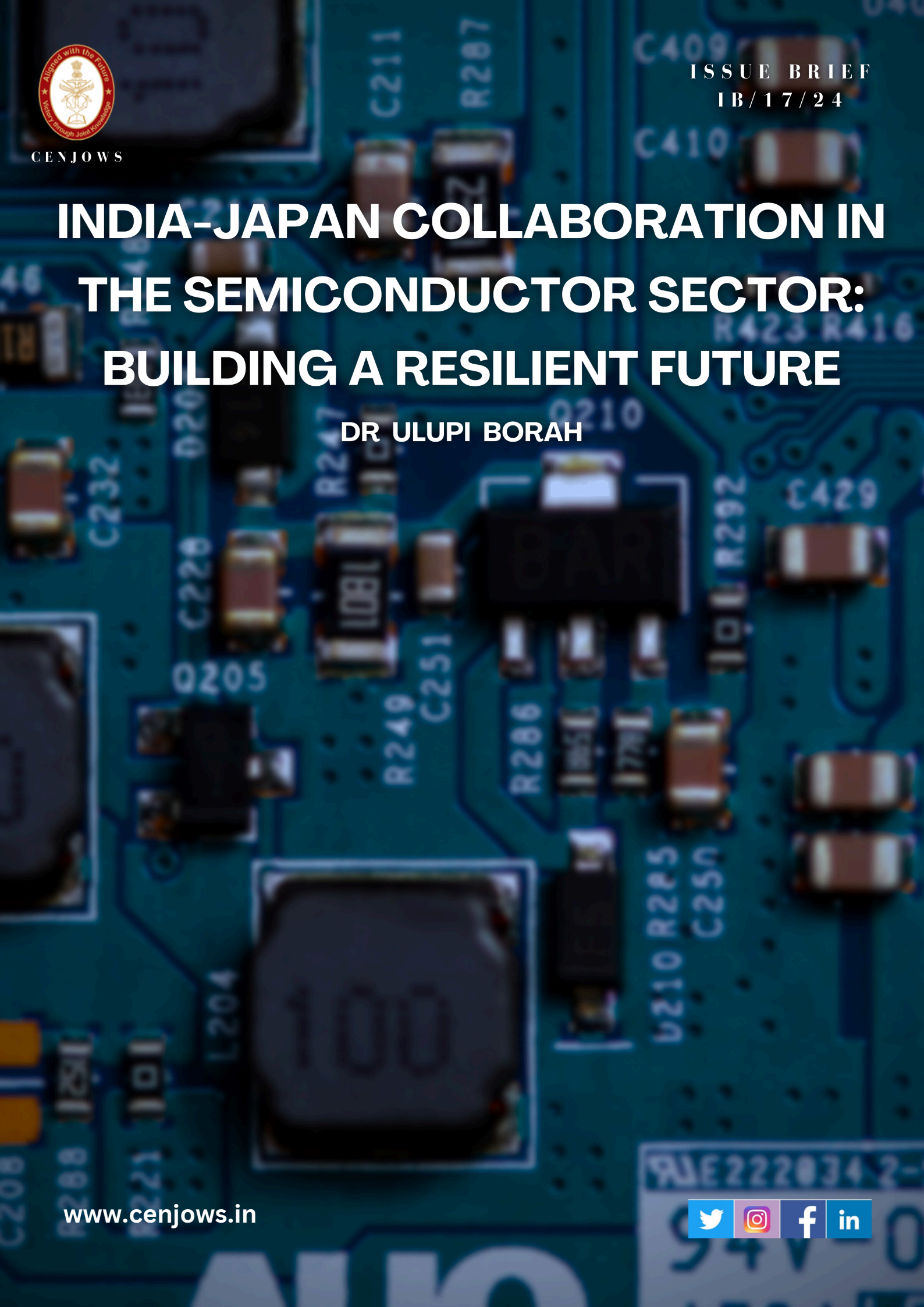

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INDIA-JAPAN COLLABORATION IN THE SEMICONDUCTOR SECTOR: BUILDING A RESILIENT FUTURE

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Abstract

The role of technology in shaping India's foreign policy is immense, with semiconductor being the backbone of modern technology. With a strong political will, today India has fostered partnership for such technology collaboration with the most advanced countries in the globe. Apart from the US, Taiwan and South Korea, New Delhi aspires to make joint efforts with Tokyo in the semiconductor sector. Japan was at the top position in terms of semiconductor manufacturing in the 1980s. However, in the current times it occupies only 10 percent of the global market. Nonetheless, Tokyo still remains relevant in various key areas and India could collaborate in those specific domains of the semiconductor sector. This paper gives a brief background of the semiconductor sector of both the countries and examines the key areas where New Delhi and Tokyo can collaborate, identify the challenges and provide few recommendations to address them.

