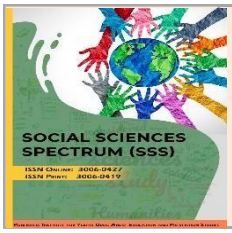

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Technology Transfer and Industrial Collaboration under CPEC: Implications for Pakistan Economic Modernization

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Abstract

The progress of Pakistan's industrial capacity, technological innovation, productivity and competitiveness will be explored in the context of the meaning of technology transfer under CPEC. The study employed a qualitative research design, and the primary source of data was from secondary sources, which were retrieved from official government publications, international publications, peer reviewed articles, and policy documents. The results indicate that CPEC offers Pakistan a unique chance to learn and gain access to modern manufacturing technologies, managerial skills, industrial skills and practices of innovation with the Chinese firms. But, some of the benefits have only been partially realized due to the lack of institutional capacities, research and development (R&D), skilled human resources and university-industry linkages. According to the study, good governance, investment in technical education, development of innovation ecosystem and policies to encourage local participation in industrial value chains will be essential to maximize technology transfer under the CPEC.

Keywords: CPEC, Technology Transfer, Industrial Collaboration, Economic Modernization, Special Economic Zones, Industrial Policy, China–Pakistan Relations, Technology Spillovers.

1.1. Introduction

The Belt and Road Initiative (BRI) of the People's Republic of China (PRC) is a global development strategy that was officially launched in 2015 with the commencement of the China–Pakistan Economic Corridor (CPEC) making it one of the most important bilateral development projects in South Asia. At first, it was estimated to cost approximately US$46 billion, and it currently includes investments in transport infrastructure, energy generation, Gwadar Port, Special Economic Zones (SEZs), and industrial cooperation, vital for Pakistan's long-term economic development plan (World Bank, 2024; Government of Pakistan, 2023). The focus of CPEC in its second phase is more towards industrialization and development of industries, technological cooperation and sustainable economic growth.

Since the dawn of industrialization and economic modernization in the developing countries, technology transfer has been recognized as one of the major elements of success. Evidence from the successful industrial transformation of East Asian economies suggests that foreign direct investment (FDI) can help in the process of technological learning, productivity growth and innovation (Lall, 2004; Blomström & Kokko, 1998). Similarly, the World Investment Report 2024 reveals that international investment and cross-border industrial cooperation are turning out to be key solutions for developing economies to strengthen technological capabilities and increase their global competitiveness (UNCTAD, 2024).

In the past, Pakistan had low tech intensity, inadequate research and development (R&D) and low participation in global value chains (GVCs), and consequently low productivity of manufacturing and export competitiveness (World Bank, 2024; OECD, 2023). However, given all the above structural challenges, CPEC Phase II focuses on industrial cooperation through SEZs, vocational training, establishing joint ventures, and technology-based investments to enhance the industry and Pakistan's productive capacity (Planning Commission of Pakistan, 2023; NDRC & Ministry of Planning, 2017).

Though numerous scholars have written about geopolitical and economic dimension of CPEC, comparatively little scholarly work has been done on the technology transfer and industrial modernisation aspects of CPEC. Current research has been mainly directed towards infrastructure development, energy security, regional connectivity, and China's strategic interests (Small, 2020; Wolf, 2020). Thus, the potential role of technology diffusion and innovation, and how industrial cooperation under CPEC can lead towards sustainable economic transformation in Pakistan, is still a large research area which needs to be explored.

To address this, gap the present study is an attempt to analyse the role of technology transfers and industrial cooperation in the context of CPEC in economic modernization of Pakistan. The research relies on Technology Spillover Theory, Absorptive Capacity Theory and Global Value Chain Theory to gauge the opportunities, challenges and policy requirements to maximize the technology spillovers and improving the competitiveness of the industries in Pakistan (Cohen & Levinthal, 1990; Gereffi, Humphrey, and Sturgeon, 2005).

1.2. Main Research Question

How technology transfer and industrial cooperation can could be used to modernize the Pakistan economy under the China–Pakistan Economic Corridor (CPEC) and what policy steps are needed to maximize the benefits?

