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The New Frontiers: Endless Opportunities

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Human evolution can be viewed as an incessant desire to expand into new frontiers. For some, frontier meant territorial expansion; for many others, a quest for knowledge to advance humanity. If one was to juxtapose this to our times, then space is the next territory to explore and conquer; advancement of technology will perhaps lead us to the road of mastering cyberspace and the virtual world. The downside of these advancements has been the earth's exploitation, which has compelled us to turn our attention to how to protect the earth. Advancement in the twentieth century has poised the twenty-first century in a direction which, as of today, is inconceivable. Thus, we have critical technologies which are revolutionising the world and have ushered in industrialisation 4.0, which would advance exploration of space and the seas. The paramount need to save our planet is also directed at using these new technologies to balance economic growth and development with sustainability.

The pandemic has been a dividing line. It brought the world to a halt, questioned many traditional premises, and necessitated search for alternatives. While the nature of the pandemic called for a global collective response, nations have generally behaved in a self-centred manner and are necessarily competitive. The pandemic has also exposed nations' vulnerabilities in meeting the challenges, be it the health sector, vaccination, or supply of resources. Therefore, the need to take cognisance of the loopholes that the pandemic has revealed

and recalibrate by taking advantage of the critical technologies is vital for advancing into a world of equitable prosperity.

Following the unprecedented challenges that COVID-19 posed to the international community, it is time for both India and Japan to reorient the focus of their Special Strategic and Global Partnership and channelise efforts to address the new set of challenges. The need to work towards building robust economies aligned to address the global concerns of climate change, the pandemic, and the fast-shifting technology paradigm has become critical to navigate the immediate regional dynamics and poise this partnership in a trajectory of advancement, progression, and expansion and make it future-ready.

A long-lasting relationship relies on carrying forward the association into new frontiers. Given the current dynamics, this partnership calls for a concentrated effort to create synergies that contribute to the betterment of the respective nations and enable a conducive environment for regional stability and prosperity. In the last summit held in 2021, Prime Minister Suga stated that he "hopes to further develop cooperation in areas such as cyber, digital, decarbonisation, health care and connectivity, and also mentioned possible collaboration in such fields as 5G, submarine cables, strengthening of industrial competitiveness and diversification of supply chain" (Ministry of Foreign Affiars, 2021). Prime Minister Suga flagged a diversified field for cooperation which would address the immediate necessities and direct the cooperation in areas of future needs. Drawing from the joint statement of 2021, this chapter will focus on first, industrialisation 4.0, which addresses the gamut of critical technologies that can be used for civilian and military purposes and ensure industrial competitiveness and cooperation. Second, since climate change is a strong global agenda, cooperation in embedding the blue economy, which addresses decarbonisation and sustainability, is also addressed. Third, outer space, which is successively gaining dominance in the technological realm, is discussed. The chapter aims to define and delineate the concepts, look at action plans and their implementation and make projections for the future.

Industrialisation 4.0

At each period of time, the Industrial Revolution has impacted lives phenomenally by changing the way people work and live and, consequently, the power dynamics . The first industrial revolution based on steam power and production mechanisation initiated the movement of people from rural to urban centres, increased the role of government to provide welfare measures, and initiated more interaction between nations. The second revolution was all about mass production. The lowering cost resulted in colonisation and subsequently led to a power struggle between nations which consumed the world in two world wars. The third revolution began with the advent of the computer, leading to programmable memory controls and information technology. This was reflected in the communication revolution and an integrated world. As a result, the world at large, progressed with a strong agenda of political stability and economic globalisation. To this end, Industrialisation 4.0 is no different. Since it is embedded in disruptive technology, which comprises artificial intelligence (AI), machine learning, deep learning, data mining, cloud computing, internet of things (IoT), cyber-physical system (CPS), mobile robotics, 3D printing, and blockchain, it would not only change the mode of production but also tremendously modify the structure of the economy and nature of labour market in the world. In turn, it would impact the power contest among nations of the advanced world. The advantages of these technologies are tremendous. Not only is there an increase in productivity, but it also facilitates efficient usage of resources and enables predictive maintenances. This new dimension of predictive maintenances has a far-reaching effect on work. It can help men to respond in advance to maintenance issues, making it most convenient and cost-efficient. It has implications in almost any field, be it agriculture or health, as it can diagnose diseases at an earlier stage, thus enabling viable solutions. These technology will also go a long way in empowering the strategic calculations of nations as these technologies can be used in the field of security. Stated as critical and emerging technologies (CET), scientists consider them a harbinger to

solutions that have eluded society. To the nations these technologies are also tools in hand to execute power. The downside of many of these technologies is that they can be manipulated and hacked, and thus the buzz about cybersecurity. Many of these technologies are testing the rules of governance and legal laws. However, it must be accepted that these technologies are here to stay and it is important for countries to recalibrate their visions.