Introduction

In the 1980s, Japan held the top global position in semiconductor manufacturing. Dynamic Random-Access Memory (DRAM)s in particular were among the many Japanese semiconductor products that American electronics companies also began to use.[1] The Japanese company Sony had already taken over as the global brand for

semiconductors. The co-founder of Sony, Akio Morita redefined the image of Japan across the world. As trade tensions between the US and Japan rose, Morita acted as an informal envoy, explaining Japan to American power brokers.[2] Meanwhile the US had already started facing deep problems in its economy and society followed by growing trade deficit and the crisis in its high tech industries. In this backdrop, Morita stated: “The US has been busy creating lawyers while Japan has been busier creating engineers.”[3] In 1986, NEC, Toshiba and Hitachi became the top three Japanese manufacturers and was able to occupy over 50 percent of the global market.[4]

However, from holding 50 percent share, Japan currently controls only 10 percent of the worldwide semiconductor market. The decline happened due to Washington's strong efforts to restrict its exports of semiconductors, especially processors with DRAM. Japan's chip makers suffered greatly as a result of these trade restrictions, a pricing war with China, and changes in the global semiconductor market trends towards specialised models. Japan, which was once a world leader in manufacturing, is currently working to recover its semiconductor sector after falling behind from global hubs like South Korea, Taiwan, and the US.[5]

Pertaining to India’s semiconductor ecosystem, the current Atmanirbhar Bharat initiative is emphasising to strengthen it. This effort can be dated back to the 1960s when companies like Bharat Electronics Ltd. (BEL) and Hindustan Aeronautics Ltd. (HAL) played a crucial role in this sector. Under Prime Minister Rajiv Gandhi’s leadership, the industry gained momentum with the creation of Semiconductor Complex (SCL). However, within a decade the complex caught fire leading to the a downfall of its manufacturing capabilities.[6] Although in 2007, the then Government of India introduced the first semiconductor policy but it could make progress only after 2015. The ‘Modified Semiconductor Policy’ came into being in 2021-2022 with an effort to boost the Assemble Testing Marking Packaging (ATMP)s, design and manufacturing in India.[7] In December 2021, the India Semiconductor Mission came into being and in order to ensure its success, it was expected to be led by world class semiconductor experts and professionals.[8]

Thus, to achieve progress in this sector, India is commencing stronger collaboration with the global semiconductor hubs. Although Japan today holds 10 percent of the global market share, yet there are a lot of areas where India can collaborate with the

1980s semiconductor manufacturing giant. The article delves into those aspects where both the countries can or have collaborated already, the challenges they face and few recommendations to address them.

India-Japan fosters collaboration

Considering the global demand for semiconductors, New Delhi and Tokyo have commenced various initiatives and efforts in this sector**.** In July 2023, a Memorandum of Cooperation (MoC) came into being between the 'Ministry of Electronics and Information Technology (MeitY)' of India and the Ministry of Economy, Trade and Industry (METI) of Japan on Japan-India semiconductor supply-chain partnership.[9]

The MoC focused on enhancing the semiconductor supply chain between India and Japan. It is primarily based on the already existing frameworks 'India-Japan Digital Partnership' (IJDP) and 'India-Japan Industrial Competitiveness Partnership' (IJICP) which promote various technology sectors.[10]

During his visit to New Delhi, the Foreign Minister of Japan, Yoshimasa Hayashi along with his Indian counterpart S. Jaishankar promoted collaboration in technology and in defence equipment.[11] According to official reports, India aspires to receive investments in supply chains and semiconductors from Japan, worth US$35.9 billion by 2027.[12]

To engage in such collaboration, the MoC signed by the two countries is of great salience considering the fact that it focused on bringing semiconductor supply chain resilience along with semiconductor design, manufacturing, equipment research and talent development. [13]

Apart from the governments, the private sectors of both countries have also initiated collaborative efforts. Rapidus Corporation of Japan, a semiconductor manufacturing company, has already initiated advanced level of discussion in this sector through direct communication with both the governments.[14] In addition, Japanese companies including Denso, Kioxia, MUFG Bank, NEC, NTT, SoftBank, Sony, and Toyota have also expressed interest in working with India.[15] Japan's Horiba Group has already initiated investments to setup a semiconductor unit in Nagpur, Maharashtra.[16]

The above paragraphs show that such collaboration is not merely a response to the global supply chain vulnerabilities but a crucial move for both Tokyo and New Delhi to attain technological autonomy.