1.3. Research Methodology

In this study, qualitative research methodology has been used to understand the effect of technology

transfer and industrial cooperation in the context of China – Pakistan Economic Corridor (CPEC) and its relevance for Pakistan's economic modernization. A qualitative approach is appropriate because the study is not based on a statistical analysis of the data, but rather on policy frameworks, industrial cooperation and institutional mechanisms.

The study is purely descriptive using secondary data from government reports, policy documents, international organizations and peer-reviewed academic literature. The major sources include the Planning Commission of Pakistan, CPEC Authority, Ministry of Planning, Development and Special Initiatives, The World Bank and Asian Development Bank (ADB) as well as research articles from Scopus and Web of Science indexed journals.

Collected data will be analyzed using thematic analysis where key themes of technology transfer, industrial collaboration, industrial upgrading and policy challenges will be identified. The study offers analysis of opportunities and challenges of technology transfer under CPEC and suggests policy recommendations to improve the industrial competitiveness and economic modernization in the long term in Pakistan.

1.4. Theoretical Framework

This study is based on the Technology Spillover Theory, Absorptive Capacity Theory and Global Value Chain (GVC) Theory to analyze the role of technology transfer and industrial collaboration in the context of China Pakistan Economic Corridor (CPEC) in Pakistan economic modernization process.

Technology Spillover Theory holds that industrial cooperation and business connection between local and foreign firms can lead to acquiring new technology, managerial skills and production knowledge through FDI (Blomström & Kokko, 1998). In the context of CPEC, diffusion of technology and improving the productivity of the industrial sector through Chinese investment and Special Economic Zones (SEZs) can be helpful.

Absorptive Capacity Theory states that technology transfer requires the recipient country to possess the absorptive capacity, which can be defined as the institutional capacity, skilled human resources and research capability (Cohen & Levinthal, 1990). Therefore, Pakistan needs to enhance its educational system and institutions of innovation and industrialization so as to harness the advantages of CPEC.

Global Value Chain (GVC) Theory is based on the fact that developing countries can access to technology and knowledge by participating in international production networks, and achieve industrial upgrading and global competitiveness (Gereffi, Humphrey, & Sturgeon, 2005). CPEC offers opportunities for Pakistan to enhance industrial cooperation with China and become a part of regional and global value chains (ADB, 2024).

All these theories together provide an integral approach to the nature of technology transfer, institutions and industrial cooperation that can lead towards industrial development and long-term economic modernization in CPEC context of Pakistan.

1.5. Literature Review

1.5.1. CPEC Studies

The China-Pakistan Economic Corridor (CPEC) has been one of the most researched parts of the Belt and Road Initiative (BRI) since its inception in 2015. So far, most literature has focused on the infrastructure development, energy security, regional connectivity and strategic cooperation between Pakistan and China which it has facilitated. CPEC has significantly contributed to enhancing the transportation infrastructure, energy generation, and investment prospects, laying the groundwork

for economic growth and integration within the region in Pakistan (Elahi, 2021; Shahzadi et al., 2025; Planning Commission of Pakistan, 2023; World Bank, 2024). But proportionately less efforts have been paid to the aspect of CPEC towards technology transfer and the industrial transformation.

1.5.2. Technology Transfer

Technology transfer is acknowledged as an important way to help in industrial development and economic growth. Foreign Direct Investment (FDI) helps in the transfer of state-of-the-art technologies, managerial skills and production techniques to domestic firms as per Blomström and Kokko (1998). Similarly, Javorcik (2004) suggests that spillover of technology is through supplier linkage and industrial cooperation, which results in improved productivity and innovation. In addition, the World Investment Report 2024 has shed light on the increased importance of technology transfer for developing countries seeking to enhance their industrial competitiveness through international investment and knowledge transfer (UNCTAD, 2024).

1.5.3. Industrial Cooperation

The development of Special Economic Zones (SEZs), joint ventures and manufacturing partnerships are a key feature of CPEC Phase II and have been the focal point of industrial cooperation. The Long-Term Plan for CPEC: Industrial collaboration aims to promote industrial upgrading, foreign investment, expand production capacity and develop a skilled workforce (NDRC & Ministry of Planning, 2017). Successful industrial cooperation can help in technology diffusion, enhance supply chain integration, and boost Pakistan's manufacturing sector, according to scholars (ADB, 2024; Planning Commission of Pakistan, 2023).

