

Assessing The Effectiveness Of India's Technology Transfer Initiative To Foster Innovation

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1. Abstract

India's systematic approach to technology transfer, rooted in the establishment of the National Research Development Corporation (NRDC) in 1953, has evolved to become a critical process of economic development, security enhancement, and global influence. This paper explores India's commitment to technology transfer, driven by recommendations from various studies and reports, ensuring rigorous scrutiny to prevent lacunas in technology transfer. India's remarkable performance in the 2022 Global Innovation Index underscores its growing global world importance in innovation. Intellectual property rights (IPR) play a centric role in safeguarding technology transfer from infringement, with the entire process protected by the transferor nation or industrial entity. India's partnership with the United States emphasizes shared values that more focusing on trade and defense deals, with attention on sustainable development during India's recent G20 presidency. The paper primarily delves into foreign licensing, attracting Foreign Direct Investment (FDI) in technology transfer. However, questions are raised about the true impact of foreign collaborations, calling for reforms to ensure genuine technological growth. This transformation reflects India's commitment to becoming a technologically advanced and self-reliant society with thriving technology-based livelihoods.

2. Introduction

India has been recognized as a crucial player in technology transfer Over the last decade in promoting economic development, strengthening internal and external security, and expanding into new markets throughout the globe. The recommendations from various studies and reports have emerged as a crucial step in ensuring the effective transfer of technology, coupled with rigorous study to prevent negative gaps during tech transfer¹. India's commitment to technology transfer aligns with its broader goals of fostering economic growth in disadvantaged regions, enhancing security, and contributing to global stability through social and political development along with India's regional sectors through public-private partnership. India's remarkable performance in the 2022 Global Innovation Index, ranking among the top 40 countries out of 132 nations, underscores its growing importance in the global innovation landscape. As the current president of the G20, India has a unique opportunity to solidify its leadership position and drive research and innovation on a global scale through geo-political ties. In the process of becoming a leading hub of technology by 2030, Intellectual Property Rights (IPR) play a pivotal role in safeguarding technology transfer, with the whole process protected by the transferor nation or industrial entity. Partnership like India and the United States has emphasized shared values of democracy, transformation, and multipolarisation after the G20 Presidency 2023 by India where

¹ Sampat B N, the bayh-dole model in developing countries: reflecting on the Indian bill on publicly funded Intellectual property

strategic partnership among all important nations shows their joint commitment with India to sustainable development goals.

3. Literature review

India currently has one of the fastest growing economies along with stepping towards self-reliant India, Tech transfer is always one of the fundamental bases of any developing nation to boost a country's goal policy for much sectoral growth through innovations, and India developed a long-term healthy multilateral relation with major interested nations like USA, UK, France, Germany as a result it helps to acquire tech understanding. by K. Sachpazidu-Wojcicka, In the Open innovation process via technology transfer and organizational innovation,² where it expressly recommends the Positive Relationship Confirmation, The surveys have provided evidence supporting a positive relationship between technology transfer and organizational innovations in the studied firms. This implies that when firms engage in technology transfer activities, it tends to have a beneficial impact on their ability to innovate within their organizational structures. Other hand the Diverse Channels of Influence The statement highlights that this positive effect on organizational innovations is not limited to a single pathway. Instead, it suggests that there are multiple channels through which technology transfer influences innovation. These channels include both material aspects, such as the transfer of tangible technologies or resources, and non-material aspects, which might involve knowledge exchange or collaboration.

Industry 4.0 technologies mean the integration of intelligent digital technologies into manufacturing and industrial processes like AI, Big Data, robotics, automation, then digital trust, and technological orientation- What matters in open innovation by MF Mubarak, M Petraite, in this research the broad finding is the fourth industrial revolution, presents a significant opportunity for both social and technological advancements. This revolution is characterized by advanced cyber-physical systems and technological infrastructure that can greatly enhance a company's productivity and innovation capabilities. However, Industry 4.0 also shortens product life cycles and requires faster innovation. Notably, the author said, the statement underscores that relying solely on internal resources will not suffice for a company to keep up with the accelerated pace of innovation in this era, implying the need for external collaborations and partnerships to thrive in the Industry 4.0 landscape by global partnership.³

In the "Transfer of Technology in Indian Defence Manufacture - Elements and Challenges" by TM Srinath, the finding of the research shows significant challenges that may occur such as intellectual

² K. Sachpazidu-Wojcicka, 'Open Innovation Process via Technology Transfer and Organizational Innovation, European Research Studies Journal Volume XXIII, Issue 1, 2020

³https://scholar.google.com/citations?view_op=view_citation&hl=en&user=KVmF_SgAAAAJ&citation_for_view=KVmF_SgAAAAJ:Zph67rFs4hoC

property rights, technological readiness of the recipient, trust between parties, costliness compared to off-the-shelf purchases, availability of skilled labor, demanding terms, high costs, reluctance to transfer niche technologies, and fear of brand dilution of small businesses to absorb technology.⁴

