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A comparative study of TVET systems in China and Pakistan: lessons for Pakistan's economic development

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This study examines the role of Technical and Vocational education and training (TVET) in fostering financial development, drawing lessons from China's TVET success to improve Pakistan's system. Using a qualitative approach, 45 documents published between 2010 and 2024 were systematically analyzed through PRISMA-guided selection and thematic coding with NVivo. The findings reveal that China's robust TVET system, supported by strong policy integration, enterprise collaboration, and sustained funding, has appreciably contributed to employment generation and poverty reduction. In contrast, Pakistan's TVET system faces demanding situations which include fragmented guidelines, insufficient funding, and weak industry linkages. The study highlights three critical areas for Pakistan: curriculum reform, improved teacher training, and more potent enterprise partnerships. By adapting China's Effective practices, Pakistan can address skill gaps, improve youth employability, and advance sustainable development goals.

KEYWORDS

TVET, economic development, China, Pakistan, lessons

1 Introduction

The revival of Technical and Vocational Education and Training (TVET) is seen as a device for the socio-economic development in the context of skills gaps and youth unemployment. TVET is imperative as it offers practical skills that are required by industries and improve the employability skills of individuals, enhancing economic productivity and ultimately economic development (Amin et al., 2023). In the research of developing countries, TVET is vital to driving growth as population pressures outstrip economic growth and mobilizing a younger demographic into an adaptable, skilled working population to back sustainable development. TVET systems are widely valued. However, their performance differs in diverse countries, depending on policy frameworks, funding mechanisms, and institutional sizes.

Pakistan, a country with more than 220 million population and with a median age of 22, is at a junction in its developmental journey (Archana, 2021). Despite having a large demographic dividend, persistent labor market challenges remain, including youth unemployment, underemployment, and a large skills mismatch (Abdullah, 2020). The much-needed TVET sector for linking these gaps is still at its beginning state so confined

with *ad hoc* strategy, improper financing, and weak-industry linkages. Only 2.5% of young people in Pakistan gets on-the-job training, and the TVET sector provides to less than 15 percent of the three million young people that enters the labor market each year. As a result, Pakistan's UHCI is only 0.20, among the lowest globally, showing that the country cannot fully use its human capital despite its economic progress (World Bank, 2023). These systemic disorganizations limit the country's capacity to influence its demographic potential and deepen socio-economic disparities, leading to poverty and social unrest.

In contrast in China TVET system presents an influential example of how strategic investments and policy reforms can redesign vocational education into a pillar of national development. Since the economic transition in 1978, China has given a huge importance on TVET as an instrument for creating jobs, decreasing poverty, and helping in technological development (Jinshan et al., 2022). Vocational education has been institutionalized and close to national development goals and labor market requirements through 1996 Vocational Education Law. However, the actual secret behind the skills development achievement of the country has been its focus on industrial partnership, rural development, and equal access to work related trainings, resulting in a skilled workforce leading successful industries like high-speed rail, logistics, and e-commerce (Min and Yuanyuan, 2019). These accomplishments demonstrate the innovative power of the kind of TVET policy and investment that these initiatives promote.

Previous studies have explored the role of TVET in economic growth and discussed challenges in both China and Pakistan. However, very few comparative studies examine how the lessons learned from China's TVET model can be adopted to Pakistan's context. Most of the researches only raise concerns about China's achievements and Pakistan's challenges but do not provide evidence of best practices or their transferability in different socio-economic and cultural contexts. This research is aimed at addressing this knowledge gap by systematically comparing the design and performance of the two TVET systems and extracting lessons for Pakistan. This research aims to investigate the potential of China's experience of TVET as a practical way for Pakistan to solve its socio-economic problems. This research aims to address the following questions:

- What are the major issues in Pakistan's TVET system?
- What factors are attributed to the success of China's TVET system?
- How can Pakistan benefit from China to enhance the TVET sector?

It emphasizes that significant investment in TVET, alongside partnerships with the industry, is necessary to prepare a skilled workforce that drives sustainable economic growth. The results offer policy suggestions for Pakistani policymakers, advocating for efforts to reform the curriculum, intensify training programs for teachers, and improve linkages between schools and the industry. Importantly, the study contributes to the wider discussions around TVET, by revealing how, when used for purpose, contextualized adaptations of successful models, can provide a pathway to address pervasive systemic challenges and unleash the potential of vocational education in developing economies.

2 Literature review

2.1 The role of TVET in economic development

It is well-acknowledged that TVET contribute to the advancement of society and the expansion of the economy. TVET serves as a strategic instrument to ensure that the workforce is competent and satisfies market demands, boosting employability, decreasing poverty, and fostering economic development (Liu and Salleh, 2024). Fighting youth unemployment is particularly crucial because it is a major issue in many developing countries where population expansion usually outpaces economic growth. By providing them with employable skills, TVET facilitates people's transfers from education to the workforce. This reduces the risk of underemployment or unemployment.

Evidence proved that in countries where TVET systems are well-integrated with labor markets, youth employment is higher and poverty levels are lower. For example, Caves et al. (2021), who demonstrated a positive relationship between education and wage income, demonstrating the economic returns of skill accumulation. This finding supports Becker (1994) human capital Theory, which emphasizes that investment in skill leads to measurable economic benefits.

Expanding on this, Khan et al. (2024) also validates the importance of TVET for economic growth in Pakistan through the mediating role of HRD. Their research study, based-on the theory of human capital, studied the determinants of TVET and their impact on economic growth in Baluchistan Pakistan. Using Structural Equation Modeling (SEM) the study exemplifies how social inclusion indicators like HRD play a simple and vital role in leveraging the economic benefits of TVET. While Khan's work empirically supports the theory, it also complements earlier conceptual contributions like those of Caves et al. (2021), reinforcing HRD as both a means and outcome of effective TVET strategies. However, Khan's et al. (2024) study shows that Pakistan's TVET system still faces challenges with weak institutional frameworks and decentralized execution, in contrast to China, where TVET changes have been heavily policy-driven and industry-linked. This shows how the two contexts' applications of human capital theory differ from one another.

Beyond its traditional functions, TVET facilitates economic growth through innovation and entrepreneurship, essential drivers in the digital and green economies. TVET also prepares individuals to thrive in increasing innovative sectors like renewable energy, information technology, and commerce. This is especially so in the setting of rapid technological advancement, as technology-based platforms are on the rise and the demand for specialized labor is set to increase (Li et al., 2024). Additionally, TVET contributes to the promotion of small and medium enterprises (SMEs), the key drivers of growth in many developing countries. TVET offers training in entrepreneurship and business management, enabling individuals to start and sustain their own businesses, which contribute to job creation and economic diversification.

Globally, rising TVET paradigms are emphasizing digital readiness, AI integration, and green talents development (UNESCO, 2022). Future-orientated TVET includes digital simulations, distance learning, and weather-conscious technical

modules, mainly relevant in post-pandemic exertions markets. China has already advanced in this direction through initiatives such as the “Internet Plus Vocational Education” program and the incorporation of AI and big data into vocational curricula (Ministry of Education of China, 2018). In contrast, Pakistan’s TVET system remains largely traditional, with limited digital infrastructure and outdated curricula. The country faces challenges such as weak internet penetration in rural areas, limited faculty training in emerging technologies, and low awareness of green skills, which restrict its ability to prepare a future-ready workforce (Government of Pakistan, 2017). Drawing lessons from China’s reforms such as digital transformation of industrial clusters, key software, new materials, integrated digital platforms, investment in virtual labs, and integration of sustainability modules (The State Council of China, 2022) Pakistan can align its TVET sector with global demands. This is particularly significant in the broader South Asian context, where youth populations are large and unemployment is high, making digital and green skill development an urgent regional priority (UNESCO, 2022). By embedding AI-driven tools, virtual training platforms, and green competencies into its vocational framework, Pakistan can not only address domestic skill gaps but also enhance its regional competitiveness in the global labor market for sustainable development.

