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INDO-U.S. TECHNOLOGICAL COOPERATION AND ITS IMPACT ON INDIA'S ECONOMIC COMPETITIVENESS: A STRATEGIC ANALYSIS

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ABSTRACT

This paper examines the strategic aspects of Indo-U.S. technological cooperation and its impact on India's economic competitiveness in the context of shifting global power dynamics and the U.S.-China rivalry. Using the National Innovation Systems (NIS) framework, the study explores how flagship Indian policies, such as Digital India, Make in India, and Startup India, interact with U.S. investments under the Initiative on Critical and Emerging Technologies (iCET). Through case studies in semiconductors, artificial intelligence, and quantum computing, the paper highlights the role of joint research centers, foreign direct investment, and innovation ecosystems in advancing India's technological capabilities. The analysis also identifies structural challenges, including regulatory delays, digital divides, and intellectual property concerns. The findings underscore the need for a cohesive innovation strategy and improved institutional coordination. The study concludes that sustained, values-based cooperation with the United States is crucial for India to achieve strategic autonomy and enhance its role as a competitive actor in the emerging Indo-Pacific technological order.

KEYWORDS: Indo-U.S. Relations, Technological Cooperation, Economic Competitiveness, ICET, Digital India, Semiconductors, AI, Strategic Partnerships, Innovation Systems.

1. INTRODUCTION

In the evolving landscape of international political economy, technological cooperation has emerged as a critical enabler of national competitiveness. For emerging powers, such collaboration is not merely a tool for economic development but a strategic pathway to global influence. India's positioning within this framework reflects its ambition to transition from a technology consumer to a co-architect of global innovation (Boruah, 2024). Among India's most strategically significant partnerships is its deepening engagement with the United States. Once defined by security and transactional diplomacy, the Indo-U.S. relationship has matured into a multifaceted strategic alliance encompassing digital infrastructure, defense technologies, clean energy, and innovation-driven trade. Within this bilateral framework, technological cooperation occupies a central role. Initiatives such as the *Initiative on Critical and Emerging Technologies (iCET)*, the *Strategic Clean Energy Partnership*, and Micron's multibillion-dollar semiconductor investment in Gujarat exemplify a shift from short-term collaboration to long-term strategic convergence. This transformation reflects shared geopolitical imperatives, including supply chain resilience, strategic autonomy, and a commitment to democratic governance of technology. It also positions India as a pivotal player in the emerging multipolar digital order (Ezell, 2024). India's domestic policy architecture, anchored in programs such as *Digital India*, *Startup India*, and *Make in India*, has created a conducive environment for high-tech investment, institutional reform, and talent mobilization. These initiatives aim to integrate India more deeply into global technology value chains while enhancing its indigenous innovation capacity (Statista, 2025). In spite of the increasing ambit of bilateral cooperation, there exists an important research void on the economic competitiveness impact of India. Scholarship on the subject frequently ignores the strategic dimensions of technological partnership, especially in frontier areas like semiconductors, artificial intelligence, and quantum computing (Centre for Public Policy Research, 2022).

This study aims to address an important gap by assessing how technological collaboration between India and the United States has influenced India's global economic standing. Drawing on sectoral analyses and strategic case examples, the research investigates whether this cooperation represents a transactional alignment or a deeper structural adjustment of India's innovation ecosystem. The paper situates the Indo-U.S. partnership within the

broader landscape of shifting global technology orders, intensifying U.S.-China rivalry, and the contested security framework of Asia. Through this approach, it becomes clear that the transfer and development of strategic technologies directly impact both the geopolitical balance of power and the economic capabilities of countries (Wechsler, 2025). In a rapidly changing global political economy, technological cooperation has become a fundamental pillar for enhancing competitiveness. For emerging powers, technological partnerships are no longer merely tools for supporting economic growth; they also amplify their political influence and position them better in global value chains. In this twenty-first century, driven by a strange digital world, strange production structures, and an economy built on broad understanding, there is a growing need for robust technological collaborations to advance our country in innovative ways. Beyond the usual buy-and-sell deals, these alliances operate within creative clusters that transcend national borders, allowing for the exploitation of copyrights, stimulating collaborative research, and channeling creative energies into ways that could shape the future of the country's development. In the Indian context, domestic policy adjustments have played a key role in maintaining this interactive trajectory. Initiatives such as "Make in India," "Startup India," and "Digital India" have established a broad foundation for infrastructure development, human capital development, and attracting more investments in technology sectors. With the development of internet services, the implementation of e-government, and the increased flow of capital into high-value-added sectors, in addition to building the third-largest startup ecosystem in the world, India has been able to consolidate its presence within global technology chains and significantly enhance its research and development capabilities. The paper looks at the National Innovation Systems (NIS) view to understand the big and set rules that move Indo-U.S. work together. The NIS view takes in how government rules, research places, firms, and people power mix to shape new idea power. Through this view, the paper can go beyond just looking at trade or money coming in. It can see how links and back-talk in groups help tech get ahead. At the same time, key parts of smart trade ideas show why it's key to keep and help top tech areas grow.