The literature reviewed in this paper highlights the significant changes that will lead to some great significance in being part of our futuristic goal in India's technology transfer initiative to foster innovation. The analyzed data from multiple sources has provided a comprehensive and in-depth understanding. The paper also identified that the technology transfer leads to a greater force which includes vast sectors under it and primarily covers defense pacts and deals. The fear of a new Artificial Intelligence model may create Intellectual property rights violations and create hurdles in the system between big technology firms that directly collaborate with government projects in various regions of India. India's recent emerging initiatives like INDUS-X under iCET related talk about expressly and giving assurance to the USA about proper technology protection in the era of cyber threats from China because the USA being a most trusted partner to India, china in the past stole many technology blueprints or sort of reverse mechanism indirectly by its force tech transfer that has been practiced since long and it result in many IPR disputes. this paper suggests that implementing the recommendations made by various studies and reports can significantly improve the proper tech transfer with appropriate scrutiny to find loopholes that may not be authorized.

4. Objective of Technology transfer initiative

India's sole purpose behind the transfer of technology is to promote economic development in underdeveloped regions and strengthen India's internal and external security, while also helping to open new markets with increased social and political stability that can have global benefits to make a resilient approach, as we can see this approach during covid 19 where India alone distribute self-made vaccine to 15 countries, it shows India's potential that possible with the proper implementation of public policy in required to promote innovation and easy access of technology at low cost.

Human capacity and technological knowledge combined contribute to India's core sectors mainly in the financial, defense, and R&D sectors, which become the government's primary objective to attract more tech transfer deals with developed nations to understand the process of development in the modern era. To create enabling and showing environments for innovation, particularly by stimulating research and development. This includes greater investment in science, technology, and innovation infrastructure by both public and private entities, which will build human capital, and bolster intellectual property systems to create greater incentives.⁵

⁴ TM Srinath, 'Transfer of Technology in Indian Defence Manufacture - Elements and Challenges TM Srinath'
<http://doi.org/10.18231/j.jmra.2020.003>

⁵ by edward harris, wipo communications division, international tech transfer can benefit all

The budget of 2023 mainly highlighted topics related to fostering or enhancing innovation, Prime Minister Narendra Modi, in his recent address at the 108th Indian Science Congress, has articulated the strategic role that science and tech would play in shaping the nation. PM Modi has said in the event that India will be the most advanced laboratory of modern science. In the 2022 report, India performed extensively well in the rank of the Top 40 countries in the 132-nation Global Innovation Index, which shows India will achieve a greater milestone in the future in both the defense and R&D sectors. As the current G20 president, India now has an opportunity to establish its credentials as a leader and a driver of research and innovation with More focused objectives on addressing major issues related to the global economy and technology collaboration with partner countries, such as because international financial stability and sustainable economic growth.⁶

5. Role and importance of IPR in technology transfer

Technology transfer is basically a wide term that is discussed as it helps developing nations to understand how innovations can improve the economy and style of livelihood, There are some forms on the basis of which power shifted from one body or entity to another such, as a licensing agreement, joint ventures, research, and development collaborations these are mainly done by big market cap companies such as Lockheed Martin, General Dynamics, Hindustan aero, Bharat electronics. Technology transfer is one of the crucial mainstream factors that transfer knowledge, skills, and expertise. In tech transfer Intellectual property right holds significant importance because the whole transfer is protected by the transferor nation or the industrial entity. In the world market, there are various kinds of products made by various entity that is the reason, IPR classifies and save the real owner's right under patents, trademark, copyrights, trade secrets, and geographical indication. One example of tech transfer other than defense which is massively shared by companies is that pharmaceutical companies may hold licenses of new drugs to a company in another country, allowing them to manufacture and sell the drug in the market it involves big tech laboratory companies.⁷

In the present time when India growing as one of the fastest economies in the world, Its defense ties and innovation sectors such as the Department of Science and Technology, and Department of Biotechnology International trade deals broadly focus on this 21st century with the essence of India's Atmanirbhar Bharat. India's recent development in military ties with the US importantly strengthened the defense sector which concluded with the visionary roadmap of industrial

⁶ Budget 2023 can boost India's march to global leadership in research & innovation, Jan 18, 2023, 06:11 IST
http://timesofindia.indiatimes.com/articleshow/97063772.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

⁷<https://enterslice.com/learning/what-is-the-significance-of-technology-transfer-in-ipr/#:~:text=One%20of%20the%20main%20benefits,the%20drug%20in%20that%20market.>

cooperation to fast-track technology tie-ups and co-production of military platforms such as air combat and land systems.⁸ It has some benefits and demerits on the IPR side and because of that both the entity must note some key points as necessary while transferring.