2.2 China’s TVET success story

China’s TVET system is a compelling example of how a series of deliberate policy reforms and continued investment can turn vocational education into a pillar of national progress. Since the economic reform and opening-up policy began in 1978, TVET has served as an important source of employment, poverty alleviation, and technology innovation in China (Jinshan et al., 2022). China’s TVET system illustrates the Human Capital Theory in action: constant investment in skills has directly improved innovation, productivity, and social inclusion. Through a range of policy designs that connect TVET with practical work, ensuring it aligns more closely with development goals and labor market demands. This strategy coupled with significant investment in TVET also enabled China to produce qualified specialists for the high-growth sectors. To fulfill the demand for skilled labor, participating in vocational education and training becomes advantageous, since the success of vocational education and training in China is also related to its emphasis on cooperation with manufacturing and rural-oriented development. China has established linkages between TVET institutions and industries to ensure that vocational training programs align with labor market needs. This contrast with Pakistan, where limited linkages between TVET institutions and industries prevent graduates from meeting employer expectations.

The human capital contributions of China’s TVET system in human capital development, are one of the key factors of economic growth. By equipping individuals in industry relevant skills, China has reduced skill deficiencies in high demand sectors, while also raising workers’ employability and productivity. This echoes existing literature on TVET regarding its human capital development function resulting in productive economic activity (Alam and Sharmin, 2023; Ogur, 2023). Becker’s (1994) human capital theory emphasizes the critical role of prioritizing investment

is crucial in education and training, especially in the developing economies where skills gaps are significant.

Not only does China’s TVET system offers insights into the role of social inclusion in vocational education, but also through the expansion of TVET in rural and underprivileged areas, China has also been able to regionalize balance and equitable opportunities for skill development. The success of this initiative demonstrates how TVET supported by sound institutional paths and stable amount of financial execution can change the lives of many people. The case for a more inclusive TVET program matches the global-level advocacy of TVET as a vehicle for reducing inequality and promoting sustainable global development (McGrath et al., 2020). For example, UNESCO’s Education for All initiative calls attention to the role of TVET in promoting social equity through the empowerment of marginalized group (UNESCO, 2014).

2.3 Challenges in Pakistan’s TVET sector

Pakistan’s TVET system has significant challenges with its effectiveness, despite its potential for economic contribution. Challenges such as fragmented policy frameworks, poor economics of scale, lack of spending and weak linkages with industry are creating hurdles in economic development. While the sector invests less than 2.5% of its GDP into education (World Bank, 2023), this inadequate public spending triggers several critical outcomes. First, fragmented policy frameworks persist because limited funds hinder the coordination and implementation of a unified national strategy. Agencies like NAVTTC and provincial TEVTAs operate in silos, as there are insufficient resources for integrated planning, data sharing, and monitoring mechanisms, leading to disjointed efforts and wasted potential. Second, chronic underfunding prevents the achievement of economies of scale. With each of the 3,740 TVET institutions struggling individually for basic resources, there is no capital to develop shared training facilities, centralized curriculum development units, or bulk procurement systems (Ahmed et al., 2021). This inefficiency multiplies costs and reduces the overall impact of the scarce funds available. Third, the direct consequence of inadequate public spending is visibly manifested in antiquated infrastructure, obsolete workshop equipment, and a severe shortage of qualified instructors who are often drawn to better-paying industry jobs (Gouhar et al., 2024). This resource scarcity renders practical, hands-on training a cornerstone of effective TVET nearly impossible.

Finally, these circumstances directly cause weak linkages with industry. Industries are reluctant to partner with institutions that train students on outdated machinery and with curricula that are decades behind modern technological practices. The deficiency of investment thus generates a vicious cycle: without funding, industry collaboration is useless, and without industry collaboration, training remains unconnected to market needs. Together, these funding-induced encounters sternly limit TVET’s capability to play a transformative role in human resource development. The system remains incapable to respond to labor market demands, consequential in a determined skills mismatch where graduates lack the skills needed by employers (Bano et al., 2022), thereby stifling industrial growth and economic development. The article employs a comparative case study

design to examine the policy frameworks, funding models, and institutional efficiency of the TVET systems in both countries, with a detailed discussion of funding provided in see section “4.2 Funding mechanisms.”

Pakistan’s TVET sector also suffers from issues related to gender differences resulting from social, cultural, financial, and religious limitations. Such negative perceptions about TVET being an option only for low achiever and slow learners could discourage enrolment, particularly in high-achieving student population (Tlapana and Myeki, 2020). A mind-set which is reinforced by limited knowledge of the career paths available through TVET, further makes the sector less appealing. These systemic inefficiencies restrict the potential role of TVET in combating youth unemployment and undermine Pakistan’s growth story through the profitable use of its demographic dividend. The imbalance between supply and demand reinforces the urgent need for fundamental reforms. Pakistan must align TVET programs with labor market needs, increase funding, and overcome social and institutional barriers. Such cultural insights further expand Pakistan’s human capital crisis by stopping full use of its demographic share.

3 Conceptual framework and methodology

3.1 Conceptual framework

In this study, we base our analysis upon human capital theory which argues that investing in education and skills makes one more productive and improves economic growth (Becker, 1994). This theory claims that TVET aids in economic development by giving a population the skills needed to fill the demands of the labor market (Khan et al., 2023), and thus lessening unemployment, enhancing productivity and spurring innovations (Khilji and Roberts, 2021). Central to this theory is the principle that education systems must align with industry requirements to ensure graduates can secure employment and contribute to economic growth. Human Capital concept is operationalized through signs consisting of public investment in competencies, graduate employability, and earnings mobility.

Complementing this, the analysis of the international transfer of educational policies and practices are combined by comparative education theory, which provides a lens to examine their transferability across socio-economic and cultural differences. Comparative schooling Theory is operationalized via an evaluation of contextual elements affecting transferability, which includes governance, institutional capacity, and cultural attitudes towards vocational training (Sreiner-Khamsi, 2012). The comparative education system explains this as the theory of adapting to the reality of local context that effective models in one country may not easily translate to success in another context and require extensive contextual adaptation (Li and Pilz, 2021). This evaluation additionally attracts at the staged framework of coverage borrowing defined by way of Phillips and Ochs (2003), which outlines how imported education regulations undergo strategies of contextualization, version, and internalization before meaningful implementation. This study proposes to combine the theoretical frameworks above to facilitate the attraction of the critically

important factors ensuring the successful functioning of China’s TVET system and a set of lessons drawn to address the challenges existing within the scope of Pakistan’s TVET solutions.

This study is guided by a conceptual framework that comprises three main pillars: (1) policy frameworks, which explore the extent to which national TVET policies align with the requirements of the economy and labor market; (2) funding mechanisms, which evaluate the resources granted to TVET institutions, their sustainability and effectiveness in addressing TVET goals; and (3) institutional effectiveness, which investigates the contribution of TVET institutions to quality education, collaboration with industries, and employability of graduates. These dimensions serve as lenses through which we can examine both countries’ TVET systems, allowing us to form a comparative understanding of their respective strengths, challenges, and practices that may be worth transferring across borders.

3.2 Methodology

This research is qualitative in nature and uses document analysis as the core method for both data collection and interpretation. Document analysis refers to the systematic examination, interpretation, and evaluation of written materials to obtain pertinent information and recognize patterns or various themes (Bowen, 2009). To enhance analytical precision, the observe adopted Braun and Clarke (2006) six-phase thematic analysis technique. After familiarization with the content material, open coding became conducted the use of NVivo software, preliminary open coding generated 48 nodes, and codes have been grouped underneath key subject matters aligned with the study’s conceptual dimensions: policy frameworks, funding contraptions, and institutional effectiveness. Those topics had been then reviewed and subtle to capture go-countrywide variations and similarities.

The document selection process was guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure transparency and replicability. The process involved four distinct phases: (1) Identification: Initial records were identified through database searching and other sources; (2) Screening: Records were screened by title and abstract for relevance to the study’s focus on TVET policy, funding, and institutional effectiveness in China and Pakistan; (3) Eligibility: The full text of potentially relevant documents was assessed against the predefined inclusion criteria; (4) Included: Documents that met all criteria were included in the final qualitative synthesis.

A systematic search was conducted on 15 February 2024. The publication period was limited to 2010–2024 to capture the most recent policy developments and contemporary analyses of both TVET systems. The search strings combined keywords and Boolean operators such as: (“TVET” OR “technical and vocational education”) AND (“China” OR “Pakistan”) AND (“policy” OR “funding” OR “employability”). An initial pool of 120 documents was collected through targeted searches of key academic databases, namely Scopus and Web of Science, alongside the official repositories of major international organizations and government bodies, such as the World Bank, UNESCO, the Ministry of Education of China, The State Council (China), Government of Pakistan and, the National Vocational and Technical Training Commission (NAVTTTC) of Pakistan.

