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Abstract

Smart city developments at home and abroad present Japan with various socioeconomic and strategic opportunities and challenges. This policy paper outlines the evolution of the Japanese government's interest in facilitating the domestic uptake of technologies associated with smart city platforms and the drivers of Tokyo's international cooperation within the smart city paradigm. It also describes intersecting national security and economic considerations that are of increasing interest to Japan's security policymakers. The paper concludes by outlining tensions between Tokyo's promotion of smart city platforms and its economic security agenda.

Keywords

Smart city; Economic security; Technology

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Introduction

This overview analyses the Japanese government's role in the promotion of smart cities at home and abroad and the associated socioeconomic and strategic opportunities and challenges. Section one briefly introduces an idealised conception of smart city functionality. Section two describes the domestic development of smart city technologies, platforms and projects in Japan. Section three identifies Japanese government initiatives to realise enhanced 'smart' urban functionality. Section four outlines Tokyo's overseas-focused smart city initiatives and provides a brief analysis of the need for overseas promotion. Section five raises some obvious and not-so-obvious national security considerations arising from smart city platform development and technology proliferation. Section six outlines Japan's economic security agenda and its connection with industrial policy. This provides the essential background for the concluding section, which offers initial thoughts on whether Japan's economic security agenda, smart city activities and overall innovation policy will be mutually helpful or harmful.

1. Conceptualising the Functions of Smart Cities

Historically, cities have been the infrastructure and technological vehicles for reaping the benefits of modernity while solving the negative political, economic and social externalities precipitated by the industrialisation process.[1] Smart cities are an even more consciously technology-mediated approach to enhancing urban functionality using 'fourth industrial revolution' (4IR) innovations. As such, they are comprised of a technology and infrastructure backbone (energy, processors, storage, communications) and 'edge' technologies and devices that connect into this backbone. Ideally, various public and private organisational entities facilitate the interconnectivity of objects, individuals and networks to generate, store, standardise, integrate, transform and share data on the natural environment and human behaviour (a data ecosystem).[2] A data linkage platform (CityOS) uses these transformed data to suggest and direct adaptive actions by government agencies, businesses, individuals and even autonomous technological agents to quickly and cheaply solve various ecological, economic and social problems.[3] These data can also enhance city stakeholders' ability to use predictive modelling to deploy new services and arrange infrastructure to support longer-term urban wellbeing.[4]

A 2018 McKinsey Global Institute (MGI) report attempted to quantify the quality-of-life gains from the proliferation of already proven smart city applications.[5] The report asserted that in the transport domain, fatalities (8-10 percent), emergency response times (20-35 percent) and commute times (15-20 percent) could all be improved with existing technology. In the health domain, the disease burden could be cut by 8-15 percent while the amount of time residents needed to deal with public and private health bureaucracy could be reduced by 45-65 percent. Crime could also be reduced by 30-40 percent. MGI estimated that existing technology could assist in cutting greenhouse gas emissions by 10-15 percent, water use by 20-30 percent and unrecycled waste by 10-20 percent.

1 Hoselitz, Bert, "The Role of Cities in the Economic Growth of Underdeveloped Countries," *Journal of Political Economy* 61, no. 3 (1953): 195-208; Lambooy, Jan, "Knowledge Production, Organisation and Agglomeration Economies," *GeoJournal* 41, no. 4 (1997): 293-300; Heblich, Stephan, Stephen J. Redding and Daniel M. Sturm, "The Making of the Modern Metropolis: Evidence from London," *The Quarterly Journal of Economics* 135, no. 4 (2020): 2059-2133; Desrochers, Pierre, "Cities and Industrial Symbiosis: Some Historical Perspectives and Policy Implications," *Journal of Industrial Ecology* 5, no. 4 (1 October 2001): 29-44; Puga, Diego, "The Magnitude and Causes of Agglomeration Economies," *Journal of Regional Science* 50, no. 1 (2010): 203-19; Friedmann, John, "The Role of Cities in National Development," *American Behavioural Scientist* 12, no. 5 (27 July 1969): 13-21.

2 Katayama, Norio, "Smart Cities in 2050: Rebuilding the Future of Japanese Cities," 2021, https://www.pwc.com/jp/en/knowledge/thoughtleadership/assets/pdf/smart-city2050-en.pdf (p. 28).

3 Davies, Alex, "Barcelona's Sentilo Smart City the First Built by a Municipality – Rethink," Rethink Technology Research Website, 27 June 2014, https://rethinkresearch.biz/articles/barcelonas-sentilo-smart-city-the-first-built-by-a-municipality/; "Urban Operating System," National Strategic Special Zones Website, 2022, https://www.chisou.go.jp/tiiki/kokusentoc/english/super-city/data-linkage-platform.html.

4 "Smart Cities for a Brighter Future," JICA Magazine 10, No.2, October 2021, https://jicamagazine.jica.go.jp/en/magazine/?date=2021_10&tits=SMART%20CITIES%20for%20A%20Brighter%20Future (p. 3); McKinsey Global Institute, "Smart Cities: Digital Solutions for a More Livable Future," 2018, https://www.mckinsey.com/~/media/McKinsey/Industries/Public and Social Sector/Our Insights/Smart cities Digital solutions for a more livable future/MGI-Smart-Cities-Executive-summary.pdf.

5 McKinsey Global Institute, "Smart Cities," pp. 3-6.

Indeed, smart cities were originally conceptualised to mitigate climate change, and more recently to meet the Sustainable Development Goals (SDGs).[6] Infrastructure building and successful smart city implementation take on additional significance given the still rapidly expanding and urbanising global population. Already, urban areas generate 80 percent of global GDP.[7] Cities will, however, be home to 68 percent of the global population in 2050, up from 55 percent today. Furthermore, 2.5 billion more people will live in cities in 2050, with almost 90 per cent of urban population growth taking place in Asia and Africa.[8] High quality green infrastructure, digital technology and big data are predicted to play important roles in keeping these growing cities functional by improving the efficiency of urban service delivery, reducing the climate burden of urbanisation and enhancing the quality of life and prosperity of residents.[9]

However, what makes a city 'smart' goes beyond the modernisation of infrastructure and the use of new, predominantly digital, technologies to guide, modify, disincentivise or amplify social behaviours. The academic literature on smart cities is critical of the emphasis on technology in framing the value of public and private smart city projects.[10] After all, although there are many 'successful' demonstration projects around the world, smart city development has struggled to go beyond the prototyping or proof-of-concept stage.[11] One of the reasons for this is poor institutional planning, coordination and public buy-in and support for scaled-up versions of smart cities which have little to do with technology performance. For example, scholars have identified a need to think about smart city design in terms of a "quadruple helix" that includes stakeholders from government (local and national), the private sector and research institutions, and significant public input.[12] The potential for surveillance and data misuse is also an ever-present concern for the public – which Alphabet (Google) found out much to its detriment when its Sidewalk Labs closed down its "sensor-laden" smart city vision for the Toronto waterfront after arousing antipathy among local residents with opaque plans and insufficient community outreach.[13]

Being smart does not always mean being digital. Institutional, social and regulatory innovations and changes that streamline approval processes for new urban projects (including housing and construction), that speed up repairs and maintenance, and that standardise materials and designs for infrastructure can be just as important and beneficial as deploying digital 'solutions.' Meddeb and Handforth also note that a technophilic focus on smart innovation may also dilute the traditional vibrancy of cities as "crucial drivers" of opportunity, chance and progress. They give the example of urban sidewalks and public spaces which can be "conduits for adventure, social interaction and unexpected encounters" – something that may vanish if social interaction in urban spaces becomes over-regularised and digitally managed for optimisation and efficiency.[14] Finally, a digitally enhanced city may be financially and logistically unrealistic or inappropriate for many regions of the world or will need to be implemented in iterative fashion rather than based on a grand design.[15] Seeing smart cities only in terms of digital technology could lead to planners overlooking natural and local area-specific solutions to various problems, despite such solutions being potentially as 'smart' and innovative and only requiring modest lower technology tweaks to have a substantive impact.

6 Kantei, "Japan's Smart Cities," 2021, https://www.kantei.go.jp/jp/singi/keikyou/pdf/Japan's_Smart_Cities-1(Main_Report).pdf.
7 Meddeb, Riad and Calum Handforth, "We Need Smarter Cities, not 'Smart Cities,'" MIT Technology Review, 27 June 2022, https://www.technologyreview.com/2022/06/27/1053896/we-need-smarter-cities/
8 United Nations Department of Economic and Social Affairs, World Urbanization Prospects 2018: Highlights, 2018, https://population.un.org/wup/.
9 Smart Cities for a Brighter Future," p. 3; Accenture, "A Resilient Future for Cities," 2021, https://www.accenture.com/_acnmedia/PDF-151/Accenture-A-Resilient-Future-for-Cities.pdf (p. 13).
10 Meddeb and Handforth, "We Need Smarter Cities, not 'Smart Cities.'"
11 Martínez-Bello, Nadhiely et al., "A Methodology for Designing Smart Urban Living Labs from the University for the Cities of the Future," *Sensors* 21, no. 20, 2021; Cosgrave, Ellie, Kate Arbuthnot and Theo Tryfonas, "Living Labs, Innovation Districts and Information Marketplaces: A Systems Approach for Smart Cities," *Procedia Computer Science* 16, 2013: 668-77.
12 Borghys, Koen et al., "Multi-Stakeholder Innovation in Smart City Discourse: Quadruple Helix Thinking in the Age of 'Platforms,'" *Frontiers in Sustainable Cities* 2, no. 5, 2020; Paskaleva, Krassimira, James Evans and Kelly Watson, "Co-Producing Smart Cities: A Quadruple Helix Approach to Assessment," *European Urban and Regional Studies* 28, no. 4 (May 31, 2021): 395-412.
13 Hawkins, Andrew J., "Alphabet's Sidewalk Labs Shuts Down Toronto Smart City Project" The Verge, 7 May 2020, https://www.theverge.com/2020/5/7/21250594/alphabet-sidewalk-labs-toronto-quayside-shutting-down.
14 Meddeb and Handforth, "We Need Smarter Cities, not 'Smart Cities.'"
15 UNDP Global Centre for Technology, Innovation and Sustainable Development, "Handbook on Smart Urban Innovations," United Nations Development Programme Website, 20 October 2021, https://www.undp.org/publications/handbook-smart-urban-innovations.

2. Smart City Development in Japan

Igata estimates that there are over 200 smart-city projects underway across Japan as of 2022.[16] One imperative for smart city development in Japan is to maintain a high quality of life for Japanese citizens given compounding demographic, economic and environmental challenges. In the thirty years between 2015 and 2045, the population of Japan is projected to decrease by about twenty million.[17] With human lifespans estimated to reach 100 years, the proportion of senior citizens in the population will at the same time grow to 36.8 percent by 2045.[18] Ageing and depopulation demographics are expected to adversely impact many homegrown industries as they face decreasing domestic demand and the challenge of securing human resources. To keep Japan's economy from shrinking in absolute terms, companies will need to increase their productivity while helping people earn incomes for longer to mitigate the burden of social security expenses on the smaller working age population. Adaptation of smart innovations could also help reverse deterioration, stabilise depopulating 'regional' areas in Japan and ensure health service provision remains up to standard even as the population shrinks. The Japanese government anticipates that these technologies will underpin innovative approaches to agriculture and food production even as human resources leave the countryside and physical labour becomes more onerous for existing but ageing farmers. Digital tools are already being deployed to bolster regional tourism by providing visitors with accessible information about special local characteristics. These adaptations could help Japan's regional communities to remain attractive places to live and end the vicious circle of factors that have driven depopulation and service cuts.[19]

The Japanese government and the private sector also conceive of smart cities as technology platforms that will drive broader technological adaptation and innovation itself.[20] Tokyo has asserted that it is essential for Japan to maintain a global technology edge in order to generate business opportunities, underwrite domestic prosperity and ultimately secure Japan's position in the international community. Table 1 identifies the technologies that are likely to support smart city development in Japan and elsewhere.