Benefits- Transfer of technology offers cost savings, sparing businesses, especially SMEs, from developing technology from scratch. This enhances the area of competitiveness, improving products and services, ultimately spurring economic growth and job creation, and aids in capacity building, particularly in developing nations by granting IPR rights.

Challenges- IPR in tech transfer may create barriers. Negotiating licensing agreements can be intricate, especially with multiple parties and differing legal frameworks. Balancing the interests of technology owners and recipients can create tensions over intellectual property rights. Concerns also arise about technology misuse, potential infringement, and the transfer of outdated technology and the other hand as in the past we have seen China's high-tech cyber activity to steal key information on military weapons become a potential threat.

6. India's defense technology transfer policy initiative

In the budget 2023 the Finance minister introduced the bill where, The Ministry of Science & Technology has received an allocation of ₹16,361.42 crores in the Union Budget, a nominal increase of 15% from the previous budget estimate, this total allocation amount further on spending the Department of Science and Technology (DST) in India received a significant increase of 32.1%, totaling ₹7,931.05 crores. This boost is largely attributed to a ₹2,000 crore allocation to the National Research Foundation, aimed at strengthening research-related institutions and fostering better connections between research, academia, and industry for innovation with inclusive development. The Department of Biotechnology (DBT) received a modest 3.9% increase, reaching ₹2,683.86 crore. However, the Biotechnology Industry Research Assistance Council (BIRAC) under DBT faced a 40% reduction in funding. The Ministry of Earth Sciences saw a 25.11% hike, totaling ₹3,319.88 crore. These allocations support research and development efforts in India, addressing a long-standing demand from the research community, despite a decline in gross expenditure on research and development since 2009-2010.⁹

a. India-US defense and technology cooperation

The recent visit of Prime Minister Narendra Modi to the US has sparked significant interest in the future of the defense relationship between India and the USA. With the emerging initiative of iCET and under its platform like INDUS-X introduced, questions arise about technology transfer, changes in India's defense policy, and the impact of technology regimes like International Traffic in Arms Regulations (ITAR) on this crucial partnership.

⁸<https://economictimes.indiatimes.com/news/defence/india-us-to-establish-ambitious-roadmap-for-defence-industrial-cooperation/articleshow/100763028.cms?from=mdr>

⁹ <https://www.indiabudget.gov.in/>

India and the USA hold immense significance for the future and present security landscape. Initiatives like INDUS-X aim to foster collaboration between startups and private sector entities like seeing a little bit of it with Tata and Lockheed Martin and other OEM (original equipment manufacturer) tie-ups, potentially enabling co-production and fast-tracking defense production during extended conflicts. This partnership becomes even more crucial given the lessons from the Russia-Ukraine war, emphasizing the importance of rapid production. The focus on cybersecurity and cutting-edge technologies like artificial intelligence and quantum computing underscores the shared interest in addressing modern security challenges. The Biden administration's commitment to elevating the defense relationship through initiatives like iCET and INDUS-X reflects a growing era of confidence and trust between the two nations. This evolving partnership not only enhances the security of both countries but also has the potential to shape global defense dynamics. India prefers multipolarity and a flexible approach in dealing with China even after the deteriorating situation between both countries, which may not align with US expectations. It's crucial for both nations to maintain their partnership, even if progress is gradual as it is good for the world economy.¹⁰

India's G20 Presidency and their commitment to sustainable development. They stressed the importance of the Quad in the Indo-Pacific and announced the U.S. co-leadership of the Indo-Pacific Oceans Initiative's Trade Connectivity and Maritime Transport pillar to expand the role of people-to-people exchange, including the Peace Corps¹¹.

The USA and India are evolving with significant developments and agreements. Notably, an MoU between GE Aerospace and Hindustan Aeronautics Limited (HAL) for co-producing F414 jet engines in India for the Indian Air Force was signed while PM Modi was in the USA this July 2023. Nonetheless, the specifics of critical technology transfer in this deal remain unclear, and it is unlikely that full technology details will be opened up in public without a commercial contract between GE and HAL. Later on, India and the US agreed to purchase 31 armed MQ-9B Sea Guardian drones from General Atomics, valued at \$3 billion. These drones, equipped with laser-guided bombs and missiles, are seen as assets to deter threats along India's land borders with China and Pakistan. However, it's uncertain how these technologies will be employed in more complex airspaces like the mountains of the Himalayas. The historical reluctance of US defense companies to transfer technology unless required by a commercial agreement with a foreign partner remains a challenge that has been seen in this agreement.¹²

¹⁰ Shreya Upadhyay, India-US Defence Partnership, *Indian Foreign Affairs Journal*, April–June 2019, Vol. 14, No. 2 (April–June 2019), pp. 116-128

¹¹ Joint Statement from India and the United States
September 08, 2023

¹² Abhijit Singh, <https://www.orfonline.org/expert-speak/us-india-defence-technology-cooperation/>

7. Innovation outcomes and impact

In the world, most technology transfers are taken from one developed country to another developing country through commercial tech transfer by private sectors which basically includes private sectors such as big companies having larger capital and taking the initiative to tie up partnerships with foreign companies so that it can execute in each level and this process includes foreign direct investment, foreign licensing, turnkey projects, technical consultancy, capital goods acquisition, international subcontracting, and joint ventures.