1.5.4. Economic Modernization

The modernization of the economy involves structural change of the industry, in order to improve productivity, technological capability, innovation and competitiveness. Experience of countries like China, South Korea, Singapore, etc. has demonstrated that (combined with good industrial policies and human capital development) technology transfer can be a source of modernization of economy and its acceleration through technology. For Pakistan, CPEC offers a chance to modernize the industrial sector, while fostering technology-intensive industries, enhancing infrastructure, and connecting domestic companies with regional and global value chains (World Bank, 2024; OECD, 2023).

1.5.5. Research Gap

There are various studies about the economic, strategic, geopolitical side of CPEC, but not much has been done on the technology transfer, industrial cooperation and economic modernization of Pakistan. So far most of the studies have been on infrastructure development, energy projects and regional connectivity, while very little has been done on the modus operandi as how technology transfer of CPEC can help in industrial upgrading and technological innovation. This study aims to fill this gap by discussing the role of technology transfer and cooperation with industry towards economic modernizations of Pakistan and proposes recommendations that could be implemented in policies to maximize development gains from CPEC.

1.6. Evolution of the China–Pakistan Economic Corridor (CPEC)

The China – Pakistan Economic Corridor (CPEC), the flagship project of the formal inauguration of the Belt and Road Initiative (BRI) in 2015, has been a striking success. With an initial investment of around US$46 billion, CPEC has been expanded to include investments in energy, transport infrastructure, Gwadar Port, Special Economic Zones (SEZs), agriculture, digital connectivity, and industrial cooperation (Government of Pakistan, 2023; Shahzadi et al.,2025; World Bank, 2024).

The development of CPEC represents the paradigm shift from infrastructural development to industrial modernisation and technology cooperation in Pakistan.

1.6.1 Phase I: Infrastructure and Energy Development

Installing the infrastructure and energy systems. Phase I – Infrastructure and Energy Development. In phase one (2015-2020) of CPEC primarily addressed the insecurity of critical infrastructure and the energy crisis in Pakistan. Electricity generation, national highways, motorways, railway improvement and Gwadar Port received the focus of the investments. These projects have substantially boosted energy availability and connectivity to transport and reduced logistical constraints for businesses (Planning Commission of Pakistan, 2023). As per the World Bank (2024), the investments in transport and energy infrastructure gave the impetus to the future industrial developments and integration of the region.

1.6.2. Phase II: Industrialization and Technology Transfer

The second stage of CPEC is not just about infrastructure development, but industrialization, technology transfer, agriculture cooperation and sustainable economic growth. This phase has much emphasis on Industry Involvement, including Special Economic Zones (SEZs), Manufacturing partnerships, Vocational Trainings, Digital technologies, and Private sector investments (Planning Commission of Pakistan, 2023). To increase the industrial capacity, technological capabilities and export competitiveness of Pakistan by increasing the joint ventures and partnerships (ADB, 2024).

1.6.3. Special Economic Zones (SEZs)

One of the most important components of CPEC Phase-II is the Special Economic Zones (SEZs). SEZs offer various investment facilities, state-of-the-art facilities and policies that are favorable to business. It is anticipated that key SEZs, such as Rashakai, Allama Iqbal Industrial City, Dhabeji, and Bostan, will facilitate export-oriented manufacturing, technology transfer, industrial clustering, and job creation (Board of Investment Pakistan, 2024). The zones are designed to help Chinese and Pakistani companies share information and knowledge, and to boost Pakistan's manufacturing industry.

1.6.4. Industrial Cooperation

The cooperation in industry is an important aspect of the CPEC long-term development strategy. One of the objectives of CPEC is to promote industrial upgrading, technological innovations, and linkage with regional and international value chains through joint ventures, foreign direct investment (FDI), and partnerships between Chinese and Pakistani firms (UNCTAD, 2024). The successful cooperation between industries is expected to increase productivity, competitiveness of local industry and will help to modernize the economy of Pakistan in the long term. However, this requires strong and effective governance, skilled-human capital, and strong institutional support to ensure that technology transfer will be effective and will support sustainable industrial development (OECD, 2023; World Bank, 2024).

