saw how the Traffy Fondue participatory platform allows the Bangkok Metropolitan Administration to monitor the efficiency of lower-level district officials at handling problems. In this context, a citizen-facing platform also becomes an instrument of governmentality within the bureaucracy.

Traditional planners may need to develop additional tools and approaches for planning for digital infrastructure, being more reflexive of the political economy of digital platforms used in planning, and develop awareness of the broader implications of urban data infrastructure in national innovation systems as well as international technological competition—domains that traditionally have been beyond the remit of "city planners." It is important to note that while the cases in this dissertation are in China and Southeast Asia, there are implications for planners and policymakers worldwide, including in North America and Europe, as well as in other contexts.

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[478] Stephen Goldsmith and Susan Crawford, *The Responsive City: Engaging Communities Through Data-Smart Governance* (John Wiley & Sons, 2014); Dhimas Anindito, Saut Sagala, and Ari Tarigan, "E-Musrenbang: A Digital Framework for Local Participatory Planning at the Community Level," *International Development Planning Review* ahead-of-print (January 21, 2021); Constantine E. Kontokosta and Boyeong Hong, "Bias in Smart City Governance: How Socio-Spatial Disparities in 311 Complaint Behavior Impact the Fairness of Data-Driven Decisions," *Sustainable Cities and Society* 64 (January 1, 2021):

Another important implication of this study for planning practice is that (ii.) planners must now engage with technology firms and companies that have a major impact on the built environment. For too long, planning as a field has focused primarily on those actors involved in decisions over spatial planning and development: local officials, real estate developers, planners themselves, or other authorities involved in regulating the built environment. When Google Maps adjust the algorithm it uses to predict traffic flows in Bangkok,[479] this will have an actual effect on traffic in Bangkok, affecting individual routing decisions and traffic conditions. Thus, whether planners like it or not, they have to contend with the power technology platforms now have over the built environment. While research has shown the growing impact of platforms on cities [480]there has been little effort on the part of planners to conceptualize new regulatory or other methods to address the impact of technology platforms on the built environment.

7. *From Policy Mobility/ Diffusion to Policy Recombination*

The concept of policy mobility has become a popular subject of inquiry in political science and public policy. From early work by Dolowitz and Marsh elaborating the concept,[481] to more recent work in critical geography drawing attention to the mutation and mobility of policies, and the degree of variegation as policies are adopted in different contexts, and the role of crises in providing opportunities for policy transfer and borrowing. McCann argued for detailed attention of the agency of specific actors and individuals behind policy transfers, while Peck and Theodore argue for more nuanced understanding of mutations as policies are adopted and translated in various contexts.[482] The notion of "best practices" or "models" must also be understood in the power implications of which cities or nations are taken as references or models, and which "knowledge" is understood as global and transferable, vs local or vernacular knowledge—a major theme of postcolonial urban studies.[483] The mechanism of "diffusion" has been favored as an

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[479] A Google Maps engineer acknowledged that Google's traffic algorithm is less accurate places like Bangkok with heavy motorcycle traffic; Presentation at MIT DUSP by Google Maps Engineer (2023)

[480] Wachsmuth and Weisler, "Airbnb and the Rent Gap." (2018)

[481] David Dolowitz and David Marsh, "Who Learns What from Whom: A Review of the Policy Transfer Literature," *Political Studies* 44, no. 2 (1996): 343–57; David P. Dolowitz and David Marsh, "Learning from Abroad: The Role of Policy Transfer in Contemporary Policy-Making," *Governance* 13, no. 1 (2000): 5–23

[482] Jamie Peck and Nik Theodore, "Mobilizing Policy: Models, Methods, and Mutations," *Geoforum*, Themed Issue: Mobilizing Policy, 41, no. 2 (March 1, 2010): 169–74

[483] Ananya Roy, "Conclusion: Postcolonial Urbanism: Speed, Hysteria, Mass Dreams," in *Worlding Cities*, ed. Ananya Roy and Aihwa Ong (Oxford, UK: Wiley-Blackwell, 2011), 307–35; Susan Parnell and Jennifer Robinson, "(Re)Theorizing Cities from the Global South: Looking Beyond Neoliberalism," *Urban Geography* 33, no. 4 (May 2012): 593–617.

explanatory concept to show how policies or models are adopted elsewhere.[484] Today, the speed with which ideas and information can be shared globally presents a need to rethink these neat models that often assume direct linear processes of borrowing by rational political actors. Proposing the concept of "fast policy," Peck argues that "policy development processes are operating across a multipolar universe within which *relative* positions become more and more mutually referential and interdependent."[485]

A starting point in this project was to ask, with the rise of alternative "models" for urban planning knowledge beyond the West, what opportunities are afforded to countries caught in between as to the policies and technologies they are able to import. China's "Belt and Road" (BRI) has been a large-scale effort to mobilize Chinese infrastructure capacity and lending throughout Eurasia and Africa. This has offered countries, particularly those in Africa and Southeast Asia, new possibilities for policy adoption beyond the West, or the established centers in Asia like Singapore and Japan. Thailand provided an ideal place to examine whether and to what degree increasing Chinese investment through BRI was actually reshaping approaches to governance and development. Among the three cases, both Singapore and China are seen as referents to some degree while Thailand is often seen as a recipient of policies or ideas, long having a very open approach to borrowing foreign technology from whomever and wherever. However, while the BRI and the rise of China has been characterized in the U.S. (especially among the foreign policy community) as constituting a new form of Chinese dominance or neocolonialism, at least in the countries examined here this notion is overblown and misleading. China is increasingly a source for expertise and reference point, especially in infrastructure sectors. At the same time—each country, even China itself, remains fully keyed into global circuits of knowledge. The adoption of the broad concept of "smart cities" and "fourth industrial revolution" in the development strategies of the three countries suggests the continued pull of ideas generated in developed countries—with Japan and Germany a popular reference point for China given their shared preference for strong manufacturing industries.