After getting rid of duplicates and screening for relevance, language, and credibility, a final pattern of 45 files changed into decided on. The very last record set comprised a combination of national coverage documents from Pakistan and China ($n = 12$), international reviews from global organizations like World Bank, UNESCO and the arena financial institution ($n = 8$), and peer-reviewed instructional articles and conference proceedings ($n = 25$). The PRISMA flow diagram (Figure 1) illustrates this selection process.

The examine employed purposive sampling to pick out files that met inclusion standards: (a) guide date from 2010 onward, (b) origin from official government agencies, international organizations, or peer-reviewed academic resources and, (c) explicit cognizance on TVET policy, structure, or implementation in China and Pakistan. Documents have been taken into consideration “credible” if published by using institutions with identified authority in TVET or education policy, and “relevant” if they without delay addressed the studies dimensions beneath research.

To enhance the validity and reliability of the findings, the examine adopted methodological triangulation via cross-referencing findings from three main information streams: (1) countrywide coverage files from China and Pakistan; (2) global policy reports (e.g., UNESCO, world financial institution); and (3) peer-reviewed academic literature (Denzin, 2009). A records matrix changed into evolved to music, evaluate, and weigh the validity of insights throughout these sources. A comprehensive matrix of all covered files, specifying author, record kind, year, country, and thematic consciousness, is provided in Appendix Table 1 for designated reference. Supply reliability changed into weighted based totally on institutional origin, book kind, and thematic relevance to make certain strong comparative evaluation.

The comparative case study method was used to, analyse the shared features and local divergences in the TVET systems of China and Pakistan. Comparative analysis helps to identify local context-specific challenges, transferable practices, and policy implications (Merriam, 1998). Furthermore, to validate the findings, preliminary insights have been reviewed by using concern count experts in TVET and comparative education to assess thematic coherence and contextual appropriateness. The analysis acknowledges the cultural, economic, and institutional differences between China and Pakistan, which leads to nuanced and contextually rooted insights. Finally, ethical issues were dealt with by using publicly available data and by crediting all the sources properly. As no original data collection with human subjects was performed, there are no issues with either informed consent or confidentiality.

This observer’s record analysis approach has numerous methodological limitations that must be mentioned. First, the reliance on virtual instructional databases and professional repositories can also have excluded applicable files from non-indexed or nearby sources. Second, the dependence on English-language materials limits the presence of valuable perceptions offered in local languages, such as Urdu and Mandarin. Third, limiting sources to reputable policies, international reviews, and peer-reviewed literature excludes gray literature like unpublished reports and practitioner perspectives, doubtlessly narrowing sensible viewpoints. Lastly, although thematic evaluation was carefully applied, a few subjectivities remain inherent in qualitative interpretation regardless of triangulation and expert validation.

4 Analysis of China’s TVET system

China has outstandingly transformed its TVET system in the last four decades, making it globally recognized model for vocational education. This transformation has been driven by a combination of fast-tracked policy reforms, sustained investment, and a strong emphasis on aligning education with labor market demands. This section examines the critical features of China’s TVET system, addresses its policy design, financing structure, and institutional efficiency.

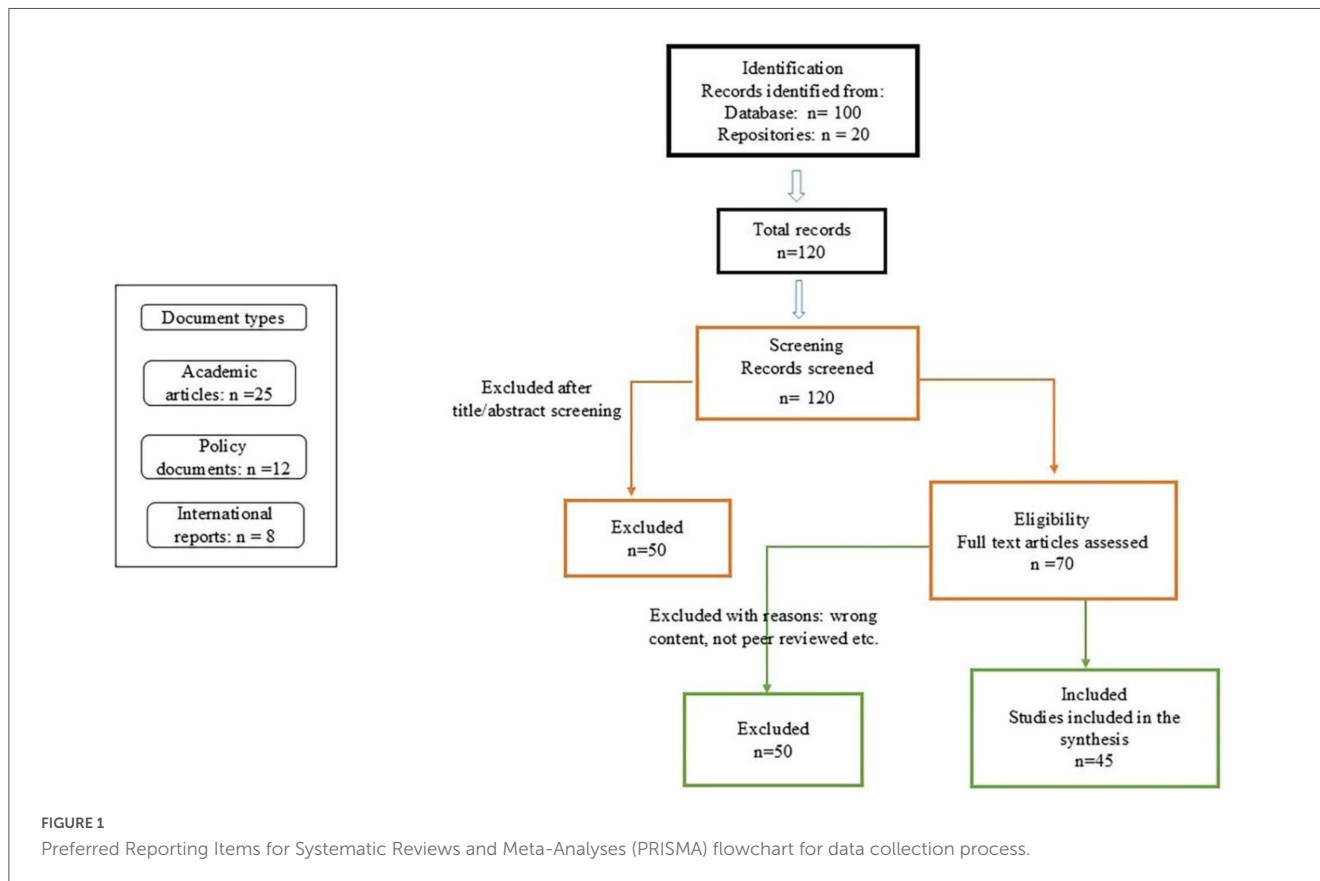
4.1 Policy frameworks

The TVET system in China is based on a solid policy framework, which was developed according to the objectives of the economic and social development in the country. The underpinnings of the framework are the Vocational Education Law, which was revised for the first time in 26 years in 2022 (Fan et al., 2024). The law formalized vocational education and added regulations to the implementation of vocational education. This legislation highlighted the importance of linking vocational education with industry requirements, thus aligning TVET programs with labor market demands. Subsequent policies, like the Medium- and Long-Term Education Reform and Development Plan, also reinforced the imperative of TVET for the modernization of China’s economy, highlighting rural development and equitable access to education, as well as the alignment of curricula with developing industries.

Flexibility is a highly relevant aspect of China’s TVET Policy framework, adapting to the changing economic setting. For instance, China’s “Made in China 2025” initiative set up in 2015 with the aim of transforming China into a high-tech manufacturing superpower has brought reforms in vocational education (Georgia, 2021). Such reforms include the implementation of the “1+X” certification system and multiple vocational certificates, providing graduates with both academic and industry-recognized credentials (Wei and Zheng, 2023). This policy innovation closely aligns education with employment needs, which allows TVET graduates to fit with the latest demands in high-growth sectors like high-speed rail, logistics, and e-commerce.

