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Evaluating core competency frameworks for general education curriculum in China's TVET: A systematic review of competency indicators and their implications

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ABSTRACT

This study evaluates core competency frameworks in China's Technical and Vocational Education and Training (TVET) system, focusing on key competency indicators across cognitive, technical, socio-emotional, and entrepreneurial domains. It examines their alignment with industry demands, emphasizing the need for competency-based education to modernize China's TVET system. Method: A systematic review approach was adopted, following PRISMA 2020 guidelines for study selection and inclusion. Relevant studies were sourced from CNKI, Web of Science, Scopus, Google Scholar, and ERIC using predefined search terms. Studies published in the last ten years focusing on China's TVET competency frameworks were included, yielding 26 selected studies. A comparative framework analysis was conducted to examine China's competency models regarding ASEAN, OECD, and UNESCO frameworks. The study identified four primary competency domains essential for TVET graduates: cognitive, technical, socio-emotional, and entrepreneurial competencies. Findings highlight an increasing emphasis on digital literacy, interdisciplinary skills, and industry relevance. The study underscores the importance of modernizing China's TVET system through competency-based education. It suggests curriculum reforms, enhanced digital training, and stronger industry-education collaboration to bridge competency gaps and improve graduates' employability in a rapidly evolving economic landscape.

Contribution/ Originality: This study provides a comprehensive analysis of China's TVET competency frameworks, offering valuable insights for curriculum reform, policy enhancements, and stronger industry-education collaboration to improve workforce readiness in an evolving economic landscape.

1. INTRODUCTION

Technical and Vocational Education and Training (TVET) is a vital pillar of China's education system and one of the most powerful drivers for building a skilled population driven toward the national economic goals of the nation (Ab Hamid, Maskur, & Mutalib, 2023). TVET stands out from other forms of training in that it is aimed at technical and occupational practice skills, by means of which students obtain technical, cognitive, and socio-emotional expertise required in today's labor markets (Abd Majid, Kasavan, & Siron, 2024). Although vocational training reforms are now attempting to integrate general education into TVET programs so that literacy, numeracy, problem-solving, communication, and flexibility skills are developed in graduates after a long period of specializing in trade education (Aldinucci, Valiente, Hurrell, & Zancajo, 2023). The incorporation of general education is a driving force in

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employability and lifelong learning, as TVET graduates can function within modern workplace contexts and respond to changing industry requirements (Asad, Mahar, Datoo, Sherwani, & Hassan, 2023). As China's relentless drive towards education modernization persists, competency-based education (CBE) has emerged as a worldwide model, emphasizing skills mastery over content memorization (Malhotra, Massoudi, & Jindal, 2023). This move is in line with China's larger economic transformation strategy, prioritizing innovation, digitalization, and industrial upgrading under the aegis of initiatives such as Made in China 2025 and the National Vocational Education Reform Implementation Plan (Luo, 2023). Thus, the measurement of China's fundamental competency systems in TVET general education is of utmost importance in identifying strengths, loopholes, and points for reform in comparison to global competency models and labor market demands (Ayanwale, Molefi, & Matsie, 2023).

Competency-Based Education (CBE) has proven to be an efficient vocational education model that guarantees the development of student competencies through experiential learning, real-world problem-solving, and industry involvement (Alt, Naamati-Schneider, & Weishut, 2023). Unlike traditional knowledge-based frameworks, CBE focuses on the application and assessment of skills, and students prove their competence through competency-based examinations (Anderson-Levitt & Gardinier, 2023). Theoretical bases of CBE rely on Bloom's Taxonomy, which categorizes learning into cognitive (knowledge), affective (attitudes), and psychomotor (skills) areas, guaranteeing students develop through higher-order thinking and problem-solving (Collier-Sewell et al., 2023). Constructivist learning theory, focusing on experiential learning and learner autonomy, underpins the integration of CBE into TVET curriculum by guaranteeing active learning and context-based knowledge acquisition (Dahri, Chinedu, Gull, & Colcha Ortiz, 2024). Global organizations such as UNESCO and OECD support 21st-century competency frameworks, which underscore the importance of critical thinking, collaboration, flexibility, and digital competence in vocational education (Michaelis & Findeisen, 2024). In China, recent policy reforms support these global competency models, but challenges involve compliance of national competency frameworks with industry needs (Jalilov Olimjon, 2023). Thus, a systematic review of competency indicators is essential in determining the efficiency of current competency models and compliance with workforce needs (McMullen, Arakawa, Anderson, Pattison, & McGrath, 2023).