Aware of the shift in technology and the course change that it demands, India and Japan have put in place policies to give direction, implement, and execute the integration of critical technologies into their society. Japan enacted its first Science and Technology Basic Law in 1995 and has reviewed it every five years. The Fifth Science and Technology Basic Plan of FY2016-2021 advocated a roadmap for Japan to become a Society 5.0. The year 2020 was a game changer for Japan as the pandemic forced Japan to recognise its economic vulnerability. The White Paper on Science and Technology (2020) derived from the Fifth Science and Technology Basic Plan of Society 5.0 stated that Japan desires to create a system that *highly* integrates *cyberspace* and *physical space* and focusses on "a flexible society brought about by reviving and rethinking humanity" (Cabinet Office, 2016) and pushes for the inclusion of innovation. The sixth plan (FY2021-2025), renamed as the Science, Technology, and Innovation Basic Plan, has taken cognisance of including innovation as one of the pillars and also added "humanities and social science" (Ueyama, 2021). The Sixth Basic Plan's concrete policies concerning Society 5.0 are described under the following three pillars: (i) Transforming our (Japan) country into a highly sustainable and resilient society through the fusion of cyberspace and physical space. (ii)Advancing knowledge creation, which designs a new society, and becomes the source of value and creation. (iii) Accelerating innovative human resources to support the new society (Ueyama, 2021). One strong directive has been a large-scale endowment to the universities to the tune of 10 trillion yen to encourage motivated, spontaneous initiatives and result in ground-breaking research. Yet another has been a goal of

30 trillion yen in government R&D investment from FY2021 to 2025 and 120 trillion yen in combined public and private R&D investment to counter fierce competition from other countries. Further, it will achieve the Society 5.0 aims of a sustainable and resilient society that ensures the people's safety and security and help each individual to realise diverse happiness. It is expected that Japan will reclaim its lost grounds in certain areas of critical technologies and attain a balance between economic growth and a sustainable, resilient society.

India has reoriented its science and technology policy in the context of the COVID-19 crisis. The fifth National Science, Technology and Innovation Policy (STIP) is under formulation as the draft is under the consultation of the stakeholders. The new policy would follow a decentralised approach, emphasising bottom-up, experts-driven, and evidence-informed research. Giving it a dynamic mechanism, the STIP includes a timely exit strategy for various policy instruments with a robust governance policy. The attempt is to bring about profound change by incorporating the inclusivity clause. A thrust on research and innovation by providing adequate digital and physical infrastructure and access to research output through the Indian Science and Technology Archive of Research has been planned. In the budget of 2022, ₹142,170 million has been earmarked for R&D. The R& D directives are on AI, genomics, Green Energy, 5G, climate change issues, with 25 per cent of the R&D budget to be allocated to start-ups and academia (Business Standard, 2022). Comparing Japan and India's science and technology policies reveals considerable similarity in their vision with sound directions in critical technology and sustainable development.

Critical and Emerging Technologies (CET)

The India-Japan partnership's new frontier will de facto concentrate on CET as it strengthens their partnership in the coming technology race. The joint statement of 2018 began the process of Japan extending its know-how in the digitalisation of India. Aligning to India's Make in India and Skill Development policy, Japan committed to providing

India with technology, training and best practices to buttress India's economic development and fast-track India's technological revolution. While CET touches all walks of life, it can broadly be divided into seven areas that significantly impact the economy. They are (i) Advanced Materials and Manufacturing, (ii) Artificial Intelligence Computing and Communications, (iii) Biotechnology Gene technology and Vaccines (iv) Energy and Environment, (v) Quantum Technology (vi) Transportation and Space.[1] This section will delineate where India and Japan can expand their cooperation and put forth a future directive.

Advanced Materials and Manufacturing

This area consists of a gamut of technologies that build and change materials to innovate materials to the extent that they perform functions far beyond what is conceivable. Additive technologies, the popular forms being 3D printing, advanced composite material, advanced magnets and superconductors, nanoscale materials and manufacturing, continuous flow chemical manufacturing, and high specification machining processes, are forerunners.

Japan stands ahead of India in most of these advanced technologies and has extended substantial assistance at the national level through platforms like "Invest India" and "Japan Plus". It has encouraged the private sector to work towards capacity-building in these areas. India has trained its attention to critical technology and is progressively doing a catch-up. For example, 3D printing, that has an immense impact on various aspects, from nanoscale material to potential human organs or guns, and has a market projection at $68.71 billion by 2028 is little explored (Fortune Business Insight, 2021). Both nations are lagging behind and are not within the first five nations when it comes to this field (Sher, 2020). While India and Japan are dynamically becoming primary adopters of this technology, they need to collaborate in research and development. India's National Strategy for Additive Manufacturing by Ministry of Electronics, Information and Technology (MeitY) integrating Atmanirbar Bharat has indicated a "conducive eco-system for

design, development and deployment" (Aryan, 2020) of 3D printing and additive manufacturing. As the Government of India looks at attracting global leaders, Japanese companies should team up to take advantage of a favourable environment.