Smart or otherwise, every successful modern city begins with an energy sector and energy infrastructure.[21] Energy provision is not only a key limiting factor in any individual city's growth but has increasingly taken on global significance. In Japan as elsewhere, smart city concepts and platforms originally developed as responses to heightened awareness of environmental issues and climate change. Smart cities are potential drivers of energy efficiency through the deployment of 'smart meters' and devices connected to 'smart grids' to optimise the management of energy demand and supply and reduce carbon emissions and those of other pollutants from fossil fuel-based energy generation. Smart metering is already quite advanced in Japan. For example, in 2021 TEPCO announced it had completed the installation of 29 million smart meters ahead of time, with smart meters reaching 100 percent of its customers.[22]

16 Igata, Akira, "Japan's Burgeoning Economic Security Strategy: Navigating amidst US-China Competition," RSC Policy Paper 2022/07, 2022, https://cadmus.eui.eu/bitstream/handle/1814/74537/RSC_PP_GGP_2022_07.pdf (p. 8).
17 "Japan's Cities Should Prepare for Growing Elderly Population," *Nippon.com*, 26 November 2019, https://www.nippon.com/en/japan-data/h00585/japan's-cities-should-prepare-for-growing-elderly-population.html.
18 Katayama, "Smart Cities in 2050," p. 6.
19 Katayama, "Smart Cities in 2050," pp. 8-9.
20 "Mitsui, KDDI Team up on 'Smart City' Platform," *NHK World*, 9 June 2022, https://www3.nhk.or.jp/nhkworld/en/news/20220609_29/.
21 "Smart Cities for a Brighter Future," p. 4.
22 TEPCO, "TEPCO Integrated Report 2020-2021," 2021, https://www.tepco.co.jp/en/wp-content/uploads/TP20-21_EN_web.pdf.

Table 1. Smart City Technologies: Components and Idealised Functions

Next Generation Energy Systems	Smart meters, smart grids, storage devices, electric vehicles, emissions management devices for energy efficiency and carbon mitigation/elimination.
Internet of Things	Wide range of sensors: visual, image, sound, light, temperature, inertial, barometric and pressure sensors. Includes low-energy sensors fabricated from novel materials.
Digital Twins	Software and hardware allowing 3D integration and visualization of data and sensors. For real-time city management purposes or predictive modelling, city planning, and disaster response purposes.
Data Integration and Management Technologies	"CityOS" software, APIs, common calling procedures, and blockchain. Platforms and technologies for enabling of open data input and output and data ecosystem, integration, and standardization technologies to make fragmented data usable. Privacy and data security technologies.
Autonomous Mobility and Mobility as a Service (MaaS)	Automated and autonomous vehicles (land and air) that build on other smart city technology platforms and GPS and satellite platforms. Enables individualized public transport, efficient delivery of healthcare and freight, and civil defence and natural disaster response functions.
Robotics and 3D Printing (Additive Manufacturing)	Labour replacement and service facilitation robotics. Manufacturing robotics, materials innovation, and 3D printing for low cost, low environmental impact. Tailored solutions to community building and construction, and infrastructure needs and business logistics. Sensor fabrication and precise integration into buildings.
Health and Pandemic Management Technologies	Health robotics, prosthetics manufacturing, medical devices, genetic services and pharmaceutical tailoring. Monitoring and testing technologies, data analysis for pandemic management. Biomedical innovations and healthcare itself positioned as playing an important role in the supporting smart cities in aging societies.
Machine Learning and Artificial Intelligence	Deep learning models and deep neural networks for automated analysis of big data and real-time decision making. AI processing initially involves collection, classification, identification, categorization, projection, visualization, optimization of data.
Processing Technologies	AI analysis requires substantial enhancements of processing power as well as different kinds of processing for visualizing 3D data in addition to other forms of data. Graphics processor units, visual processor units, and AI chips (TPUs and AIPUs) required that build on CPU enhancements from transistor miniaturization. Quantum processing identified as valuable for automated travel purposes.
Next Generation Telecommunications	5G, 6G and modular Open Ran systems. Low-power wide-area (LPWA) networks specifically for IoT sensors. Wireless telecommunications networks and data storage technologies allowing throughput of big data as well as cloud computing itself as well as data transmission for sharing of data for decision making or directing behaviour of autonomous or human actors using other smart city technologies.

Installing 'smart grids' is the current focus of smart urban energy development in Japan. Smart grids are networks of various devices and sensors that automatically monitor energy flows, seamlessly communicate with each other and adjust changes in energy supply (generation) and demand (use) accordingly. Smart meters, enhanced storage devices and various devices connected to a smart power grid allow the efficient incorporation of various types of decentralised energy sources in daily lives, enabling greater progress towards 'carbon zero.'[23] A smart grid not only enhances efficiency through optimisation of current carbon-intensive generation to reduce carbon emissions but allows the installation of a more diverse set of applications that increase the reliability, survivability and responsiveness of the grid.[24] There are numerous trials of smart grids in Japan, beginning with demonstration projects in Yokohama, Toyota, Keihanna and Kitakyushu. These projects bring together major vendors of smart grid technologies and electronics such as Hitachi, Toshiba and Mitsubishi. These high-tech companies have then developed partnerships with renewable energy providers, real estate developers, local governments and universities.[25]

By connecting smart grids to low-carbon energy generation sources and storage devices, energy generation can be both optimised and made 'green.' Following the 3/11 triple disaster, the focus of smart community development was broadened to support the recovery, revitalisation and resilience of destroyed regions in the Tohoku area with a specific focus on renewable energy. In 2020, Prime Minister Suga Yoshihide changed government policy to make an explicit national commitment to a "a carbon-neutral decarbonised society by 2050." Suga's industry minister told a news conference that "Carbon neutrality itself is a growth strategy, and we must carry it out with all we have."[26] The government established the ¥2 trillion 'Green Innovation Fund' to support the zero-carbon agenda and ultimately its economic strategy.[27] The Japanese government also enrolled the New Energy

23 European Commission, "Smart Grids and Meters," 4 January 2022, https://energy.ec.europa.eu/topics/markets-and-consumers/smart-grids-and-meters_en.
24 Katayama, "Smart Cities in 2050," p. 27.
25 Wallace, Corey, "Japan's strategic contrast: continuing influence despite relative power decline in Southeast Asia," *Pacific Review* 32, no. 5 (2019): 863-97.
26 "Suga Vows to Meet Japan's Zero-Emissions Goal by 2050," *Nikkei Asia*, 26 October 2020, https://asia.nikkei.com/Politics/Suga-vows-to-meet-Japan-s-zero-emissions-goal-by-2050.
27 Lies, Elaine, "Japan Aims for Zero Emissions, Carbon Neutral Society by 2050 – PM," *Reuters*, 26 October 2020, https://jp.reuters.

and Industrial Technology Development Organization (NEDO), a prominent Japanese innovation accelerator and technology proliferator, to administer the fund for ten years and drive forward innovations in energy-related ICT systems, storage batteries, hydrogen and fuel cell technologies, and CO_2 capture, utilisation and storage (CCUS).[28]

In the last decade the Japanese public and private sectors have expanded the smart city agenda beyond the energy domain to include health service provision, public transportation systems and mobility, construction and public works, agricultural productivity in the light of rural depopulation and the promotion of national disaster resilience. To realise the imagined benefits of smart cities, Tokyo has emphasised the need for public and private sector coordination on deploying Internet of Things (IoT) sensors and artificial intelligence (AI) applications for data collection, processing and autonomous management.[29] IoT advocates envision sensors being distributed throughout cities and inside buildings to generate massive volumes of data that can be transformed and transmitted via telecommunications systems to monitor the real-time state of urban infrastructure (including lifelines such as roads, bridges and water systems). Public service providers, businesses and even autonomous systems would in turn initiate appropriate responses to direct and optimise urban activity.[30]

While Japan has been slower than many countries in integrating ICT applications in businesses, it has maintained significant advantages in sensor technology innovation.[31] The Japanese government provides incentives to companies investing in IoT devices focused on productivity and cybersecurity and has tasked NEDO with leading IoT development and implementation cooperation among Japanese public and private institutions.[32] It is also essential to distribute sensors and integrate data connected and managed through a City OS to create 'digital twins.'[33]

com/article/japan-politics-suga-idUSKBN27B0FB.

28 "Special Report: Creating the Future through Innovation," *Focus NEDO* 80 (2021), https://www.nedo.go.jp/content/100933495.pdf.

29 "The 5th Science and Technology Basic Plan," *Cabinet Office of Japan Website*, 22 January 2016, https://web.archive.org/web/20180921012126/http://www8.cao.go.jp/cstp/english/basic/5thbasicplan.pdf.

30 Bonafini, Federico et al., "Cluster of IoT Sensors for Smart Cities: Impact of the Communication Infrastructure over Computational Performance," *2019 IEEE Sensors Applications Symposium (SAS), Conference Proceedings*, 3 May 2019; Cisco, "IOE-Driven Smart City Barcelona Initiative Cuts Water Bills, Boosts Parking Revenues, Creates Jobs and More," 2014, http://web.archive.org/web/20150910194051/http://www.cisco.com/assets/global/ZA/tomorrow-starts-here/pdf/barcelona_jurisdiction_profile_za.pdf.

31 Ōkawara Katsuyuki, "Japan's Electronics Makers Unveil a Future Shaped by the Internet of Things," *Nippon.com*, 9 December 2016, https://www.nippon.com/en/currents/d00269/; Furukawa, Keiichi, "Sony Steps up Image Sensor Tech, Targeting 60% Market Share," *Nikkei Asia*, 18 June 2022, https://asia.nikkei.com/Business/Electronics/Sony-steps-up-image-sensor-tech-targeting-60-market-share. "Sony Aims for Biggest Share of Global Image Sensor Market," *NHK News*, 20 June 2022, https://www3.nhk.or.jp/nhkworld/en/news/20220620_13/.

32 Matsubara, Mihoko, "Japan's Cybersecurity Must Address Gaps in IoT and Cloud Security," *East Asia Forum*, 14 August 2018, https://www.eastasiaforum.org/2018/08/14/japans-cybersecurity-must-address-gaps-in-iot-and-cloud-security/; New Energy and Industrial Technology Development Organization, "Profile of IoT Promotion Department (FY2021): A Future Interweaving the Cyber and the Physical," *NEDO Website,* 2021, https://www.nedo.go.jp/content/100898591.pdf; New Energy and Industrial Technology Development Organization, "Cross-Ministerial Strategic Innovation Promotion Program," *NEDO Website*, 5 February 2021, https://www.nedo.go.jp/english/activities/ZZpage_100139.html.

33 Cityzenith, "Urban Digital Twins Set to Create the First Real World Metaverse for the Decarbonization of Buildings," *The Smart City Journal*, 15 March 2022, https://www.thesmartcityjournal.com/en/technology/urban-digital-twins-set-to-create-the-first-real-world-metaverse-for-the-decarbonization-of-buildings.

Digital twins recreate physical space in cyberspace by using real-time big data. Using a digital twin of a city or some other physical environment, real time data inputs, throughputs and outputs allows users to visualise buildings, streets and ultimately a whole city and its physical and digital networks.

Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) is in the process of developing a digital twin of the whole of Japan using open data 3D city models. Called *Plateau*,[34] the ostensible purpose of the project is to enhance disaster simulations in order to make predictions and prepare and coordinate responses and evacuation plans. It may also allow delivery services using drones and air mobility to operate in disaster situations. Eventually the project will allow the MLIT and others to track urban activity and town planning to optimise city spaces for a variety of urban services and functions in the future.[35] The MLIT's aim is to operate the digital twin as a single platform that will be open to the private sector and individuals, potentially facilitating the further development of technologies and services and the sharing of valuable data.[36] *Plateau* debuted a public interface for a 3D city model of Tokyo's 23 wards in 2021 ahead of the release of models for 56 more cities.[37]

Digital twinning is also essential in order to utilise autonomous vehicles and robots for product and healthcare delivery, and freight and public transport. In the last five years the Japanese government has dedicated much funding and attention to supporting cross-industry coordination on technology and standard development for the use and uptake of autonomous vehicles in Japan. It has begun to build the necessary legislative infrastructure to make self-driving vehicles more commonplace.[38] Self-driving technology in Japan is already able to handle highway driving at level three, which still requires a human to take the wheel in the case of an emergency. In 2021, the MLIT and the Ministry of Economy, Trade and Industry (METI) announced successful trials of a truck platooning system on the Shin Tomei Expressway with no drivers in the following trucks.[39] In 2021 the METI also oversaw the testing of public driving systems in Chatan, Okinawa and in 2023 will trial level 4 (close to fully automated) bus driving systems in four rural areas. This will be increased to 40 locations by 2025.[40]

The government also laid a critical foundation stone for self-driving vehicles when the Michibiki Quasi-Zenith Satellite System came online in 2018. A Japanese enhancement of GPS, the system will be expanded from four to seven satellites in 2023. This will allow a reduction of GPS positioning errors in Japan and other countries using the system in Asia from several meters to around a few centimetres. In conjunction with high-precision digital mapping data, embedded IoT sensors and sensors on board vehicles, Michibiki will support major improvements in the positioning, driving accuracy and safety of autonomous vehicles. The government tested the Michibiki system with self-driving buses in Okinawa in 2018 to benchmark sensor technologies.[41] Autonomous sensor-enhanced mobile robots could leverage these digital twin, satellite and sensor technologies to move around obstacles during emergencies to transfer goods (and people) after a disaster – in addition to in the normal course of business.