FDI in technology transfer:

The Absorption of Foreign Technology and Local Innovation Efforts which greatly popped up in the observation of how India's trade policy improved many livelihood styles and implementation models, the foreign collaboration certainly raised questions regarding the actual innovation and development happened or not, which broadly taken in many studies and needs to make reforms for particular focusing on the real positive growth in technology transfer, foreign companies that have partnerships with local companies in manufacturing industries tend to invest in research and development (R&D) to improve their innovative capabilities. Such examples in the past are- Many foreign manufacturing companies with local partnerships didn't spend any money on research and development in 2015-16. In fact, about 55.5% of them didn't invest anything in R&D. Among the remaining companies, about one-third spent less than 1% of their earnings on R&D during that time. Only a very small percentage (1.8%) of these companies spent more than 5% of their earnings on R&D.¹³

Foreign Direct Investment (FDI) has taken a crucial role in technology transfer, particularly in the context of India's current economic progression. Early, there was optimism that technical collaborations, including patent and design transfers, would facilitate ToT in the international market. Furthermore, it became evident that such collaborations often led to limited technology transfer, primarily resulting in last royalty payments. In India, until the 1990s, the Technology Policy Statement of 1982 strongly favored FDI as a source of technology as the growing world depends upon the other market. Patent laws constrained direct technology transfer through the purchase of drawings and designs. Nevertheless, there's a growing recognition that indirect technology transfer through spillover benefits is equally significant. Transnational Corporations (TNCs) introducing new products or processes in the host country particularly inadvertently diffuse technology to domestic firms, which can be competitors or suppliers to different foreign companies. This current situation enhances the technological capabilities of domestic entities. The rate of technology transfer is contingent upon factors like the technology gap between domestic and foreign firms. A wider technology gap often leads to more substantial and effective technology

¹³ Swati Verma, Technology Transfer through FDI in India: Mode, Extent and Prospects, October 2020

transfer, generating a “catch-effect.”¹⁴

Foreign licensing:

In India, licensing and merchandising which is also called part of foreign licensing, are experiencing significant growth, especially in the sports and entertainment sectors. This includes popular international brands like FIFA, Real Madrid, The Smiley Company, and the NBA, all of which are attracting business, retail activity, and consumer interest in the country which has taken a trend among youths. English football clubs like Manchester United have also established licensed academies and are also selling various merchandise in India which can be basically related to wearing products. The demand for sports-related products is increasing, particularly for adult clothing as well as teens at present time including accessories, and footwear, both online and in physical stores, and this trend is expected to continue to expand. A 2017 report estimates that the retail licensing market in India is worth approximately \$1.26 billion, which is now beyond it. Within this market, entertainment licensing accounts for \$406 million, fashion licensing for \$594 million, and sports licensing for \$30 million.¹⁵

Joint ventures and technology transfer:

France-India Horizon 2047 strategic partnership

India and France have a strategic relationship like brothers, both nations are strengthening their collaboration in science, technology, and academia to promote self-reliance and progress over the years. They're focusing on scientific cooperation, advanced digital technologies like AI and quantum tech, healthcare partnerships, cybersecurity, digital regulation, supporting startups, and defense ties as India received all 36 Rafael jets last year under the 2016 agreement. They're also working on a Digital Public Infrastructure (DPI) approach for inclusive digital economies. Most importantly, they're implementing a Unified Payment Interface (UPI) in France and building interconnected platforms in areas like mobility, commerce, and culture. Both countries aim to extend this approach to other regions like the Indo-Pacific and Africa, emphasizing the importance of digital innovation in the modern age.¹⁶

a. Technology advancement and commercialization in India:

In recent years, technology has become a pivotal topic for national progress and competitiveness. While India initiated scientific infrastructure for growth innovation and development after independence to boost self-reliance, the real emphasis on technology development and

¹⁴ Manoj Pant and Sangeeta Mondal, Discussion Papers in Economics FDI, Technology Transfer and Spillover: A Case Study of India

¹⁵ The rise of licensing in India, Ranjan Narula and Swati Dalal, RNA, Technology and IP Attorneys 01 May 2018