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[484] David Marsh and J.C. Sharman, "Policy Diffusion and Policy Transfer," *Policy Studies* 30, no. 3 (June 1, 2009): 269–88

[485] Jamie Peck and Nik Theodore, *Fast Policy: Experimental Statecraft at the Thresholds of Neoliberalism* (U of Minnesota Press, 2015).

Case	Constituent Relationships and Country Countries
Thailand Smart Cities	Line (Japan), Cisco/IBM (U.S.), Huawei (China), U.S. Smart Cities Exchange Program (Phuket-Las Vegas), ASEAN Smart Cities Network (Singapore)
Singapore Digital Twin	Dassault Systems (France), Unity (U.S.),

Table 8. Sources of Technology by Country in smart city projects in Singapore and Thailand

Thailand offered a unique vantage point from which to consider if and how the rise of alternative reference points of advanced urban development are reshaping approaches to development in smaller countries. On the one hand, China has signed an MOU with Thailand to build the first part of a proposed high-speed rail corridor from Kunming to Singapore, with the first section between Bangkok and Korat using Chinese technology. Notably, in contrast to neighboring Laos, Thailand rejected China's initial proposal for ownership of land and operations, opting to finance and operate the line through Thai entities.[486] Thailand has also become a successful base for Chinese tech companies like Huawei and Alibaba. At the same time, unlike countries in Africa where China has been quite active, Thailand is a well-developed market for European, American, and Japanese firms. The country was a key U.S. ally during the cold war and maintains close relationships with the U.S. military, despite moving closer to China in recent years.

On the ground, the simple binaries of Thailand shifting to adopt the "Chinese model" were more illusory. Despite the welcoming of Chinese infrastructure in certain projects, Thailand has exerted considerable agency in balancing great powers and foreign investors. This is also seen at the level of urban policy adoption, where local leaders are plugged into various global circuits of knowledge (See Figure 36, below). The international director for Thailand's Digital Economy Promotion Agency, himself holding a PhD from Harvard, told me about his recent study trips to Austria, South Korea, Japan, the United States to observe smart city projects and technology there or undertake training courses. Partnerships with Huawei are welcomed but they are only one among many players in the country. Increasingly, "middle powers" like Thailand have considerable agency to borrow and adopt policies freely based on suitability, relevance or cost.

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[486] David M. Lampton, Selina Ho, and Cheng-Chwee Kuik, *Rivers of Iron: Railroads and Chinese Power in Southeast Asia*, First edition (Oakland, California: University of California Press, 2020).

On a visit to Nakhon Si Thammarat to learn about the smart city project there, a consultant from Japan's JICA joined. The DEPA director was keen to link the Mayor of this small city with international experts. The developer of the city's citizen feedback app had already borrowed the idea from a Japanese case using Line, the Japan-based messaging platform also dominant in Thailand, for e-governance in the city of Fukuoka. The mayor of Nakhon Si Thammarat had worked in Japan, has a PhD from the U.S, and was highly knowledgeable about international trends and best practices.

Figure 36. Regional and Global Knowledge Networks: links between Thai smart city projects and cities or companies in China, South Korea, and Japan, Singapore, Europe, and North America (Author, 2024)

All of this is to suggest that officials, politicians, and companies in countries like Thailand can increasingly borrow and recombine policies and ideas from wherever they find them. More often than not, these officials are well-traveled, educated at elite institutions in the "global north," and maintain relationships and connections with companies and agencies from many countries. It is indeed increasingly difficult to determine where "ideas" originate. At the same time, "policy mobility" may not be the most suitable way to describe the rapid iteration, prototyping, and

modification that can be observed, particularly for digital platforms observed in this dissertation. Ideas such as the "fourth industrial revolution" or "smart city" may be generated in the West, suggesting a degree of hegemonic "knowledge-power" discourse that postcolonial theorists have critiqued.[487] However, in many of the projects I observed, terms or concepts often serve as a form of internal legitimation. The actual project may benefit certain domestic interests, reward local companies or constituents, or follow from some preexisting relationship. The manifest function of such referential concepts may suggest policy borrowing, but often only the surface-level concept is borrowed while the content of the policy or project may have little to do with the original idea. In this situation, the "policy concept" becomes more akin to a window dressing or post-rationalization to justify whatever project is being pushed by particular actors and lend prestige to their own domestic goals.

8. *A Note of Caution of the "Data Turn" in Planning*
Finally, this study offers a cautionary tale for the growing fetishization and trust planners and city officials are putting in a whole range of instruments for data collection and optimization. Far from being "neutral solutions" as we would be led to believe, city data dashboards, digital twins, and IoT infrastructures must always be analyzed both in terms of how they are embedded within broader ecosystems (national politics, local-central state relations, etc). The potential for various unintended impacts must also be examined—for example, while the citizen platform Traffy Fondue and other "citizen complaint platforms" have been pitched as giving citizens a voice in urban governance, this is a debatable claim that requires more detailed study. As the chapter on Thailand also showed, this particular platform is also being used by the Bangkok Metropolitan Administration (BMA) as a form of disciplinary governance on lower-level district *khet* officials. This effect is a result of Thailand's particular form of hierarchical governance and may be distinct from the effect of similar platforms if deployed in contexts where elected officials are not subject to "disciplinary inspection" from superiors.