34 "PLATEAU by MLIT," MLIT Website, 1 July 2022, https://www.mlit.go.jp/plateau/.

35 Furutani, Kasey, "This Free Virtual 3D Model Lets You Explore Tokyo's 23 Central Wards," *Timeout*, 6 April 2021, https://www.timeout.com/tokyo/news/this-free-virtual-3d-model-lets-you-explore-tokyos-23-central-wards-040621.

36 Katayama, "Smart Cities in 2050," p. 28.

37 MLIT, "報道発表資料：Project PLATEAU
全国56都市の3D都市モデルのオープンデータ化を完了 - 国土交通省," Ministry of Land, Infrastructure, Transport and Tourism Website, 6 August 2021, https://www.mlit.go.jp/report/press/toshi03_hh_000078.html.

38 Machida, Noritake, "'Level 4' Self-Driving Transit Cars in Japan Won't Require Licensed Passengers," *The Mainichi*, 2 April 2021, https://mainichi.jp/english/articles/20210402/p2a/00m/0na/025000c.

39 "Successful Autonomous Driving Technology Tests for Truck Platooning," *Ministry of Economy, Trade and Industry Website*, 5 March 2021, https://www.meti.go.jp/english/press/2021/0305_003.html.

40 "Japan to Create Legal Framework for Level 4 Self-Driving Cars," *Nikkei Asia*, 23 December 2021, https://asia.nikkei.com/Business/Automobiles/Japan-to-create-legal-framework-for-level-4-self-driving-cars; "Driverless Autonomous Driving Mobility Services to Start in Seaside Resort in Chatan Town, Okinawa Prefecture," *Ministry of Economy, Trade and Industry Website,* 2021, https://www.meti.go.jp/english/press/2021/0330_002.html. Level 4 is not complete autonomy but vehicles are expected to safely drive or stop on designated routes without human interaction even in bad weather or when an emergency vehicle approaches.

41 "We Are Tomodachi Winter 2018," *Government of Japan Website*, 2018, https://www.japan.go.jp/letters/ebook69/html5.html (pp. 28-29).

Artificial intelligence, satellite technology and digital twinning could also enable automatic transportation to be three dimensional. Air mobility could solve traffic congestion in large cities, free up transport routes for freight, improve logistics and resolve labour shortages in depopulating cities while ensuring economic activity remains constant. In 2018 the Japanese government launched a Public-Private Conference for Future Air Mobility Revolution, which published a roadmap towards an air mobility revolution under the auspices of the METI and the MLIT.[42] The government has also vigorously promoted the activities of SkyDrive, a company formed by a consortium of major Japanese companies dedicated to developing a compact two-seat vertical take-off and landing electric-powered aerial vehicle. In 2022 SkyDrive announced a partnership with Suzuki ahead of plans to launch a 'flying car' service in Osaka during the 2025 World Expo. The partnership with Suzuki is important because of long-term potential for business in India, where Suzuki has roughly half of the auto market.[43]

The Japanese private sector has struck out on its own in the area of 'green' next generation mobility, which will require new infrastructure for secure communications and charging/fuelling stations. Working with self-driving technology parts makers Denso and Aisin Seiki,[44] Toyota has begun building 'Woven City' on 175 acres of land at the base of Mount Fuji.[45] The company envisages self-driving cars powered with hydrogen fuel cells 'interweaving' with pedestrian traffic. Toyota plans to develop the area into a complete fully sustainable smart city using robotics, AI and smart homes for 2000 residents. When announcing his personal investment of ¥5 billion in the holding company that will oversee the development of Woven City, Toyota Motor President Akio Toyoda argued that the project represented a transformation of Toyota's business model in much the same way that Toyota's first car engine in 1934 helped transform it from an auto loom manufacturer to an automobile company in the interwar years.[46]

A whole range of other 4IR technologies are likely to constitute integral parts of the infrastructure backbone of future smart cities like Toyota's Woven City. Artificial intelligence, analytics and deep learning applications that will enable smart city functioning will depend on enhancements in high-bandwidth and near-instantaneous processing and communications. Therefore, not only have next generation telecommunications (5G, 6G) attracted the Japanese government's attention but it has prioritised adaptations in processing power predicated on the use of more advanced AI chips and quantum computing for investment and incentivisation. As Table 1 above indicates, there are a range of other technological possibilities for smart city development, including in the health and construction sectors.

3. Smart Cities and Mission-Oriented Innovation Policy in Japan

In addition to the ministry-specific initiatives identified above, the Japanese cabinet has also increasingly taken the lead in smart city development to ensure the development of the necessary competencies in a group of technologies relevant to smart cities. In an example of what the OECD terms "mission-oriented innovation policy,"[47] in 2013 the Japanese government announced plans to strengthen the Council for Science, Technology and Innovation's headquarters function and encourage cross-ministry and multi-sectoral engagement, planning and technology development and sharing.

42 "Advanced Air Mobility in Japan 2021: Our Development and Beyond," *Ministry of Land, Infrastructure, Transport and Tourism Website*, 2021, https://www.mlit.go.jp/koku/content/Advanced_Air_Mobility_in_JAPAN_2021.pdf.

43 "Japan's Suzuki, SkyDrive Sign Deal to Develop, Market 'Flying Cars'," *Reuters*, 22 March 2022, https://www.reuters.com/technology/japans-suzuki-skydrive-sign-deal-develop-market-flying-cars-2022-03-22/; Sasaki, Takashi, "Flying Cars to Take to the Skies," *Government of Japan Website*, March 2021, https://www.gov-online.go.jp/eng/publicity/book/hlj/html/202103/202103_07_en.html.

44 Noguchi, Kazuhiro, "Toyota Chief Personally Invests $45m in Self-Driving Smart City," *Nikkei Asia*, 26 June 2021, https://asia.nikkei.com/Business/Automobiles/Toyota-chief-personally-invests-45m-in-self-driving-smart-city.

45 Warren, Katie, "What Toyota's 175-Acre Smart City in Japan Will Look Like: Photos," *Business Insider*, 24 February 2021, https://www.businessinsider.com/toyota-city-of-the-future-japan-mt-fuji-2020-1.

46 Noguchi, "Toyota Chief Personally Invests $45m."

47 Larrue, Philippe, "Mission-Oriented Innovation Policy in Japan: Challenges, Opportunities and Future Options," *OECD Science, Technology and Industry Policy Papers*, no. 106, 2021: 77, https://www.oecd-ilibrary.org/science-and-technology/mission-oriented-innovation-policy-in-japan_a93ac4d4-en.

In 2014 the cabinet established the ImPACT programme with an annual ¥55 billion budget, and followed this with the initiation of a Cross-ministerial Strategic Innovation Promotion programme (SIP). Both programmes were tasked with promoting cross-ministry coordination on high-risk technology development.[48] Individual SIP programmes were funded with a total of ¥50 billion a year and a Programme Director (PD) was appointed who is responsible for breaking through ministerial silos, promoting coordination between government, industry and academic entities, and ensuring end-to-end research and development (R&D) is conducted (as opposed to leaving projects floundering at the conceptual or successful technology demonstration stages).

The specific policy and technology transformation the government wanted to see was codified in 2016 with the launch of the Society 5.0 framing concept. The fifth Science and Technology Basic Plan stated that creating a "super smart society" by integrating 4IR technologies in daily life heralded a new stage in human societal evolution. This fifth stage followed the previous four stages of hunter-gatherer, agrarian, industrial and information societies. The government positioned Society 5.0 innovation as a growth opportunity for a 'super-aged' Japan attempting to remain socioeconomically prosperous and in the 2017 Growth Strategy promised to accelerate the realisation of the Society 5.0 vision to "address the most important social problems facing Japan, as well as contribute to the resurgence of the Japanese economy."[49] The government also put the Society 5.0 vision alongside Germany's 'Industry 4.0,' the United States' 'Advanced Manufacturing Partnership' and China's 'Made in China 2025' industrial visions.[50]

A second tranche of SIP programmes announced in 2018 therefore tightly complemented the government's Society 5.0 plan and smart city promotion (Table 2).[51] In 2018 the government also established the Public/Private R&D Investment Strategic Expansion PrograM (PRISM) to "guide" R&D measures enacted by each ministry and agency to "the R&D investment target areas," thereby optimising public and private R&D expenditure. A number of measures were identified under the rubrics of AI technology, biotechnology, quantum technology and innovative construction and infrastructure technology (with a focus on disaster resilience and infrastructure maintenance).[52] The government also renamed the ImPACT program 'the Moonshot Research and Development Program.'[53]

In October 2018 the government then rebranded its domestic smart city agenda as it announced plans to nurture 'Super Cities' based on the Society 5.0 vision.[54] A legislative change to the National Strategic Special Zones Law followed in 2020. In theory, this legislation allows designated National Strategic Zones to more flexibly adapt government regulations to enable easier and quicker embedding of technology in city infrastructure and to proliferate autonomous driving, cashless payments, telemedicine and other services.[55] In 2021 the Suga government announced that it would establish a ¥100 billion fund to support research and development in advanced technologies to strengthen industrial competitiveness, with a view to accelerating the use of AI, biotech and robotic

48 "Comprehensive Strategy on Science, Technology and Innovation," *Cabinet Office of Japan,* 2014, https://web.archive.org/web/20180921012422/http://www8.cao.go.jp/cstp/english/doc/2014stistrategy_provisonal.pdf.

49 "2017 Growth Strategy Japan," 2017, *Ministry of Foreign Affairs of Japan Website,* https://www.mofa.go.jp/files/000272312.pdf; "SIP 'Pioneering the Future: Japanese Science, Technology and Innovation 2017,'" *Cabinet Office of Japan Website,* p. 4, https://web.archive.org/web/20181027043135/http://www8.cao.go.jp/cstp/panhu/sip_english/sip_en.html.

50 "The 5th Science and Technology Basic Plan," *Cabinet Office of Japan*, pp. 12-13.

51 "SIP 'Pioneering the Future: Japanese Science, Technology and Innovation 2021,'" *Cabinet Office of Japan*, 2021, https://www8.cao.go.jp/cstp/panhu/sip_english/sip_en.html.

52 "PRISM 'Aiming at Inducing Public/Private R&D Investment 2021,'" *Cabinet Office of Japan*, 2021, https://www8.cao.go.jp/cstp/panhu/prism2021_e/2021.html (pp. 13-14). PRISM is supported with a ¥10 billion annual budget. "官民研究開発投資拡大プログラムについてPRISM: Public/Private R&D Investment Strategic Expansion PrograM," *Cabinet Office of Japan,* 2022, https://www8.cao.go.jp/cstp/gaiyo/sip/190404/siryo1.pdf.

53 "Moonshot Reseach and Development Program," *Cabinet Office of Japan,* 2022, https://www8.cao.go.jp/cstp/english/moonshot/top.html. Broeckaert, Lena, "Digital Transformation in Japan: Assessing Business Opportunities for EU SMEs," 2022 (pp.14, 118).

54 Jiji, "Japan Enacts High-Tech 'Super City' Bill," *The Japan Times*, 27 May 2020, https://www.japantimes.co.jp/news/2020/05/27/national/japan-enacts-high-tech-super-city-bill/.