India's quest to not just use, but also make world tech shows its big goal to shift from just taking in tech to actively inventing it. This goal builds on its large young population, the rise of its digital market, and rules that increasingly support those who start new

businesses and think up new ideas. Among its many global links, its ties with the United States are deep. In the past, there was little trust between these two countries, and their meetings were limited after the end of the Cold War. However, over the past two decades, relations have developed significantly, gradually moving from caution to a solid and broad partnership, based at its core on strategic interests. Today, the two countries are closely linked in some of the most important areas of the modern era, such as defense technology, renewable energy, cybersecurity, semiconductors, and advanced digital services. Together, these ties form a solid foundation for a shared strategic vision for the Indo-Pacific region. Projects like the Initiative on Critical and Emerging Technologies (iCET), the U.S.-India Clean Energy Partnership, and big business moves such as Micron's new semiconductor plant in Gujarat clearly show how closely their goals now come together. These moves, unlike short-lived economic deals, have been clearly aimed at strengthening supply chain resilience after COVID-19, protecting technological independence, and deliberately promoting democratic values in digital governance. On the domestic side, policy changes were absolutely crucial for staying on this ambitious track. Programs like Digital India, Startup India, and Make in India were deliberately introduced to attract high-tech investments, reform institutions, and steadily build human capital. With faster broadband, steadily improving e-governance, increasing flows of foreign capital into value-rich industries, and the careful growth of the world's third-largest startup ecosystem, India has firmly embedded itself in global technology value chains while simultaneously nurturing its own research and development capabilities. His research is based on the concept of the National Innovation System (NIS) to understand how Indian-American cooperation is shaped. The relationship between the two countries is not based solely on hard numbers such as trade volume or investment value, but rather on a broader network of government policies, research institutions, private companies, and human capital working together to build a sustainable innovation capacity. From a different perspective, strong partnerships and ties become more valuable than money itself, because they are what clearly demonstrate a country's strength in science and technology. Here, the idea of smart trade converges with the larger goal of maintaining and expanding advanced technologies while using interstate relations to gradually reduce the need for others. The technology battle between the US and China has made India an unusually

important player, especially in the G4, which includes the US, Japan, and Australia. This agreement has made it possible to share things like supply security, establish certain standards, and conduct studies together in a pleasant way. However, India walks a careful tightrope, benefiting from collaborations while maintaining its freedom, especially on important issues like intelligence that thinks for itself, how we communicate with each other, and the exotic minerals that give us life. Of course, the path is fraught with surprises. India is still stuck with old issues, such as poorly maintained roads in some places, strangely complex laws, conflicts over who owns ideas, and strange technological disparities between cities. All of these obstacles make it very difficult to reap the full benefits of working with other countries. Moreover, even when working together, the goals may be different. While America is throwing its weight behind ensuring the flow of goods, India is focused on creating jobs here and there, as if building a fortress of self-sufficiency. This is somewhat strange. If these differing views are not carefully managed, they could become problems that disrupt cooperation. Existing studies often examine either the economic impact of India's technology policy or the geopolitical dimensions of its foreign policy. This article bridges these two areas and explores how techno-economic cooperation as an aspect of geo-economics can influence India's competitiveness not just in terms of GDP or export value, but also through innovation-led growth, setting global technology standards, and governing digital public goods.

The empirical research focuses on semiconductors, artificial intelligence, and quantum computing advanced sectors characterized by rapid innovation, strategic competition, and significant economic potential. Through collaborative R&D efforts, investment flows, and ecosystem building, the research addresses a central question: Is the Indo-US partnership delivering only mutual economic benefits, or is it reshaping India's innovation ecosystem more deeply? The research, in the end, puts such processes in the larger Indo-Pacific security context, in which tech partnerships are the cornerstone of cyber security, energy security, and tech self-sufficiency. The findings are that sustained, value-driven collaboration in emerging tech could both increase India's global competitiveness and ensure its strategic autonomy. Historically, Indo-U.S. technology relations were deeply uneven, having been heavily constrained by Cold War geopolitics, India's policy of non-alignment, and strict American export controls. However, the economic

liberalization reforms of 1991 represented a true turning point, gradually opening India's doors to foreign investment and propelling it to integrate more deeply into global supply chains. From that span, collaboration has grown stronger, like a tree growing roots in a national innovation system. This system focuses on conducting research together, sowing seeds of knowledge, sharing experiences, transmitting sunshine, aligning our laws, and sharing a common language. At the same time, the frenzied technology race between the US and China has created India as a rapidly growing democracy with a wealth of brilliant minds in science, technology, engineering, and mathematics. This has made its relationship with the US a cornerstone of its plan to transform the Indo-Pacific. By integrating the wonders of technology into the core of its policy, India is cementing its position as a global decision-maker, enabling it to contribute to shaping the coming digital transformation and its rules and regulations.

1.1. The Strategic Foundations of Technological Cooperation

The techno relationship among India and the US perfectly mirrors a gradual yet significant political and strategic thaw. During the early decades following India's independence in 1947, bilateral engagement in the field of technology remained limited, constrained by both geopolitical rivalries and ideological divides. India's commitment to a policy of non-alignment prevented it from going fully with either the Soviet bloc or the Western camp led by Washington. At the same time, stringent U.S. export control measures under the Coordinating Committee for Multilateral Export Controls (CoCom) imposed severe restrictions on the transfer of dual-use technologies, advanced scientific equipment, and defense-related innovations to India. This restrictive environment curtailed India's early access to cutting-edge technologies, delaying the possibility of deeper technological cooperation between the two countries.

A slow but notable shift occurred in the 1980s, with limited cooperative projects in agriculture (such as Green Revolution-related collaborations) and public health research. However, the true watershed moment came with the 1991 economic liberalization reforms, which dismantled many trade barriers, encouraged foreign direct investment, and opened the Indian economy to global technology flows. The period between 1991 and 2005 witnessed a gradual intensification of Indo-U.S. technology interactions, particularly in information technology services, pharmaceuticals, and space science. The signing of

the Civil Nuclear Energy Agreement between the United States and India in 2005 not only marked a strategic shift in defense and energy cooperation, but also laid the foundation for building broader trust in advanced technology. Since the mid-2000s, and particularly after the partnership was upgraded to a Comprehensive Global Strategic Partnership in 2016, the focus has shifted decisively toward critical and emerging technologies. This phase has been characterized by the integration of stakeholders from government, the private sector, and academia into organized platforms for sustained collaboration, enabling a transition from limited and isolated joint research projects to systematic multi-sector partnerships.