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[487] Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences*, Reissue edition (New York NY: Vintage, 1994); Antonio Gramsci and Eric J. Hobsbawm, *The Antonio Gramsci Reader: Selected Writings 1916-1935*, ed. David Forgacs (New York: New York University Press, 2000).

The fetishization for the growing amount of urban data is also seen in planning scholarship, where an emergent "data turn" is visible in the growing amounts of scholarship, research funding, and faculty positions privileging quantitative and big-data based modes of scholarship over other methods. The apparent availability of data is "causing researchers to flock to the study of phenomena identifiable in growing Big Data, and ignore phenomena not so inscribed."[488] One example of this in planning literature is the litany of papers that purport to discover some urban pattern using an online database, such as processing Google Street View imagery. These methods are often uncritical and un-reflexive in their faith in the processes of data collection, the biases and statistical decisions made to determine what gets counted and what does not, and a corresponding neglect of conditions or interpretive insights that cannot be derived from readily available online datasets. The assumptions that more data will naturally lead to better decisions or more efficient processes continue to shape public policy approaches both in the U.S. and globally, as this study has shown. Rather than the binary of throwing out these research methodologies, or uncritically accepting data as absolute truth, there is a middle ground option that requires planning scholars and practitioners to be more reflexive and transparent about the contextual and place-specific forces shaping data for planning decisions: local politics, the material interests of firms behind data platforms. Ultimately the privileging of big data-centric methods in urban research risks foreclosing a whole set of questions that need to be unpacked about the problematic assumptions and blind spots such approaches often imply.

Similar critiques have already been made of the smart city in its early form. However, this dissertation has shown how the political ecology of such data platforms stretches much further beyond the city limits—questions over data are fundamentally enmeshed in projects of national governance and international competition. Qualification of the results generated through online data platforms will need to consider the political context in which they are embedded, as has been shown throughout the examples in this dissertation. For planners or software developers is not enough to merely "involve citizens" and absolve oneself of any further responsibility to reflect critically on the effects and affordances of particular technologies. Rather, urban planners should always be aware and critical of the sources of information on cities, and seek to

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[488] Petter Törnberg and Anton Törnberg, "The Limits of Computation: A Philosophical Critique of Contemporary Big Data Research," *Big Data & Society* 5, no. 2 (July 1, 2018)

supplement or qualify the results of big data analyses with insights and observations gleaned from grounded qualitative assessments, as this study has done.

Contributions

This dissertation has aimed to challenge conventional wisdom on the "smart city," arguing that far from being a neoliberal or homogenizing concept, the "smart city" as traveling imaginary has taken on new significance to both *national* development strategies and *international* competition, such as U.S.-China competition in infrastructure.

In terms of contributions to understanding of late development, this dissertation argues that data and digital infrastructure are increasingly crucial to the strategies of developing and middle-income countries (and some wealthy countries, too, like Singapore). Whereas so-called "developmental states" disciplined manufacturing and finance capital through policies of selective state support and incentives,[489] today national governments are disciplining data capital through a combination of regulatory policies on the digital economy but also through deployment of cyber-physical infrastructure, often trialed through pilot national-level projects. This state-provided cyber-physical infrastructure serves as a way to incubate new sectors but also assert control over urban data, increasingly conceived of as a resource and public infrastructure. Whether the cases discussed in this dissertation are harbingers of a broader global shift toward greater state control of the digital economy is an open question. But given increasing geopolitical fracturing and the embrace of industrial policy in previously "liberal market economies,"[490] and what some term the emergence of "state platform capitalism,"[491] it is fairly evident that the trends observed in China, Singapore, and Thailand are not entirely unique to the region but may exemplify future modes of governance based on increasing state regulation of digital data for national development.

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[489] Johnson, *Miti and the Japanese Miracle*; Amsden, *The Rise of" the Rest"*; Haggard, *Developmental States*.
[490] Peter A. Hall and David Soskice, *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage* (Oxford: Oxford University Press, 2001).
[491] Steve Rolf and Seth Schindler, "The US–China Rivalry and the Emergence of State Platform Capitalism," *Environment and Planning A: Economy and Space*, January 11, 2023

Another contribution to understanding of urban governance and development is to update our understanding of the relationship between the urban and the national state in the digital age. Given that much of the data companies extract is generated in and by cities, does this further exacerbate concentration of wealth and resources in primate or superstar cities, or does it offer any hope of smaller cities to assert "local digital sovereignty" over their own data? Thailand is illustrative of this—while Thailand 4.0 was a national policy and state-owned enterprises like PTT have the resources to deploy nationwide platforms at scale, local governments are also mobilizing to use their own digital resources to invest and boost their local economies, seen in the creation of City Development Companies (i.e. in Phuket and Khon Kaen) to manage both physical and digital infrastructure projects.