¹⁶ Horizon 2047: 25th Anniversary of the India-France Strategic Partnership, Towards A Century of India-France Relations, July 14, 2023

commercialization began in the 1980s. Policymakers recognized that technology wasn't just essential for progress but also for survival in a competitive world along with a civilized society with proper technology-based livelihood, especially the economy and defense sector. This shift reflected the concede of technology as a potent force for economic advancement. Policies shifted to promote innovation, research, and technology-driven entrepreneurship which gave rise to unicorns with a startup cultural environment, the importance of growing startups is of utmost necessary as we can see USA holds a significant amount of unicorns in sectors like Arm and defense supplier, medicines industry, IT sectors these are the basis which given potential strength to the government to work with independent power and it helps to make multipolarization ties with partner countries while dealing of transfer of technology.¹⁷

Under the Technology Transfer and Commercialization Rules, 2020 (TTCR), technology transfer can be done through various means such as licensing, and joint ventures. The process of technology transfer in India is regulated by the Indian Patent Office. The patent office reviews the application and provides the patent applicant with an examination report. The report includes an analysis of the patentability of the invention, any prior art, and other information related to the invention. The patent office also provides guidance on the best practices for technology transfer in India.

In this process licensing technology directly to private entrepreneurs and it through a public sector mediator and that's how it has been popularly adopted for transfer in technology transfer. One of the most important things included while licensing the transfer of technology is a memorandum of understanding, which agrees to pay a fixed rate of royalty for the use of the name and use the product to generate profit with a vision of specific sector development. Later on, a distinct drive towards technology generation and commercialization is mostly seen among scientists growing interest in research leading to patentable technology is broadly visible. For example in India, commercialization in Scientific innovations helps to improve crop productivity and efficiency often inclined to and taken for granted, which happened through technology licensing processes, scientific fraternity, and stakeholders' contributions in this part of technological innovation are slowly moving forward the process of assigning value to the most intellectual efforts put it forth by the scientist of each department.¹⁸

b. Contribution to economic growth

The most fundamental structural question that was raised decades back when there were any new developments related to the global summit and bilateral meetings to strengthen ties with any other nation to build India's self-reliant Atma Nirbhar Bharat at present initiative. There are some main

¹⁷ Commercialization of new technologies in India: An empirical study of perceptions of technology institutions February 2003, Technovation 23(2):113-120, DOI:10.1016/S0166-4972(01)00095-5

¹⁸ <https://nopr.niscpr.res.in/bitstream/123456789/33582/1/JIPR%2020%286%29%20363-374.pdf>

points that need to be highlighted, which include firstly, **Investments and collaborations** It works through foreign direct investment in India when any technology transfer takes place between two different national companies, and eventually, it boosts employment generation as the company advances or expands the work. Secondly, **domestic manufacturing**, and **skill development** help in the economic sector through domestic manufacturing in sectors specific like transport, and real estate by availing Intellectual Property rights, Lastly,¹⁹ **ancillary industries**, include some sectors such as infrastructure development, maintenance services, logistics, and software development, resulting in a ripple effect of job creation and economic activity, The Indian Government has undertaken a series of measures to bolster the economy and turn the COVID-19 disruption into an opportunity for growth to make India through technologically advanced and self-reliant. These initiatives include Atmanirbhar packages, the Production Linked Incentive (PLI) Scheme across various ministries, investment prospects through the National Infrastructure Pipeline (NIP) and National Monetisation Pipeline (NMP), the India Industrial Land Bank (IILB), Industrial Park Rating System (IPRS), and a soft launch of the National Single Window System (NSWS). To expedite investments, Project Development Cells (PDCs) have been established in relevant government ministries and departments, forming an institutional mechanism for streamlined project development.²⁰

C. Impacts on the research and development ecosystem

The importance of research and development (R&D) in driving economic growth, sustainability, efficiency, and global competitiveness cannot be exaggerated. For India to secure its future success and growth, a transformative approach to its science, innovation, and R&D ecosystem is the sole way one nation's economic system gets stronger. In the Union budget for 2023-24, the Ministry of Science and Technology has been allocated Rs 16,361 crore, which marks a 15% increase from the previous year. While this demonstrates a pivotal step towards prioritizing R&D, but one important question arises from an economic and development perspective: Is this increase sufficient to catalyze India's R&D ecosystem to the desired level?

One of the crucial measures to evaluate the strength of an R&D ecosystem is the Gross Expenditure on R&D (GERD). India's GERD, as reported in NITI Aayog's India Innovation Index Report 2021, is strikingly low, standing at a mere \$43 per capita. When compared to its BRICS and ASEAN peers like Russia (\$285), Brazil (\$173), and Malaysia (\$293), India's GERD expenditure is concerning. Interestingly, India even lags behind nations like South Africa (\$105 per capita) and Mexico (\$64 per capita). To secure India's R&D ecosystem, India must take a substantial leap in increasing its GERD expenditure, which aims to reach international

¹⁹<https://urbantransportnews.com/article/how-technology-transfer-is-revolutionizing-the-transportation-sector-in-india#:~:text=Ancillary%20Industries%3A%20The%20growth%20of,job%20creation%20and%20economic%20activity.>

²⁰ <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1882145>

standards. Sufficient funding is a fundamental essential for stimulating innovation, fostering research and technology development, nurturing collaborative ventures between academia and industry, and cultivating a robust culture of scientific environment.