1.2. Strategic Agreements and Emerging Technology Initiatives

The United States is working to develop technological cooperation for children in the coming years. Among these advanced measures, the Frontfoot 2023 plan has been launched, which includes marvels such as smart computers, artificial intelligence, large-scale laser technologies, and chips. This construction is positioned as a reliable way to stimulate social creativity, as well as to help the two countries solve mathematical and graphical problems, and also to overcome difficulties in support methods. In this modern framework, the transfer plans and mission take on a different form, as narrow industrial cooperation constitutes greater support for intelligent interoperability. This is most clearly evident in the areas of arms transfers and the green energy alliance between the two countries, and does not encourage lasting cooperation in the long term. This allocation of technological links between India and the United States is based on an overlapping structure, with official bodies and ordinary people working together. Through bilateral working groups, inter-ministerial committees, and platforms bringing together the public and private sectors, regulatory standards are coordinated, research priorities are identified, and industrial strategies are drawn up to ensure the continuity and expansion of this cooperation. The two sides' goals reinforce each other: India seeks access to advanced technologies, capacity building, and attracting foreign direct investment, while the United States views India as a strategic partner to ensure the resilience of global supply chains and counterbalance Chinese influence in the Indo-Pacific region. India's national programs, such as *Semicon India* and *Make in India*, function as enabling mechanisms within this architecture, incentivizing U.S. firms to integrate

India into their global innovation networks (Gupta, 2024).

Beyond institutional mechanisms, soft power and diplomatic outreach have played a pivotal role in cementing India-U.S. technological ties. High-level visits, joint statements, and summit diplomacy have consistently emphasized the shared democratic values and innovation-oriented ethos that bind the two nations. The cultural affinity of India's tech diaspora in Silicon Valley, English-language scientific collaboration, and India's growing participation in multilateral tech platforms all contribute to an ecosystem of trust. These diplomatic channels serve not only to operationalize agreements but also to project a shared vision of inclusive, rules-based technological governance (Foreign Policy, The Policy Circle, 2022).

1.3. Institutional And Ecosystem Linkages

The architecture supporting this cooperation is multi-layered and multi-actor in nature. Key components include:

- Bilateral working groups on areas like AI governance, semiconductor supply chains, and cyber security resilience.
- Public-private platforms such as the U.S.-India CEO Forum, which align corporate investment plans with policy priorities.
- University-led consortia, including joint PhD programs, research fellowships, and technology transfer offices linking U.S. and Indian higher education institutions.
- Government-to-government task forces, which work on harmonizing standards, aligning export control regulations, and creating fast-track approval mechanisms for technology-related investments.

From India's side, domestic plans such as Simeon India, Make in India, and Aatmanirbhar Bharat appear to be supportive measures, offering financial rewards, infrastructure boosts, and political stability to attract American business.

India represents a large chess piece for the United States against China, a rapidly growing exotic market that buys everything new and exciting.

1.4. Diplomatic And Cultural Dimensions

In addition to official channels, subtle kindness and whispered communications have strengthened the two countries' technology partnerships. Summits, such as Prime Minister Modi's visit to Washington in 2023, have been used to announce major digital deals and demonstrate a political desire for lasting cooperation, like the trunk of a tree. It's no secret that

Indians have left a strong mark on Silicon Valley, but their role goes beyond personal superiority. They are like the strange connection between India's imagination and America's technological power. It's not just a language that unites us; it encompasses the myriad aspects of our culture, building strong bridges of friendship with India's participation in influential international alliances. The magic of this collaboration lies in its transcendence of theory or remaining confined to halls; It has become very tangible and impacts people's daily lives. Thanks to programs like iCET and clean energy projects, cooperation has expanded to include important areas like agriculture and healthcare. Take, for example, the India-US Artificial Intelligence Project, which began suddenly in 2022. This step allowed for joint research into the truth and error of AI, its use for better agriculture, and even the development of useful new medicines that saved many lives. Shouldn't we remember working together in space? Through teamwork, satellite projects and Earth surveys began, and this has truly advanced cooperation between our two countries. This wasn't just a short-lived friendship; it has become an eternal covenant with completely understandable goals. Old forums, such as the Indian-American Scientists Club, are simplifying scientific work plans and removing legal complexities in a remarkable way. One of the most important outcomes of this union is the Innovation Corridor between Bengaluru and Silicon Valley, connecting new Indian companies with American funding and research, and giving Indian innovators global opportunities that were once unimaginable. So what happened? India is no longer just a recipient of technology, but also a co-creator of new solutions from the ground up. Collaboration is not just good for money; it gives us incredible strength to tackle the challenges of our time, such as changing weather and network security, and helps create a digital ecosystem that is understandable and fair to all people around the world.

1.5. Technology And Competitiveness in India's Development Vision

If we try to understand how India envisions its future and strength in the 21st century, we find that technology is at the heart of this vision and its driving force. India's ambition is no longer limited to traditional economic growth, but rather something deeper: to be a major player on the global stage, become a center of innovation, and build a resilient, competitive economy.

1. Following Indo-U.S. collaboration, India wishes to:

2. Enhance local innovation capacity – via joint R&D centers, tech parks, and startup accelerators.
3. Enhancing industrial value chains especially in electronics design and clean energy technologies.
4. Building standards-setting capability to get a seat at the table to write the world's rules on AI ethics, 5G interoperability, and data governance.
5. Levelling up human capital through skill transfer programs, STEM education exchanges, and research fellowships.