4.2 Funding mechanisms

The evidence shows that China invests significantly in technical and vocational education. The government spends about 4% of its GDP on education, with a strong focus on TVET (Ministry of Education of China, 2022). The financial investment made by China in TVET is about one order of magnitude higher, as the subsidy amount to TVET in 2021 was CNY 128.7 billion (USD 20 billion), compared to the USD 52 million for K-12 schools and universities while an annual increase of 18.5% was recorded from the previous years (Altaf and Shabir, 2024). This finance supported the establishment of more than 15,000 vocational schools serving over 22 million secondary and post-secondary students (Zhang et al., 2020). Alongside the public financing mechanisms, China has also utilized public-private



partnerships and international collaboration through programs such as the “Internet Plus” Vocational Education Initiative to support TVET (Altaf et al., 2023). As an example, collaborations with multinational corporations have aided in the establishment of state-of-the-art training centers and the embedding of cutting-edge technologies in vocational curricula.

This is complemented by innovative models such as public-private partnerships and incentives to involve the private sector in vocational training. For instance, vulnerable groups are provided subsidies and scholarships to afford TVET, ensuring equitable access. Moreover, targeted programs, including subsidized loans, tax breaks, and social insurance incentives, promote the self-employment of vocational graduates (Luo et al., 2024). Not only do these initiatives expand access to vocational education, but they also empower graduates to fuel economic growth through entrepreneurship.

Over the past two decades, reforms have also attended to the alignment of funding with strategic goals. For example, students from rural and underserved regions benefit from grant-in-aid schemes specifically targeting these students to enhance TVET rates. Also, the National Qualification Framework (NQF) and the Paradigm of “Education Modernization 2035” plan emphasize the improvement of infrastructure, teacher training, and curriculum as priority areas for investment, providing a favorable environment for the sustainable development of vocational education (The State Council of the People’s Republic of China, 2025). Such well-rounded financing has led to impressive growth in TVET enrolment and graduation rates. From 1998 to 2018, TVET enrolment grew 5-fold to 3.69 million, while graduation rates

increased by 16.6 times to 3.66 million (Zhang et al., 2020). It also collaborates internationally to exchange training models (Zhang, 2023), uses curriculum comparisons to improve strategies (Chen et al., 2021). These initiatives aim to keep its TVET competitive and aligned with global trends.

4.3 Institutional effectiveness

China’s TVET system is truly successful at producing skilled manpower to fulfill the requirements of the fast-paced changing market. Overall, TVET institutions in China are highly diversified from Senior Skilled Workers Schools to Higher Vocational Colleges, with each type of institution dealing with specific industries. These institutions provide practical, hands-on training and thus ensure that graduates acquire the technical and vocational skills necessary for employment (Han and Li, 2022; Jinshan et al., 2022). Shenzhen Polytechnic, one of China’s premier vocational schools, has established its brand as an innovation and entrepreneurship incubator by combining technical skills training and business incubation programs.

They also emphasize teacher training and curriculum development to enhance the quality of education. Several government programs are intended to educate TVET instructors on new technologies, practices, and standards. As per MOE (Ministry of Education of China, 2019b), those reforms are part of a broader method to build high-stage “double-certified” teaching groups and to permit bidirectional flows between industry experts and vocational teachers. Furthermore, with its concentration on

TABLE 1 Comparative analysis of Technical and Vocational education and training (TVET) systems: China's model and implications for Pakistan and developing economies.

Dimension	China's TVET system (current state)	Pakistan's TVET system (current state)	Key transferable lessons for Pakistan	Broader implications for developing/South Asian economies
Policy framework	Centralized, strategic, and stable. Guided by robust legislation (e.g., Vocational Education Law). Aligned with national economic goals (e.g., "Made in China 2025").	Fragmented, reactive, and unstable. Overlapping mandates between federal and provincial bodies (e.g., NAVTTC vs. TEVTAs). Lack of long-term vision.	Develop a unified, long-term national TVET policy with clear delineation of federal-provincial roles. Ensure policy stability and alignment with national industrial strategies.	Demonstrates the critical importance of policy coherence and stability for TVET success. A centralized strategic vision is essential, even in decentralized governance systems.
Funding mechanism	High, sustained public investment (~4% of GDP on education). Innovative financing (PPPs, industry partnerships). Schemes for equity (rural subsidies, scholarships).	Chronically low investment (<2.5% of GDP on education). Heavy reliance on unsustainable donor funding. Inefficient resource use due to a lack of economies of scale.	Significantly increase and protect public investment in TVET. Develop innovative PPP models with industry. Implement targeted financial assistance for marginalized groups.	Highlights that sustainable domestic investment is non-negotiable. Donor aid should complement, not replace, strategic public funding. Equity-focused financing is key to inclusion.
Industry linkage	Deeply integrated. Mandated collaboration ensures curriculum relevance, modern equipment, and "double-certified" instructors. Strong focus on emerging sectors (AI, green tech).	Weak and dysfunctional. Industry reluctance to partner due to outdated infrastructure and curricula. Major skills mismatch exists.	Mandate industry participation in curriculum development and governance. Create incentives for firms to offer apprenticeships and modernize training facilities.	Underscores that strong industry-academia linkages are the cornerstone of reducing skills mismatch and ensuring graduate employability.
Outcomes and impact	High enrollment and graduation rates. ~95% graduate employability. Significant contribution to poverty reduction and technological advancement (e.g., high-speed rail).	Low enrollment, particularly among women and high achievers. Low employability of graduates. Fails to leverage demographic dividend, contributing to youth unemployment.	Focus on measuring and achieving tangible outcomes like employment rates. Launch awareness campaigns to improve the perception of TVET.	Proves that TVET can be a powerful driver of economic development and social mobility when systems are well-designed and effectively implemented.
Technology and future-readiness	Active integration of digital skills, AI, and green technologies into curricula. Initiatives like "Internet Plus Vocational Education" prepare a future-ready workforce.	Largely traditional and outdated curricula. Limited digital infrastructure and teacher training in emerging technologies.	Prioritize digital transformation: Invest in virtual labs, update curricula with AI and green skills, and train instructors in emerging technologies.	Shows that integrating digital and green skills is essential for competitiveness in the global labor market and for achieving sustainable development goals (SDGs).

partnership with industries, TVET institutions have been able to stay updated with new technologies and to modify their curricula. Such collaborations between employers and education providers can play a significant role prompting partnerships with business organizations in the renewable energy and information technology sectors resulting in the development of specialized training programs preparing students for careers in emerging industries (Zhang et al., 2020). By helping students gain not only technical knowledge, but also their entrepreneurial skills, this nurtures the students until they become individuals who are ready to enter the able-bodied labor market.

Even with its successes, China's TVET system has many challenges ahead, especially in terms of changing the societal mindset around vocational and technical education (Qing et al., 2023). TVET has been seen as a second-rate education, primarily open to students not given access to academic education. Consequently, the government undertook public awareness campaigns and used incentives like funded high achievers' scholarships and stipends for students in vocational programs. Some of this has begun to pay off as the public perception has slowly changed and TVET continues to be established as another (viable) pathway to gainful employment and economic mobility (Chen et al., 2024).

5 Analysis of Pakistan's TVET challenges

Pakistan's TVET system suffers from grave problems, which is why it is unable to cater to the socio-economic needs of the country. Yes, while it has the potential to reduce youth unemployment, enhance productivity and thereby stimulate economic growth the sector is not without systemic defects, such as underfunding, disjointed policy and weak industry linkages. This section assesses the major challenges facing Pakistan's TVET system, including policy gaps, resource limitations, and institutional barriers.

5.1 Policy gaps

The 2015 TVET Policy established Pakistan's inaugural unified national framework for vocational education, intending to alleviate skill deficiencies and unemployment (Ashraf et al., 2024). Prior to 2015, initiatives were fragmented, with agencies including provincial technical education and Vocational education government (TEVTA) and national Vocational and Technical training commission (NAVTTC) overseeing vocational education

at the same time as missing the specified standardization and coherence with hard work marketplace requirements (Chamadia and Mubarik, 2021). The 2015 strategy enhanced TVET via governance adjustments, standardized curricula, and higher federal-provincial collaboration. Though, its execution encountered barriers, together with useful resource boundaries, inadequate monitoring, and coordination deficiencies, main to variable fulfillment. Continuous funding and better enterprise collaboration are important to completely actualize its capacity.