Limitations & Future Directions

The rise of national-led strategies on digital development are only accelerating, particularly in the non-Western world as countries look to embrace new digital infrastructure to leap ahead of older technologies and cultivate emerging sectors. Future research could expand beyond the cases here, particularly outside of Asia to look at if and how the dynamics observed in these cases are observed in other parts of the world such as Latin America, Africa, or the Middle East. African nations have become major markets for Chinese infrastructure (physical and digital) companies and urban solutions. Limiting this study to countries in regional proximity helped simplify the vast cultural and political institution differences between countries that might have made direct comparisons more difficult. This is a future avenue for research but was beyond the bounds of this study.

One thing this study did not do was to measure "outputs of innovation" empirically, such as through measuring economic performance of the countries, whether or not the policies and projects discussed in the dissertation lead to measurable impacts such as through creating new industrial clusters, research output, or new industries. Because many of the projects are ongoing and/or in early stages of development this was not feasible and was not the primary object of the study. The project was concerned primarily with understanding the motivations, discourses, and dynamics shaping the policies and technologies adopted in these countries. The evaluation of these efforts may not be discernible for the next few years. However, even without empirically

measuring "outputs" such as innovations, patents or venture capital this study showed a process by which ideas evolve and transform in specific contexts—this highlighted the role of key political actors and the role of ideas and discourses in shaping national policy. The ways in which concepts like the "smart city" or "fourth IR" are localized through translation—both discursively and practically is highly institutionally and culturally embedded. It also defies the neat directional logic of theories of policy transfer, mobility, or diffusion. Because countries and individuals in developing countries have almost instantaneous access to information, the process of idea diffusion can occur almost instantly. Countries are freer than ever to pick and choose, to borrow, combine and create new amalgamations from diverse sources of technology and ideas. It can be hard to pin down where exactly a "policy" or a "project" originated from—oftentimes the sources of inspiration are multiple and disparate. Thus what I observed was more a process of "policy recombination" rather than diffusion, transfer, or direct adoption.

Another limitation of this research is that I was not primarily examining the uptake and reception of ideas about smart cities in the general public. This is a worthwhile area of inquiry, following earlier calls to examine "actually existing smart cities"[492] and the agenda of digital anthropology more broadly to examine the effects and uptake of digital technologies from a deeper anthropological perspective. This study adopted anthropological methods but was mostly limited to elites and professionals to look at their critical role in shaping discourse of futurity and urbanism in their contexts. They serve as links between global universities (sites of knowledge production) and their home contexts. But it is also critical to understand how citizens adopt or resist the ideas promoted in these projects or pursue their own insurgent forms of digital urban citizenship. This was a topic of my earlier paper 'The Insurgent Smart City," which examined insurgent digital tactics in the Hong Kong protests.[493]

Many of the digital platforms examined in this project, such as in Singapore's Smart Nation program, Thailand's various citizen feedback platforms, and China's digital government service platforms will have significant implications for the relationship between citizens and

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[492] Taylor Shelton, Matthew Zook, and Alan Wiig, "The 'Actually Existing Smart City,'" *Cambridge Journal of Regions, Economy and Society* 8, no. 1 (March 1, 2015): 13–25

[493] Andrew Stokols, "The Insurgent Smart City: How a Social Movement Created an Alternative Imaginary of the Smart City," *Journal of Urban Affairs*, July 2023, 1–18

governments in the digital era. The rise of the state as a provider of digital hardware and software infrastructures suggests that far from digital technologies leading to a "space of autonomy" or a "space of flows" as Castells predicted in the early emergence of the internet, digital technologies are increasingly intertwined with digital citizenship at various scales—national, regional, and local. Of course, the internet still enables near instantaneous global transmission of information between cities and allows rapid diffusion of ideas (we see this in the facility with which ideas about innovation or policies are adopted rapidly). But the everyday lived realities of contemporary urban life are increasingly dependent on place and context-specific assemblages of digital platforms, inserted as I have shown into the physical and institutional environment. What this means for the future of citizen agency is also not entirely clear—in some cases, the embedding of digital infrastructure as a form of surveillance and governmentality clearly entails a reduction in the anonymity and perhaps freedom citizens have. However, in other cases local digital infrastructures may offer greater agency for communities or cities to leverage data as a resource for development. One implication of this dissertation is that the future of digital technologies and the future of cities is not predetermined--either by some teleological logic of development or some autonomous logic of technological determinism. People, communities, nations are shaping and will continue to shape their digital futures. While the prospect of an ever more technologized urban existence has come to be accepted as a *fait accompli*, there is yet room for divergent alternatives. This dissertation has opened up an analytical space to understand the divergent digital urban futures already under construction in different parts of the world, and highlighted how crucial it is to situate urban digital platforms not only within *city*-centric political economies, but also within national state institutions and within the geopolitics of international technological competition. Opening up such an analytical space is the first step in understanding the coordinates and pressure points by which communities and citizens can and will be able to intervene to shape their own futures.