Table 1: Comparative Matrix - India-U.S. Vs. China Tech Partnerships

Feature	India-U.S. (iCET Model)	China (Made in China 2025)
Innovation Strategy	Collaborative, private-sector-led	State-driven, government-led
Governance Values	Open, democratic, rules-based	Centralized, opaque, authoritarian
Foreign Policy Alignment	Indo-Pacific, QUAD, strategic balancing	BRI, SCO, assertive tech nationalism
Data Governance	Debates on localization, privacy, and digital sovereignty	State control, surveillance-heavy
Soft Power	Silicon Valley diaspora, multilateralism	Belt & Road Tech Diplomacy
IP and Legal Regimes	Improving, still developing	More vigorous enforcement, but IP theft concerns
Tech Sectors Targeted	Semiconductors, AI, Quantum, Digital Infrastructure	Robotics, AI, Aerospace, 5G

This contrast makes up relief the various normative, strategic, and operational foundations of India's tech relationship with the U.S. compared with China. While the China strategy is based on centralized state power and scaling up quickly, India-U.S. strategy skews toward networked innovation, diffuse governance, and private-sector drive a model closer to dominant liberal economic international norms.

2. THEORETICAL FRAMEWORK: NATIONAL INNOVATION SYSTEMS AND ECONOMIC COMPETITIVENESS

Theory Basics: How Nations Innovate and Compete in the Economy

The Indian approach to national development today is led by the strategic use of technology on the economic development process. As described by the National Innovation Systems theory, the investigation of the phenomena of the interactions of the government institutions and private firms, universities, and the diverse policy systems sheds light on the above fact. NIS does not put emphasis on the R&D expenditure but on the institutional coordination and the dissemination of knowledge of a country that decides the degree of the technological competences and status of competitiveness on the international level (Dutta, 2010).

India's innovation system is characterized by strong state involvement, manifested through targeted programs, fiscal incentives, and an expanding network of public-private partnerships designed to stimulate technological progress. This integrated model holds the promise of reducing external technological dependence while fostering indigenous solutions across a wide spectrum of

sectors, from pharmaceuticals to space exploration and emerging areas such as quantum computing. At the same time, India's deepening engagement with global innovation ecosystems—most prominently through partnerships with the United States—has given rise to a hybrid framework in which domestic policy reforms increasingly converge with international norms and best practices.

Domestic human capital, diaspora expertise, and foreign alliances form a complex dynamic that drives India's innovation ecosystem. While India relies heavily on the intellectual resources of its global diaspora, it also benefits from a large, educated workforce and a vibrant startup ecosystem. These resources have been effectively channeled to enhance R&D, transform knowledge into practical applications, and commercialize it. In this context, innovation can be viewed as a highly dynamic and flexible system, constantly shaped by interactions between government policies, institutional capabilities, global networks, and geopolitical imperatives, rather than a linear or entirely autonomous process. This fluid architecture clarifies how India's cooperative initiatives, especially with the United States, function less as a one-way transfer of technology and more as Complimentary mutual creative processes support long-term competitiveness.

2.1. India's Policy Push: Digital India, Make in India, Startup India

India's quest for technological competitiveness stems from a trilogy of national transformation initiatives: Digital India, Make in India, and Startup India. These flagship initiatives, launched in the mid-2010s, aim at infrastructure rejuvenation, indigenous

production, and robust innovation ecosystem. Together, they form the cornerstone of India's mission to be a digitally empowered, self-sufficient economy at the forefront of global technological value chains (Boruah, 2024).

Digital India seeks to bridge the digital divide by expanding internet access, promoting e-governance, and enabling digital service delivery. It has accelerated the growth of India's digital economy, particularly in sectors such as fintech, health tech, and education platforms. Meanwhile, make in India is designed to attract investment in manufacturing by easing regulations and offering incentives to both global and domestic companies in sectors such as electronics, automotive, and defense. This program has gained renewed importance as India aspires to become a global alternative to China in the post-pandemic supply chain reconfiguration.

Startup India, on the other hand, targets India's vibrant youth and entrepreneurial base, aiming to position the country as a hub for innovation-led growth. Through exemption from taxes, streamlined regulatory compliance, and access to funding, the initiative has catalysed the emergence of over 100 unicorns and made India the world's third-largest startup ecosystem. The most important aspect is that all these policy efforts are connected and complementary strategies, all cumulatively working towards a national innovation narrative in competitiveness, inclusiveness, and strategic autonomy.

2.2. Foreign Direct Investment and Technology Transfer

Foreign Direct Investment (FDI) has been a cornerstone of India's strategy to enhance its technological capabilities and economic competitiveness. By attracting global capital into high-tech sectors—such as semiconductors, information technology, renewable energy, and defense—India has positioned itself not just as a low-cost destination but as an emerging innovation hub. FDI flows often bring advanced technologies, managerial expertise, and access to international markets, all of which are crucial for enhancing domestic productivity and integrating into global value chains (Centre for Public Policy Research, 2022).

Recent Indo-U.S. collaborations have significantly amplified this trend. For instance, strategic investments by U.S. companies such as Micron Technology and Google signal confidence in India's regulatory and industrial environment. The establishment of advanced R&D facilities and

semiconductor assembly plants, particularly in states like Gujarat and Telangana, marks a shift from traditional outsourcing to strategic co-development. These investments are increasingly framed within the lens of technological sovereignty and digital security, reflecting a shared interest in de-risking global supply chains and diversifying away from China (Ministry of External Affairs, 2024).

To support these inflows, the Indian government has enacted sector-specific policies, including the Production-Linked Incentive (PLI) scheme, liberalized FDI norms, and state-level innovation clusters. These mechanisms not only facilitate capital inflows but also accelerate the absorption and adaptation of foreign technologies within the local ecosystem. However, the success of technology transfer hinges on India's ability to strengthen its intellectual property regime, improve regulatory clarity, and invest in technical education and upskilling to ensure long-term sustainability.