Despite the growing emphasis on competency-based education, there remain gaps and challenges in China's TVET system. One of the key issues is the absence of standardization of competency models, leading to divergence between institutions and across regions (George, Ekong, Pandey, & Pandey, 2023). Second, TVET curricula lag behind industry requirements, with many programs founded on outdated sets of skills that do not reflect changing labor market requirements (Halik Bassah, Adnin, & Mohd Asri Mohd, 2023). While technical and vocational competencies are strongly embedded, general education dimensions e.g., socio-emotional, entrepreneurial, and cognitive abilities are poorly developed, thus graduates are less able to cope with interdisciplinary and innovation-driven labor markets (Abd Majid et al., 2024). In addition, as digitalization transforms industries, digital competence, AI literacy, and interdisciplinary problem-solving are highly required, but most TVET institutions fall behind in embedding such new competencies (Jamaludin, Hamid, & Alias, 2023). Such issues call for a careful study of China's competency models of TVET, strength and weakness mapping of the existing system, and best international practices benchmarking (Ab Hamid et al., 2023). The purpose of this research is to bridge this gap by conducting a systematic review of China's TVET general education competency indicators and clarifying the possibilities for curriculum reform and improvement of competency-based training (Alt et al., 2023).

The primary aim of this study is to examine the core competency frameworks in China's TVET general education and evaluate their effectiveness in preparing students for the workforce. The study seeks to assess how well these competency models align with global standards and industry demands, ensuring that TVET graduates possess the necessary skills for employment and lifelong learning. The specific objectives of this research are:

- To analyze the existing competency frameworks in China's TVET general education and evaluate their structure, focus areas, and applicability in modern vocational education.

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- To identify key competency indicators that contribute to workforce readiness, including cognitive, technical, socio-emotional, and entrepreneurial competencies.
- To assess the effectiveness of these competency indicators in bridging the gap between TVET curricula and industry workforce needs.
- To explore the implications of competency-based education in TVET for students, educators, and policymakers, with a focus on improving curriculum design and instructional methodologies.

This instruction is greatly beneficial to China's TVET sector, human resource development professionals, policymakers, and instructors. By way of a systematic appraisal of competency models in general education in vocational training, the study presents useful data on curriculum performance and what needs to be improved (Aldinucci et al., 2023). With the expanding economy of China and the high level of demand for skilled labor, this study contributes to bridging the gap between the matching of educational capability and industry demands to enable TVET graduates to acquire practical, cognitive, and socio-emotional competencies that are in demand in the changing labor market (Asad et al., 2023). Apart from that, this study informs evidence-based policy-level reforms with empirical competency deficits that can be utilized in the planning of standard and forward-looking TVET curricula (Dahri et al., 2024). The conclusions of this study also have an impact on education benchmarking across countries, making China's TVET system possible to benchmark with global competency models and best practices (Halik Bassah et al., 2023). Lastly, this study contributes to the general discourse of education modernization, skill acquisition, and economic resilience, underpinning the importance of competency-based education in ensuring lifelong employability and national competitiveness (Phung et al., 2024).

2. METHODOLOGY

2.1. Systematic Review Approach

The study in this paper applies a systematic review method to explore key competency indicators in China's TVET general education curriculum (Ayanwale et al., 2023). Systematic review is an appropriate method for conducting and combining literature studies, identifying patterns, and marking out boundaries of research gaps on competency-based learning (Collier-Sewell et al., 2023). Unlike traditional narrative reviews, a systematic review is a replicable and systematic procedure that excludes bias and accounts for the reliability and comprehensiveness of evidence (Keller, Walker, Amenduni, Tela, & Cattaneo, 2025). Given that TVET is constantly evolving to meet international and local competency standards, a systematic procedure can allow for detailed analysis of the correspondence between competency frameworks and education policy objectives (Jamaludin et al., 2023).

In favor of enhanced methodological transparency, the present review is conducted based on PRISMA 2020 guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses that specify an order of conduct of a proper, well-defined study identification procedure, screening, eligibility, and inclusion. The use of PRISMA helps achieve systematic screening of studies based on pre-specified inclusion and exclusion criteria with applicability in accepting only valid as well as related sources. Four fundamental stages of the review process are as follows: (1) retrieving relevant studies from selected databases, (2) de-duplication, (3) abstract and full-text screening of the studies, and (4) final inclusion against the eligibility criteria. A PRISMA flow diagram is used for reporting process selection to achieve transparency of the ways in which the studies were narrowed down and scrutinized. The systematic review methodology not only enables transparency of data synthesis and collection but also enables effective comparisons of China's TVET competency frameworks with international models.