55 Igata, "Japan's Burgeoning Economic Security Strategy," p. 8.

applications in Japanese industry.[56] In 2021 the government also announced that it would establish a university endowment fund worth ¥10 trillion to support basic science research to arrest the fall in global rankings and the international reputations of Japanese universities.[57] In June 2022, the Kishida administration further centred Society 5.0 in the government's Integrated Innovation Strategy and signalled a need to reinforce the above mission-oriented initiatives and funds with a stronger Japanese venture capital market, stronger mechanisms to support start-ups and more extensive public-private R&D investment with R&D tax incentives and enhancements to the Small Business Innovation Research programme.[58]

Table 2. Basic Details of SIP Projects (Second Tranche)

Project (Annual Budget 2018)	Program Director
Big Data and AI-enabled Cyberspace Technologies (¥2.1 billion)	Anzai Yuichiro (Director of Center for Science Information Analysis)
Intelligent Knowledge Processing Infrastructure (¥2 billion)	Saso Hideyuki (Senior Fellow, Fujitsu Laboratories Ltd)
Cyber Physical Security for IoT (¥2.5 billion)	Goto Atsuhiro (President, Institute of Information Security)
Automated Driving for Universal Services (¥3 billion)	Kuzumaki Seigo (Fellow, Toyota Motor Corporation)
"Materials Integration" for Revolutionary Design System of Structural Materials (¥2.5 billion)	Mishima Yoshinao (Tokyo Institute of Technology, Former Chairman, NEDO, Executive Director, TSC)
Photonics and Quantum Technology for Society 5.0 (¥2.5 billion)	Nishida Naoto (Fellow, Toshiba Corporation)
Technologies for Smart Bio-Industry and Agriculture (¥3.2 billion)	Kobayashi Noriaki (Kirin Holdings Co. Ltd. Senior Executive Officer)
Energy systems for IoE Society (¥2.5 billion)	Kashiwagi Takao (Professor Emeritus, Tokyo Tech, Project Leader, AES)
National Resilience against Natural Disasters (¥2.5 billion)	Hori Muneo (Director-General, Value-Added-Information Generation, JAMSTEC)
Innovative AI Hospital System (¥3 billion)	Nakamura Yusuke (Director, Cancer Precision Medicine Center, Japanese Foundation for Cancer Research)
Smart Logistics (¥1.23 billion)	Tanaka Yorimasa (Managing Officer, Yamato Holdings Co., Ltd)
Exploration of Deep Sea Resources (¥3 billion)	Ishii Shouichi (Advisor to Board of Directors, JAPEX)

56 "Japan to Set up 100 Bil. Yen Fund for Advanced Technologies R&D," *Kyodo News*, 17 October 2021, https://nordot.app/822383780541267968?c=445918389795193953.

57 Normile, Dennis, "Japan tries – again – to revitalize its research," *Science*, 25 May 2022, https://www.science.org/content/article/japan-tries-again-revitalize-its-research; Otake, Tomoko, "Will a ¥10 trillion fund be the savior of Japan's universities?" *The Japan Times*, 22 June 2022, https://www.japantimes.co.jp/news/2022/06/22/national/endowment-fund-research-academic-culture/; Takeo, Yuko and Emi Urabe, "Japan's Big New Innovation Fund Risks Playing It Too Safe," *Bloomberg*, 9 January 2021, https://www.bloomberg.com/news/articles/2021-02-08/japan-s-100-billion-innovation-fund-risks-playing-it-too-safe; "4 Japan Universities to Apply for 10 Tril. Yen Gov't Fund: Survey," *The Mainichi*, 29 May 2022, https://mainichi.jp/english/articles/20220529/p2g/00m/0na/010000c.

58 "Integrated Innovation Strategy 2022," *Cabinet Office of Japan,* 2022, https://www.japan.go.jp/kizuna/_userdata/pdf/2022/summer2022/integrated_innovation_strategy.pdf.

4. Smart City Development and Promotion Overseas

Demand for smart city projects and services overseas has caught the attention of the Japanese private sector, including large trading houses like Sojitz and Mitsubishi, and smaller companies working in consortia.[59] Tie-ups between Japanese corporations, finance and aid providers, national and municipal government agencies and their overseas counterparts have also pushed the development of smart cities to the forefront of Japan's foreign policy. Tokyo touts the benefits of Japanese public and private sector involvement in projects in ASEAN nations in particular, and vigorously advertises the availability of various forms of support from Japanese government agencies (Table 3).[60]

Table 3. Government-Facilitated Support for Overseas Smart City Promotion

Agency	Possible Support
Japan International Cooperation Agency (JICA)	Technical support for developing countries to formulate/implement urban development and smart city master plans to attract private sector finance and investment for developing public transport/social infrastructure.
Japan Bank for International Cooperation (JBIC)	Supports smart city infrastructure building, especially energy and green mobility projects. Support comes in the form of loans, guarantees, and equity investments in infrastructure.
Nippon Export and Investment Insurance (NEXI)	Provides insurance covering country and credit risks associated with export, investment, and loan activities overseas by Japanese companies. NEXI provides "Green Innovation" loan insurance with higher coverage rates for projects that contribute to environmental protection and energy conservation and use renewable energy, smart grid, energy management system, green mobility, hydrogen and fuel-cell related technologies.
Japan Overseas Infrastructure Investment Corporation for Transport and Urban Development (JOIN)	Special purpose legal entity established in 2014 to provide funding for overseas transportation and urban development projects. Focuses on developing, operating and maintaining energy facilities, communication facilities, water supply, waste treatment facilities. Particularly supportive of Public-Private-Partnerships.
Japan ICT Fund (JICT)	Special purpose legal entity established in 2015 to expand overseas uptake of Japanese ICT products and services. Provides risk capital, expert advice, post-investment assistance, and organizes financing. Focuses on services such as remote medical care, remote education, and smart-agriculture.
Ministry of Environment of Japan (MOEJ)	Administers a Joint Crediting Mechanism (JCM) funding program that provides support to offset the initial cost of introducing Japanese decarbonization and low carbon technologies and equipment in JCM partner countries since 2011. Geared to support JCM model projects by MOEJ, projects partnering with JICA, ADB, REDD+ model projects, and JCM demonstration projects by NEDO.
Medical Excellence Japan	Special purpose legal entity established with the support of METI in 2011 to serve as central organizational hub to facilitate cooperation between governments, medical and academic research organizations, and healthcare providers to expand overseas uptake of Japan's healthcare and medical care sector services and devices. Comprised of 45 member companies as of April 1, 2022.

In late 2020 the Japanese government announced ¥250 billion of financing through JOIN and JBIC to further support smart-city projects in southeast Asia that involve Japanese companies and specifically focus on decarbonisation measures.[61] The Japanese government agreed with ASEAN that it would target 26 cities in the 10 ASEAN member nations for smart city transformation and it asked these cities to draw up plans and engage with Japanese companies about feasibility. In May 2021, the government stimulated further high tech decarbonisation initiatives in ASEAN with a US$10 billion loan facility.[62] The Japanese government is also an enthusiastic supporter of the ASEAN Smart Cities Network (ASCN) and in 2019 it established the Japan Association for Smart Cities in ASEAN (JASCA) to engage with the network together with 242 Japanese private sector corporations, 7 government ministries, 16 public agencies and 9 municipalities (Yokohama, Toyama, Utsunomiya, Fujieda, Saitama, Takamatsu, Masuda, Kitakyushu and Chiyoda).[63]

59 "$2.4bn Japan Fund to Help Decarbonization in 26 ASEAN Cities," *Nikkei Asia*, 17 December 2020, https://asia.nikkei.com/Spotlight/Environment/2.4bn-Japan-fund-to-help-decarbonization-in-26-ASEAN-cities.
60 Kantei, "Japan's Smart Cities," pp. 20-21.
61 "$2.4bn Japan Fund to Help Decarbonization in 26 ASEAN Cities."
62 Arai, Juntaro, "ASEAN to Receive $10bn Decarbonization Support from Japan," *Nikkei Asia*, 6 May 2021, https://asia.nikkei.com/Spotlight/Environment/Climate-Change/ASEAN-to-receive-10bn-decarbonization-support-from-Japan.
63 JASCA, "What Is JASCA," *3rd ASEAN-Japan Smart Cities Network High Level Meeting Website*, 2021, http://ascnjapan2021.jp/eng/dl/jasca.pdf.

Japanese government ministries such as the METI and the MLIT have also engaged with ASCN at high-level meetings since 2019, while Japan's local municipalities have taken on a hybrid business promotion and diplomatic engagement role by reaching out to cities in Asia to share knowledge on infrastructure and smart city development.[64]

Smart city technologies could help optimise the benefits from potential future markets and production sites through promoting urban agglomeration economies and disaggregated trade in tasks already taking place in the region.[65] The provision of both urban and connectivity infrastructure is designed both to enable emerging nations to exploit their natural and labour resources and capture value for their nation-building and to enable the functioning of Japan's production networks and supply chains in the Indo-Pacific, the economic importance of which for Japan's private sector is increasing.[66]Tokyo therefore supports ASEAN connectivity initiatives,[67] economic corridor plans and industrial and special economic zone initiatives with a variety of mechanisms as it pursues what it calls 'Partnerships for Quality Infrastructure' (see below for more details).[68]

To support this infrastructure and technology drive, the Japanese government has begun to tout its "internationally recognised infrastructure development track record" at home and abroad in its regional diplomacy and positioned itself as a provider of high-quality infrastructure that is not only economically valuable but also allows the sustainable development of cities.[69] JICA, for example, recently announced major progress in the redevelopment of areas of Bangkok in the Bang Sue Grand Station project that it planned in consultations on Transit Oriented Development (TOD), which is considered one of the key features of Japan's post-war development policy at home and abroad. Bang Sue is now the largest rail terminal in ASEAN and was designed to be central in Bangkok and southeast Asia's rail networks and regional airports. The Japanese and Thai governments, however, also envision the surrounding areas being reborn as a smart city based on smart mobility, smart energy and smart environment applications.[70]

Domestic demographic challenges will be better addressed with international cooperation and engagement. As was noted above, there are many 'successful' demonstration projects around the world, but far fewer fully fledged smart city success stories. As many living 'laboratories' as possible conducting as many smart city 'experiments' as possible around the world helps stakeholders and policy planners gain greater insights into which models, institutional arrangements and groups of technologies work well in which situations.[71] Overseas cooperation and export opportunities will provide even greater incentives for Japanese companies, including start-ups, to focus on smart city services and technologies with knock-on effects addressing demographic challenges.

While ageing Japan, northeast Asian nations and some European nations face one type of demographic challenge, emerging nations face a different kind. In the Indo-Pacific, many nations are simultaneously undergoing rapid population growth and rapid urbanisation. These trends are not necessarily negative. Countries in the Mekong, the Bay of Bengal and eastern Africa could develop into valuable sites of industrial productivity and skilled human resources for Japanese commercial interests if these countries are integrated in existing supply chains.[72] Without balanced economic

64 "Asia Smart City Alliance (ASCA)," *Y-PORT Website,* https://yport.city.yokohama.lg.jp/en/city-promotion/asia-smart-city-alliance-asca
65 Wallace, "Leaving (North-East) Asia?" p. 897; Grossman, Gene and Esteban Rossi-Hansberg, "Trading Tasks: A Simple Theory of Offshoring," *American Economic Review* 98, no. 5 (2008): 1978-97.
66 Connectivity infrastructure connects nodes in production networks that have specialised functions through intercity roads, rail and bridges, multimodal ports, airports, harmonised cross-border customs and regulatory systems, cross-border logistics management services and cross-border information and communications technologies and energy infrastructure.
67 "Japan-ASEAN Connectivity Initiative," *Ministry of Foreign Affairs Website,* 2020, https://www.mofa.go.jp/files/100114591.pdf.
68 Wallace, Corey, "Leaving (North-East) Asia? Japan's Southern Strategy," *International Affairs* 94, no. 4, 2018: 883-904; Wallace, "Japan's Strategic Contrast".
69 Kantei, "Japan's Smart Cities," p. 4.
70 "Smart Cities for a Brighter Future," pp. 8-9.
71 Martínez-Bello et al., "A Methodology for Designing Smart Urban Living Labs"; Cosgrave et al., "Living Labs, Innovation Districts and Information Marketplaces."
72 Kuroiwa, Ikuo. *Plugging into Production Networks: Industrialization Strategy in Less Developed South-East Asian Countries*, Singapore: Singapore Institute of Southeast Asian Studies – Yusof Ishak Institute, 2009.