A major challenge is the poor structure of the TVET system, with overlapping roles between federal and provincial agencies. For instance, NAVTTC and TEVTAs often operate independently without coordination, resulting in inefficiencies and uneven policy implementation. This lack of alignment reduces the effectiveness of programs and limits the labor market's ability to benefit from them (NAVTTC, 2013).

In addition, while the government has made policy strides in TVET education reform like the National Skill Strategy (NSS) phase 1 (2009–16) and phase 2 (2017–22), it still faces considerable questions, in terms of governance and investment. The Federal Ministry of Education and Professional Training is responsible for policy planning, but policy is also formulated by other ministries (e.g., Agriculture, Industries, and Labor) at the federal and provincial levels (Ashraf et al., 2024). Recent research alludes to vague policy guidelines, lack of distinction among regulatory authorities, and absence of committed backing to TVET as persistent challenges facing the sector (Haider et al., 2021). Ali et al. (2024) further argue that without integrated oversight and long-time period sustainability planning, Pakistan's TVET policies continue to be fragmented and reactive rather than strategic.

Moreover, national TVET policies in Pakistan remain reactive rather than proactive in anticipating the changing demands of the economy. For instance, the National Skills Strategy stresses the need for TVET programs to be aligned with industry needs, but its implementation has been stalled by bureaucratic bottlenecks and lack of political will (Javed et al., 2023). Furthermore, there is no long-term vision for TVET, resulting in piecemeal reforms that do not address the underlying causes of inefficiencies in the sector (Kiani et al., 2022). In the absence of guidance toward a coherent and forward-looking policy framework, the TVET system in Pakistan will continue to struggle to produce a skilled workforce capable of driving economic growth.

Pakistan's TVET reforms face entrenched political and financial system demanding situations. Provincial governments, especially in Sindh and Baluchistan, face up to federal oversight to guard local patronage systems (Haider et al., 2021). For example, the 2015 National Skill Strategy was diluted in Sindh because of disputes over fund allocation (Javed, 2020). Cultural resistance additionally persists; rural communities often view vocational education as "low reputation," while conservative groups oppose women's participation in technical fields (Askari et al., 2022). Those factors underscore the want for political purchase-in and network sensitization earlier than systemic reforms.

5.2 Funding constraints

Pakistan's TVET system also suffers from inadequate investment. Education accounts for less than 2.5% of the GDP in

the country, and only a very small proportion of that expenditure is allocated to vocational training. Moreover, the most recent reports show that the investment in education at federal and provincial levels in FY2022 was 1.7% of GDP (up 37.3% from Rs 802.2 billion to Rs 1,101.7 billion) (GOP, 2023). Consequently, chronic underfunding has resulted in outdated infrastructure, inadequate training facilities, and a lack of qualified instructors (Ahmed et al., 2021). Poor institutional resources, for instance, hinder students from acquiring the hands-on skills that some employers are seeking. TVET on the other hand, tends to revolve around outdated curricula and does not often synchronize with the changing nature of industries (Government of Pakistan, 2019).

Pakistan's TVET system has also historically relied on donor grants from international organizations such as World Bank, ADB, UNESCO, UNICEF, GIZ, ILO, and USAID (Bano, 2007), and the financial constraints are not only in terms of domestic resources. While these contributions are critical to supporting immediate efforts but donor-dependent initiatives often fail to have both long-term financial planning and local ownership, thus proving unsustainable when the external aid stops. A recent example is the withdrawal of USAID that will affect 1.7 million people in Pakistan by cutting them off from education and health facilities, as per UN agency (Smith, 2025). China's TVET aid under CPEC and bilateral programs, while valuable, theme-specific, (e.g., cross-border technical universities and Luban Workshops) may end up fragmented, with no comprehensive plans in areas like infrastructure, machinery, regular maintenance, and faculty training (Tang et al., 2024). Addressing this requires balancing "hard power" elements (e.g., advanced equipment) with technology transfer and human resource development as "soft power" components in these initiatives.

The financial shortfall has wider economic ramifications. Pakistan's labor force is growing faster than the economy, leading to a rise in unemployed youth. This discourages potential students from enrolling, as TVET institutions are unable to absorb a considerable percentage of young workers due to limited resources (Azeem et al., 2022). The gap can be addressed with further investment in updating training centers and optimizing teacher training programs, and aligning curricula with industry needs. In the absence of significant financial intervention, the TVET sector will find it hard to perform its function of providing the required skills necessary for economic growth and sustainable employment in Pakistan (Javed, 2020).

5.3 Institutional barriers

Institutional inefficiencies further compound the challenges for Pakistan's TVET system. A major problem is the unavailability of connection between the industry and TVET institutions causing lack of relevance in training programs and a mismatch of skills. The heterogeneity in TVET system and untrained syllabi lead to dearth of flourishing job Market. Even more, exposure to workplaces is limited during training, which also impacts the employability of TVET graduates, as fewer of them are equipped with practical skills and an understanding of what working in a sector entails.

Although in recent years, Pakistan has promoted gender inclusion in its TVET sector through initiatives by NAVTTC,

UNESCO, UN Women, and NGOs. For instance, NAVTTC established Women Vocational Training Institutes (WVTIs) and quotas for women, while UNESCO and UN Women supported training in male-dominated fields and rural sectors like handicrafts (Ashraf et al., 2024). NGOs like the Aurat Foundation and SPO (Strengthening Participatory Organization) launched community-based programs (Askari et al., 2022). However, challenges such as gender stereotypes, urban-centric training centers, lack of gender-sensitive infrastructure, and weak monitoring persist. These issues pose some of the most pressing challenges for Pakistan's TVET system, where enrolment rates for female students remain strikingly low. Cultural norms and financial constraints further compromise female participation, particularly in male-dominated fields. Despite reforms like BISP (Benazir Income Support Programme), studies highlight persistent problems of corruption (Ahmad, 2024) and inefficiency. Addressing these barriers is crucial for achieving equitable TVET outcomes.

In addition, yet, the poor image and low attractiveness of TVET discourages enrolment, particularly for high achiever students. The sector's appeal is further limited with the lack of awareness of available career opportunities through TVET leaving persistent negative perception. Moreover, Pakistan's TVET system struggles with inadequate organization, a shortage of qualified trainers, and limited access to modern equipment as institutional barriers (Raza and Khalid, 2017; Gouhar et al., 2024). These inefficiencies not only restrict the potential of TVET in combating youth unemployment, but also impede Pakistan's capacity to exploit its demographic dividend in driving economic growth.

6 Comparative lessons and adaptation strategies

6.1 Transferable lessons

China's remarkable progress on TVET over decades offers crucial lessons for Pakistan, gleaned from the importance of policy integration, accounting for demand, sustainable funding models, and industry engagement. China's TVET system is driven by its all-encompassing regulatory framework and its rapid restructuring of education and training models. The 1996 Chinese TVET Law, for instance, contained a formal definition of vocational education by mapping out the formal description of responsibilities of the Ministry of Education (MOE) and the Ministry of Human Resources and Social Security (MHRSS), contributing to a growing system of formalization. China's centralized governance version contrasts with Pakistan's decentralized federal shape, in which overlapping mandates among NAVTTC and provincial TEVTAs create inefficiencies. Pakistan's system of TEVT would become more sensitive to the requirements of its labor market if there were a clearer distinction and delineation of relationships and responsibilities between the Ministry and the Skills Development Councils which are not only streamlined with each other but effectively coordinated with various classes of jobs.

Another key lesson is China's focus on funding mechanisms. The national education reforms of 2009, for example, which included the establishment of tuition fee payment stipends for secondary high school students across the country, also led to

significant increases in both TVET enrolment and employment performance, reaching 95% graduate employability. China's TVET initiatives have also benefited from public-private partnerships and international collaborations. To enhance industry engagement, Pakistan's federal government must mandate (PPP) Public Private Partnership frameworks for TVET institutions, with clear, backed accountability mechanisms. This could be done by creating transparent and accountable financial policies that will help maximize the ability of financing to support programs with significant impact (Government of Pakistan, 2018).