Comparative Study of India's Collaboration with Taiwan, the US and South Korea

Despite such collaborations, it is crucial to understand the relationship between New Delhi and Tokyo in a broader context. This would involve a comparative analysis of India's relationship with Taiwan, the US and South Korea. Such analysis would be able to identify the existing gaps and challenges both Tokyo and New Delhi face and make further recommendations to address them.

India-Taiwan Collaboration

Taiwan has already shown its eagerness to enhance its collaboration with India in the semiconductor sector. In May 2024, the 'India Taiwan Semiconductor Forum' took place. This encouraged the industry leaders, government agencies and research institutions of both the parties to collaborate. The focus is to create a robust semiconductor ecosystem including setting up of fabrication plants in India.[17] The IT Ministry met with industry leaders and government officials in Taipei to assure them of policy stability, particularly on changes in import laws and customs levies on inputs. In India, the first commercial fab is being opened by Tata Electronics in Gujarat in partnership with the Taiwanese chipmaker, Powerchip Semiconductor Manufacturing Corp (PSMC). The investment made on this fabrication would be Rs 91,0000 crore ($11.1 billion).[18] Taisys, headquartered in Taiwan is strategising a $100 million investment in its Indian Subsidiary to spearhead crucial chip design initiatives.[19] Taiwan's Deputy Minister for Taiwan's National Development, Kao Shien-Quey, stated that there was "huge scope" for collaboration and that major Taiwanese technology giants were looking to India as a key destination to strengthen their global supply chains.[20] Thus, Taiwan remains a significant partner for India and it is anticipated that this collaboration will not just solidify the technological capabilities but also boost economic cooperation between the two countries. This could be one of the most saliant strategic moves in commencing New Delhi as the global semiconductor hubs in the next few years.

India-US Collaboration

In May 2022, President Biden and Prime Minister Modi announced the United States-India Initiative on Critical and Emerging Technology (iCET) to elevate and expand a strategic technology partnership and defence industrial cooperation between the two countries' governments, businesses, and academic institutions.[21] Improving bilateral

collaboration on robust semiconductor supply chains and supporting the development of a semiconductor design, manufacturing, and fabrication ecosystem in India remained some of the highlights. The U.S. Semiconductor Industry Association (SIA) in partnership with the India Electronics Semiconductor Association (IESA) along with Government of India Semiconductor Mission organised a task force to boost the growth of semiconductor ecosystem in both the countries.[22] In March 2023, following the Commercial Dialogue, to create a robust semiconductor supply chain and innovation partnership, a Memorandum of Understanding (MoU) was signed between the two countries.[23]

Micron Technology, Inc., a US-based chipmaker, has already started creating its $2.75 billion assembly, testing, and packaging plant (ATMP) in Sanand, Gujarat.[24] Lam Research has also shown interest in terms of establishing research centres in India.
Such initiatives will definitely enable to diversify the engineering talent and secure global supply chains. New Delhi may anticipate strengthening its standing in the global innovation arena, which may ultimately help it build a strong semiconductor ecosystem of its own. Thus, the US remains one of the largest partners for India in this sector where it can further its goals.

India-South Korea Collaboration

In March 2024, the 10th joint commission meeting in Seoul took place which was co-chaired by External Affairs Minister of India, S. Jaishankar and his South Korean counterpart Cho Tae-yul. Both the sides aspired to deepen cooperation in new technologies especially semiconductors apart from green hydrogen, and professional mobility. [25] In addition, both the countries look forward to create a resilient semiconductor supply chain. The semiconductor industry in India is receiving a huge boost when Simmtech, a South Korean company, revealed plans to establish a production facility in Sanand, Gujarat. Simmtech plans to invest Rs 1,250 crore ($152.4 million) to help build a strong semiconductor ecosystem in the state.[26] Although India's collaboration with South Korea is relatively recent but their focus in this sector has gained momentum in the last couple of years. It is not just New Delhi but Seoul too has shown interest in expanding its presence in New Delhi considering the latter's growing market and the political will to promote this sector.