growth in terms of sectoral composition and socioeconomic equity, and 'smart urbanisation' based on mitigating the problems of traffic congestion, traffic safety and housing supply, which loom large in the emerging world, the potentials for rapid growth in young populations and urbanisation to result in either a demographic dividend or demographic disaster cannot be discounted.[73]

Climate change also looms large as a confounder of ambitious plans in the emerging world to achieve OECD levels of development in the current century. The potentials of smart cities to benefit the global environment are obvious, premised as they are on enhanced energy efficiency, social resilience and new forms of energy generation to mitigate climate change.[74] Helping various emerging nations negotiate the 'dirty' carbon-intensive industrial stage in their development and helping more nations join the ranks of the OECD will enhance Japan's diplomatic profile and prosperity given the increasing importance of trade for its domestic and international wellbeing.[75]

Escaping the middle-income trap is by no means guaranteed for many emerging Indo-Pacific nations – not even for China – and the development of cities, infrastructure and connectivity – smart or otherwise – is essential for economic, social, environmental and political stability. These challenges have all been exposed and compounded by the COVID-19 pandemic.[76] Post-pandemic challenges and lessons may, however, accelerate the deployment of collaborative data-driven infrastructure as the pandemic illustrated the economic centrality of urban areas and the importance of public health. The Asia-Pacific region in particular is expected to see considerable growth in demand for smart city solutions.[77] These recent developments provide incentives for the Japanese government to continue (re)connecting its foreign development policy to its infrastructure export and industrial strategies.[78]

The Japanese government is also attempting to use the energy, capital and technology of Japan's private sector to drive strategic outcomes and gain economic benefits. China's burgeoning strategic and economic influence has sharpened the national interest focus of Japan's policymakers and led government agencies to consider strengthening the provision of infrastructure aid, the promotion of economic linkages, and coordination with other countries on urban and industrial development policy beyond north-east Asia. Reflecting this, the 'Free and Open Indo-Pacific Strategy' (FOIP) was officially introduced in 2017 as a "new foreign policy strategy."[79] The FOIP was born out of increased urgency among top-level Japanese political actors and changing perceptions in Japan about China's foreign policy goals and Beijing's willingness to use its military and economic power to coerce other nations. The Japanese government has become more conscious of how its development, trade and investment, and industrial foreign economic policies can be aligned with other nations' regional preferences to maximise the geopolitical utility of diplomacy and investment.[80]

The most prominent recent example of this is the 2015 Partnership for Quality Infrastructure (PQI). Tokyo announced more substantial and flexible forms of concessional financing and aid, and enhanced insurance cover and guarantees for political and commercial risks deriving from infrastructure projects involving Japanese companies. Table 3 above shows the mechanisms that can put 'value-added' smart city innovations at the centre of Japan's promised high quality enhancement of regional infrastructure, thereby enabling Japan's Free and Open Indo-Pacific strategy.

73 Canning, David, Sangeeta Raja and Abdo S. Yazbeck, "Africa's Demographic Transition: Dividend or Disaster?" 2015, https://openknowledge.worldbank.org/handle/10986/22036. Wallace, "Japan's Strategic Contrast," p. 888; Wallace, "Leaving (North-East) Asia?" pp. 896-903.

74 "Cities Are in the Frontline for Cutting Carbon Emissions, New IEA Report Finds," *International Energy Agency Website*, 1 June 2016, https://www.iea.org/news/cities-are-in-the-frontline-for-cutting-carbon-emissions-new-iea-report-finds.

75 Amina, Syed, "The Decoupling of Economic Growth from Carbon Emissions: UK Evidence," *Office for National Statistics*, 19 October 2019, https://archive.ph/wip/NJNfS.

76 "コロナ禍後の社会変化と期待されるイノベーション像" [Post-COVID-19 Social Changes and Expectations of Innovation] *NEDO Website*, 24 June 2020, https://www.nedo.go.jp/content/100919493.pdf.

77 Onga, Gigi, "Smart City Market to Value US$2.46 Trillion in Five Years," *FutureIoT*, 5 November 2020, https://futureiot.tech/smart-city-market-to-value-us2-46-trillion-in-five-years/; Grand View Research, "Smart Cities Market Size & Growth Report, 2022-2030," accessed 6 July 2022, https://www.grandviewresearch.com/industry-analysis/smart-cities-market.

78 Wallace, "Leaving (North-East) Asia?"

79 Wallace, Corey, "Japan's Strategic Pivot South: Diversifying the Dual Hedge," *International Relations of the Asia-Pacific* 13, no. 3 (2013): 479-517, (p. 506).

80 Wallace, "Leaving (North-East) Asia?" pp. 896-902.

Tokyo continues to position itself as a sensitive partner to countries in southeast Asia, the Bay of Bengal and eastern Africa and a robust commitment to smart city development could enhance Japan's strategic contrast with China in its diplomacy as the latter builds its hard power resources throughout the Indo-Pacific region.[81] To continue to burnish its international image, Tokyo's embrace of both the smart city agenda and the SDGs in its foreign policy will need to go beyond being a branding exercise. Japan has a major opportunity to continue adapting its unique post-war approach to development assistance by promoting the development and adoption of smart city growth to assist in the realisation of the SDGs, given that the goals are predicated on sustainable economic growth, political resilience and environmental wellbeing.[82]

In the long term, this should reduce China's ability to economically coerce other nations and Japan itself.[83] Well implemented smart city platforms offer the opportunity to not only offset some of the challenges of climate change and build resilience into cities but can also help emerging nations realise their potential using their own resources, thereby maintaining or enhancing their strategic autonomy. Therefore, smart city promotion overseas adds to Japan's foreign policy toolkit, provides options to address pressing demographic challenges both at home and abroad, and offers opportunities to revitalise its technology and industrial sectors. Smart city promotion is one more tool that may help Tokyo preserve the influence that Japan built up in decades of constructive diplomacy in the Indo-Pacific region.

5. National Security Considerations

Failing to help Indo-Pacific nations take advantage of their demographic dividends through infrastructure assistance would not only be an economic or diplomatic missed opportunity. There are also national security considerations. Rapidly growing but dysfunctional cities poorly connected to rural communities are likely to be susceptible to natural disasters and global economic downturns, be breeding sites for internal conflicts and corrupt politics, and may potentially develop into humanitarian challenges as climate change deepens. This in turn, could lead to an increase in cross-national violence and crime, and a rise in political instability and authoritarianism as a response to instability. This would be economically and strategically disadvantageous for Japan and could result in greater pressure for Japan's Self-Defense Forces to be dispatched overseas despite the significant pressures already on them closer to home.

Climate change and socioeconomic instability could also precipitate geopolitical conflict in the Indo-Pacific. This would threaten Japan's agricultural produce supply chains and energy access. Japan is only 37.17 percent self-sufficient in food in terms of calories and 67 percent in terms of quantity.[84] Demographic trends and a continuing decrease in the amount of farmland in use in Japan make it unlikely that it can ramp up domestic food production if a military crisis developed.[85] Japan is likely to continue importing over ¥10 trillion worth of agricultural products annually as it did in 2021.[86] Stronger infrastructure promotion is therefore important to ensure the development and stability of the nations that significantly contribute to Japan's food imports.

81 Wallace, "Japan's Strategic Contrast."
82 Kantei, "Japan's Smart Cities," p. 12.
83 Wallace, "Leaving (North-East) Asia?" p. 900; Wallace, "Japan's Strategic Contrast."
84 Suzuki, Nobuhiro, "No Independence Without Self-Sufficiency: Japan's Pressing Need to Boost Food Security," *Nippon.com*, 26 April 2022, https://www.nippon.com/en/japan-topics/g02082/; "食料自給率最低３７％ ２０年度 米需要減響く" [Worst-ever Level of Foodstuff Self-Sufficiency in 2020: 37%; Effects of Rice Cosumption Reduction] *Japan Agricultural News*, 26 August 2021, https://www.agrinews.co.jp/news/index/21907.
85 Yoshikawa, Yusaku, "Japan's Food Self-Sufficiency Debate Overlooks the Core Problem," *The Diplomat*, 13 May 2022, https://thediplomat.com/2022/05/japans-food-self-sufficiency-debate-overlooks-the-core-problem/.
86 MAFF International Economy Division, "農林水産物輸出入概況 2021年" [Agricultural, Forestry and Fisheries Products Import/Export Overview 2021] *MAFF Website,* 2022, https://www.maff.go.jp/j/tokei/kouhyou/kokusai/attach/pdf/index-102.pdf.

Even before the Fukushima nuclear power plant incident in 2011, Japan produced a maximum of only 20.3 percent of its final energy consumption. By 2020, this figure had only recovered to 11 percent after dropping to a low of 6.4 percent in 2014.[87] Japan is the world's fourth-largest crude oil importer, the world's largest importer of liquefied natural gas (LNG) and the third-largest importer of coal. Japan not only lacks energy self-sufficiency, but also international oil and natural gas pipelines, meaning that almost all energy arrives in Japan on tankers after having navigated maritime chokepoints. The Middle East accounted for 89 percent of Japan's crude oil imports in 2019, while southeast Asia and Australia accounted for 67 percent of its LNG imports.[88]

The continuing functioning of supply chains and production networks through infrastructure promotion is also essential for income generation given Japan's lack of exportable natural mineral and energy resources. With trade in general also making up an increasingly higher percentage of Japan's GDP since 1994, clearly the wellbeing and security of emerging nations in the Indo-Pacific is a core strategic and security concern for Tokyo.[89] In addition to stabilising regional societies by mitigating the impacts of climate change and promoting sustainable development, smart city implementation could also help reduce Japan's energy and agricultural dependence, although it is unlikely to eliminate it. Building a smart grid and using next generation urban mobility (enabled by EVs and green hydrogen) could, for example, be a major boon for energy security. It would allow Japan to reduce its reliance on foreign energy resources and reduce the incentive for malicious foreign or internal actors to target large power generating infrastructure or companies with cyber or kinetic attacks during a national security crisis. In addition to enhancing energy security, smart-grid-facilitated power generation would also be more 'resilient' to natural disasters if energy was generated and stored locally.[90] Furthermore, natural disasters in the Indo-Pacific region may have even greater impacts than they do now – already estimated to cost ¥675 billion a year – as emerging nations urbanise, populations increase and climate change accelerates. Japan is well positioned to help developing cities plan for natural disasters, foster resilience, mitigate impacts and quickly recover.[91] By using some of the tools for disaster mitigation Japan has identified for its own purposes, Tokyo could help enhance national security resilience in the wider region.

Smart city promotion and innovation could also indirectly enhance Japan's military security and the technological underpinnings of Japan's defence industry base. Every single smart city technology described in this report is inherently dual use and has significant military applications. This is already obvious in the cyber and space domains. It is also true for sensors, drones and aerial vehicles, satellites, artificial intelligence and high-level processing capability. There are also a number of potential applications that are not so obvious. For example, digital twining could enable rapid prototyping, allowing evolutionary approaches rather than batch approaches to procurement, which has been a problem for Japan given its limitations in industrial defence production.[92] Together with 3D printing, production of high tech but affordable quantities of equipment tailored for specific uses with lower economies of scale becomes increasingly possible. Maintenance costs could be reduced and real-time and tailored battlefield logistics could also be enhanced through the envisaged fabrication of parts or even small platforms (like drones).[93]

87 Agency for Natural Resources and Energy, "Understanding the Current Energy Situation in Japan," *METI*, 13 August 2019, https://www.enecho.meti.go.jp/en/category/special/article/energyissue2019_01.html.
88 "Country Analysis Executive Summary: Japan," *United States EIA Website,* October 2020, https://www.eia.gov/international/content/analysis/countries_long/Japan/japan.pdf.
89 "Trade (% of GDP) – Japan," *The World Bank,* 2022, https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS?locations=JP.
90 Katayama, "Smart Cities in 2050," p. 23.
91 Igata, "Japan's Burgeoning Economic Security Strategy," p. 8.
92 Layton, Peter, "Prototype Warfare, Innovation and the Fourth Industrial Age," 6 February 2019, https://www.researchgate.net/publication/331115078_Prototype_warfare_innovation_and_the_fourth_industrial_age (p. 56).
93 Layton, Peter, "Mobilisation in the Information Technology Era ," *Logistics In War*, 9 June 2019, https://logisticsinwar.com/2019/06/09/mobilisation-in-the-information-technology-era/.