The collaboration between TVET institutions and industries has been a pillar for China's success. In addition, vocational institutes in China focus on practical, industry-aligned education, creating a workforce ready to fulfill the needs of a competitive global economy (Asako, 2020). Furthermore, updating curricula according to the demands of the market and including technological developments in training programs would strengthen Pakistan's technical education even more. This approach is critical to ensuring that a capable workforce is prepared for emerging sectors, especially renewables and ICT (Information, Communications, and Technology).

6.2 Contextual adaptation

Although China's TVET model offers valuable insights for learning, it requires careful contextual modification to be applied in Pakistan. For policy transfer to work, one needs to understand local conditions, because socio-economic and cultural differences make it impossible to apply reform homogeneously (Yang, 2023). Sreiner-Khamsi (2012) cautions that policy borrowing is regularly shaped by using political interests and institutional potential, and may generate unintended consequences if contextual factors are neglected. For instance, although China's centralized governance system has proved to be effective, Pakistan is yet to strike a balance between national and provincial roles in its federal system of governance. However, China's centralized administrative model may not align with Pakistan's decentralized federal governance. Importing China's framework wholesale can also pose a risk of misalignment. Moreover, institutional corruption and inconsistent accountability in Pakistan may also undermine coverage replication, suggesting a need for phased, pilot-tested version. Regional inequality must be addressed, and inclusive strategy making sensitive to Pakistan's socio-cultural realities must be promoted if reform is to succeed (Allauddin et al., 2020). Moreover, there is also a dire need for Pakistan to inject gender inclusion and the issue of rural development into its TVET policies, as they are areas that remain crucial to addressing inequities in access and outcomes.

China's emphasis on education for alleviating poverty holds a significant lesson for Pakistan. Subsidies for rural areas that are now tuition-free have been an important part of this equation, contributing to higher enrolment and decreasing economic barriers (Ministry of Education of China, 2019a). In a similar fashion, Pakistan needs to implement targeted financial assistance programs for needy communities, particularly in areas where poverty and gender disparities are most prevalent. Such initiatives could be inspired by China's long-term strategy, which has pulled more than

500 million people out of poverty and, when paired with effective governance and investment, shows how education can change a nation.

The other area which requiring adaptation is innovation and digital empowerment. The TVET institutions in Pakistan need to invest in digital resources, simulations, and virtual laboratories to improve the learning experience immensely. Fostering clusters of research and innovation through academia and industry collaboration can lead to solutions that are aligned closely with industry needs. The faculty members and students must be enabled to innovate and work on similar applied research projects relevant to existing and emerging needs aligned with global benchmarks in TVET. China's integration of green skills into TVET highlights the growing worldwide emphasis on sustainability a dimension Pakistan's TVET regulations presently lack. As shown with initiatives like the "reduce, reuse and recycle" framework included in China's 12th Five-Year Plan, TVET can contribute to environmentally sustainable practices (Carlo, 2023). Greening Pakistan's TVET curricula and the development of green skills would contribute toward Pakistan's transition to an environmentally sustainable economy and the ability to achieve global targets such as climate change.

Finally, contextual adaptation also requires addressing persistent skill gaps and youth employability challenges, which are not unique to Pakistan but characteristic of many developing economies. In India, despite the intensive scope of Skill India Mission, research indicates that graduates mostly lack industry-relevant capabilities, resulting in underemployment (Archana, 2021). Likewise, Bangladesh faces lasting employability gaps as TVET graduates struggle to match the labor market demands, especially in technical and soft skills (Maurer et al., 2025). In Sri Lanka, youth unemployment has partly linked to misalignments between vocational curricula and employer expectations (Sosale et al., 2023). These regional inclinations show that Pakistan's challenges are part of a wider South Asian pattern, where skill disparities hinder economic transformation. By adapting China's effective policies such as competency-based curricula, close industry linkages, and incorporation of evolving technologies can therefore offer Pakistan with practical approaches to minimize skill gaps, improve employability, and foster sustainable development.

7 Policy recommendations and practical implications

Building on the comparative insights drawn in see section "6 Comparative lessons and adaptation strategies," which are summarized in Table 1 below, this section offers actionable policy recommendations and practical implications precise to Pakistan's TVET landscape. The table provides a structured overview of the key differences between the Chinese and Pakistani TVET systems and the core lessons derived from this analysis. We anticipate that this study makes important practical contributions to the arena of TVET and economic development, especially for Pakistan. The research offers actionable insights on systemic challenges faced by Pakistan by analyzing the successful model of TVET in China.

The study underlines the need for TVET programs to be aligned with the demands of the labor market, especially in rapidly

expanding sectors like renewable energy, artificial intelligence, and advanced manufacturing. Pakistan's TVET reform should comprise virtual equipment together with VR-based Training, AI-driven evaluation modules, and modules on climate adaptation in agriculture and creation aligning with SDG targets. This aligns with international suggestions inclusive of those by way of UNESCO-UNEVOC (UNESCO, 2022), which advise embedding sustainability and virtual literacy in TVET frameworks. NAVTTC must collaborate with CPEC authorities to design authorized training programs in renewable energy and advanced production, prioritizing districts with high unemployment rates. This will help Pakistan as it will decrease their dependence on foreign workers and will strengthen employability of the country and hence its economy. This study is ensuring Equity and inclusion as core priorities. For example, as per Khan and Ali (2024), 28% of rural women in Pakistan were enrolled in formal TVET programs. To tackle this gap, the government should expand vocational education centers in the underserved areas, offering culturally appropriate programs suited for local economic activities and implementing financial support mechanisms, such as scholarships and stipends. These initiatives will promote greater female participation in non-traditional fields, such as engineering and technology, and digital trades, fostering upward mobility and inclusive economic growth.

The study emphasizes the importance of international partnerships in improving the quality and relevance of Pakistan's TVET system. Drawing in skill development frameworks and instruction mediums from nations with effective TVET frameworks, for example, Germany, South Korea, and the Asian Development Bank (ADB), will give Pakistan access to the information, assets, and best practices needed to enhance the quality of TVET in Pakistan. Rather than replicating foreign models wholesale, Pakistan should selectively adapt practices that suit its socioeconomic realities such as competency-based certification, blended learning systems, and demand-driven curricula. Pakistan's TVET curricula should incorporate global competency benchmarks (e.g., Germany's dual-training system) to enhance labor mobility (Asad et al., 2023). Furthermore, the alignment of Pakistan's TVET certificates with global credentials can facilitate the mobility of its skilled manpower and cross-border employment.

Finally, the research highlights the importance of governance reform for efficiency and transparency. Another aspect of the accountability of the TVET system in China is that the provincial governments are responsible for local education, and they are regularly inspected to maintain the required standards of education (Xuepei et al., 2019). In addition, introducing anti-corruption measures and developing clear metrics for assessing the impact of each TVET program can help ensure transparency and accountability as well. Regularly reviewing and testing staff to ensure they are competent to carry out inspections and audits to ensure the efficient use of resources and confirm that training programs are aligned with the company's objectives and needs.

8 Theoretical implications

The comparative examination between the two TVET systems of China and Pakistan offers substantial implications for theory

that cover beyond these two countries, presenting insights applicable to vocational education theory in the developing and South Asian economies. Cumulatively in capturing lessons learnt particularly with experiences of these two systems of TVET, this study contributes to the disciplinary discussions on the issue of TVET with particular focus on ensuring policy coherence as well as sustainable financing mechanisms, and enterprise collaborations and TVET provision being adapted to the different contextual realities.

The researcher pointed out that a common policy framework for TVET would make systems across the region impactful. The centralized governance system, formalized by the Vocational Education Law, enabled the alignment of the TVET programs with national development goals and labor market requirements in the Chinese context. However, this dual approach can lead to problems in Pakistan, a broad policy framework characterized by the jurisdictional overlaps between federal and provincial governments makes it difficult to implement structural TVET reforms. This comparative governance analysis offers a theoretical model for understanding policy implementation resistance in decentralized developing nations, a common feature across South Asia (e.g., India, Bangladesh). This scale-tip paints a picture of the theoretical significance of the governance architectures for achieving a policy resistance and alert operations. Such findings echo the principles of contextual adaptation, whereby the development and implementation of policy reflect place while aligning with national level goals succeed (Allauddin et al., 2020).