Table 1: *Evolution of the China–Pakistan Economic Corridor (CPEC): Phase I vs. Phase II*

Dimension	Phase I (2015–2020)	Phase II (2021–Present)
Primary Focus	Infrastructure and energy development	Industrialization, technology transfer, and economic modernization
Key Objectives	Address energy shortages, improve transport infrastructure, and enhance regional connectivity	Promote industrial cooperation, technological innovation, export competitiveness, and sustainable economic growth
Major Sectors	Energy projects, highways, motorways, Gwadar Port, and transport infrastructure	Special Economic Zones (SEZs), manufacturing, agriculture, ICT, digital economy, and industrial cooperation
Investment Strategy	Large-scale public infrastructure investment	Industrial investment, joint ventures, private-sector participation, and foreign direct investment (FDI)
Technology Transfer	Limited emphasis on technology and innovation	Greater emphasis on technology transfer, industrial upgrading, skills development, and innovation
Special Economic Zones (SEZs)	Planning and policy formulation	Development and operationalization of SEZs to attract domestic and foreign investment
Industrial Collaboration	Limited industrial partnerships	Expansion of China–Pakistan industrial cooperation through manufacturing and joint ventures
Expected Outcomes	Improved energy supply, transport connectivity, and logistics efficiency	Industrial modernization, employment generation, technology spillovers, export diversification, and integration into global value chains

1.7. Technology Transfer under CPEC

Now the China-Pakistan Economic Corridor (CPEC) is no longer just an infrastructure growth project, rather it's a platform for industrial cooperation and technological development. During the second phase of CPEC, the emphasis has been placed on the technology transfer, industrial cooperation and establishment of Special Economic Zones (SEZs) for improving the competitiveness of the Pakistani economy and manufacturing industry (Planning Commission of Pakistan, 2023). The technology transfer under CPEC is being made under different modes of technology transfer, including foreign direct investment (FDI), joint ventures, industrial partnerships, training of human resources, technology licensing and transfer of knowledge between Chinese and Pakistani companies (UNCTAD, 2024).

Chinese foreign direct investment is one of the most important ways of transferring technology. Multinational enterprises can contribute to increasing the productivity of domestic industries through their modern management methods, quality control systems, technical skills and production technologies (Blomström & Kokko, 1998). Modern manufacturing technologies can help industries in Pakistan to become more competitive in the local and international market by improving their efficiency and quality, through cooperation with Chinese industry companies (World Bank, 2024).

Another key path of transferring technology is the formation of Special Economic Zones (SEZs) under CPEC. The main goals of SEZs are to attract export industries, promote concentration of industries and to promote interaction between export investors and local firms. These industrial ecosystems facilitate the close interaction between companies and provide knowledge spillovers, supplier development and innovation (NDRC & Ministry of Planning, 2017). Well managed, SEZs can turn into hubs of technological learning and industrial upgrading in Pakistan (ADB, 2024).

Transfer of technology is not only about manufacturing process but it is also about human capital development within the CPEC. Vocational training, technical education, and exchanges of professionals are offered through the support of China which enable the Pakistani engineers, technicians and managers to learn new technical skills and managerial knowledge. The World Investment Report 2024 shows that investing in human capital is a key investment for ensuring that a country has the capacity to absorb and effectively use advanced technologies (UNCTAD, 2024).

Yet, these opportunities are affected by the institutional capacity of Pakistan in terms of effectiveness of technology transfer. Nevertheless, the country still has some problems in terms of harnessing foreign technologies as indicated by its poor research and development (R&D) capabilities, poor linkage with universities and educational institutions, shortage of skilled labor, and poor innovation policies (OECD, 2023; World Bank, 2024). Therefore, complementary domestic reforms are needed to ensure optimum utilization of the technological component of CPEC including innovations system, technical education and involvement of local industry in Chinese owned industrial projects.