Artificial Intelligence Computing and Communications

This area, which is trendy among the CET, consists of a vast array of fields, including data analytics (Big Data), integrated circuit design and fabrication, advanced optical communication, radio frequency communication, AI algorithms, and hardware accelerators. For laymen, this technology is visible in the form of cellular networks (5G/6G), robotics, laser optical, optical routing, gaming, and the internet of things (IoT).

It is in this field that India and Japan have advanced their partnership. "Japan–India IOT Investment Initiative", as mentioned in India-Japan Vision 2025, has found roots through a memorandum of cooperation (MoC) signed by the prime ministers in 2018 to boost initiatives such as Digital India, Smart city, Start-up India, and promote artificial intelligence (AI) and internet of things (IoT) technologies. Further, India's Defence Research and Development Organisation (DRDO) and Acquisition, Technology and Logistical Agency (ATLA) of Japan have been working since 2018 on a slew of joint projects in the areas of Unmanned Ground Vehicle (UGV) and Robotics in which Japan has very advanced technology (Siddiqui, 2018). Japan furthered its commitment by promising to invest $140 million in IoT and AI via public-private partnership (Sugihara, 2019) start-ups. Submarine optical cable laying is yet another strong area for collaboration. NEC (Nippon Denki Kabushiki-gaisha), a Japan-based corporation, was roped in to lay submarine cable in the strategic zone between Chennai and the Andaman and Nicobar Islands. Deepening their partnership in January 2021, India's IT Minister Ravi Shankar Prasad and Japan's Minister of Internal Affairs Takeda Ryota signed a comprehensive MoC in the field of ICT (Information Communication Technologies)

and digital technology. This will facilitate more Japanese private companies collaborating and joining forces to develop products and services that touch people's lives. Blockchain technology which looks at storing large volume of data in a way that is secured, easily retrievable, and decentralised has huge potential for India with a large population. Japan is a leader in this technology and can collaborate with India in various fields where 'big data' creation is required. According to a study by Brookings Institution (Fatima, 2022), Japan is at the 87th percentile in technology and research. It ranks lower in investment and stands at the 75 percentile. On the other hand, India scores poorly on research initiatives at the 57th percentile, with an investment close to Japan at the 78th percentile. Given India's commitment, the AI and computing power segment can find easy synergies and encourage private investment and collaborative research.

The cellular network story has been different. As illustrated in chapter seven, Indian companies such as Sterlite Technologies, HCL, Wipro, and Tech Mahindra had collaborated to provide Rakuten's 5G networks as Japan was late in recognising this upgradation. However, by 2021, Japan had upped its game to advance 6G, "a technology for the 2030s" (Wakikawa, 2021). As is often the case in Japan, the government has put $9.6 billion, and Sony, NTT (Nippon Telegraph and Telephone Corporation) and Intel are in partnership in establishing a developmental projects. This consortium has constructively signed an MoU with Finland for joint research and with the US a shared investment of $4.5 billion for developing 6G (Wakikawa, 2021). Though India too lags in its roll-out of 5G, towards the end of 2022, the Department of Telephone (DoT) has constituted a 6G Technology Innovation Group (TIG) to co-create and develop a 6G technology ecosystem by increased participation in a capability description, standard development in the international standard-setting body to prepare India's manufacturing and services eco-system to capitalise on the 6G opportunity. Falling back on India's strength in software and Japan's strength in hardware, one

can be optimistic that a strong collaboration in this field is likely as Japan strengthens its technology.

India and Japan in October 2020 finalised a cybersecurity agreement that focuses on 5G technology, AI and critical information infrastructure in pursuit of the Free and Open Indo-Pacific, paving the way for the future. Areas that are bound to see strong cooperation are protective cybersecurity technologies, which have some inherent strength in India that Japan will harness to create synergies. In addition, natural language processing, neural networks, and deep learning will, in due course, find collaboration among the private sector to address the need of the society.