The importance of sustainable endowment mechanisms is, again, another theoretical implication of this study as a critical factor in success for TVET systems. China's continuing investment in TVET, along with innovative models such as public-private partnerships (PPPs) has allowed training facilities to modernize and curricula to be developed in line with business standards, as well as the recruitment of qualified instructors. This stand in stark contrast to funding challenges faced by many developing economies, where TVET remains persistently underfunded. The study enhances the theoretical notion of resource mobilization in vocational education by representing that sustainable legacy mainly through PPPs and strategic public funding is not simply helpful but vital for TVET reform in resource-constrained backgrounds like Pakistan (Mack, 2024), and other nations dependent on international donor support to fill critical funding gaps. Significantly, when located in the broader South Asian context, similar encounters and opportunities emerge: for example, India's Skill India Mission validates how large-scale public investment combined with industry partnerships can mobilize resources (Kabadurmus, 2021), while Bangladesh's dependence on international donor support for TVET modernization confirms the role of foreign funding in dealing capacity gaps (Maurer et al., 2025). Sri Lanka shows how constant government funding can soothe vocational reforms despite political challenges (Archana, 2021). These comparative understandings highlight that Pakistan's road shouldn't be understood in isolation, but as part of a larger regional barrier for effective resource activation in vocational education.

Moreover, the study facilitated in theoretical discourse in vocational education by further adding to the understanding of skills alignment as it underscored the implication of industry collaboration as a key factor for TVET success (Siddiky and Uh, 2020; Omar and Kamaruzaman, 2024). The strong industrial

partnerships in China have further confirmed that training provided via TVET programs leads to high graduate employment. Such close collaboration assists in overcoming challenges related to skills mismatches. This finding has broad theoretical implications for South Asia, where weak industry-institute linkages are a common barrier to youth employability. The research demonstrates that the theoretical argument for collaboration is a practical pillar for enhancing graduate employability (Kebede et al., 2024), a lesson vital for the entire region.

The study also emphasizes the significance of curricular design in skills alignment. For example, China has adopted a new approach to vocational education systems which incorporates the use of advanced technologies such as AI and Big Data into TVET curricula. This understanding generates a sense of urgency for TVET systems in developing economies to develop their syllabi to keep pace with global technological developments and the demands of emerging sectors, moving beyond traditional and often obsolete skill sets (GOP, 2024).

Finally, the study advances theoretical knowledge on contextual adaptation in TVET systems. China's successful model of social protection and poverty alleviation has lessons for Pakistan, but the differences in social, economic, and cultural realities across developing nations, South Asia in particular, must be kept in mind. This finding echoes the theoretical framework of inclusive development, which highlights the importance of eliminating inequalities in access and outcomes so that all people benefit from economic growth. For example, while China focused rural poverty through tuition-free programs, Pakistan's challenge also includes deep-seated gender inequalities, necessitating theoretically distinct, gender-sensitive policies to boost female enrollment in non-traditional sectors. This highlights that the theoretical principle of presence must be contextually operationalized, a central attention for policymakers across South Asia and the Global South.

9 Conclusion

This comparative study reveals the similar yet contrasting TVET journeys of China and Pakistan and how vocational education has the potential to alleviate some of their economic and social problems. In this respect, preliminary results suggest that the existing system of China in TVET can be a model for Pakistan owing to strong policy frameworks, continued investment, and strong linkages with industries that form the backbone of the system whereas systemic inefficiencies underpin the system of Pakistan giving rise to fragmented policies, lack of adequate investment and poor linkages with industry. Findings underline the importance of aligning TVET delivery with labor market needs through strategic planning, promoting inclusive policies to address gender and regional disparities, and leveraging international partnerships to enhance the quality and relevance of vocational training. Necessary changes in the TVET system in Pakistan can be made by formulating a proper governance structure, investing in new educational programs, and creating sector-wise adaptation of the programs. This paper demonstrates how exemplary contextual adaptations of successful TVET models can meet the systemic

challenges facing the sector and fulfill the promise of vocational education in developing economies. Pakistan can embark on this path of prosperity by learning from the Chinese experience and contextualizing the reforms to its own context, thereby harnessing its demographic dividend and achieving its developmental goals.

Data availability statement

The original contributions presented in this study are included in this article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

NB: Formal analysis, Data curation, Conceptualization, Software, Writing – review & editing, Methodology, Writing – original draft.

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Appendix

Appendix 1 Matrix of reviewed documents.

References	Research method	Key finding (brief)	Theme	Source type
Abdullah (2020)	Analytical review	Reviewed the state of basic education in Pakistan, highlighting systemic challenges.	Policy framework	Peer-reviewed academic article
Ahmad (2024)	Case study	Examined Benazir Income Support Program in social protection and clientelism context.	Policy framework	Peer-reviewed academic article
Ahmed et al. (2021)	Qualitative study (interviews)	Teachers' perspectives on factors influencing service-learning in Pakistani vocational education.	Institutional effectiveness	Peer-reviewed academic article
Alam and Sharmin (2023)	Empirical study	Japanese language skills in Bangladesh TVET programs improve graduate employability.	Institutional effectiveness	Peer-reviewed academic article
Alam and Sharmin (2023)	Case-based qualitative study	Assessed Japanese language skills for employability	Skills development in TVET	Peer-reviewed academic article
Allauddin et al. (2020)	Descriptive case analysis	Analyzed changing China–Pakistan relations and its impact on bilateral cooperation.	Policy reform and sustainability	Peer-reviewed academic article
Altaf et al. (2023)	Policy review and evaluation	Evaluated current TVET policies and practices in Pakistan, linking them to employment and industry outcomes.	Policy framework	Peer-reviewed academic article
Askari et al. (2022)	Review	Identified challenges and opportunities for women's education in Pakistan.	Policy framework	Peer-reviewed academic article
Asad et al. (2023)	Quantitative study	Assessed quality assurance impact on TVET programs for digital employment in Pakistan.	Institutional effectiveness	Peer-reviewed academic article
Asako (2020)	Literature review	Examined TVET reforms and development in China.	Policy framework	Peer-reviewed academic article
Ashraf et al. (2024)	Historical/descriptive study	Documented historical developments and current TVET situation in Pakistan.	Institutional effectiveness	Peer-reviewed academic article
Azeem et al. (2022)	Quantitative study	Vocational self-efficacy moderates social support's effect on student interest in TVET in Pakistan.	Institutional effectiveness	Peer-reviewed academic article
Bano (2007)	Country case study/document review	Profiled Pakistan's education progress toward EFA goals.	Policy framework	International report (UNESCO)
Bano et al. (2022)	Mixed methods study	Identified emerging challenges in Pakistan's TVET amid CPEC initiatives.	Policy framework, funding mechanism	Peer-reviewed academic article
Becker (1994)	Theoretical/economic analysis	Human capital theory linking education with fertility and economic growth.	Policy framework	Peer-reviewed academic book
Bowen (2009)	Methodological review	Document analysis as a qualitative research method.	N/A (methodological)	Peer-reviewed academic article

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Appendix 1 (Continued)