While the recent budgetary allocations by parliament are commendable and represent a step in the right direction, sustained and substantial investments in R&D are vitally important. These investments will play a pivotal role in India's quest to leverage the transformative potential of science and technology in its growth trajectory over the coming decades. The data underscores the pressing need for India to make significant enhancements in its R&D expenditure to propel economic growth and enhance global competitiveness. As India aspires to become a 5 or 10 trillion-dollar economy, it must align its R&D spending with that of its BRICS and ASEAN counterparts, such as Russia, Brazil, and Malaysia. Furthermore, India's GERD as a percentage of GDP has remained stagnant at around 0.7% for a decade, falling behind countries like Brazil and South Africa. This lackluster investment in R&D could exacerbate the issue of "brain drain," where talented individuals seek opportunities abroad due to limited prospects at home.²¹

Private sector involvement in R&D in India is also lagging behind because of several reasons such as lack of proper funds, less expertized personnel more vibrant infrastructure based on work area, with a meager contribution of approximately 36%, significantly below global averages. Conversely, countries like the United States, South Korea, and Israel witness robust private-sector engagement in their technology sectors, with contributions exceeding 70%. A call to action is directed towards Indian businesses to substantially augment their R&D expenditures, surpassing the government sector and enriching the nation's R&D ecosystem. This endeavor will not only fortify India's position as an innovation hub but also cultivate an environment conducive to scientific advancements and economic growth.

8. Factors Affecting Effectiveness

The effectiveness of technology transfer and innovation in India is influenced by multiple factors. These factors encompass diffusion, commercial aspects, political considerations, environmental benefits, replacement benefits, human resources, economic fluctuations, and so on. Nevertheless, recent attention has been given to the concept of public value, which emphasizes the overall sustainability of ToT. In the scenario of public impact, it is essential to assess the interplay of factors at micro and macro levels and how they affect commercialization in a smoother form. Successful ToT in India requires collaboration among multiple stakeholders to address complex knowledge-related tasks, such as imaging, incubating, representing, marketing, and sustaining the evolving technology. This process falls under the purview of institutional sustainability, It is noteworthy that Western countries have traditionally led in technology development, research, and

²¹ <https://www.linkedin.com/pulse/rd-ecosystem-india-where-we-stand-frsc-fics-macs/>

commercialization. India, while still evolving its innovation capabilities, has been taking steps to embrace and adapt to this process.²² There are some key factors that mainly become a reason India does not willingly compete with China which is a decade ahead in technology.

- I. **Acceptance of Restrictions:** One of the key factors is India's willingness to accept the restrictions and conditions that come with technology transfer, particularly those imposed by the International Traffic in Arms Regulations (ITAR). It can impose strict limitations on the use and modification of technology received from the U.S. If India is not fully willing to comply with these restrictions, it can be a future hurdle in the smooth transfer and cooperation with the U.S. as they are more concerned with misuse of technology by any other nation through India.
- II. **Intellectual Property (IP) Concerns:** The limits imposed by ITAR on India's ability to add its own intellectual property to the technology it receives can be a significant hurdle. India may want the transparency to adapt and innovate upon the technology it acquires, but ITAR restrictions may hamper this process.
- III. **Bureaucratic Processes:** The approval processes for advanced defense technology transfer are described as "onerous," which means very difficult or needs cooperation effort. If India's own deal-making and bureaucratic processes are slow or cumbersome, it can delay the transfer of technology. Curtail the middle person of authority to make India's bureaucratic process more efficient and easily adaptable so that it can reach its goal within the specified time to finish the target.
- IV. **Overconfidence and Perception:** There may be a perception of overconfidence on the part of the U.S., which can hinder effective collaboration. The U.S. needs to recognize and appreciate India's growing IT expertise and the potential for mutual progress. Failure to do so can lead to missed opportunities, as the projection made by the World Bank by 2027-28 India become 3rd largest economy and some projections said India has potential growth and could surpass the USA by 2075 becoming 2nd largest economy, it is important to maintain diplomatic ties rather overconfidence in the emerging global market could lead bad consequences.²³

To better understand and assess the relative influence of these identified factors on the successful transfer of technology in India, a holistic model is proposed. This model aims to provide a comprehensive framework for evaluating and enhancing ToT effectiveness, taking into account the unique dynamics and challenges of the Indian context. India should process ToT is supported by the government levels it may help in diminishing the technological gap between foreign and local firms by establishing policies and systems encouraging R&D, those gaps should need to meet up