2.2. Data Collection Strategy

Data was gathered through a large-scale search in different databases to yield a comprehensive overview of relevant literature on TVET competency frameworks. Databases used included China National Knowledge Infrastructure (CNKI) when searching for research in Chinese language documents, Web of Science and Scopus for

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international high-impact publications, Google Scholar for standard academic papers, and ERIC (Education Resources Information Center) for studies on education. The databases were utilized for the purpose of conveying a variety of perspectives, both global and Chinese, on competency-based education in TVET.

A systematic search strategy was employed using Boolean operators (AND, OR) and targeted keyword combinations to refine search results. The primary search terms included.

- "TVET core competencies" AND "China vocational education".
- "TVET curriculum indicators" AND "competency-based education in China".
- "General education competencies in vocational training".
- "OECD and UNESCO competency models for TVET".

Filters were applied to limit the search to studies published within the last ten years (2014–2024) to ensure that the findings reflect contemporary trends and policy developments. Only peer-reviewed journal articles, government policy reports, and official TVET framework documents were considered to ensure the credibility and validity of the sources.

The inclusion criteria (Table 1) for selecting studies were as follows:

1. Studies focusing on China's TVET general education and competency frameworks.
2. Research that explicitly examines competency indicators in vocational education.
3. Publications from peer-reviewed journals, policy reports, and government documents to ensure academic and practical relevance.
4. Studies providing comparative insights into competency-based education models from international frameworks (e.g., OECD, ASEAN, UNESCO).

The exclusion criteria were:

1. Studies focusing exclusively on technical skills without addressing general education competencies.
2. Research that does not discuss competency indicators within the Chinese TVET context.
3. Opinion articles, conference abstracts, and non-peer-reviewed sources to maintain quality control.

Following the initial search, duplicate studies were removed, and titles and abstracts were screened for relevance. A full-text review was conducted for shortlisted studies to ensure they met the inclusion criteria. The final selection of 26 studies was then subjected to thematic analysis to extract relevant competency indicators and trends in curriculum development.

Table 1. Inclusion and exclusion criteria for the systematic review.

Criteria	Inclusion	Exclusion
Timeframe	Studies published within the last 10 years	Studies published before the last decade
Focus area	Research on China's TVET general education competency frameworks	Studies focusing solely on technical skills without general education elements
Publication type	Peer-reviewed journal articles, policy reports, government documents	Non-peer-reviewed sources, opinion pieces, blog posts
Geographical scope	Studies focused on China's TVET system	Research not specifically related to China
Competency indicators	Studies discussing cognitive, technical, socio-emotional, and entrepreneurial competencies	Studies lacking a discussion of competency indicators in China's context

2.3. Data Analysis and Synthesis

To systematically analyze the extracted data, a thematic categorization approach was adopted. Competency indicators identified in the selected studies were classified into four key domains.

- Cognitive competencies (e.g., literacy, numeracy, analytical thinking).
- Technical competencies (e.g., digital skills, industry-specific knowledge).
- Socio-emotional competencies (e.g., communication, teamwork, leadership).
- Entrepreneurial competencies (e.g., innovation, adaptability, business acumen).

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This classification facilitated systematic assessment of competency-based education integration into China's TVET curriculum and the level of priority assigned to general education competencies. In addition, a comparative analysis was conducted to identify China's competency model in comparison with international models, including those of OECD, ASEAN, and UNESCO. Cross-framework analysis allowed for the identification of gaps, alignment, and areas for improvement in China's TVET education system. Framework mapping was also used to identify the structure, definition, and classification of competencies in different education models. This included an analysis of how competencies are encoded in curriculum frameworks, assessment requirements, and pedagogy. Mapping of frameworks allowed for the identification of best practice competency-based education and to make recommendations to enhance China's general education response in TVET.