References	Research method	Key finding (brief)	Theme	Source type
Carlo (2023)	Descriptive/review	Digital empowerment initiatives in China's vocational education sector.	Institutional effectiveness	International report
Chamadia and Mubarik (2021)	Experimental study	Assessed effectiveness of vocational training programs in Pakistan.	Institutional effectiveness	Peer-reviewed academic article
Chen et al. (2021)	Collaborative instrument development	Developed analysis instrument for international TVET curriculum comparison.	Institutional effectiveness	Peer-reviewed academic article
Chen et al. (2024)	Systematic review	Reviewed Chinese TVET policies and their role in national development.	Policy framework	Peer-reviewed academic article
Georgia (2021)	Descriptive timeline	Overview of China's "Made in China 2025" innovation strategy timeline.	Policy framework	International report
GOP (2023)	National statistical survey	Summarized economic indicators including education investment	National education and economic policy	National policy document (Pakistan)
GOP (2024)	Policy formulation framework	Provides the guiding framework for developing consistent and harmonized education policies in Pakistan	Education policy and governance Pakistan	National policy framework document
Government of Pakistan (2017)	Policy formulation	Sets national education strategy, identifying challenges (access, quality) and proposing reforms for all sub-sectors.	National education policy and strategy, Pakistan	National policy document (Pakistan)
Government of Pakistan (2019)	Curriculum framework development	Establishes a unified framework for standardizing learning outcomes and integrating national values across all education levels	Curriculum development and standardization (Pakistan)	National curriculum framework
Government of Pakistan (2018)	Policy formulation	Specifically outlines TVET reforms focused on governance, quality, industrial links, and access to skills training.	TVET policy and skills development	National policy document
Gouhar et al. (2024)	Qualitative study	Explored vocational educators' perspectives on inclusive education policies and practices in Pakistan.	Policy Framework	Peer-reviewed academic article
Han and Li (2022)	Conference Paper/Descriptive	Developed a 6C English education system for Sanya citizens under Hainan free trade port.	Institutional effectiveness	Conference proceedings
Altaf and Shabir (2024)	Policy evaluation study	Systematic evaluation of TVET policies and implications for employment and industrial growth in Pakistan.	Policy framework	Peer-reviewed academic article
Javed (2020)	Provincial analysis	Reviewed youth development challenges in Pakistan by province.	Policy framework, funding mechanism	Peer-reviewed academic article
Javed et al. (2023)	Cross-sectional study	Assessed dental students' preparedness in Pakistan.	Institutional Effectiveness	Peer-reviewed academic article
Creswell (2009)	Research methodology book	Outlines qualitative, quantitative, and mixed methods research design.	N/A (methodological)	Peer-reviewed academic article
Haider et al. (2021)	Qualitative study	Identified challenges and opportunities in Sindh's TVET sector.	Policy framework	Peer-reviewed academic article
Caves et al. (2021)	Literature review	Explored education-employment linkages in TVET programs at various development stages.	Institutional effectiveness	Peer-reviewed academic article

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References	Research method	Key finding (brief)	Theme	Source type
Kebede et al. (2024)	Literature review	Linked TVET with industry as pathway to employability in Ethiopia.	Policy framework	Peer-reviewed academic article
Khan et al. (2023)	Empirical study	Investigated ICT adoption in Pakistan's TVET sector.	Institutional effectiveness	Peer-reviewed academic article
Khan and Ali (2024)	Data analysis/quantitative	Identified socio-economic determinants of TVET demand in Pakistan using PSLM data.	Policy framework	Peer-reviewed academic article
Khilji and Roberts (2021)	Research strategy paper	Proposed policy development strategy for soft skills acquisition in TVET.	Policy framework	Conference paper
Kiani et al. (2022)	Empirical study	Evaluated instructional planning and strategies for teachers in Pakistan.	Institutional effectiveness	Peer-reviewed academic article
Li and Pilz (2021)	Literature review	International transfer of TVET highlighting challenges and practices.	Institutional effectiveness	Peer-reviewed academic article
Li et al. (2024)	Literature review	Determinants of TVET and economic development in the digital age.	Policy framework	Peer-reviewed academic article
Liu and Salleh (2024)	Empirical study	Relationship between TVET and employment competence in Yunnan, China.	Institutional effectiveness	Peer-reviewed academic article
Luo et al. (2024)	Intervention study	Effectiveness of technical communication module for vocational students.	Institutional effectiveness	Peer-reviewed academic
Mack (2024)	Empirical/case study	Impact of funding on administration and efficiency of TVET institutions.	Funding mechanism, institutional effectiveness	Peer-reviewed academic
Merriam (1998)	Methodological book	Guide on qualitative research and case study methods in education.	N/A (methodological)	Academic book
Min and Yuanyuan (2019)	Conceptual study	Talent training model under "One Belt One Road" initiative.	Policy framework	Peer-reviewed academic
Ministry of Education of China (2022)	Government strategy outline	Defined priorities for China's 2022 education reforms	National TVET policy framework	National policy document
Ministry of Education of China (2018)	Govt. report/policy analysis	Highlights achievements and future strategic direction for China's VET, focusing on scale, quality and economic alignment	TVET policy framework and reform	National policy report
Ministry of Education of China (2019a)	Govt. report policy communication	Communicates commitment to policy, stability and continuity in education for long term development.	Education policy stability, and implementation	National policy document
Ministry of Education of China (2019b)	Government reply report	Outlined reforms in response to NPC recommendations on TVET	TVET policy implementation	National policy document
Khan et al. (2024)	Quantitative Study	HR development mediates effect of TVET on economic growth in Pakistan.	Policy framework	Peer-reviewed academic
NAVTTTC (2013)	Policy vision document	Laid out Pakistan's TVET Vision 2025	National TVET strategy and policy	National policy document
Denzin (2009)	Theoretical research methods	Intro to sociological research methods.	N/A (methodological)	Academic book
Ogur (2023)	Conceptual review	TVET's role in economy and sustainable development.	Policy framework	Peer-reviewed academic article

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References	Research method	Key finding (brief)	Theme	Source type
Omar and Kamaruzaman (2024)	Bibliometric review	Industry collaboration trends in TVET.	Institutional effectiveness	Peer-reviewed academic article
Qing et al. (2023)	Empirical study	Vocational college attractiveness and challenges in Shanxi, China.	Institutional effectiveness	Peer-reviewed academic
Raza and Khalid (2017)	Qualitative case study	Obstacles to technical education enhancement in Pakistan.	Policy framework	Peer-reviewed academic article
Amin et al. (2023)	Review study	Current and future prospects of Malaysian TVET.	Policy framework	Peer-reviewed academic article
Siddiky and Uh (2020)	Policy review	Need for policies linking TVET and industry in Bangladesh.	Policy framework	Peer-reviewed academic article
McGrath et al. (2020)	Literature review	TVET and African development: challenges and policy insights.	Policy framework	Peer-reviewed academic article
Smith (2025)	Organizational report	Highlighted UNFPA's support for girls and women in South Asia	Funding mechanism	International report
Sreiner-Khamsi (2012)	Theoretical synthesis	Addressed global trends in policy borrowing and lending	Comparative education policy	Peer-reviewed academic article
Tang et al. (2024)	Case study	Evaluation of China's foreign aid in TVET via CPEC.	Policy framework	Peer-reviewed academic article
The State Council of the People's Republic of China (2025)	Government strategy document	Laid out China's education blueprint toward 2035	National policy framework	National policy document
The State Council of China (2022)	National strategic planning	Outlines national strategy for digital economy development, driving demands for digital and AI skills in the workforce	Digital transformation and future skills	National strategic plan
Tlapano and Myeki (2020)	Survey study	Student perceptions of TVET colleges in Buffalo City, South Africa.	Institutional effectiveness	Peer-reviewed academic article
UNESCO (2014)	Strategic policy framework	Presented UNESCO's 2014–2021 education strategy	Policy framework	International report
UNESCO (2022)	Strategic vision document	Defined TVET transformation strategy 2022–2029	Policy framework	International report
Wei and Zheng (2023)	Innovation research	Research on "1+X" certificate system innovation in applied undergraduate education in China.	Institutional effectiveness	Peer-reviewed academic article
World Bank (2023)	Policy note	Assessed Pakistan's human capital challenges and opportunities	Policy framework and funding mechanism	International report
Xuepei et al. (2019)	Comparative study	Comparison of primary education in China and Pakistan (1947–2018).	Policy framework	Peer-reviewed academic article
Yang (2023)	Policy analysis	Educational policy transfer from structure-agency perspective.	Education policy transfer	Peer-reviewed academic article
Fan et al. (2024)	Developmental analysis	Overview and development of China's TVET system.	TVET reform and policy development	Peer-reviewed academic article
Jinshan et al. (2022)	Case study	Impacts of vocational training institutes in Hainan (China) and Punjab (Pakistan).	Institutional effectiveness	Peer-reviewed academic article
Zhang et al. (2020)	Descriptive report	Introduction to China's TVET and internships for comparative research.	Institutional effectiveness	International report
Zhang (2023)	Analytical study	Development of vocational education in China using dual VET system model.	Institutional effectiveness	Peer-reviewed academic article