2.3. Sectoral Deep Dives

Semiconductors: The semiconductor sector has been an area of Indo-U.S. collaboration, whereby Indian firms have attracted multi-billion-dollar investments from corporations in the United States, such as Micron, Applied Materials, and Lam Research. The initiatives, as well as the supply-chain diversification, also give India opportunities of having fabrication plants, packaging centers with advanced packaging, and designing centers for chips. With the geopolitical nature of the semiconductors' supply chains, the investment gives India greater influence in the governance of the world technologies.

Artificial Intelligence: India-US AI partnerships span a wide range of sectors, such as agriculture, diagnostic healthcare, and smart transportation. A partnership between Indian Institutes of Technology and US institutions has resulted in the development of AI-powered systems that can estimate crop yields, provide telemedicine services, and predict traffic. These models demonstrate how AI can practically address development challenges while opening up new marketable business opportunities.

Semiconductors: The semiconductor sector has also been a prominent area of Indo-US cooperation. Indian companies have attracted billions of dollars in investments from US giants such as Micron, Applied Materials, and Lam Research. These investments, coupled with efforts to diversify global supply chains, represent a significant opportunity for India, supporting the establishment of advanced manufacturing facilities, advanced packaging

centers, and leading chip design centers. Given the geopolitical nature of the semiconductor supply chain, these investments give India a greater role and influence in global technology governance.

AI: The Indo-U.S. partnership in artificial intelligence spans a wide range of fields, including smart transportation, agriculture, and healthcare. Collaborative projects between American universities and India's IITs have already produced practical solutions such as traffic prediction systems, telemedicine platforms, and AI-driven crop estimation models. These examples show how AI is not only helping address development challenges but also creating new opportunities for commercialization. Through the U.S.-India Strategic Clean Energy Partnership, both countries have also strengthened cooperation in green hydrogen, advanced battery storage, and carbon capture technologies. By combining India's large-scale manufacturing strengths with U.S. innovation networks, the two sides are well-positioned to speed up the commercialization of low-carbon technologies. This makes India an attractive hub for cost-effective, scalable, and sustainable clean energy solutions and positions the partnership as a driver of meaningful global climate action.

2.4. Role Of Joint Ventures And R&D Hubs

Collaborative R&D ventures and innovation hubs are central to India's strategy for enhancing competitiveness. U.S.-India joint ventures in fields such as artificial intelligence, space research, and pharmaceutical manufacturing demonstrate how bilateral cooperation can enhance indigenous capabilities. Institutions such as the Indo-U.S. Science and Technology Forum support joint research, faculty exchange, and commercialization pathways for frontier technologies. These hubs serve not only as platforms for innovation but also as nodes of geopolitical alignment, advancing shared strategic objectives in high-tech governance (Indo-U.S. Science and Technology Forum, 2025).

2.5. Case Studies: Emerging Technologies as Strategic Assets

India's ambition to assert itself as a leading technological power has been increasingly grounded in concrete, high-impact collaborations with the United States, particularly in emerging and strategic sectors such as semiconductors, artificial intelligence, and quantum computing. These case studies provide valuable insights into how bilateral cooperation translates into tangible economic and technological gains.

One of the most prominent examples is the 2023 investment by Micron Technology, a U.S.-based semiconductor giant, to establish an assembly, testing, and packaging facility in Gujarat. With a total investment of \$2.75 billion, partially supported by Indian central and state governments, this Initiative marks a significant milestone in India's semiconductor roadmap (Mohan, 2024). The plant is not only expected to create thousands of skilled jobs but also to strengthen India's domestic capabilities in a sector traditionally dominated by East Asian countries. It signifies a shift from India being merely a consumer of high-tech components to becoming an active node in the global semiconductor value chain.

Similarly, bilateral cooperation in the fields of artificial intelligence (AI) and quantum computing is growing under the framework of the U.S.-India Initiative on Critical and Emerging Technologies (iCET). This includes joint research grants, academic exchange programs, and public-private partnerships focused on developing secure, ethical, and scalable AI systems. In particular, collaborations between Microsoft and India's Digital India program aim to skill over 500,000 young people by 2026 in AI, data science, and cloud technologies, contributing directly to workforce competitiveness (Nadella, 2025).

These technological collaborations are also closely tied to supply chain resilience. The COVID-19 pandemic and U.S.-China tensions have catalyzed a global rethinking of supply chain dependencies, and India is being positioned as a trusted, democratic alternative. The U.S. Section 301 report on India's digital services tax revealed that 120 multinational digital service companies were actively engaged in the Indian market in 2023, reflecting both India's growing consumer base and its strategic relevance in global digital flows (United States Trade Representative, n.d.).

Below is a chart representing the number of companies subject to India's Digital Services Tax, illustrating India's attractiveness as a hub for tech giants despite regulatory challenges:

This presence is not only economically significant but also strategically vital in shaping global norms around data governance and digital trade.

Collectively, these cases underscore that India's technological ascent is not solely the result of domestic policy or market size. Instead, it is increasingly driven by strategically aligned partnerships that offer mutual benefits. The economic metrics, including rising FDI in high-tech sectors, rapid growth in digital infrastructure, and increased intellectual property generation, point to a trajectory of growing competitiveness. However, the

long-term impact depends on sustained policy support, institutional capacity, and the ability to strike a balance between national interests and global integration.

The growing depth of India–U.S. technological cooperation holds broader strategic implications that extend beyond bilateral economic benefits. At its

core, this partnership aligns with both nations' long-term geopolitical objectives: India's ambition to secure a prominent role in the global digital economy, and the United States' interest in cultivating reliable technology allies in the Indo-Pacific region. The breadth and scale of these investments are highlighted in Table 2

Table 2: Major U.S. Tech Investors in India.