Biotechnology, Gene Technologies and Vaccines

The global biotechnology market size was valued at $752.88 billion in 2020 and is expected to expand at a compound annual growth rate (CAGR) of 15.83 per cent from 2021 to 2028 (Grand View Research, March 2021). Favourable government initiatives worldwide drive the market. Due to the biotechnology sector's growth in developing countries, such as India and China, it has attracted investments. The pandemic has been a game changer for this sector, especially pharmaceutical. Today, India figures among the top twelve destinations of biotechnology-related industry because of its cheap skilled labour, infrastructure facilities, policy support, and epidemiological factors, including the patient pool. The industry comprises more than 2,700 biotech start-ups and more than 2,500 biotech companies. India has 665 FDA-approved plants in the US; 44 per cent of the global abbreviated new drug applications (ANDA) and more than 1,400 manufacturing plants, which are compliant with WHO (IBEF, December, 2021). However, India's strength continues to be the generic drug. The growth of this sector is forecasted to reach $150 billion by 2025, and its contribution to the global biotechnology market is expected to grow to 19 per cent. The largest segment is biopharmaceutical which accounts for 62 per cent as of 2020 (IBEF, December, 2021). In a study conducted by thinkBiotech, Japan's overall score among 54 nations stood at 15,

with intellectual property protection rights at rank 3; however, it had a low score of 19 in education and workforce (thinkBiotech, January 2022).

So far, Japan's footprint in India in this sector is sparse. Though Eisai[2] has entrenched its operation in India, Japanese companies are not encashing on it, given India's advantage. The pandemic brought to the forefront Japan's vulnerability in this sector, and India has been trying to get the pharma and medical device sector of Japan to invest in India. The challenge for the Indian pharmaceutical market is a stable price and policy environment and quality compliance scrutiny. The US generic market has also deterred Japanese companies. However, with the Asia-Pacific region expected to expand at the fastest growth rate of 16.8 per cent, with the health-related application holding 68.6 per cent of market share in 2020 (Grand View Research, March 2021), Japan's strength in R&D and technology can form a synergy with the skilled workforce in India.

India holds a major share in the world of vaccine manufacturing, which came to the limelight because of the COVID-19 pandemic. While India manufactures the vaccine, its distribution has always been a challenge because of the infrastructure. Japan, in June 2021, supported India by providing $9.3 million (Ministry of Foreign Affairs, 2021) from its Overseas Development Assistance budget overhead of the Emergency Grant Aid scheme. This was provided for cold chain equipment and related assistance. This was part of the larger scheme of assisting the fight against COVID-19 in developing nations. However, one can witness a more extensive synergy in vaccine diplomacy in the Quad platform. When the Quad leaders met in March 2021, one identified area for the working group was "Vaccine Distribution", wherein the US and Japan promised a plan to fund India's production and Australia promised to pitch in with the logistics, to produce and transport 1 billion doses by 2022.[3] Given this direction, it is hoped that in future, the technology in use for vaccine manufacturing will find more utilities to enable furthering this partnership.

Quantum Technologies

Quantum technology has four key areas—quantum cryptography, quantum communications, quantum sensors, and quantum computing. While Japan and India figure within the top ten nations in the world in this technology, China and the US are way ahead. This technology is all about speed and securitising passwords. It has strong implications for the financial world.

In quantum technology, Japan is one of the top nations. The Government of Japan is determined to invest $276 million in ten years to be one of the leading countries in quantum technology (Disha, 2021). While quantum technology has different uses, Japan is focused on gaining leadership in the practical use of quantum cryptography by 2025. Apart from government policies supporting R&D activities through the Quantum Leap Flagship Programme, private sectors have also pushed to develop R&D strategies to counter China's growing domination in this sector.

Quantum technology got a heads-up when Government of India made a budget allocation of $1.2 billion was made to the National Mission on Quantum in the budget of 2020 for five years. This was to be disbursed by the Department of Science and Technology, Government of India. The identified four domains reflect the areas mentioned earlier. The drive to engage leading global companies to provide platforms for research and innovations has resulted in IBM partnering with some Indian educational institutions. A similar exercise with Japanese companies can also yield maximum benefit to both nations as this technology is the backbone of many other critical technologies.

Energy and Environment

This area transcends both the critical technology and the sustainable development goals as it is the single most contributor that addresses climate change issues. Developments in this sector are biofuels, applications for directed energy technologies, including power consumer electronics, recharging electric vehicles, powering aerial drones, ground-space energy transfer, IoT devices and advanced

weapons. It also includes electric batteries through renewable energies, and hydrogen- and ammonia-powered electricity generation as these two have low or zero-emission, and zero-carbon alternatives. While nuclear-based energy also figures within this sector, one would avoid any discussion, given complexities concerning anything nuclear in India-Japan relations.[4] Further, since the civil nuclear deal that was inked between Japan and India has not made much headway, it can be assumed that there must be intricacies that await navigation.