²² <https://www.mdpi.com/2071-1050/13/10/5600>

²³ By David Brunnstrom, June 24, 2023, Ambitious plans for US-India technology sharing face hurdles

through high capital, lower transaction costs between industries, reasonable cost pricing to curtail the trade barrier factors, which reduced the factors harming effectiveness.²⁴

9. Lessons from global best practices

In this research paper the main comparison with China's Forced Technology Transfer (FTT) policy, shows how India must incorporate a proper policy for innovation in the democratic structure of the country. Since long to till now many countries doing this forced transfer of technology which greatly impacts a country's futuristic approach, In donald trump regime On September 18, 2018, the Office of the U.S. Trade Representative (USTR) published a list of approximately \$200 billion worth of Chinese imports that will be subject to additional tariffs' as part of the continuous response to China's FTT practices and theft of American IP.²⁵ The tariff which was supposed around 10% initially that was later on in trumps US-China trade war climbed up to 25% in May 2019, In the scenario of the dominance of China's government to the foreign companies to avail easy IP rights, which works through bargaining power it shifted from original producers to domestic companies.²⁶

Practice concept in China/China's joint venture agreements in FTT policy

Forced Technology Transfer (FTT) is an informal government practice, that is largely associated with China's industrial policy but in some cases, China's government indirectly controls such policy. FTT involves requiring foreign investors to transfer technology to the host country as a condition for giving market access or investment opportunities, it is mostly called China's debt track. This practice is typically implemented without formal written laws or rules basically not binding from any authorized statute, making it challenging to detect and combat. China, in particular, has been widely known for its utilization of FTT policies as part of its industrial strategy. Historically since globalization started, China had 'market for technology' rules that granted limited market access to foreign investors who transferred advanced technologies to the country.

One of the primary methods China employs to induce technology transfer from foreign companies is through foreign ownership restrictions, it's more like producing self-made products by reverse engineering of real products. These restrictions require foreign companies to form joint ventures (JVs) with Chinese partners, In the last many years with the stipulation that the Chinese party owns a significant portion of the venture. Once a JV is incorporated, foreign companies are often

²⁴ <https://www.sciencedirect.com/science/article/abs/pii/S0960148110004143>

²⁵ Office of the U.S. Trade Representative, USTR Finalizes Tariffs on \$200 Billion of Chinese Imports in Response to China's Unfair Trade Practices (Sept. 18, 2018), <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/september/ustr-finalizes-tariffs-200> [https://perma.cc/CC6F-HS2T].

²⁶ dan prud'homm & taolue zhang, china's intellectual property regime for innovation risks to business and national development 78 (2019);

compelled to provide their Chinese partners with trade secrets and confidential information, which is against IP regulations. This occurs because government approvals are required for JV operations, and the government may insist on technology and information transfer as part of the approval process.

India's key learning policy from the China-USA trade war:

International trade is the backbone of a country's economy, as a developing nation we should focus more on diplomacy and ties with developed nations for the national interest as we can see how the trade war between China and the USA harming all other developing countries and it indirectly compensated by the general buyers. Technology Transfer is the elemental key from where we can access the advanced form of innovation as it gives an approach, to how India as a country should work on such research and development things so that India can get the second most powerful economy of the world by 2034. China's suppression approach, where falsely acquired technology but did not give the market autonomy for running the business of an international company wouldn't lead China to become flexible and versatile in the international market. It speaks that India's fair practice with foreign technology transfer and good commercialization of the policy will lead to the nation steady growth but eventually, the rule of law must need to be followed as India is the largest democracy in the world where Atmanirbhar Bharat, Make in India like initiative busting and challenging the global market inflation which can be reflected at present time where India's economic growth constantly growing with 6.5% annually, it giving edge to technology innovation for the better technology advancement.

10. Recommendations

India's technology transfer policy at the present time taken place is revolutionary as the US-India ties getting in the right direction under the current regime, which greatly impacts India's R&D sector to foster innovation, but there are some gaps in this process where the policy must needs a completely executed tactic so such technologies to deliver to the general consumer of the nation so that domestic market as well as regional beneficiaries can get the ultimate result of this tech transfer, there are some points could add in between to fulfill the gap and make the ToT way stronger and vibrant.

- I. It is suggested that the presence of loopholes, notably a lack of clarity in technology transfer agreements, can indeed raise concerns in defense collaborations. In cases like the co-production of F414 jet engines by HAL with GE Aerospace, the absence of a clear roadmap for executing the transfer, especially for sensitive hot turbine technology, may be attributed to GE Aerospace's commercial interests. The protection of proprietary technologies is a legitimate concern for businesses, as divulging them may invite competition or compromise uniqueness This is the reason 100% technology transfer somehow becomes a barrier. However, it is important for the United States to recognize

that India has made remarkable and achieved milestones over years of progress, both in terms of innovation and its emerging role in global geopolitics. India's commitment towards responsible and healthy technology use, coupled with its efforts toward self-reliance, aligns with U.S. interests, particularly in addressing shared challenges, such as the complex geopolitical landscape, especially in the Indo-Pacific, notably its stance on China.