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Appendix 1: List of Interviewees

Thailand

1. Director, True Digital Park, True Digital Corporation (August 17, 2022)
2. Head of Strategy and Investment, CP Future City Development Corporation (August 29, 2022; September 20, 2022)
3. Professor of Urban Planning and Consultant, Chulalongkorn University (September 8, 2022)
4. Professor of International Studies, China Studies Center of Chulalongkorn University (August 28,2022)
5. Presentation by Director of Eastern Economic Corridor Office at Foreign Correspondents Club of Thailand (August 18, 2022)
6. Journalists at Foreign Correspondents Club (August 18, 2022)
7. Attache, Singapore Embassy Thailand (August 18, 2022)
8. Director of 5G Innovation, True Digital Corporation (September 20, 2022)
9. Chairman of Board of Directors of AIS/Thaicom Telecom (September 24, 2022)
10. Director of EECi Innovation Hub, Wangchan Valley, Thailand National Science Technology Development Agency (NSTDA), (December 21, 2022)
11. Former Assistant to Deputy Prime Minister of Thailand, Minister of Commerce, currently with World Bank Thailand (December 22, 2022)
12. Presentation, President of Kasikorn Bank at True Digital Park (December 19, 2022)
13. Digital Director, Watashi Engineering (December 22, 2023, ongoing conversations)
14. Retired Deputy President, Bank of Asia (December 26, 2023, ongoing conversations)
15. Urban planner at nonprofit advocacy group, Bangkok (January 4, 2023)
16. Director of Future Tales Lab, DTGO Corporation (January 6, 2023)
17. Professor of History, Chulalongkorn University (January 7, 2023)
18. Director of International Outreach, Digital Economy Promotion Agency (January 11, 2023)
19. Mayor of Nakhon Si Thammarat (January 23, 2023)
20. Software Developer and CEO of Siam InnoCity (January 22, 2023)
21. Executive Vice President, Digital Economy Promotion Agency (February 3, 2023)
22. Senior Executive Vice President, Digital Economy Promotion Agency (February 3, 2023)
23. Professor of Urban Planning and Consultant, Chulalongkorn University (Jan 11, 2023)
24. Presentation at Chiang Mai Smart City Conference (February 23, 2023)
25. Vice Chairman/Director, WHA Corporation (February 28, 2023)
26. Director, WHA Corporation (Feburary 28, 2023)
27. Consultant on EEC U-Tapao Aerotropolis development (March 14, 2023)
28. Environmental Activist, EEC Watch (March 14, 2023)
29. Director, Thai National Innovation Agency --NIA (April 10, 2023)
30. Executive Vice President of Global Operations, Seagate (April 18, 2023)
31. Founder and CEO, Bedrock Analytics—PTT-EP/ARV Ventures (April 19, 2023)
32. Director, JICA Thailand Office (April 24, 2023)
33. Phuket City Development Corporation (May 4, 2023)

34. Director of DEPA Southern Office Phuket (May 5, 2023)
35. Founder, Strategy 613, Business consultant for China-Thailand Investment (May 10, 2023)
36. Founder Khon Kaen City Development Corporation/ CEO of Cho Thavee Corp (May 16, 2023)
    a. Second Interview, July 28, 2023
37. Smart Cities Project Director, Asian Development Bank (May 17, 2023)
38. Managing Director, CISCO Systems Thailand and Myanmar (May 19, 2023)
39. Software Developer, Bedrock Analytics/PTT-ARV (May 31, 2023)
40. Representative, Khon Kaen Municipality (July 20, 2023)
41. Director, Khon Kaen branch of Thailand Creative Economy Agency (July 20, 2023)
42. Professor, Khon Kaen University and Director of Khon Kaen City Data Lab (July 20, 2023)
43. Vice President, Rajamangala University Khon Kaen (July 20, 2023)
44. Professor of Urban Planning, Chulalongkorn University (July 21, 2023)
45. Freelance urban planner and consultant (July 21, 2023)
46. Professor of Architecture and Planning Thammasat University, consultant (July 25, 2023)
47. Professor of Urban Planning and Consultant to EEC (August 9, 2023)
48. Project Managers/Director, DTGO Corporation (August 22, 2023)
49. Chadchart Sittipunt, Governor of Bangkok (August 25, 2023)
50. Policy Advisor, Move Forward Party (September 14, 2023)

Singapore

51. Head of Smart City Projects at Smart Nation Digital Government Office SNDGO (September 2, 2022; February 12, 2023)
52. Assistant to Director, Smart Nation Digital Government Office SNDGO (September 22, 2022)
53. Engineer and Project Director, GovTech SNDGO (September 16, 2022)
54. Assistant Manager for New Estates Div 1, JTC (September 16, 2022)
55. Senior Manager, New Estates Div 1, JTC (September 16, 2022)
56. Director of Public Policy Asia-Pacific, Amazon Web Services (February 6, 2023)
57. Professor of Political Science, National University of Singapore (February 7, 2023)
58. Deputy Director, JTC Jurong Innovation District (February 10, 2023)
59. CEO, Enterprise Singapore (February 13, 2023)
60. Deputy Director, Smart Nation Sensor Project, SNDGO (February 13, 2023)
61. CEO, Jurong Town Corporation (February 14, 2023)
62. Senior Manager, Economic Development Board (February 15, 2023)
63. Deputy Director for Malaysia and Brunei, Ministry of Foreign Affairs Singapore (February 16, 2023)
64. Professor of Architecture, National University of Singapore (February 20, 2023)
65. Director of Innovation Center, CREATE MIT SMART (March 31, 2023)
66. Activist, Transformative Justice NGO (April 18, 2023)
67. Personal Communication, Deputy Director, National Parks Board (April 2023)
68. Researcher and Lead Investigator, ETH Singapore Future Cities Lab (July 17, 2023)
69. Personal Communication, Deputy Manager, Land Transport Authority (September 25, 2023)
70. Personal Communication, Manager, Land Transport Authority (September 25, 2023)