Even in industries that still require scaled-up manufacturing infrastructure to put together high-performance frames such as shipbuilding and jet fighter production, the use of digital design and manufacturing (digital schematics based on enhanced 3D computation and virtual technologies, analytical assistance by AI, robotics and additive manufacturing) will dramatically speed up output while enhancing evolutionary approaches to production.[94]

4IR technologies, all of which will constitute important parts of smart city platforms, could therefore be "game-changing" military technologies – as the Japanese government seems to be aware.[95] One Ministry of Defence (MOD) official, for example, admitted the ministry was watching the ImPACT project closely for military spin-ons.[96] In 2015, the government established the National Security Technology Research Promotion Fund, which is administered by the defence ministry's Acquisition, Technology and Logistics Agency (ATLA). The fund provides resources in basic research areas that are expected to be dual use.[97] The financial extent of the new dual use promotion fund is still somewhat limited at ¥10 billion annually, although it was considerably scaled up in the first two years after its initial establishment.

In 2015 the government did, however, begin discussions about tasking NEDO – the largest single state-funded R&D agency – with working with firms to harness technologies with both military and commercial uses.[98] The long-term aim appears to be to turn NEDO into a Japanese version of the Pentagon's Defense Advanced Research Projects Agency (DARPA), which funds a wide range of innovative and high-risk research, often with military applications.[99] Despite these discussions, NEDO currently does not explicitly see itself as a military technology accelerator,[100] although NEDO Washington, DC did commission a paper entitled 'DARPA's Process for Creating New Programs' from American experts on DARPA's innovation process soon after NEDO's 2015 reorganisation. The advanced R&D role for defence is for now still occupied by the MOD-supervised ATLA.[101] Nevertheless, NEDO is developing technologies such as robots, sensors, autonomous vehicles, ceramics, carbon fibre, nanotechnology 'bonding' and other innovations in material science that could be too expensive for commercial customers but beneficial for Japan's military industrial base – including for building an indigenous fighter and future-proofing aerial systems.[102]

There has been significant resistance among Japanese academics to the National Security Technology Research Promotion Fund, the ImPACT project and moves to make NEDO a dual use technology accelerator. In 2017, the Science Council of Japan reaffirmed its recommendation that its members should boycott military research, which was first promulgated in 1950.[103] However, in the view of some scientific commentators the end use of modern scientific research and technologies is increasingly difficult to separate from the intentions of researchers and developers to the point of

94 Layton, "Prototype Warfare", p. 14.

95 Jimbo, Ken, "How Japan Should Approach Military Tech Competition," *The Japan Times*, 28 December 2021, https://archive.ph/DJMpQ; Jiji, "Japan Planning ¥100 Billion Tech Fund for Economic Security," *The Japan Times*, 17 October 2021, https://www.japantimes.co.jp/news/2021/10/17/business/economy-business/japanese-technology-economic-security-fund/.

96 Cyranoski, David, "Japanese Academics Spooked by Military Science Incursions," *Nature* 521, May 2015: 13-14, https://www.nature.com/articles/521013a.

97 Mallapaty, Smriti, "What Japan's Election Means for Controversial Defence Research," *Nature*, 22 July 2022, https://www.nature.com/articles/d41586-022-02017-y.

98 Kelly and Kubo, "Exclusive: Japan Civilian R&D Agency to Get Military Role to Spur Arms Innovation."

99 Oue, "Why Economic Security in Japan Needs to Include the Defense Industry."

100 Cheney, David W. and Richard Van Atta, "DARPA's Process for Creating New Programs," in Boone, William, Bonvillian, Patrick Windham and Richard Van Atta (eds.), Open Book Publishers, 2019. The paper was completed in March 2016 and publicly released in 2019.

101 "R&D Vision," *ATLA Website,* https://www.mod.go.jp/atla/en/policy/policy_vision.html. ATLA absorbed the Technical Research and Development Institute in 2015.

102 Kelly and Kubo, "Exclusive: Japan Civilian R&D Agency to Get Military Role to Spur Arms Innovation."

103 Cyranoski, David, "Japanese Scientists Call for Boycott of Military Research," *Nature,* 6 April 2017, https://www.nature.com/articles/nature.2017.21779; Cyranoski, "Japanese Academics Spooked by Military Science Incursions."

being almost meaningless.[104] For example, a Russian Orlan-10 surveillance drone downed in Ukraine in July 2022 was constructed with a range of parts from all over the world, including a Japanese engine that would not have been authorised for military use.[105] There is therefore significant long-term potential for the Japanese government to leverage 'spin-ons' from civilian and private sector R&D and technology proliferation in Japan and globally to make up qualitative capability gaps in military defence, potentially including exports of such 'dual use' technologies with the loosening of restrictions on arms exports since the 1990s.[106]

Needless to say, the potential for spin-offs from military research to smart city development is also great if the Kishida administration dedicates an expected increase in defence spending to enhancing defence R&D. Currently, only around a fifteenth of Japan's defence budget goes to R&D, which is much less than the one-sixth of a considerably larger defence budget spent by the United States. Only three percent of overall Japanese government R&D is dedicated to the defence sector, amounting to around 0.02 percent of GDP – far less than that of most major nations and many OECD members.[107] In absolute terms, Japan spends considerably less on defence R&D than South Korea and the United Kingdom. However, the ruling Liberal Democratic Party (LDP) through its defence council recently committed to pushing for a fivefold increase in defence R&D to ¥1 trillion yen. Other politicians and notable commentators, including a former SDF Chief of the Joint Chief of Staff and some in left-leaning opposition parties, have added their voices to supporting prioritisation of defence R&D should the MOD get a substantive injection.[108]

6. Industrial Policy and Economic Security

In addition to national security leveraging, smart city development in Japan and promotion overseas could ultimately be a platform for revitalising Japan's domestic economic potential given the niche industrial and technology abilities the nation still possesses, such as in image sensor technology.[109] R&D expenditure alone for smart city research and innovation is expected to be in the hundreds of billions of US dollars, while the total market for R&D and purchases of goods and services could grow into the trillions of US dollars by 2030.[110] While COVID-19 set many countries back economically, it could compel local municipalities to focus on developing data-driven infrastructure and open data platforms and on using artificial intelligence for crowd analytics to enhance healthcare provision and public security.[111] Business reports estimate the compound annual growth rate (CAGR) in most smart city technology sectors to be between 18 and 30 percent for the foreseeable future.[112]

104 Oue, "Why Economic Security in Japan Needs to Include the Defense Industry"; Cyranoski, "Japanese Scientists Call for Boycott of Military Research"; "Japanese Academics Spooked by Military Science Incursions"; Mallapaty, "What Japan's Election Means for Controversial Defence Research"; Okubo, Yuuki, "経済安全保障推進法の成立と今後の注目ポイント" [Passage of the Economic Security Promotion Act: Future Points of Interest] *Mitsubishi Research Institute*, 17 June 2022, https://www.mri.co.jp/knowledge/column/20220617.html.

105 Shoaib, Alia, "Ukraine Strips Down Captured Russian Drone, Says it is Full of Western Parts, CNN Reports," *Business Insider*, 24 July 2022, https://www.businessinsider.com/ukraine-captured-russian-drone-western-parts-2022-7.

106 While Japan's defence R&D significantly lags behind other nations', Japanese businesses generally spend more as a percentage of a GDP on R&D than other major economies. Only ROK and Israel in the OECD spend more than Japan according to this measure. OECD data are available at https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB

107 OECD, "OECD Main Science and Technology Indicators. R&D Highlights in the March 2022 Publication," *OECD Directorate for Science, Technology and Innovation*, http://www.oecd.org/sti/msti2022.pdf; Kobara, Junnosuke, Konatsu Ochi and Natsumi Kawasaki, "Japan's Defense Industry on the Ropes amid Growing Threats," *Nikkei Asia*, 12 January 2022, https://asia.nikkei.com/Spotlight/Datawatch/Japan-s-defense-industry-on-the-ropes-amid-growing-threats.

108 "防衛研究費、１兆円確保を　自民議連" [LDP Parliamentary Group Demands ¥1 trillion for Defence R&D] *Jiji News,* 16 June 2022, https://www.jiji.com/jc/article?k=2022061600790; "自民、防衛研究費の増額提唱　立民など一部野党も賛同" [The Liberal Democratic Party Advocates Increased Defence R&D Spending, Receives Support from Opposition Parties, Including CDP] *Nikkei Shimbun,* 29 May 2022, https://www.nikkei.com/article/DGXZQOUA290Q50Z20C22A5000000/; Kawano, Katsutoshi, "防衛費の増額は、いったい何に使うべきなのか？" [How Should Japan Use an Increased Defence Budget?] *Nippon.com,* 6 July 2022, https://www.nippon.com/ja/japan-topics/g02162/.

109 The image sensor market alone is predicted to expand by 34 percent to US$25.1 billion between 2021 and 2025. "Sony Aims for Biggest Share of Global Image Sensor Market"; Furukawa, "Sony Steps up Image Sensor Tech, Targeting 60% Market Share."

110 Onga, Gigi, "Smart City Market to Value US$2.46 Trillion in Five Years," *FutureIoT*, 5 November 2020, https://futureiot.tech/smart-city-market-to-value-us2-46-trillion-in-five-years/; Grand View Research, "Smart Cities Market Size & Growth Report, 2022-2030," 6 July 2022, https://www.grandviewresearch.com/industry-analysis/smart-cities-market.

111 Onga, "Smart City Market to Value US$2.46 Trillion in Five Years."

112 Grand View Research, "Smart Cities Market Size & Growth Report"; Onga, "Smart City Market to Value US$2.46 Trillion in Five Years".

The opportunities promised by smart city and Society 5.0 technologies together with perceptions of a relative decline in Japan's industrial, technological and overall economic competitiveness have prompted a revitalisation of Japan's bureaucracy-led industrial policy in the last decade – in some ways reflecting the MITI-driven industrial policy of Cold War Japan before the deregulation of industrial policy in the 1990s.[113] The METI's resurgence initially focused on promoting traditional infrastructure exports, in which Japan remains competitive. Japan enjoyed a spike in overseas infrastructure orders from ¥15 trillion in 2014 to ¥23 trillion in 2018. However, the COVID-19 pandemic resulted in the target of ¥30 trillion by 2020 being missed, but the Japanese government is targeting new areas such as telemedicine and drones for infrastructure export promotion. Tokyo is now aiming to facilitate ¥34 trillion of infrastructure exports by 2025.[114] As was noted above, smart city technology development as a distinct added value to infrastructure exports is increasingly coming into the purview of industrial policymakers.

The METI's increased prominence and influence on foreign policy during the Abe administration represented an enhancement of Japan's economic statecraft. This was also increasingly supplemented with a focus on 'economic security.' Igata and Glosserman argue that the economic security agenda and its institutionalisation may ultimately turn out to be more important for national security than many other security-related changes initiated during Abe's tenure.[115] The economic security agenda was formulated against the background of a perceived weaponisation of interdependence and China's purported exploitation of the globalisation of trade and technology to its economic and military benefit – and to the detriment of the wellbeing and security of others.[116] Analysts note that Japan in particular is strategically dependent on China for hundreds of imported goods,[117] including many of the products and inputs important for smart cities such as storage batteries and solar panels.[118] Shortages of key equipment during the COVID-19 pandemic and most recently concerns about the impact of Russia's invasion of Ukraine and global economic activity have further driven home the double-edged nature of globalisation.

From the end of the Abe administration to the Suga administration and the Kishida administration, prominent members of the LDP, such as Amari Akira, worked on the agenda.[119] An early important move was made in 2019 with the enhancement of the National Security Secretariat with an economic division dedicated to economic statecraft and emerging technologies.[120] The division subsequently grew into the largest of the NSS's seven divisions and "is providing direction and coordination throughout the Japanese government, including in divisions that focus on technology and economic security that were recently set up in ministries to accommodate the restructuring of the NSS."[121] Tokyo has also revised the Foreign Exchange and Foreign Trade Act, lowering the threshold for approval of foreign investments from ten percent of a company's shares to one percent, to allow it to assess investments in areas of crucial significance for national security. The METI has also formulated guidance for Japanese universities to help control the use and export of nuclear, radar and other sensitive technologies with potential military uses, while cybersecurity regulations have also been strengthened and applied to a wider range of Japanese government agencies.[122]

113 Johnson, Chalmers, *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925-1975.* (Stanford University Press, 1982); Nakamura, Akira, "MITI and the Japanese Miracle Revisited: Reevaluation of the Administrative-Centered Government," *Public Administration Review* 71, no. 6, 2011: 931-33; Igata, "Japan's Burgeoning Economic Security Strategy"; Wallace, "Japan's Strategic Pivot South," p. 506.