Company	Year	Amount Invested	Target Sector	Strategic Impact
Amazon	2020 -25	\$14.7 billion	E-commerce, cloud, infrastructure	Boosts India's digital economy
Google	2020	\$10.5 billion	Jio partnership, digital infrastructure	Strengthens telecom + local platforms
Apple	2024	\$22 billion	Smartphone manufacturing	Reduces China dependence
Microsoft	2025	Skilling 5 lakh AI talents	National AI ecosystem	Human capital, innovation capacity

Source: Compiled From Public Disclosures and Industry Reports (Statista, 2025; Ministry of External Affairs, 2024; Mohan, 2024).

For India, the benefits are multi-layered. Enhanced technology transfer, strategic investment, and R&D collaboration enable not only domestic industrial upgrading but also improved strategic autonomy in sectors like semiconductors and AI, where global leadership is often concentrated in a few nations, partnerships with the U.S. help bridge capability gaps while boosting India's capacity to contribute to international supply chains on more equal terms (Ezell, 2024). Moreover, technology cooperation has become a soft power tool for India to project itself as a trustworthy partner committed to democratic values, data security, and global innovation governance (Gupta, 2024).

At the policy level, platforms like the iCET initiative institutionalize strategic dialogue and reduce uncertainty for investors, while reinforcing a rules-based framework for future cooperation. Importantly, this cooperation is not confined to elite-level agreements. Initiatives such as Digital India, Startup India, and state-level incentives have created a domestic environment that is increasingly conducive to innovation and foreign participation. When paired with U.S. expertise, these reforms create a synergistic momentum that accelerates competitiveness beyond isolated transactions.

However, several challenges remain. Regulatory complexity, infrastructure bottlenecks, and skill gaps can hinder the full absorption of transferred technologies. Furthermore, India must navigate this growing alignment without becoming overdependent on a single partner, especially amid global technological fragmentation and rising digital protectionism. Strategic balancing with Europe, East Asia, and emerging Global South tech powers will be critical.

From a regional security standpoint, India's technological rise, if managed wisely, can contribute

to broader Asian stability by diversifying global innovation flows and offering a counterbalance to authoritarian tech ecosystems. As India becomes more integrated into global innovation supply chains, its voice in shaping digital standards, ethical frameworks, and tech diplomacy will carry increasing weight (Chaudhuri & Bhandari, 2024).

In essence, India–U.S. technological collaboration is a fundamental pillar of economic and political plan rather than a minor part of bilateral ties. The success of this collaboration will be judged not only by trade volumes or investment numbers but also by the extent to which it improves India's ability to innovate, compete, and lead on the world scene. This connection offers policymakers, academics, and strategists equally a persuasive case of how shared democratic ideals and strategic interests might come together to propel long-term innovation-driven growth.

2.6. Strategic Implications in the Context of Great Power Competition

Strengthening of great power competition, particularly between the United States and China, was improved the strategic significance of India's position within the broader international networks of technology. As a rising great power that brings together both democratic dominance and burgeoning technological capacities, India has become a key factor in shaping the contours of 21st-century techno-geopolitics. In this context, Indo–U.S. collaboration on technologies is more than an act as an economic partnership; it also provides a strategic counterbalance against China's regional dominance within select and emerging technologies.

While China has been embracing state-led innovations under plans like Made in China 2025, India emphasizes open collaboration, private

entrepreneurship, and regulatory reform, often receiving U.S. support. Strategic partnership, such as the Initiative on Critical and Emerging Technologies (iCET), serves as platforms of collaborative development across spaces like semiconductors, quantum computing, artificial intelligence, and cybersecurity, where Chinese development has raised concerns over authoritarian tech governance (Gupta, 2024). In these regards, India is becoming increasingly seen as a recipient of and participant in the diversification of foreign tech supply chains, therefore reducing dependence on Chinese technologies in the critical sectors.

India's growing participation in multilateral strategic groupings, especially the Quadrilateral Security Dialogue (QUAD), further reflects its evolving role in the Indo-Pacific tech architecture. Through QUAD's technology working groups and proposed infrastructure corridors, India contributes to creating secure, transparent, and interoperable digital ecosystems in Asia. These alliances underscore how technology is no longer a neutral domain, but a key axis of influence and alignment in a bifurcating global order (Chaudhuri & Bhandari, 2024).

However, strategic alignment also introduces new complexities. As India deepens its engagement with the U.S. and Western partners, it must carefully manage the risks of overdependence and potential constraints on digital sovereignty. Concerns over digital colonialism, where global platforms exert disproportionate influence over domestic markets and data ecosystems, are not unfounded. India's push for data localization, indigenous innovation, and strategic autonomy reflects an effort to strike a balance between openness and resilience (Ezell, 2024).

The political economy of digital taxation also illustrates these tensions. India's Digital Services Tax (DST) has impacted several foreign firms, many of which are based in the U.S., prompting diplomatic and trade friction. As shown in **Figure 1**, a significant number of multinational companies subject to DST are American, highlighting the friction between national digital policies and transnational economic interests. While designed to ensure fair taxation in the digital age, such measures can also create points of contention within otherwise cooperative frameworks.