71. Former Planner, Land Transport Authority (September 27, 2023)
72. Engineer CTO Office, ST Engineering (December 29, 2023)
73. Director, Keppel Infrastructure Holdings (January 8, 2024)
74. Landscape architect, Gardens by the Bay (January 11, 2024)
75. Personal Communication with Smart District Lead, JTC (January 15, 2024)
76. Former Permanent Secretary of Ministry of Foreign Affairs, Singapore (January 15, 2024)

China

77. Urban planner and designer with Xiong'an Masterplan, Skidmore Owings and Merrill (June 7, 2023)
78. Professor of Urban Planning Tongji University Shanghai (October 2022)
79. Professor of Urban Planning, Tsinghua University (July 2023)
80. Professor of Architecture, Tsinghua University formerly of China Academy of Urban Planning and Design (July 7, 2023)
81. Professor, Renmin University of China (July 12, 2024)
82. Professor, Beijing Forestry University (July 2, 2023)
83. Professor Beijing Forestry University (October 27, 2023)
84. Professor of Digital Planning Beijing Capital University of Finance (June 27, 2023)
85. Head of Digital Planning Lab, Beijing Planning Institute (June 8, 2023)
86. Former Financial Lead, CR Land (Huarun) Xiong'an (March 31, 2023)
87. Presentation at Harvard Yenching Center, Professor of Economics and Director National School of Development Peking University (November 27, 2023)
88. Senior Director, Kingsoft Cloud Beijing (February 12, 2024)
89. Conversation with Xiong'an Resident 1 (June 12, 2024)
90. Conversation with Xiong'an Resident 2 (June 12, 2024)
91. Conversation with Xiong'an Resident 3 (June 12, 2024)
92. Conversation with Xiong'an Resident 4 (June 13, 2024)
93. Conversation with Xiong'an Resident 5 (June 13, 2024)
94. Conversation with Xiong'an Resident 6 (June 13, 2024)
95. Conversation with Xiong'an Resident 7 (June 14, 2024)
96. Conversation with Xiong'an Resident 8 (June 14, 2024)

Non-Country Specific Interviews

97. Professor, Mediated Environments, MIT Media Lab (December 1, 2022)
98. Researcher, Industrial Performance Center MIT (October 5, 2022)
99. Professor of Electrical Engineering and Computer Science, MIT (October 23, 2022)
100. Professor of Media Arts and Sciences, MIT Media Lab (November 28, 2023)

Appendix 2: Sample Interview Questions

Interview 1
1. What is the overall strategy of _____ and can you talk about the strategy and overall plan when the company was set up?

2. Can you comment on the current situation and strategy of ___ with regard to sites across the EEC and greater Bangkok Area for example the following?
    a. Makkasan
    b. Pattaya
    c. Chonburi
    d. Chaechongsao
    e. U-Tapao (aerotropolis?)

3. What is the current status of land acquisition with regard to the above-mentioned sites

4. As per recent news reports, ___ has preferred to renegotiate the contract with the consortium. Could you comment on why ___ wants to do this?

5. Do you think a new Thai government (whenever that happens) will affect the government's policy with regards to the EEC and ___ role in the airport corridor project? Because the ___ was a signature policy of Prayut, will the new government seek to amend the current ___ plan?

6. What is the economic prospect of the rail and property corridor from _____ perspective at the current moment?

7. How are the current collaboration with___? Do they have differing perspectives on the project? Will their role as rail technology provider change at all if the contract is renegotiated?

8. What about _____ strategy outside the EEC (Bangkok and/or elsewhere in Thailand)?

Interview 2

1.What is the status of the "smart city districts" within Bangkok (Rama IV, Chula, True Digital Park, Yothi…), how do these districts fit into the city's larger strategy and your expressed desire to attract more startups/innovation in Bangkok?
a. Role of foreign technology vendors
b. Coordination with landowners (Chula, CP, etc?)

2. Traffy Fondue: You've presented this as a key "platform" that can aid in solving urban problems, can you discuss how this platform has or has not changed governance structures—what challenges remain or that the platform cannot address?
        a. Summary statistics of the number of problems addressed to date?
        b. Data on each district and how they use the platform
        c. Who is actually making decisions on which problems to address and prioritize?