Challenges for India to establish a stronger collaboration

From the preceding paragraphs, it can be seen how Taiwan, the US and South Korea have catered to the semiconductor industry of India. Based on such analysis, it is crucial to highlight the challenges India is facing in building a more compatible relationship with Japan in this sector. Some of those challenges have been discussed elaborately in the following paragraphs:

- **Reliant on Designs**: Although Japan is ahead of the curve in semiconductor fab manufacture, it is still reliant on others for design. Japan still has some Integrated Devise Manufacturing (IDM) plants, but they are becoming increasingly difficult to operate and are in a weaker position. Consequently, Tokyo wants to collaborate with countries such as the US, Taiwan, and China. The Japanese semiconductor company Rapidus has collaborated with the American multinational company IBM to advance logic scaling technology specially to develop 2 nanometre (nm) node technology.[27] Meanwhile Taiwan Semiconductor Manufacturing Company (TSMC) with the help of the Government of Japan announced to develop a second Japanese plant in Kumamoto prefecture that would be operational by the end of 2027. The total investment would worth more than $20 billion. [28] The South Korean company Samsung has already expanded in Japan in terms of chip packaging and testing. In light of these, while Japan has developed strong collaborations with the major semiconductor hubs, New Delhi is yet to strengthen its collaboration with Tokyo. In terms of fabs and IDMS, India has not been able to reach a position where countries like the US, Taiwan, South Korea or China have reached. Hence, Japan might not find it that attractive to collaborate with India when its interests are not served well.
- **Integrating Supply Chain**: Japan plans to collaborate with Taiwan in an integrating supply chain. The Ministry of Economic Affairs (MOEA) of Japan, believes that by creating an industrial district in Kyushu, it would be able to aid local semiconductor component companies in providing parts to TSMC.[29] A resilient supply chain would also enable Japan to reduce its dependency on other regions. India's foothold in this aspect is very recent and is still emerging. New Delhi is yet to become a major global player and might not be that appealing to Japan in the current state.
- **Collaboration at University Level**: Japan has collaborated with the US in R&D at a university level to enhance research and advance the workforce in this

sector. In May 2023, the 'U.S.-Japan University Partnership for Workforce Advancement and Research & Development in Semiconductors (UPWARDS) for the Future' was established.[30] The partnership is expected to strengthen ties between industry and higher education in Japan and the US. At least $60 million contribution is expected in the next five years by Japan.[31] India also has such collaboration between the Indian Institute of Technology Hyderabad (IITH) and the Japanese semiconductor company Renesas Electronics Corporation.[32] However, there success could be limited by certain challenges, most notably a technological and financial gap between them. India is still creating the requisite infrastructure, which may slow down the overall process.

- **Political Compulsion**: While discussing on the Senkaku islands, the focus has always been on the escalating tensions between China and Japan and the ramifications for the US. However, Taiwan too remains a claimant to these islands considering its geographical proximity. Despite being a claimant state in both the East and South China Seas, the voice of Taiwan is frequently ignored due to its diplomatic isolation. However, it could be a point of tension between Taiwan and Japan if its strategic and economic interests are not balanced well. Therefore, the US has always encouraged Taiwan to collaborate with Japan in the semiconductor sector to avoid any kind of instability in the region. TSMC has already opened its plants in the Kumamoto prefecture. It is evident that if a country invests in another, it would always want to maintain a symbiotic relationship devoid of any conflict. Such political compulsions have been one of the reasons behind such cooperation in this sector. In terms of India, there is no such political or strategic compulsion which would encourage Japan to strengthen it relationship in this sector. Neither a third country, such as the US, would advocate for such mutually advantageous relationships between the two countries like it has done for Taiwan and Japan.

Recommendations

- **Joint Ventures in Semiconductor Materials and Production Equipment:** Although Japan is reliant on others for design or IDM but in terms of semiconductor materials, Japan still contributes 56% share of the global market and 32% for semiconductor production equipment. This makes it the most essential base for Japan's transition away from its reliance on China.[33] In addition, Tokyo has developed world-class technology in the 'back-end process',

which is critical to future technological innovation, and semiconductor manufacturers have begun to invest in Japan.[34] This could provide New Delhi an opportunity to form joint ventures with Tokyo in semiconductor manufacturing facilities especially in production equipment. India can also reduce its reliance on others if it collaborates with Japan on 'back end process' since it is believed that in the upcoming times, the ATMP plants can boost the growth of a comprehensive semiconductor ecosystem in India.