3. LITERATURE REVIEW

Competency-based learning is one of the greatest strategies in general education in TVET, wherein the focus lies on developing whole competencies as opposed to accumulating knowledge (Ab Hamid et al., 2023). Competency-based learning is distinct from knowledge-based learning, in which accumulating theoretical knowledge is the center of attention, since competency-based learning focuses on implementing knowledge in practice (George et al., 2023). This is consistent with global education reforms where equipping students to be critical thinkers, problem solvers, and adaptable to the evolving demands of the working environment is paramount (Li & Li, 2023). TVET general education competencies are typically classified into cognitive, technical, socio-emotional, and entrepreneurial skills (Aldinucci et al., 2023). Cognitive skills, such as literacy, numeracy, and problem-solving, are the pillars of effective decision-making and problem-solving in vocational settings (Yang, 2023). Technical skills, such as digital competence and knowledge of the sector, are required to adapt to the requirements of increasingly technology-intensive and automated working environments (Dahri et al., 2024). In addition, socio-emotional skills such as communication, teamwork, and leadership have been identified to be at the core of collaboration in the workplace and career advancement (Keller et al., 2025). Entrepreneurial skills such as innovation, adaptability, and business acumen are particularly applicable in China's rapidly evolving economic environment, where entrepreneurship and self-employment are becoming more career options (Sun & Li, 2023).

China's competency frameworks on TVET have been crafted in a way that integrates these different competency areas into the general education curriculum as a whole, in response to the overall goals of the National Vocational Education Reform Implementation Plan (McMullen et al., 2023). However, a comparative review of competency models that have been drafted by international organizations like UNESCO and OECD shows that although China has been able to adopt holistic competency frameworks, implementation strategies and evaluation mechanisms are still different (Asad et al., 2023). The ASEAN TVET competency model, for example, places more emphasis on regional integration of labor markets and border employability skills, particularly in the context of economic cooperation under the ASEAN Economic Community (Muchira, Morris, Wawire, & Oh, 2023). UNESCO's competency-based learning model, similarly, places more emphasis on lifelong learning with an emphasis on sustainability, digitalization, and social responsibility (Okagbue et al., 2023). The OECD Learning Framework 2030 also places emphasis on adaptability and future-proofing competencies and promotes interdisciplinary and problem-based learning approaches (Abd Majid et al., 2024). While some of China's competency frameworks on TVET align with these international models, namely in the recognition of digital and socio-emotional competencies, they still remain inflexibly devoted to traditional subject-based curricula, which may limit interdisciplinary learning and innovation in vocational education (Aldinucci et al., 2023).

One of the biggest impediments to competency-based learning adoption in China's TVET system is the rigidity of existing curricula, which are predisposed to a lack of interdisciplinary competence and potential for effective competency development (Ayanwale et al., 2023). China's conventional TVET programs are more curriculum-oriented, focusing on pre-determined technical competencies for use in specified industries and less on cross-

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disciplinary learning and implementing practical solutions (Yang & Welch, 2023). This rigidity impedes competencies that span more than one discipline, e.g., digital competency with an entrepreneurial mindset. There is also a constant mismatch between TVET competency training and industry demands, and numerous employers complain about graduates lacking essential soft skills that will enable them to perform at their best in workplaces (Jalilov Olimjon, 2023). Industry operators have called for greater interaction between vocational institutions and employers to bring competency training closer to workforce needs, but resistance from institutions and bureaucratic hurdles have derailed reform efforts (Alt et al., 2023). Additionally, the rapid pace of technology development has discouraged TVET institutions from continuously revising their curricula to accommodate changing industry demands, leading to gaps in the preparation of TVET graduates to match new labor markets (Halik Bassah et al., 2023).

Another critical issue in the implementation of competency frameworks is the lack of proper emphasis on digital and innovation competencies, which are essential to succeed in the current globalized and technology-driven economy (Collier-Sewell et al., 2023). Although China has recognized the significance of digital competencies in TVET education, the majority of programs do not sufficiently build training in digital competencies such as artificial intelligence, data analytics, and digital entrepreneurship (Ye, He, Bai, & Wu, 2024). Underlying this lack is the insufficient availability of resources to acquire high-level technological infrastructure and digital learning materials in the majority of TVET schools, particularly rural ones (Dahri et al., 2024). Additionally, capacity development among teachers is a major bottleneck as most of them are accustomed to conventional pedagogical approaches and lack experience in incorporating digital tools in competency-based education (McMullen et al., 2023). This teaching capacity deficit has constrained the proper application of digital competencies despite government initiatives towards the enhancement of TVET curricula (Ayanwale et al., 2023). These issues would be tackled through a multi-stakeholder response in the form of policy reform to render the curriculum more adaptable, increase industry-academia collaboration, and investment in ICT infrastructure and teacher training (Vargas, Heradio, Donoso, & Farias, 2023). Being a more vision-focused and dynamic competency-based learning strategy, China's TVET system has the chance to enhance students' capacity for developing the abilities to sustain career progress and continuous learning in the fast-changing and ever-increasing complexity of the job market (Asad et al., 2023). Table 2 shows a comparative overview of major competency models in TVET education, including their purposes and uses. China's National TVET Framework emphasizes workforce preparation and technical training, but is not interdisciplinary. ASEAN's competency model encourages cross-border employability, whereas the OECD Learning Framework focuses on 21st-century skills like creativity, digital literacy, and problem-solving. UNESCO's competency-based model encourages sustainable development and interdisciplinary learning, which is in line with international educational trends. The industry-based competency frameworks also emphasize the importance of TVET systems matching the needs of the labor market, and the implication is that China's TVET system might improve by including more adaptable, industry-oriented components in its curriculum.