1.8. Industrial Collaboration and Special Economic Zones (SEZs)

Industrial Cooperation is an integral component of the second phase of China-Pakistan Economic Corridor (CPEC) aimed at industrialization, technology transfer and export generated activities. CPEC is expected to help strengthen the industrial capacity of Pakistan with the help of Special Economic Zones (SEZs), Joint Ventures (JVs) and Strategic Partnerships (SPs) while enhancing the Foreign Direct Investment (FDI) and sustainable economic growth.

It is believed that the SEZs will encourage the cooperation between the firms of China and Pakistan. These zones provide tax breaks, better infrastructure and simplified regulations to attract manufacturing and exporting companies. The SEZs are being developed with the objectives of industrial clustering, industrial supply chain and transfer of technology and managerial capabilities from Chinese firms to the local industry (NDRC & Ministry of Planning, 2017, Long-Term Plan for CPEC 2017-2030)

Under CPEC, major SEZs are identified, such as Rashakai Special Economic Zone (Khyber Pakhtunkhwa), Allama Iqbal Industrial City (Punjab), Dhabeji Special Economic Zone (Sindh) and Bostan Special Economic Zone (Balochistan). According to the Board of Investment Pakistan (2024), these zones will attract investors across various sectors including manufacturing, engineering, pharmaceuticals, information technology, textiles, food processing, and renewable energy, resulting in employment creation and industrial expansion for Pakistan.

Under CPEC, the cooperation in the field of industry also facilitates the formation of Chinese-Pakistani joint ventures, enabling the industries, which have been established in Pakistan, to access modern production technologies, modern management methods and international quality standards. Such synergies can result in increased production, quality and competitiveness of Pakistan's industries in the regional and international markets (World Bank, 2024). Furthermore, collaboration with Chinese companies can help in building local suppliers networks, helping small and medium-sized enterprises (SMEs) integrate into regional and international value chains (UNCTAD, 2024).

However, the success of industrial cooperation depends on Pakistan's ability to address various structural issues. The country still faces challenges on the ability to fully benefit from the industrial partnerships, such as the lack of industrial infrastructure, technical skills, policy uncertainty and R&D (research and development) (OECD, 2023). Hence, institutional governance, skill development, innovation based industrial policies would be vital to reap the maximum benefit from SEZs and industrial cooperation through CPEC in the long run.

In general, industrial cooperation under the CPEC can revolutionize the manufacturing sector of Pakistan in terms of technology diffusion, inflow of investment, job creation and competitiveness of industries. To harvest these gains, however, policies for the SEZs, greater public private partnership, and ongoing investments in human capital and technological innovation must be made.

Conclusion

China Pakistan Economic Corridor (CPEC) has grown from a big infrastructure project to a roadmap for industrial collaboration, technology transfer, and economic modernization. This research concludes that CPEC Phase II opens a unique opportunity for Pakistan to develop its industries through technological cooperation with Chinese companies, foreign direct investment (FDI), and special economic zones (SEZs) and knowledge sharing with Chinese companies. If designed and implemented correctly, these investments can improve productivity in industry, technological capability, competitiveness and overall economic growth (Planning Commission of Pakistan, 2023; World Bank, 2024).

The research also reveals that technology transfer is not enough for sustainable change of the industries. Institutional capacity, skilled human resources, research and development (R&D), innovation ecosystem and consistent industrial policies in Pakistan are key to the proper absorption of the technology and use of advanced technology. Low level of investment in research and development, weak governance, absence of university-industry linkages, and low involvement of local industries continue to be the key challenges in harnessing the full potential of CPEC with regard to technology and industry (OECD, 2023; UNCTAD, 2024).

However, for optimal developmental outcomes of CPEC, Pakistan should emphasize the technical education institutions, research and innovation institutions, public–private partnerships, and competitiveness of SMEs and governance of SEZ. These will help in the effective absorption of technology, industrial upgrading, and effective incorporation of Pakistan into regional and global value chains (ADB, 2024).

In sum, one should not only see CPEC as an infrastructure and connectivity project, but also as a long-term enabler to technological progress and industrial transformation. Through complementary domestic reforms, innovative industrial policies can help Pakistan to reap the best out of the CPEC for sustainable economic modernization to secure a strong footing in the evolving regional and global economy.

Conflict of Interest

The authors showed no conflict of interest.

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