While in the past experiences like the termination of the 2019 joint project under the Defense Technology and Trade Initiative (DTTI) may have made the U.S. cautious about technology transfer because it may prove a loss or insufficient, India's evolving capabilities and its growing significance as a strategic partner make it a dependable collaborator. To address concerns and potential disputes arising from a lack of transparency between countries, the U.S. can work towards fostering greater openness and trust in its technology transfer agreements with India.

- II. It is suggested that India's stance should actively encourage the growth of a robust private defense sector. By doing so, it can create a conducive environment for technology transfer from U.S.-based companies and establish standardized security protocols for easy reliability. Promoting private defense firms ensures that they adhere to stringent government security standards while expediting technology transfer, reducing costs, and accelerating development for example recently Tata Group and European aviation major Airbus made and supplied the C295 transport aircraft. This is the first time that the Indian defense ministry has entrusted a private company.²⁷
- III. India should implement a National human resource policy to attract talent back to the country, matching Western salaries and living standards. China's success in sending students abroad to acquire skills is an example as we have seen in India's context where 2.25 lakh people renounced Indian citizenship in 2022 but in China, most of the students after developing their skills from foreign universities, go back to China. India should focus on nurturing talent through collaborations between technical institutes like IITs, NITs, and other tech institutes from the country to dedicated R&D institutes for defense technology. Recent examples of technology transfer initiatives, the HAL-Safran Chopper joint venture to be in place within 3 months India has expedited work on a new military helicopter, which already includes the design and development of a new engine and heavy involvement of the private sector's skilled people for easy execution.²⁸
- IV. In the defense industry in the global market India's stance and prioritization of defense/tech companies like HAL because private companies are often driven by profit

²⁷<https://carnegieendowment.org/2018/01/10/removing-barriers-to-u.s.-india-defense-trade-pub-75206>

²⁸ TM Srinath, Transfer of Technology in Indian Defence Manufacture - Elements and Challenges, Original Research Article <http://doi.org/10.18231/j.jmra.2020.003>

motives. At the time commercial contracts are finalized, and private relationships are nurtured, it aligns the interests of both parties. Defense companies are more likely to share critical technologies when they see a direct financial benefit because the US government does not presume to act on behalf of US defense companies that own their intellectual property, which can be achieved through commercial agreements. These agreements provide a clear framework for ToT, production, and profit-sharing, making it more likely that advanced defense technologies will be transferred to India²⁹.

- V. The Department of Defense (DoD) should enhance its efforts to foster collaboration between laboratories and industries. This can be achieved by increasing the number of licensees and cultivating more strong partnerships. To facilitate recommendations for improving lab-industry interaction are offered. there is a conversation regarding the inclusion of necessary contract clauses in Government agreements, addressing pertinent issues associated with contractual requirements to further facilitate effective collaboration between the DoD and industry stakeholders.
- VI. India should consider the smooth streamlining of its technology transfer policy by prioritizing trust-based partnerships with Original Equipment Manufacturers (OEM) or countries that have a proven track record of successful technology transfers in the past. This approach can help overcome the challenges of lengthy procurement processes because technology can always move ahead in evolving innovation.

11. Conclusion

The establishment of a robust Transfer of Technology (ToT) policy in India is imperative, and its successful action is upon enduring mutual trust in political leadership, irrespective of party lines. Particularly in matters concerning national security, trust becomes a foundation for effective technology transfer. Once a ToT policy is in place and trust is cultivated with foreign countries and firms or companies, the process should proceed smoothly, provided that commercial considerations are adequately addressed. Ensuring the safety of foreign Original Equipment Manufacturer (OEM) investments and guaranteeing profitability through economies of scale while safeguarding Intellectual Property Rights (IPR) are essential components of the policy agreement. The Government of India has recently adopted innovation policies with multifaceted objectives, including addressing skill shortages, elevating global rankings in science, fostering commercial applications of research, and establishing a comprehensive innovation ecosystem in domestic as well as global systems. These policies underscore India's commitment to bridging the gap between science and society while promoting inclusivity and collaboration between the public and private

²⁹ ABHIJIT SINGH, US-India defence technology cooperation: Between illusion and reality

sectors in the realm of innovation. Regarding India's international relations, the nation's preference for a multipolar world order and a flexible approach in its dealings with countries like China highlights its strategic and concerning awareness. On the other hand, it is crucial for both India and the USA to manage expectations and continue to build the groundwork for a robust and enduring strategic partnership, while maintaining momentum in strategic partnerships, even if progress is gradual, remains essential.