Energy transition is a strong agenda for nations, and Japan and India have outlined their policies to enable this transition which looks at renewable energy gaining precedence and efficient use of electricity. While Japan has its challenge of energy security concerns, India too needs to combat the cost of procuring energy and its distribution of electricity. However, suppose one is to delineate their goals, namely securing energy supplies, enhancing self-sufficiency, and creating an optimal energy mix of low-carbon sources, in that case, it is evident they have a lot in common. While government-level cooperation to help India's energy transition through JICA (Japan International Cooperation Agency)for innovation and financing solar, wind, small hydro units have been in place, India, with a large automobile sector, is an excellent source for electric vehicles (EV). For example, Honda has set up a battery-sharing service subsidiarity in India called Honda Power Pack Energy India Pvt. Ltd, which will offer battery-sharing service for small mobility enabling penetration of EV and providing support to vehicle OEMs (*Economic Times*, 2021). Thus, in this field both government sector as well as private sector can contribute immensely. The Japan desk at Prime Minister's Office has been influencing Japanese business to invest in this sector.

Quad Critical and Emerging Technology Working Group (QCET)

While the scope of bilateral engagements between Japan and India will continue to be explored, promoting the concept of "like-minded" countries coming together to cooperate, collaborate, and aid technological advancement collectively is a ruse to contain

China's ascendency in critical technology. When the Quad Leader Summit took place on a virtual platform in March 2021, which was in many ways a revival of Quad that had floundered for various reasons, the four members—the US, Japan, Australia and India—came up with a joint statement called "The Spirit of the Quad", in which three working groups were created of which QCET was one. A brilliant move to look beyond traditional security by forming this working group makes Quad a platform to sharpen technology power and flow simultaneously addressing the overpowering question of technology governance. The QCET also synchronises itself with all four nations' national science and technology plans, thus complementing national interest. QCET enables plugging the gap of supply chain disruption caused by the pandemic by forming the Supply Chain Resilient Initiative (SCRI) among Japan, Australia, and India. The SCRI has paved the way for alternatives through a multilateral arrangement that can harness the strength of India and Japan beyond their bilateral partnership. This arrangement is already visible in Quad members working towards securing rare-earth procurement by creating an alternative supply chain to reduce dependency on China.

Critical technologies have the potential to change lives beyond conception. They hold the key to economic growth for countries like India and a comeback for Japan's economy, which has been long awaiting a wonder product like the Walkman. Both of them have areas of complementariness that can be drawn to nurture this new frontier. The need of the hour for Japan, especially the private sector, is to stop procrastinating and invest capital and R&D in India. For India, too, it is critical to learn from the past opportunities lost. It is necessary to create policy support, flexible governance and a productive eco-system to bolster this partnership.

Blue Economy

As land resources diminish, the ocean has emerged as a new resource frontier. The ocean is also an excellent climate stabiliser as it directly absorbs heat and recycles an overwhelming share of greenhouse

gases. Rising temperature has caused an unusual number of tsunamis, and typhoons and played havoc with people's lives. Rising sea levels have caused submerging of valuable land. Many island states are facing the possibility of losing their habitat. The ultimatum that stares at us is that rising temperature will hurt the water cycle and disrupt marine diversity.

The term "blue economy" was used by Gunter Pauli in his 2010 book "The Blue Economy: 10 years–100 innovations–100 million Jobs", which speaks of a "blue economy business model" which will help in the transition of a scarcity-ridden society to an abundance one "with what is locally available" (Gunter, 2010). The UN General Assembly adopted resolution 70/226 on 22 December 2015 in which it decided to "convene the high-level United Nations Conference to Support the Implementation of Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development to support the implementation of Sustainable Development Goal 14" (World Bank, 2017). Since then, the blue economy made significant inroads into the world narrative as a strategy to safeguard the world's ocean and water resources. Some estimates suggest that ocean-based productivity will exceed corresponding land-based production in many sectors in terms of value and employment generation by 2030. However, these benefits would likely accrue only if the oceans remain healthy (Chansoria, 2020).

Different world agencies' definition of the concept of the blue economy has differing angles. However, the most comprehensive definition is from the World Bank, which states that it is "the sustainable use of ocean resources for economic growth, improved livelihood and jobs, while preserving the health of the oceans ecosystem" (World Bank, 2017). While the purpose of a definition is to explain the meaning of a term and give a structure, this definition is subject to differing interpretations of stakeholders and in turn has the potential for some conflicts to arise due to different stakeholders preferences and interests (Voyer, 2018).

The blue economy is considered as the "next multiplier of economic growth and well-being" (Economic Advisory Council, 2020) and is placed within the debate of "economic growth and development". A viable blue economy is also an answer to tackling climate change and thus has implication for strategic calculation. Consideration for the good governance of the oceans for "free and open' navigation of the seas, the equitable harnessing of the ocean wealth, and the protection of the small island states whose livelihood can be enhanced by policies that address their requirement has been set as a priority. Thus by promoting blue economy, through aid and investment, nations can influence strategic considerations.