114 Kaneko, Satsuki, "Japan to Boost Startup Subsidies for Infrastructure Orders Abroad," *Nikkei Asia,* 15 March 2022, https://asia.nikkei.com/Business/Startups/Japan-to-boost-startup-subsidies-for-infrastructure-orders-abroad.

115 Igata, Akira and Brad Glosserman, "Japan's New Economic Statecraft," *Washington Quarterly* 44, no. 3 (2021): 25-42, p. 28.

116 Okubo, "Passage of the Economic Security Promotion Act."

117 Igata and Glosserman, "Japan's Economic Statecraft."

118 Suzuki, Kazuto, "Toward a New Tech Policy for the Age of Economic Security," *Tokyo Foundation for Policy Research*, 28 February 2022, https://www.tkfd.or.jp/en/research/detail.php?id=880.

119 Glosserman, Brad, "Kishida Doubles Down on Economic Security," *The Japan Times,* 12 October 2021, https://www.japantimes.co.jp/opinion/2021/10/12/commentary/japan-commentary/kishida-economic-security/.

120 The NSS was established following the disbandment of the Japanese National Security Council in late-2013. The six original divisions of the NSS were general affairs, intelligence, strategy planning and three policy planning divisions focusing on different regions.

121 Igata and Glosserman, "Japan's New Economic Statecraft," pp. 29-30.

122 Igata and Glosserman. "Japan's New Economic Statecraft," p. 32.

Officially, the government did not complete the formulation of a 'Basic Policy' on economic security until the end of the Suga administration in mid-2021. This policy document identified the four main areas the government would later target in economic security legislation.[123] With the government policy already set, the candidates to replace Suga as LDP president and prime minister in the September 2021 LDP leadership race rushed to embrace the 'new' economic security agenda. The eventual winner, Kishida Fumio, had paid significant attention to the economic security platform while he was LDP policy chief and used it as a way to signal to the LDP's conservative wing that he was not a defence dove despite his previous reputation for being one.[124] One of Kishida's first acts as prime minister was, therefore, to establish a new minister for economic security. The role was given to Kobayashi Takayuki, a former Ministry of Finance official and parliamentary vice minister for defence in the Abe cabinet.[125]

Kishida then put economic security at the centre of his lower house electoral campaign, which was held soon afterwards. Kishida pledged to secure Japan's "strategic autonomy" and "strategic indispensability" through domestic and foreign policy initiatives focused on economic security.[126] After the election, Kishida moved forward with legislation and promised to rewrite the National Security Strategy to codify the role that economic security will play in Japan's security strategy. In May 2022, the Economic Security Promotion Act passed through the Diet. The stated intention of the legislation was to "protect the economic wellbeing of the state and citizens from harmful acts precipitated by the complex international situation and socio-economic change." Chapters two to five of the legislation focus on the supply chain security of "critical commodities," and establish a system to screen "core infrastructure providers," supporting programmes for "advanced critical technologies" with major national security implications and establishing a mechanism for non-disclosure of patent applications with major national security implications (see Table 4).[127]

Economic security considerations have also increasingly framed the outreach of Japanese foreign policy and many of Japan's measures are aligned with measures introduced by other nations.[128] Japan followed Australia, New Zealand, the United Kingdom and eventually the United States in either officially or effectively banning Chinese telecommunications vendors from their 5G systems while providing incentives for Japanese makers to collaborate in providing alternative products and network options – including working with business partners in 'like-minded' nations if required.[129] A number of 'minilateral' economic security and industrial cooperation initiatives have also been established. These include the Supply Chain Resilience Initiative (SCRI) with Australia and India in 2021,[130] a Quad-focused effort to diversify supply chains through initiatives in semiconductors, vaccines, batteries and rare earth minerals, and to establish 'green' energy supply chain development partnerships,[131] and the Indo-Pacific Economic Framework (IPEF).

123 Okawa, Shintaro, "Overview of the Economic Security Bill and its Impact on Business," *CISTEC Website,* 28 February 2022, https://www.cistec.or.jp/service/zdata_gaitame_kaisei2019/20220228-eng.pdf.

124 Wallace, Corey, "Three Hawks and a Dove: Defence Issues and the 2021 LDP Election," *9Dashline*, 27 October 2021, https://www.9dashline.com/article/three-hawks-and-a-dove-defence-issues-and-the-2021-ldp-election; "Kishida's Opportunity to Shake Up Japanese Defence Policy," *East Asia Forum,* 11 November 2021, https://www.eastasiaforum.org/2021/11/11/kishidas-opportunity-to-shake-up-japanese-defence-policy/.

125 He was also given the technology and space policy portfolios.

126 Glosserman, "Japan Doubles Down on Economic Security."

127 "経済安全保障推進法案の概要" [Summary of the Economic Security Promotion Bill] *Cabinet Secretariat of Japan Website*, 28 February 2022, https://www.cas.go.jp/jp/houan/220225/siryou1.pdf.

128 Wallace, Corey and Giulio Pugliese, "Japan 2020: Abe's Well-Laid Plans Go Awry," *Asia Maior*, 2021, https://www.academia.edu/49185835/Japan_2020_Abes_Well_laid_Plans_Go_Awry.

129 "Japan to Ban Huawei, ZTE from Govt Contracts – Yomiuri," *Reuters*, 7 December 2018, https://www.reuters.com/article/japan-china-huawei-idUSL4N1YB6JJ; Suzuki, Wataru, "NTT and NEC Eye 'Made-In-Japan' 5G as US-China Tensions Grow," *Nikkei Asia*, 25 June 2020; Wallace and Pugliese, "Japan 2020."

130 Nandi, Shreya, "Supply Chain Plan: Japanese Government Selects Six Indian Projects," Business Standard News, 6 May 2022, https://www.business-standard.com/article/economy-policy/supply-chain-plan-japanese-government-selects-six-indian-projects-122050600024_1.html; Kaneko, Satsuki, "Japan, Australia and India Target Indo-Pacific Supply-Chain Code," *Nikkei Asia*, 16 March 2022, https://asia.nikkei.com/Spotlight/Supply-Chain/Japan-Australia-and-India-target-Indo-Pacific-supply-chain-code; "令和３年度補正 海外市場調査等事業費補助金" [Subsidies for Overseas Market Research and Other Business Expenses: 2021 Supplement] *Japan Machinery Federation*, 2022, http://www.jmf.or.jp/content/files/katudou/2022indonew.pdf.

131 "Fact Sheet: Quad Leaders' Summit," *Ministry of Foreign Affairs of Japan Website*, 2021, https://www.mofa.go.jp/mofaj/files/100238181.pdf.

The latter boasted the participation of 12 nations representing 40 percent of global GDP. It positioned itself as helping IPEF members to continue to enjoy the benefits of 'connected,' 'resilient,' 'clean' and 'fair' economies in contrast with the PRC.[132]

Table 4. Summary of the Economic Security Promotion Act (Chapters 2 to 5)

Chapter	Purpose
Chapter Two	Purports to strengthen cabinet oversight of economic security by strengthening critical supply chains. Enables relevant ministers to designate certain commodities as "critical commodities", forcing providers to create plans and/or implement economic security-enhancing measures. The government may provide subsidies and loans to designated enterprises to this end if necessary. The most likely materials or products to be designated critical commodities are semiconductors, minerals such as rare earths, batteries, and pharmaceuticals.
Chapter Three	Enables the use of cabinet orders to designate businesses as core infrastructure providers. Such providers would be subject to notification and screening requirements (in principle, 30 days) of any outsourcing installation, maintenance, management, of critical facilities to prevent possible tampering. The government identified 14 broad areas of infrastructure provision subject to the abovementioned requirements: electricity, gas, oil, water, railways, freight, ocean freight, airlines, airports, communications, broadcasting, post, finance, and credit cards.
Chapter Four	Empowers ministers to take measures, including financial support, to promote research and development of "advanced critical technologies". Such technologies are those with potential future uses in private sector and government infrastructure, that enhance counterterrorism and cyber-attack countermeasures, and promote national security broadly. Compels the government to formulate basic guidelines for advanced critical technologies R&D and the proper sharing and use of these technologies to enhance national security rather than undermine it. The legislation enables the government to set up Private-Public Partnership R&D Councils for individual projects led by a consenting principal investigator.
Chapter Five	Legislates the introduction of a closed-door system for patent applications where disclosure or information leakage through the normal patent process is highly likely to compromise national security. The patent owner still enjoys legal rights under Japan's patent legislation and could qualify for compensation for non-disclosure. Chapter five identifies the screening and decision-making processes for this system.

In 2020 the government also independently announced a programme of pecuniary enticements worth up to ¥220 billion for Japanese companies currently in China to shift their manufacturing either back to Japan or to other countries in Asia. The intention was to reduce Japan's reliance on China in general and to bolster the resilience of Japan's regional supply chains. Southeast Asia, India and Bangladesh have been the major beneficiaries of these so-called 'China Exit' subsidies. In multiple rounds, the Japanese government has subsidised more than 200 Japanese companies. The majority of these recipient companies have set up *new* production facilities somewhere other than China even if they have maintained their Chinese sites at the same time.[133] This is still an important outcome, even if it was not necessarily the original intention. Electric vehicle battery parts makers and semiconductor supply chain reshoring have been particular areas of focus for the government and Tokyo has managed to attract Japanese companies supplying chipmaking giants such as the Taiwan Semiconductor Manufacturing Co. (TSMC) back to Japan. The government then later used another subsidy scheme to entice TSMC itself to set up a factory in Japan by promising to cover half the factory's construction costs.[134]

132 Toshiya, Takahashi, "Japan's economic security bill a balance between business and the bureaucracy," *East Asia Forum,* 26 June 2022, https://www.eastasiaforum.org/2022/06/26/japans-economic-security-bill-balances-business-and-the-bureaucracy/

133 "Japan Reveals 87 Projects Eligible for 'China Exit' Subsidies," *Nikkei Asia*, 17 July 2020, https://asia.nikkei.com/Economy/Japan-reveals-87-projects-eligible-for-China-exit-subsidies; Gakuto, Takako, "Japan Adds India and Bangladesh to 'China Exit' Subsidy Destinations ," *Nikkei Asia*, 4 September 2020, https://asia.nikkei.com/Economy/Japan-adds-India-and-Bangladesh-to-China-exit-subsidy-destinations; Akiyama, Hiroyuki, "Japan Companies Line up for 'China Exit' Subsidies to Come Home," *Nikkei Asia*, 9 September 2020, https://asia.nikkei.com/Economy/Japan-companies-line-up-for-China-exit-subsidies-to-come-home.

134 Chen, Frank, "Japanese Manufacturers Beat a Path out of China," *Asia Times*, 29 December 2020, https://asiatimes.com/2020/12/japanese-manufacturers-beat-a-path-out-of-china/; Regalado, Francesca, "Japan Chip Suppliers Reap Benefits of 'China Exit' Subsidy," *Nikkei Asia*, 25 February 2021, https://asia.nikkei.com/Economy/Trade/Japan-chip-suppliers-reap-benefits-of-China-exit-subsidy.

7. Smart Cities and Economic Security: Mutually Helpful or Harmful?

The most obvious implication of Japan's smart city drive for economic security is the potential for technology leakage. There are numerous examples of ties with Japanese companies and research institutions having helped overseas companies take commercial advantage of innovative technologies developed in Japan.[135] This extends to industrial and military innovation. In November 2020 Kyodo News revealed 45 research collaboration agreements with Chinese universities intimately involved in research designed to strengthen the People's Liberation Army (subject to restrictions in the United States) and connected to China's Thousand Talents programme and Civil-Military Fusion agenda.[136] Dual use leveraging could, therefore, go both ways as Japanese technologies developed for smart cities could help other nations modernise their militaries.