- **Opportunities for Collaboration in Technology Transfer**: Japan is one of the largest suppliers of photoresist coating and high-end aluminium electrolytic capacitors. They are critical in manufacturing the most advanced chips. It has been estimated that at least 60 percent of the global market share for another 70 advanced materials is contributed by Japan.[35] With a 25 percent share of the global market, Tokyo Ohka Kogyo is one of the largest producers of photoresist and it has doubled in the recent times. [36] India could collaborate with Japan on this aspect. New Delhi can get advanced materials from Japan and as a part of technology transfer initiatives, both the countries can collaborate in photoresist coating and high-end aluminium electrolytic capacitors.
- **Strategic Collaboration with Japanese Manufacturers:** Semiconductor production equipment accounts for almost 60% of Japan's semiconductor equipment exports, with components accounting for approximately 20%.[37] In terms of manufacturers, TEL (Tokyo Electron) is Japan's largest semiconductor equipment maker and the world's third largest.[38] New Delhi, specially under the Modi administration is emphasising greatly on enhancing the semiconductor manufacturing capabilities. Collaborating with Tokyo in this aspect would give India the access to world class technology especially in semiconductor equipment. In addition, any collaboration with TEL would be a strategic move for India considering it to be a global major player in this sector.
- **Leveraging Japan's Expertise in Node Development:** India could leverage Japan's expertise to access sub-30 nm, sub-60 nm and sub-200 nm. These nodes are mostly significant in producing high-performance, energy efficient chips.
- **Academic and Research Collaborations in Semiconductor R&D:** University of Hiroshima, Japan, is one of the institutes in the country which is extensively involved in commencing research and development in semiconductors. Director of the Research Institute for Nanodevices of Hiroshima University, Teramoto

Akinobu, stated that partnership is significant to develop a network as a system. This would also include a strong workforce with great expertise.[39] India which has started to upgrade its skilled workforce especially in design physics and process technology, has an excellent potential to collaborate with such institutions. In addition, it provides an excellent chance for Indian academic institutes and universities, particularly IITs, to interact and improve India's semiconductor ecosystem.

- **Promoting Gender Diversity/Parity and Academic Exchange:** Japan also encourages the participation of more female researchers in this sector. In order to support women, scholarships have been offered by the Hiroshima University. Aoto Nahomi, who used to work for Hiroshima-based Micron Memory Japan stated:

  "I am absolutely certain that both technology and society benefit when people from different backgrounds share their ideas and opinions."[40] The female researchers of India should be encouraged to avail such scholarships. The Government of India could also promote exchange programs with Japanese institutes to foster research in this sector and further strengthen the ties between the two countries.

- **Leveraging FOIP Framework:** Being an active partner of the Japan initiated 'Free and Open Indo-Pacific (FOIP)', New Delhi might use this platform in collaborating with Japan in the field of technology. The third and the fourth pillar of the 2023 released 'New Plan for FOIP' by the Ministry of Foreign Affairs, Japan, mentioned about the role of advanced technology to achieve vigorous growth in the region. [41] Semiconductor being the backbone of modern technology, New Delhi can leverage this framework to foster this sector with Japan.

Conclusion

India is in the pursuit of developing a strong semiconductor ecosystem. Considering Japan's dominance in the past and technological expertise especially in semiconductor materials and production equipment, it could be positioned as one of the most potential partners for India. However, the progress of such partnership depends on how far New Delhi can present itself as a capable and attractive partner in the global landscape. Meanwhile Taiwan and the US have already established robust ties with Japan in this sector. Hence, India needs to emphasis on few key aspects including supply chain integration, meet the technological gap, fostering R&D etc. In addition, China remains a

significant factor since both the nations wish to reduce their dependency on China. Thus, developing stronger collaboration would enable both Tokyo and New Delhi to secure their positions in the global supply chain of semiconductors.