The blue economy encompasses a large number of sectors. Broadly they are:

- Harvesting and trade of marine living resources, including fisheries, aquaculture, marine biotechnology, etc.
- Extraction and use of marine non-living non-renewable resources such as minerals, oil and gas, and desalination.
- Use of renewable natural forces such as wind, wave, and tidal energy.
- Commerce and trade in and around the oceans involve transport, coastal development, and tourism.
- Indirect contribution to economic activities and environments deals with carbon sequestration, coastal protection, waste management, and biodiversity protection (United Nations, 2018).

Because of their geography, Japan and India find relevance in investing in incorporating blue economy principles into their economic and strategic calculations. Japan has the sixth-longest coastline in the world (29,751 km/18,486 mi) (Japan, n.d.) and India, with a coastline of 7,516.6 km (4,671 mi) (Ministry of Home, 2017), ranks 18th in the world. Historically, people of both these nations have used the seas to eke out a living. Today, Japan's use of the ocean and its policies on the same are far more advanced than that of India. Japan began the formulation of its Ocean Policy in 2007. The Third

Basic Plan on Ocean Policy, formulated in May 2018, refers to space technologies in many instances, including the collaboration between space and maritime policies, promotion of R&D aimed at realising Society 5.0 (Cabinet, 2018), and the enhancement of Maritime Domain Awareness (MDA) (Ocean Policy Research Institute, 2019). Moreover, the R&D of high-speed communications technologies uses satellites to transmit large volumes of oceanographic data. The integration of space, communications, and marine technologies has given Japan a niche in promoting blue economy. Japan has followed a multipronged approach to embed blue economy into its Ocean Policy and has many examples to illustrate its commitment. The current Basic Plan has emphasised restructuring and regulating the traditional fishery industries to ensure the growth of this industry in line with the environmental concerns. Due to attention being focused on the blue economy, the Taketomi Municipality created Japan's first local government-level Basic Plan on Ocean Policy in March 2011 and has since updated its efforts by aligning to the Basic Ocean Plan of the country. Not only has it constructively tried to address concerns of maintaining an eco-friendly environment along with increasing tourism and employment generation of locals, but it has also extended its effort to "make the ocean that separates us the one that connects us" by reaching out to other Pacific Island nations to enable knowledge sharing.[5] The Hinase district in Okayama has seen local fishing community efforts to restore eelgrass beds; the Onna village in Okinawa is restoring coral reef through a project by local fishers; knowledge of aquaculture of *mozuku* seaweed is being used to benefit preserving health of the coral reefs. The Fukushima disaster redefined Japan's energy policy, and a renewed endeavour to increase the percentage of renewable energy in its energy basket has resulted in the innovative practice of building offshore Mega Solar Power Plant on reclaimed land jutting into the cerulean waters (Upton, 2014). Japan has also been successfully implementing an Ocean Monitoring system using marine and space technology. Ocean monitoring which involves observation data to understand historical changes and the current state of oceans and seas, through

highly defined instruments and measuring techniques, has become one of Japan's most sought-after industry.

For India, the blue economy is a recent development. In February 2019, the Government of India in its Vision of New India in 2030 (Press Bureau of India, 2019) has highlighted blue economy as sixth of the ten-core dimensions of economic growth. In adherence to the already established areas of concerns as marked by the international organisations, India has drafted its blue economy policy in 2020, which is under review. It sets a strong agenda in the traditional fishing and marine environment areas and new industries of infrastructure and logistics. Giving due importance to technology, skill development, energy and security concerns of the seas and ocean, the Government of India has been advised to set up different working groups to enable effective embedding of this concept to realise its full potential. It also would look into the governance in terms of a national accounting framework. Given the wide range of activities listed in the draft policy, it is easy to see the potential synergy that India can harness through cooperation with Japan. The examples listed earlier are strong guidelines for learning from Japanese experience, be it aquaculture, setting up of solar plants by reclaiming land, or ocean monitoring technology to aid military and civilian purposes.