4.City Data platforms: There are a range of efforts or initiatives within Thailand to create city data platforms, including Trafy, PTT's Bedrock, city data companies (Phuket or Khon Kaen, for example). What is BMA trying to do to use data as a resource?
a.   City Data lab: what's the goal here and what are you going to do with the data
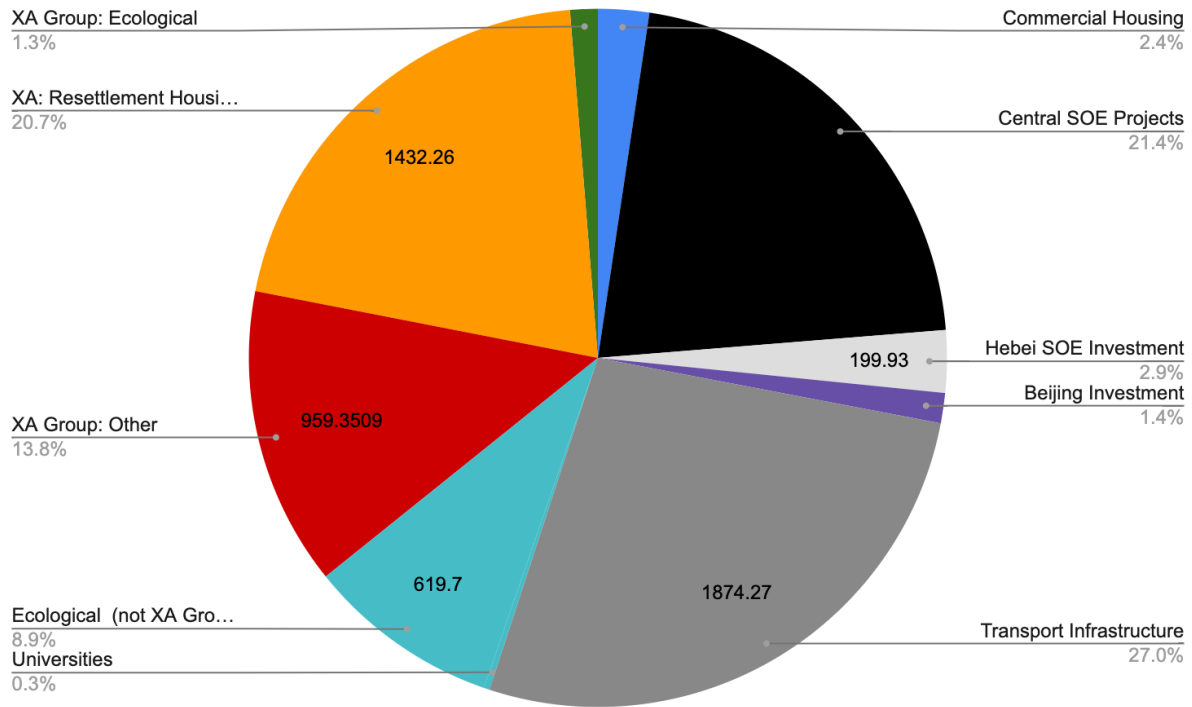
5.   Fiscal/Revenue: Limited revenue is a big challenge for BMA and many cities outside Bangkok in Thailand. According to some statistics, Bangkok and other cities in Thailand only collect a small portion of what they could in tax revenue from land/housing/billboards or other sources—what could BMA do (using data or other means) to collect more revenue?
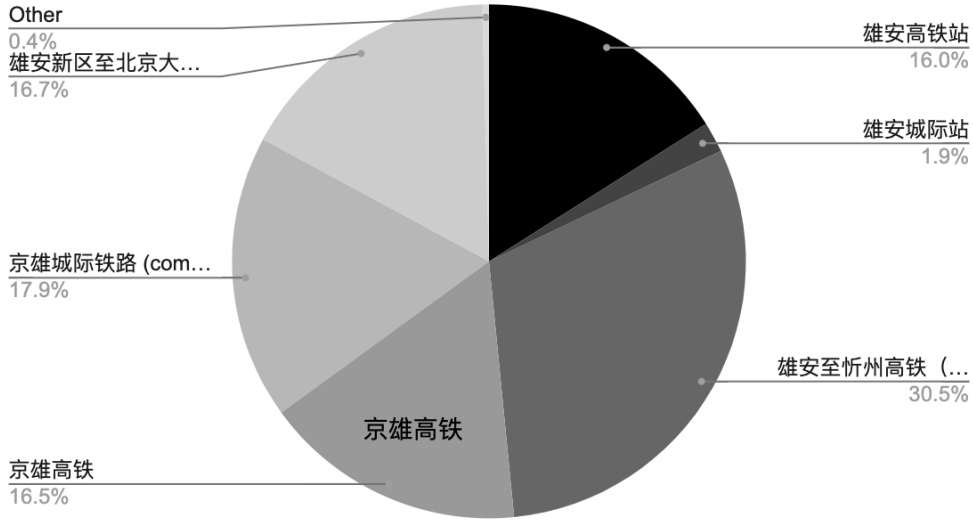
Appendix 3: Dataset on Xiong'an Financing

Note: this data was gathered at the end of 2023.

Type of Investment	（RMB 亿元)
Commercial Housing	163.9
Central SOE Projects	1481.1551
Hebei SOE Investment	199.93
Beijing Investment	96.6755
Transport Infrastructure	1874.27
Universities	18.654
Ecological (not XA Group)	619.7
XA Group: Other	959.3509
XA: Resettlement Housing	1432.26
XA Group: Ecological	88.78

Total: **6934.6755**

Transport Projects In Xiong'an

- Other 0.4%
- 雄安新区至北京大… 16.7%
- 京雄城际铁路 (com… 17.9%
- 京雄高铁 16.5%
- 京雄高铁
- 雄安高铁站 16.0%
- 雄安城际站 1.9%
- 雄安至忻州高铁（… 30.5%