DISCLAIMER

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Endnotes

[1] Semiconductor History Museum of Japan, (2011), "Trends in the Semiconductor Industry", [Online: Web], Accessed 03 September, 2024, URL: https://www.shmj.or.jp/english/trends/trd80s.html
[2] Chris Miller, Chip War, (London: Simon and Schuster), 109-10
[3] Ibid
[4] Semiconductor History Museum of Japan, (2011), "Trends in the Semiconductor Industry", [Online: Web], Accessed 03 September, 2024,URL: https://www.shmj.or.jp/english/trends/trd80s.html
[5] Pratnashree Basu and Namisha Binaykiya , (2024), "Rebuilding Japan's Chip Industry", Observer Research Foundation, [Online: Web], Accessed 03 September, 2024,URL: https://www.orfonline.org/expert-speak/rebuilding-japan-s-chip-industry#:~:text=Key%20strengths&text=Japanese%20firms%20control%20a%20significant
[6] Trisha Ray, (2023), "Lessons from India's past for its semiconductor future", Observer Research Foundation, [Online: web], Accessed 12 June 2024, URL: https://www.orfonline.org/expert-speak/lessons-from-indias-past-for-its-semiconductor-future
[7] Ministry of Electronics and Information Technology (2022), "Modified Programme for Semiconductors and Display Fab Ecosystem", Government of India, URL: https://www.meity.gov.in/esdm/Semiconductors-and-Display-Fab-Ecosystem
[8] Ibid
[9] Business Standard, (2023), "Cabinet approves MoC between India, Japan for semiconductor development", [Online: Web], Accessed 17 August 2024, URL: https://www.business-standard.com/economy/news/cabinet-approves-moc-between-india-japan-for-semiconductor-development-123102500626_1.html
[10] Ibid
[11] Ibid
[12] T_HQ, (2023), "India and Japan's Silicon Handshake", [Online: Web], Accessed 27 August 2024, URL: https://techhq.com/2023/08/india-japans-silicon-handshakes/
[13] Ibid
[14] Naina Bharadwaj, (2023), "India-Japan Economic Partnership: Bilateral Trade, Infrastructure Projects, and Semiconductor Collaboration", [Online: Web], Accessed 17 August 2024, URL: https://www.india-briefing.com/news/india-japan-trade-investment-data-fy2023-new-frontier-areas-cooperation-29096.html/
[15] Ibid
[16] Geeta Nair, (2024), "Japan's Horiba to set up semicon unit in Nagpur industrial estate", Financial Express, [Online: Web], Accessed 17 August 2024, URL: https://www.financialexpress.com/business/industry-japans-horiba-to-set-up-semicon-unit-in-nagpur-industrial-estate-3546493/
[17] SEMI, (2024), "India and Taiwan Deepen Collaboration to Drive Semiconductor Development", EE Times, [Online: Web], Accessed 17 August 2024, URL: https://www.eetindia.co.in/india-and-taiwan-deepen-collaboration-to-drive-semiconductor-development/#:~:text=As%20the%20India%2DTaiwan%20Semiconductor,partnerships%20between%20the%20two%20markets.
[18] Soumyarendra Barik, (2024), "India assures Taiwan of policy stability in semiconductor sector", The Indian Express, [Online: Web], Accessed 17 August 2024, URL:

https://indianexpress.com/article/business/india-assures-taiwan-of-policy-stability-in-semiconductor-sector-9493429/lite/

[19] Businesswire, (2024), "Taiwan Based Taisys to Invest USD100 Million in Indian Semiconductor Design Platform", [Online: Web], Accessed 17 August 2024, URL: https://www.businesswireindia.com/taiwan-based-taisys-to-invest-usd100-million-in-indian-semiconductor-design-platform-88843.html

[20] Ibid

[21] The White House, (2023), "FACT SHEET: United States and India Elevate Strategic Partnership with the initiative on Critical and Emerging Technology (iCET)", Government of the United States of America, [Online: Web], Accessed 17 August 2024, URL: https://www.whitehouse.gov/briefing-room/statements-releases/2023/01/31/fact-sheet-united-states-and-india-elevate-strategic-partnership-with-the-initiative-on-critical-and-emerging-technology-icet/

[22] Ibid

[23] Press Information Bureau, (2023), "MoU on semiconductor Supply Chain and Innovation Partnership between India and US signed following the Commercial Dialogue 2023", Ministry of Commerce and Industry, Government of India**,** [Online: Web], Accessed 17 August 2024, URL: https://pib.gov.in/Pressreleaseshare.aspx?PRID=1905522