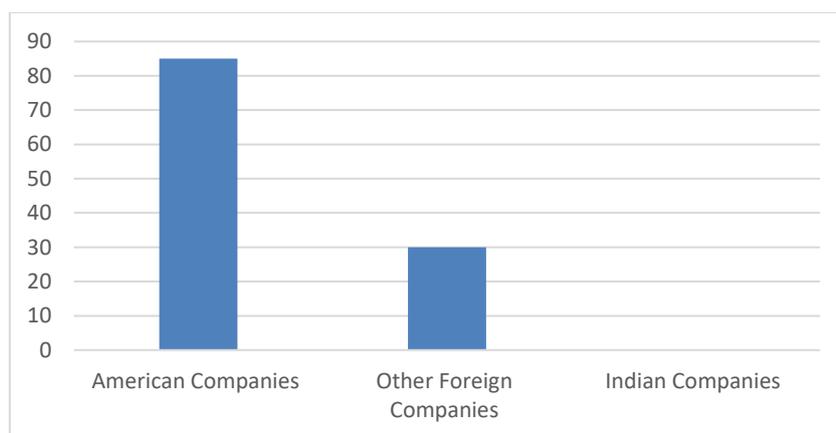


Figure 1: Foreign Companies Subject to The Digital Services Tax In India, Including American Companies.

2.7. Challenges And Policy Gaps

Although there has been great improvement in Indo-U.S. technological collaboration and the momentum created by flagship programs, the strategic relationship runs against a set of continuing obstacles that might weaken or even dilute its effects. These difficulties stem from geopolitical realities, ambiguous policies, and structural constraints. Effective bilateral initiatives may be developed with an appreciation of them; not only for identifying obstacles in India's innovation path.

2.8. Infrastructure

Though still patchy nationally, India's digital

infrastructure has grown quickly in metropolitan regions. Tier 1 cities like Pune, Hyderabad, and Bengaluru offer high-speed broadband connection, strong 5G readiness, and technologically sophisticated parks that are world competitive. Tier 2 and Tier 3 cities, let alone rural areas, on the other hand, still fight with fluctuating electricity availability, poor lastmile fiber optic coverage, and uneven internet speeds.

This inequality has several consequences:

Geographical concentration of benefits: Bilateral technological investments—especially in artificial intelligence, semiconductors design, and sophisticated manufacturing—usually cluster in

urban innovation centers. This raises the possibility of "islands of excellence" surrounded by areas left out of the hightech economy.

- Constraints on Scaling: For Indo-U.S. projects aiming digital agriculture, remote health monitoring, or elearning, insufficient rural infrastructure might hamper scalability and thereby confine pilots. regional rather than national in character.
- For U.S. investors assessing panIndia activities, infrastructure gaps raise operating costs and delay schedules, therefore reducing the appeal of some projects.

Vietnam's swift investment in countrywide 5G coverage and Estonia's homogenous egovernance infrastructure show how consistent national systems may speed inclusive technological adoption.

2.9. Bureaucratic

Despite changes and efforts to facilitate business, India's regulatory environment remains complex and multi-layered. There are several ministerial bodies involved, including the Ministry of Electronics and Information Technology (MeitY), the Ministry of Promotion of Industry and Internal Trade (DPIIT), and state-level IT councils. For example:

The struggle for coordination between central and state policies on industrial corridors sometimes leads to delays in obtaining land and environmental approvals for new factories, particularly in the semiconductor sector.

The controversy surrounding the Digital Services Tax has sparked issues with the Office of the US Trade Representative, creating uncertainty for digital service providers.

Compared to Singapore, which has a "single window" approach where foreign investors can obtain permits, compliance, and financial registration through a unified technology portal, India's system remains more complex and fragmented.

2.10. IP And Localization

Intellectual property rights (IPRs) are currently sensitive challenges in technology cooperation between India and the United States. Several US officials are concerned about issues such as the lengthy processing time for IP litigation in India, which can sometimes extend over half decade, making long-term planning difficult. Handling early-stage technology disputes, such as AI model authorship or semiconductor process patents, is also relatively limited, and enforcement varies from state to state, creating uncertainty for companies operating

across borders. Data localization requirements, on the other hand, are another example of both challenges and opportunities. They give India greater leverage to protect its digital sovereignty, but they also make cross-border data management more complex for US companies, particularly in cloud computing, AI development, and digital financial services. Thus, the partners must strike a delicate balance between protecting India's digital interests and fostering effective technology cooperation to ensure a sustainable and mutually beneficial partnership in the long term.

2.11. Innovation Strategy

India's innovation ecosystem is broad but siloed. Programs such as Startup India, Digital India, and Make in India have catalyzed investment and entrepreneurship, but lack a unified innovation strategy that links academia, industry, and government in a seamless pipeline from research to commercialization.

Key fragmentation points include:

- Duplication of R&D funding across ministries.
- Weak university-industry linkages in deep tech domains.
- State-by-state disparities in innovation policy.

This contrasts with Israel's integrated innovation policy, which links defense research, venture capital, and university labs into a coherent ecosystem – an approach that Indo-U.S. dialogues could adapt. (Centre for Public Policy Research, 2022).

2.12. Human Capital and Skills Mismatch

India produces over a million engineering graduates annually, but only a fraction possesses industry-ready skills for frontier technologies.

In fields such as semiconductor fabrication, quantum computing algorithms, and cybersecurity compliance, there is a notable gap between curriculum content and industry requirements.

This mismatch manifests in:

- Heavy reliance on on-the-job training by U.S. firms in India.
- Slower absorption of transferred technologies in joint projects.
- Concentration of advanced skills in a limited number of elite institutions, leaving a talent gap in second-tier universities.

2.13. Regulatory Uncertainty in Emerging Technologies

The regulatory frameworks for emerging technologies such as AI ethics, quantum encryption, and biotechnology remain in early stages of

development in India.

This uncertainty affects joint Indo-U.S. projects in two ways:

- Delays in project initiation when regulatory approval pathways are unclear.
- Risk aversion by investors, who may avoid sectors without clear legal boundaries on liability, privacy, and export controls.

2.14. Geopolitical Sensitivities and Strategic Balancing

Indo-U.S. technological cooperation is also influenced by India's strategic balancing between multiple global partners. While India seeks deeper integration with the U.S., it also maintains significant defense and technology ties with Russia, and engages economically with China. This balancing act can complicate technology transfer agreements when U.S. policymakers impose restrictions to prevent sensitive technologies from indirectly benefiting strategic rivals.