Xiong'an: Sources of Finance (亿元）

- Hebei Bonds 25.5% — 2,520.63
- Postal Savings Bank 邮政储蓄银行 20.2% — 2000
- ICBC 工商银行 5.0% — 500
- China Development Bank 国开银行 9.4% — 933
- Bank of China 中国银行 8.1% — 800
- China Construction Bank 建设银行 18.7% — 1850
- Agricultural Bank of China 13.1% — 1300
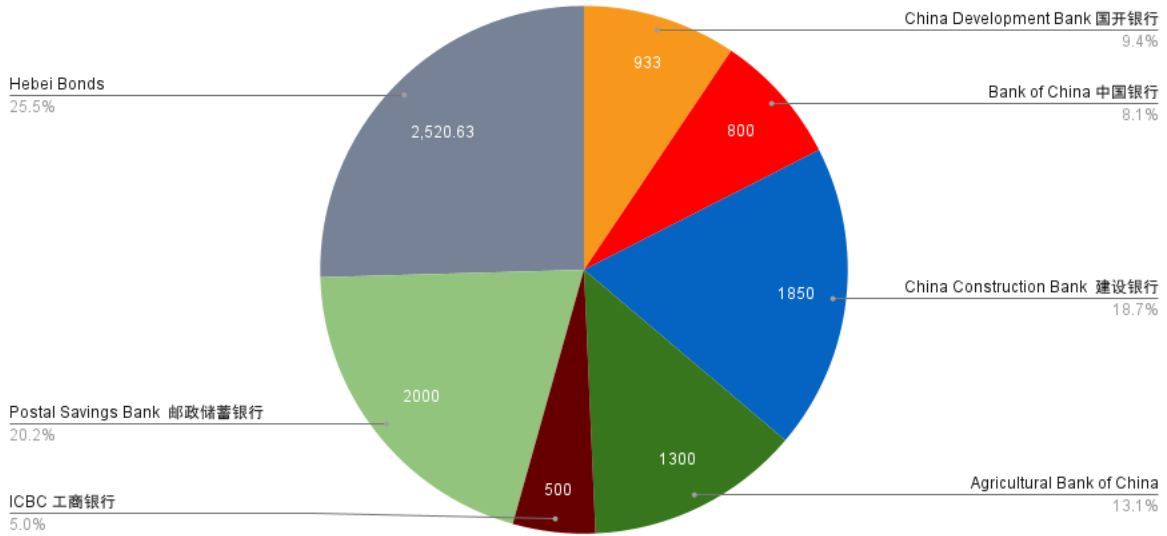
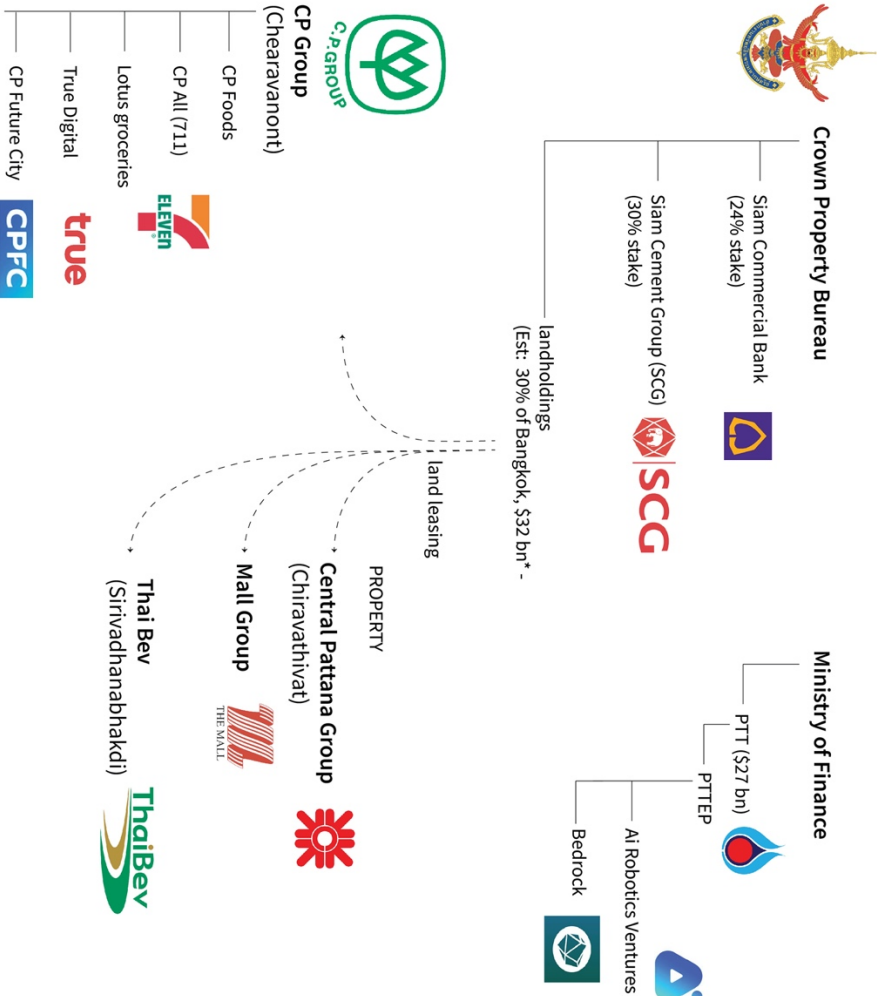**Appendix 4: Family and State Capital in Thailand**

STATE CAPITAL

FAMILY CAPITAL

* estimated by Porphant (2015)

Crown Property Bureau

Siam Commercial Bank
(24% stake)

Siam Cement Group (SCG)
(30% stake)

landholdings
(Est: 30% of Bangkok, $32 bn* -

PROPERTY

land leasing

Central Pattana Group
(Chiravathivat)

Mall Group

Thai Bev
(Sirivadhanabhakdi)

CP Group
(Chearavanont)

CP Foods

CP All (711)

Lotus groceries

True Digital

CP Future City

Ministry of Finance

PTT ($27 bn)

PTTEP

Ai Robotics Ventures

Bedrock

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