[24] HT Correspondent, (2023), "Micron begins construction of $2.75 billion semiconductor plant in Gujarat", Hindustan Times, [Online: Web], Accessed 17 August 2024, URL: https://www.hindustantimes.com/business/micron-begins-construction-of-2-75-billion-semiconductor-plant-in-gujarat-101695478422567.html

[25] Minsitry of External Affairs, (2024), "India, South Korea to boost tech, semiconductor cooperation", Government of India, [Online: Web], Accessed 18 August 2024, URL: https://indbiz.gov.in/india-south-korea-to-boost-tech-semiconductor-cooperation/#:~:text=During%20a%20bilateral%20joint%20commission,by%20External%20Affairs%20Minister%20S.

[26] Saurabh, (2024), "Simmtech To Set Up Semiconductor Plant In Sanand, Gujarat", ADDA Current Affairs, [Online: Web], Accessed 18 August 2024, URL: https://currentaffairs.adda247.com/simmtech-to-set-up-semiconductor-plant-in-sanand-gujarat/#:~:text=With%20an%20investment%20of%20Rs,Gujarat%20Global%20Summit%20in%20Gandhinagar.

[27] IBM (2022), "IBM and Rapidus Form Strategic Partnership to Build Advanced Semiconductor Technology and Ecosystem in Japan", [Online: Web], Accessed 18 August 2024, URL: https://newsroom.ibm.com/2022-12-12-IBM-and-Rapidus-Form-Strategic-Partnership-to-Build-Advanced-Semiconductor-Technology-and-Ecosystem-in-Japan

[28] Reuters, (2024), "TSMC to build second Japan chip factory, raising investment to $20 bln", [Online: Web], Accessed 18 August 2024, URL: https://www.reuters.com/technology/tsmc-build-second-japan-chip-factory-raising-investment-20-bln-2024-02-06/

[29] Lisa Wang , (2024), "MOEA plans Japan chip supply chain", Taipei Times, [Online: Web], Accessed 18 August 2024, URL:https://www.taipeitimes.com/News/biz/archives/2024/05/31/2003818635

[30] KIZUNA, (2023), "Japan-U.S. Partnership to Foster Diverse Talent for the Semiconductor Industry", [Online: Web], Accessed 18 August 2024, URL: https://www.japan.go.jp/kizuna/2023/09/diverse_talent_for_the_semiconductor.html

[31] Ibid

[32] Renesas, (2024), "Renesas and Indian Institute of Technology Hyderabad Sign Agreement to Accelerate India's Semiconductor Independence", [Online: Web], Accessed 18 August 2024, URL: https://www.renesas.com/us/en/about/newsroom/renesas-and-indian-institute-technology-hyderabad-sign-agreement-accelerate-india-s-semiconductor

[33] Musha Research Commentary, (2023), "Japanese Stocks Outstandingly High, U.S.-China Confrontation and Super Weak Yen Turned the Tide", https://www.musha.co.jp/attachment/647d5ae7-4e50-47cf-9dc2-0195ac1a01f4/Musha%2520Reseach%2520Commentary%2520(Strategy%2520Bulletin%2520Vol%252 0333)_2023.06.05.pdf

[34] Ibid

[35] Julian Ryan, (2021), "Japan strengthens hold on semiconductor raw materials amid global chip shortage", South China Morning Post, [Online: web], Accessed: 25 August 2024, URL: https://www.scmp.com/week-asia/politics/article/3150323/japan-strengthens-hold-semiconductor-raw-materials-amid-global?module=perpetual_scroll_0&pgtype=article

[36] Ibid

[37] Eva Chen, (2024), "Japan's Semiconductor Equipment Industry Policies and Guidelines",Inves Taiwan, URL: https://investtaiwan.nat.gov.tw/intelNewsPage202404150001eng?lang=eng&search=202404150001

[38] Ibid
[39] KIZUNA, (2023), “Japan-U.S. Partnership to Foster Diverse Talent for the Semiconductor Industry”, [Online: Web], Accessed 18 August 2024, URL: https://www.japan.go.jp/kizuna/2023/09/diverse_talent_for_the_semiconductor.html
[40] Ibid
[41] Ministry of Foreign Affairs, (2023), “New Plans for Free and Open Indo-Pacific”, Government of Japan, [Online: Web], Accessed: 27 August 2024, URL: https://www.mofa.go.jp/files/100484990.pdf