R&D Funding Gaps: Despite policy commitments, India's R&D expenditure has hovered around 0.7% of GDP – significantly below the OECD average of 2.5%. This underinvestment constrains the capacity of universities, public research institutions, and private firms to undertake high-risk, high-reward research. In contrast, the United States invests heavily in frontier technology R&D, creating an asymmetry that can limit India's bargaining power in collaborative projects.

Cybersecurity and Data Protection: As Indo-U.S. technological cooperation deepens, cybersecurity vulnerabilities and data protection concerns have become more pronounced. The absence of a fully operationalized data protection framework in India creates uncertainty for cross-border digital trade and joint R&D in sensitive sectors. Harmonizing cybersecurity protocols and privacy laws will be essential to build trust in the digital ecosystem.

Regional Disparities in Innovation Capacity: India's innovation hubs are concentrated in a few metropolitan regions such as Bengaluru, Hyderabad, and Pune. This geographic imbalance risks excluding large parts of the country from the benefits of global technology partnerships. Policy measures that expand incubation centers, skill training programs, and digital infrastructure in Tier-2 and Tier-3 cities can help democratize innovation.

2.15. Implications For the Indo-U.S. Partnership

The persistence of these challenges could create a two-tier cooperation model: High-functioning

collaboration in a few flagship projects (semiconductors, space tech, defense R&D). Stalled or uneven progress in broader innovation diffusion, particularly in rural and semi-urban India. Addressing these gaps will require not just domestic policy reforms in India but also co-designed bilateral mechanisms like joint infrastructure funds, policy harmonization task forces, and talent development programs, to ensure that technological cooperation translates into sustained economic competitiveness.

3. CONCLUSION AND STRATEGIC RECOMMENDATIONS

The Indo-U.S. technological partnership has consistently remained one of the strongest pillars supporting India's broader strategy to enhance economic competitiveness on the global stage. What was once a sharply targeted bilateral relationship has gradually evolved into a multi-dimensional, broad-based strategic engagement, characterized by deeply integrated cooperation in semiconductors, artificial intelligence, quantum computing, space technology, and clean energy. Efforts like the India-US project for critical and emerging technologies and smart investments like Micron's chip factory in Gujarat represent a significant shift from a temporary relationship to a strong, lasting connection between innovation methods. This relationship with the US not only increases India's new ideas, but also makes it important in global trade, helping it to be a decision maker in technology regulations and how they are properly managed. With support, India can access entirely new technologies, attract abundant foreign capital, and use innovative digital methods to project its influence. This cooperation has important global goals, particularly to deter China's technological ambitions and secure important supply routes through the East Asian seas. But the path is still very difficult, and many obstacles always appear. Some issues remain, such as dilapidated roads, red tape, and the protection of new ideas, which prevent us from fully benefiting from this cooperation. In addition, legislative hesitation in new industries and the problem of unifying innovation plans between the government, states, and private sector companies can stall progress if not managed properly. The digital divide between cities and villages threatens to create marginalized areas, which reduces the opportunities to benefit from working together in new technology in general.

3.1. Strategic Recommendations for Policymakers

Boosting IP and Data governance by developing

ubiquitous internet networks: deploying faster, more powerful internet in every home, deploying 5G, and providing consistent lighting in villages and small towns. This Robert Good, from India and America, has moved away from the big cities only, and is making creative money everywhere. Facilitating government transactions: Amazing privatization methods make things easier for investors from everywhere in the world of advanced technology, and this is by signing applications, late work, and knowledge contracts much faster. The phoenix regulatory environment and information will strengthen investor risks and abstention. Focusing on ways to manage intellectual property and our information: Protecting intellectual property rights like the best methods in the world, ending litigation periods, and explaining data protection laws for collective action. Equalizing our control of the digital world and the flow of information between countries necessary for artificial intelligence and internet services. Adopting a single ethnic stream of innovation: bringing together advanced progress (such as New India projects, "Make in India," and "India Online") into a unified creative vision, and organizing the work of ministries, governments, and accredited universities. This integration could eliminate duplication and support better utilization of resources. Dedicate people to advanced sciences: Change the way science and math are taught to address the lack of expertise in chipmaking, microcomputing, quantum computing, data protection, and rapid understanding of artificial intelligence. Increase the educational cycle between India and the US, with work programs and collaborations between schools to create a diverse and legally prepared team for tomorrow. Enhance the specialization of government tools between countries: Strict engineering committees between

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India and the US will remain in place forever, and include people from both the government and schools, so they can quickly monitor developments, adjust regulations, and anticipate changing technologies.

3.2. Future Outlook and Research Directions

India stands at a critical turning point in the global technology landscape. Sustaining its current momentum requires a clear strategic vision, policies capable of adapting to rapid changes, and proactive, effective institutional reforms. The growing technology rivalry between the United States and China presents new opportunities for India to establish itself as a reliable partner in international value chains, but it also poses challenges that must be managed carefully to preserve its strategic autonomy.

Future academic research could explore several key areas:

Comparing India–U.S. tech startup collaborations with China's technology diplomacy, particularly within the framework of the Belt and Road Initiative.

Examining industry-level cooperation outcomes through case studies in green energy, fintech, and defense technology.

Developing quantitative models to assess the long-term economic impact of bilateral technology cooperation, using indicators such as innovation performance, foreign direct investment flows, trade diversification, and labor market shifts.

With consistent strategic direction and sustained political commitment, Indo–U.S. technological cooperation has the potential to become the cornerstone of India's rise as a global innovation hub—bridging advanced and emerging economies and securing a leading role in shaping the digital century.

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