Japan has always been at the forefront of engaging with nations on ocean-related issues. Way back in 1959, Japan had signed the Antarctic Treaty along with other major nations for scientific collaboration and had set up its base. The latest expedition was by the ship named *Shirase*. A ship capable of breaking ice reached Showa Station, the Japanese Anataric base, in November 2021 to conduct a set of research and observation functions. Japan has also advocated a strong legal environmental policy concerning the Antarctic region. The research project titled the Arctic Challenge for Sustainability (ArCS) has progressed since 2015. In 2019, in collaboration with the Multi-disciplinary Drifting Observatory for the Study of Arctic Climate, an international project led by Germany, Japan has been using its ship *Mirai*[6] for this purpose. Japan's

interest includes energy and food security, economic interests in new shipping opportunities, the extraction of natural resources, urgent environmental action, and a search for a stronger position in the current global and regional order. With the recent development of incorporating blue economy in its Ocean Policy, Japan is increasing its activities aligned to the cause of sustainable development and environmental concern in the Antarctic and Arctic region. Further, as the resource-rich Arctic region increases its stakeholders, Japan is aligning with the liberal order to ensure good governance of this region. India's growing position in the world order has also enabled its presence in the Arctic and Antarctic regions. Its Antarctic adventure began in 1981 when scientists tentatively commenced their research. Today India has three bases *Dakshin Gangotri*, *Maitri*, and *Bharati*. *Maitri* and *Bharati* are engaged in scientific research, a multi-disciplinary, multi-institutional programme under the National Centre for Antarctic Ocean Research, Ministry of Earth Science. India has set up a base named *Himadri* in the Arctic region to carry out scientific research in 2008. India was given an observer status in the Arctic Council in 2013 that was renewed in 2022. It has an Arctic Policy at a draft stage in line with the larger Arctic framework, which is rather similar to that of the non-Arctic states. Research on glaciology, atmospheric sciences, and biological sciences has been progressing in Antarctic and Arctic regions and drawing world attention. As both nations regard operations in these two regions as critical to their international standing, it would be wise to find some comparative advantage to forge stronger bonds. Further, as the Arctic region gains strategic significance, Japan and India have established a bilateral relation based on trust and have more reasons to cooperate and collaborate.

When connectivity is the game in the multilateral outing and infrastructure development, a tool to strengthen connectivity needs to factor in principles of blue economy as part of sustainability. This is where the Blue-Dot Network (BDN), a multilateral Indo-Pacific initiative began by US with Japan, Australia, and soon after, included India , that aims to improve the standards of infrastructure

investment in the Indo-Pacific, has a crucial role to play. Often looked upon as a counter to the Chinese Belt and Road Initiative (BRI), its approach, however, is not to offer funds or loans. Instead, it will serve as a globally recognised seal of approval for major infrastructure projects, emphasising environmental and quality concerns and financial implications. The BDN a global quality acceptance seal intends to bring government, private sector, and civil society together through stronger trade and economic ties and foster finance, investment, and technological cooperation (Department of State, n.d.). The BDN based on the G20 Principles for Quality Infrastructure and the G7 Charlevoix Commitment on Innovation Financing for Development and Equator Principles. In so doing, BDN envisions promoting a transparent and sustainable infrastructural environment, which also serves as a strategic retaliation to Beijing's BRI. BDN straddles strategic and economic diplomacy and is positioned in tandem with the bigger architectural power game that has originated in the Indo-Pacific region. This initiative has a future in the long-term perspective of India and Japan's bilateral relations. India is also promoting connectivity and infrastructure in its neighbourhood. Through the National Perspective Plan, India aims to revitalise 7,500 km of India's coastline, 14,500 km of navigable waterway, and its maritime sector, and also expand its presence in the Indo-Pacific region by its policy of SAGAR, Project Mausam, and SAGARMALA (Ministry of Ports, Shipping and Waterways, n.d.). Joining this forum positions India to broaden its sphere of influence and further joint projects with Japan, as mentioned in the joint statement of 2018 between Prime Minister Modi and Prime Minister Abe. So far, India and Japan's cooperation in the third country has been mixed.[7] This partnership has borne fruits in their cooperation in Bangladesh. Japan's Marubeni Corporation and India's Larsen & Toubro collaborated in building the 400-MW Bibiyana-III Gas Based Combined Cycle Power Plant in Bangladesh in 2016. In 2018, they engaged in their first joint venture to build a rail system in a third country and won the contract for constructing Bangladesh's first mass rapid transit system. The collaborating on

two projects in Bangladesh: the Ramgarh-Baraiyarhat Highway and the Jamuna Railway Bridge is a connectivity project. The former is being funded through an Indian Line of Credit, a grant from the World Bank, and loans provided by Japan. The latter will utilise soft loans from Japan and construct an Indian infrastructure company. In due course, as the Northeast region infrastructure links up to Sylhet in Bangladesh, this project will extend connectivity to the ports of Bangladesh. Similarly, India and Japan have set up an LNG (Liquefied Natural Gas) terminal in Sri Lanka. The Asia-Africa Growth Corridor, which involves a gamut of joint infrastructure projects, has strong potential for the immediate future.