Given the focus on promoting technology abroad, the challenge of preventing technology leakage is compounded in the smart city domain. While it may be possible to restrict who participates in smart city development projects and implements smart city infrastructure in Japan, a number of Japanese companies are engaged – either directly or indirectly – in smart city development with Chinese companies in China, and even in southeast Asia.[137] Furthermore, even if the shine has come off China as a cheap location for production, Japanese companies are still very interested in the Chinese market. With its promise of massive data access, China is particularly attractive for AI development given the importance of data in training AI models. Direct and indirect cooperation between Japanese and Chinese public agencies and private sectors in the smart city space also takes place overseas.[138] In 2018, turning Chonburi in Thailand into a smart city was identified as the first of fifty joint Japan-China projects.[139] Sino-Japanese collaboration could enhance Thailand as a logistics and production hub by leveraging complementary infrastructure building strengths, and promote the further development of integrated smart cities, industrial parks and SEZs throughout the Mekong subregion. The financial support of foreign smart city projects by the Japanese private sector may end up helping PRC commercial entities do more business.

From a strictly business point of view, this is not necessarily a win-lose proposition. It is possible that PRC commercial entities will at the same time proliferate Japanese or shared infrastructure and technological standards and protocols (such as in networked devices and electric vehicle charging). China is also increasingly a major player in smart city innovation in the Asia region as it builds on implementation at home. For example, by 2019 Alibaba had implemented its 'City Brain' in 22 Chinese cities and had begun providing the technology to Kuala Lumpur.[140] More broadly, the Japanese business community is still interested in tie-ups with Chinese commercial entities and sees the Belt and Road Initiative as attractive despite the commercial and strategic risks that come with it. It is therefore not surprising that the Japanese private sector has mixed feelings about the Japanese government's economic security agenda and the possibility that it may impede overseas cooperation.[141] In reality, it will be very difficult to control who is involved and 'connected' in any given smart city project overseas, especially given that by their nature smart cities are supposed to be decentralised networks that facilitate the interconnectivity of different service providers and devices.

135 Misumi, Yuki, "China startup makes large, flexible solar panels in industry first," *Nikkei Asia,* 19 July 2022, https://t.co/9HYynBUFVX

136 Feng, Gao and Gigi Lee, "Japanese Universities' Ties to China's Military-Linked Schools Sparks Concern," *Radio Free Asia,* 30 November 2020, https://www.rfa.org/english/news/china/japan-pla-research-11302020174438.html; Mallapaty, Smriti, "Japan Considers Tougher Rules on Research Interference amid US-China Tensions," *Nature*, 4 August 2020, https://www.nature.com/articles/d41586-020-02273-w.

137 "Toyota Expands Collaboration in Mobility as a Service (MaaS) with Didi Chuxing, a Leading Ride-hailing Platform," *Toyota Website,* https://global.toyota/en/newsroom/corporate/28993116.html.

138 Armstrong, Shiro, "Japan Joins to Shape China's Belt and Road," *East Asia Forum,* 28 October 2018, http://www.eastasiaforum.org/2018/10/28/japan-joins-to-shape-chinas-belt-and-road/.

139 Shigeta, Shunsuke, "Thai 'smart city' to be first of 50 Japan-China joint projects," *Nikkei Asia,* 25 October 2018, https://asia.nikkei.com/Politics/International-relations/Thai-smart-city-to-be-first-of-50-Japan-China-joint-projects.

140 "City Brain Now in 23 Cities in Asia," *Alibaba Cloud,* 28 October 2019, https://www.alibabacloud.com/blog/city-brain-now-in-23-cities-in-asia_595479

141 Toshiya, Takahashi, "Japan's economic security bill a balance between business and the bureaucracy," *East Asia Forum,* 26 June 2022, https://www.eastasiaforum.org/2022/06/26/japans-economic-security-bill-balances-business-and-the-bureaucracy/

The involvement of Japanese companies in overseas smart city development could also complicate the cybersecurity of infrastructure both in Japan and regionally. As various networking and digital technologies become "deeply embedded in physical infrastructure and the internet of things (IoT) emerges" and generates immense volumes of data, Igata notes the inadequacy of existing cybersecurity practices and protocols. He recommends that Tokyo should "aggressively push for adoption of high cybersecurity standards throughout the Indo-Pacific as part of its ODA program and incorporate them into the build-in process to ensure the safety and security of critical infrastructure equipment and systems."[142] Data safety and reliability are important not only for economic security itself but also to reassure the public at home and abroad that smart technologies do not represent threats to privacy and security. Failure to provide this reassurance is likely to lead to stagnation of the smart city agenda.

On the other hand, the public-private partnership R&D councils that the government will establish based on the economic security legislation to develop 'advanced critical technologies' are likely to enhance the smart city agenda given the overlapping technological elements. The R&D of these technologies will be funded with appropriations from the third supplementary budget of 2021, which functioned as a stimulus for post-pandemic recovery. ¥500 billion ($4.3 billion) was earmarked for the Economic Security Critical Technology Development Programme. Economic security-focused technology development will therefore further erode the already tenuous distinction between civilian and military technology, especially in areas pertaining to radar systems and sensors (for "oceanographic research") and computing power.[143]

Japan could work against itself, however, in both the smart city space and in innovation policy in general if the economic security justification for intervening in the economy becomes too pronounced. As Suzuki notes, risk mitigation is a double-edged sword and new regulations, such as closed patenting, could also inhibit commerce and innovation. Suzuki also notes that the supply chain security concern headlined by the government in the economic security legislation might limit the ability of Japanese companies to cooperate with overseas partners and be included in international R&D consortia. These restrictions could in turn impede the sourcing of materials, equipment and devices. Oversensitivity to the potential for security leakage could discourage Japanese companies from developing technologies if incentives to export are weakened due to worries about military diversion. Furthermore, Suzuki notes that while "supply-chain reform presents an opportunity for the development of home-grown technologies," Japan may not benefit all that much if it "merely transfers its dependence from one foreign country to another" or relies on foreign manufacturers like TSMC to build facilities in Japan.[144] Furthermore, building supply chain resilience is easier said than done given the sheer complexity and obscurity of parts and technologies needed to manufacture things like semiconductors.[145] Government intervention in such a case could do harm without achieving the original objective.

Tightened investment screening and restrictions on foreign students and researchers could also negatively impact commerce and scientific research given the importance for both of the free flow of diverse financial and intellectual inputs.[146] After all, in 2017 16 percent of all foreign researchers in Japan were from China, a number similar to those from the United States. The impact on universities of targeting Chinese students could also be felt in other ways. Japanese universities are increasingly reliant on international tuition fees, and in 2019 almost 40 percent of the 228,403 international students in Japan were from China.[147]

142 Igata, "Japan's Burgeoning Economic Security Strategy," p. 7.
143 "済安全保障重要技術育成プログラムについて" [About the Economic Security Critical Technology Development Programme] *Cabinet Office of Japan Website*, 21 June 2022, https://www8.cao.go.jp/cstp/anzen_anshin/program/1kai/siryo2-1.pdf.
144 Suzuki, "Toward a New Tech Policy for the Age of Economic Security."
145 Cheng Ting-Fang and Lauly Li, "The Resilience Myth: Fatal flaws in the Push to Secure Chip Supply Chains," *Nikkei Asia,* 27 July 2022, https://asia.nikkei.com/Spotlight/The-Big-Story/The-resilience-myth-Fatal-flaws-in-the-push-to-secure-chip-supply-chains.
146 Suzuki, "Toward a New Tech Policy for the Age of Economic Security."
147 Mallapaty, "Japan Considers Tougher Rules."

Supply chain controls, digital infrastructure building requirements, and a closed patent system could all undermine open innovation, prevent partnerships from developing, particularly with overseas innovators, and divert the innovation process towards government and other vested interest preferences and away from identifying the most pressing needs and most innovative solutions.[148] Concerns have also been raised about bureaucratic and vested commercial interests using economic security legislation to prioritise rent seeking over innovation and practical applications as new affiliated bodies are created to which ministries can second senior Japanese bureaucrats and provide more opportunities for *amakudari*.[149]

Glosserman notes that the METI, already moving its way back to the centre of Japan's industrial and economic planning during the Abe administration, was again "flexing its muscles" in the Kishida administration. Glosserman also expresses concern about economic nationalism driving too much of the implementation and administration of economic security legislation. By confusing "parochial interests with genuine national security concerns," the economic security legislation gives officials greater scope to "justify protectionism" after a period of liberalisation in Japan during the Abe administration. Glosserman similarly worries that the "strategic autonomy" and "strategic indispensability" buzzwords propounded by the Kishida administration are "capable of accommodating just about any policy." For example, changes to foreign investment regulations to strengthen Tokyo's ability to screen foreign investments "produced an expansive definition of national security, one that included *onsen* owners and the operators of baseball stadiums."[150]

Over-strict rules and major interventions in the name of economic security could also undermine Japan's recently enhanced economic statecraft. If Japan were to invoke economic security in ways that worked against WTO rules, for example, it could undermine Tokyo's only recently won reputation for being a less protectionist trading nation.[151] Based on his reading of the 2021 Growth Strategy, Glosserman also recommends that in its efforts to encourage supply chain resilience Tokyo should be careful to "check the impulse to focus on indigenous production" or to go too far to "keep important production infrastructure at home."[152]

Much will depend on how vigorously the Japanese government uses its new discretionary tools, and there are still a number of unanswered questions regarding the implementation of the new legislation.[153] In the end the measures may turn out to be insufficient rather than too onerous. There is still significant stove piping in Japan's bureaucracy, which may prevent sufficient communication and regulation over the 'defensive' measures identified in the legislation. There is also the issue of insufficient coordination regarding 'offensive' economic security measures which require Japan to look even more outwardly to identify, track and utilise foreign technologies to address national vulnerabilities.[154] It is therefore unclear whether the government, as it identified in its summary of the economic security legislation, can make full use of critical advanced technologies – many that also support smart city development – to continue to secure its position in the international community.

148 Shaede, Ulrike, *The Business Reinvention of Japan: How to Make Sense of the New Japan and Why It Matters,* Stanford University Press, 2020.
149 akahashi, Toshiya, "Japan's Economic Security Bill a Balance between Business and the Bureaucracy," *East Asia Forum,* 26 June 2022, https://www.eastasiaforum.org/2022/06/26/japans-economic-security-bill-balances-business-and-the-bureaucracy/.
150 Glosserman, Brad, "Kishida Doubles Down on Economic Security," *The Japan Times,* 12 October 2021, https://www.japantimes.co.jp/opinion/2021/10/12/commentary/japan-commentary/kishida-economic-security/.
151 Okubo, "Passage of the Economic Security Promotion Act."
152 Glosserman, Brad, "Kishida Doubles Down on Economic Security."
153 Okubo, "Passage of the Economic Security Promotion Act"; Okawa, Shintaro, "Overview of the Economic Security Bill and its Impact on Business," p. 13.
154 Suzuki, "Toward a New Tech Policy for the Age of Economic Security"; Glosserman, "Kishida Doubles Down on Economic Security."

There are no simple answers to the various balancing acts the Japanese government has to perform regarding economic security, smart city promotion, innovation policy and economic prosperity. However, it is ultimately important to remember that economic prosperity itself is economic security and the foundation of national security.[155] The enhancement of economic security and statecraft on the basis of economic prosperity is not only important domestically for the wellbeing of the Japanese population but, as we are seeing in the case of Russia's invasion of Ukraine, has its place in traditional geopolitics and in imposing costs on challengers to global norms. Defensiveness that undermines innovation may work against achieving "strategic indispensability," which Glosserman argues is "only possible in the context of relations with other countries."[156] In addition to defensive economic security measures, even greater emphasis is likely to need to be placed on nurturing critical advanced technologies to ensure Japan remains technologically and economically competitive. Therefore, proactively supporting smart city development overseas through a forward-looking approach to innovation and strategic tie-ups between domestic innovators and overseas R&D platforms facilitated by economic statecraft could significantly contribute to Japan's 'economic security.' Smart city promotion would be a valuable vehicle to enhance Japan's national and economic security, industrial strength and international profile while shouldering its global responsibilities.

155 Editorial Board, "Reform Nowhere to be Found in a Shrinking Japan," *East Asia Forum,* 27 June 2022, https://www.eastasiaforum.org/2022/06/27/reform-nowhere-to-be-found-in-a-shrinking-japan/; Takahashi, Toshiya, "Japan's Economic Security Bill."

156 Glosserman, "Kishida Doubles Down on Economic Security."

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