Outer Space Cooperation

Discussion on new frontiers is incomplete if one omits outer space. Outer space is marked by a nation's claim of technological supremacy and its strategic overreach. "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies" by United Nations in 1964, continues to be a reference point for activities in outer space. A domain that was entirely state-based has changed to include the private sector in manufacturing and developing space-related products. The global space industry is worth $350 billion, and it is estimated that the sector is expected to reach more than the $1 trillion by 2040. "The Space Tech 2021 report" from Space Tech Analytics noted that there are around 10,000 private sector companies and 5,000 leading investors in the area of space tech (Rajagopalan, 2022).

India and Japan's space programme trajectory has many similarities. Both the nations' space programmes space programmes began in the civil and scientific domain before moving on to exploring security-related tech development. This move is essential because of the dynamics in the Asia-Pacific region, especially with a rising China, North Korea's missile programme, US engagement post-Cold War, and the contest within the Indo-Pacific region. In view

of these developments, while the earlier days of bilateral space cooperation looked at data sharing for disaster management, in 2019, the India-Japan Space Dialogue set a firm foot in the security realm by discussing Maritime Domain Awareness, Space Situational Awareness and Positioning Services.

Since monitoring the oceans to secure it is an agenda, data gathered by Japan QZSS (Quasi-Zenith Satellite System) and India IRNSS (Indian Regional Navigation Satellite System) can be complementary. IRNSS has a regional outreach centred on India and encompassing a rectangular zone from latitude 50 degrees in the North to 30 degrees in the South and from longitude 30 degrees East to 130 degrees East. The QZSS revolves around 135 Meridian East. A combined force of these two gives Japan and India positioning data in the strategic South China Sea and the Indian Ocean (Wang, Zaminpardaz et al., 2019). Space Situational Awareness is in focus as India upgrades its space programme. In 2019, India established the Space Situational Awareness Control Centre in collaboration with the US. Pooling resources has a strong outcome in this field and will also allow for maritime defence awareness.

As Japan and India's maritime forces join hands in bilateral and multilateral exercises, support from the space programme by enriched data would go a long way. As there is crowding in space, protecting space assets from space debris, inactive satellites and near-earth asteroids are common concerns that India is keen to address. Japan's key strength lies in the use of robotics in its space programme, and it has been developing technology to take care of space debris. This potential business opportunity has also encouraged a few Japanese companies to join in. Collaborative research in this area would be a fruitful exercise in contributing to the environmental concern of the space. Space is the last frontier, and the future will determine how the world can reap benefits from its commitment to space. Rather, it is clear that efficiently pooling financial, physical and human resources will foster comparative advantage. Like-minded nations have the advantage of seizing this opportunity.

Quo Vadis?

The new vistas of opportunity that open up for cooperation and collaboration in the game-changing technological realm are tremendous. Two dynamically differing concerns will consume the world's attention. They are outer space and the oceans. The set of critical technologies is the variable that will impinge on, impact, and direct the future of these two territories. As discussed in this chapter, Japan and India have already identified a plethora of areas in which critical technologies can work. However, it is also well known that the line between civil use and military use of technology is very porous. Thus, it is not only cooperation and collaboration for technological development that is vital, but, as the new space race escalates, it also becomes important to protect space assets and create platforms for enacting legal laws for global governance. This is also applicable to the blue economy, which focuses on global governance's economic and strategic concerns.

For India, industrialisation 4.0 is the springboard to catapult the economy to greater heights. For Japan, industrialisation 4.0 can be a comeback from its lost grounds. As advocated by the US, enhancing technological capability and gaining supremacy through cooperation between "like-minded nations" will promote stronger synergies between India and Japan. There is evidence of moves in the right direction from the policymakers. It is important to bolster this partnership with a significant multiplier effect at the ground level.

The complexity of the world order compels both these nations to work in multilateral forums. It is to their advantage that both of them consolidate and cooperate to strengthen their technological capabilities and become the powers to reckon with, to influence the world, especially in areas of global governance, to ensure that equitable prosperity is guaranteed for all nations in the future.

Notes

1. Compiled from https://www.pmc.gov.au/resource-centre/domestic-policy/action-plan-critical-technologies.
2. Eisai is a leading pharmaceutical industry in Japan, which has a manufacturing base in India.

3. This has been derailed due to India's unprecedented surge in April-June of 2021.
4. One may note that Japan took well over six years to sign the civil nuclear deal with India.
5. For more details, visit https://www.spf.org/global-data/opri/wp_2019_en.pdf.
6. For further details, visit http://www.jamstec.go.jp/e/about/equipment/ships/mirai.html. Accessed on 15 February 2022.
7. The failure of the Chabahar Port joint project of India and Japan, which had strategic value, has considerably hampered third-country investment participation.

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