Table 2. Key competency frameworks in TVET education.

Framework	Description	Application in TVET
China's national TVET framework	Emphasizes workforce readiness, technical skills, and industry collaboration	Integrates vocational skills with academic learning, but has limited flexibility
ASEAN TVET competency model	Focuses on employability skills, regional mobility, and lifelong learning	Encourages cross-border recognition of skills and adaptability
OECD learning framework	Highlights 21st-century skills, including problem-solving, digital literacy, and creativity	Aims to develop holistic competencies for future workforce challenges
UNESCO competency-based learning	Promotes sustainable development, global citizenship, and interdisciplinary learning	Supports competency-based education (CBE) with a focus on equity and inclusivity
Industry-specific competency models	Developed in collaboration with enterprises to address evolving labor market needs	Aligns TVET training with industry expectations and emerging technology trends

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4. FINDINGS

4.1. Identified Core Competency Indicators in China's TVET System

China's TVET system has increasingly become cognitive and skills-oriented in an academic sense as the basis for vocational success. Literacy and numeracy continue to be central, as they are the foundation for successful communication and problem-solving in academic and working environments (Ab Hamid et al., 2023). Scientific understanding above the level of literacy increasingly becomes an important core element, particularly in technological streams where knowledge of supporting scientific principles is needed to make vocational skills applicable (Tobback, Verhaest, Baert, & De Witte, 2023). Critical thinking has also emerged as an important characteristic, remaining consistent with international competency-based learning trends that prioritize analysis and independent problem-solving (Okagbue et al., 2023). In spite of such innovations, issues still abound in providing a homogenized embedding of cognitive capabilities across various TVET programs, particularly in weighing theoretical education against practical skill attainment (Jamaludin et al., 2023). Even as much emphasis is placed at the policy levels of government on the high relevance of these capabilities, there are loopholes in implementation, particularly in institutions with restricted resources where common education courses could come second to technical training.

The TVET technical and vocational skills developed in China are highly relevant to industry requirements, especially in technical problem-solving, industry knowledge, and digital literacy (Abd Majid et al., 2024). With digital transformation in full swing at a neck-breaking pace across industries, digital literacy has emerged as a mandatory component of TVET programs, making graduates proficient in fundamental coding, data analysis, and digital communication (Aldinucci et al., 2023). Competency frameworks also heavily emphasize technical problem-solving, with students motivated to master problem-solving skills in order to troubleshoot and innovate in their line of activity (Alt et al., 2023). While industry applicability is an overarching philosophy behind competency design, there is a lag between shifting technological requirements and the responsiveness of TVET curriculum (Dahri et al., 2024). Most programs fail to incorporate emerging technologies such as artificial intelligence, blockchain, and smart manufacturing due to outmoded training facilities and incompetent instructors (George et al., 2023). Hence, while technical competencies are well-defined, their practice implementation differs across various TVET institutions.

Socio-emotional and interpersonal competencies have become increasingly important within China's TVET system to respond to the importance of soft skills in employability within the labor market. Communication, teamwork, and adaptability are emphasized as fundamental competencies in increasing employability in a globalized labor market (Anderson-Levitt & Gardinier, 2023). Employers increasingly look for employees who can effectively work in culturally diverse teams and adapt to continuously changing working conditions, and hence such competencies are crucial within modern TVET curricula (Halik Bassah et al., 2023). Cultural competency has also become an emerging priority, particularly with China's attempts to expand international networks of trade and international cooperation in sectors such as manufacturing and tourism (Yang, 2023). Nevertheless, despite policy-driven attempts at incorporating such competencies within TVET learning, assessment mechanisms are underdeveloped. Traditional assessment mechanisms are biased toward the demonstration of technical competence as compared to socio-emotional intelligence, leading to a deficiency of standardized models of evaluation for testing such competencies (Keller et al., 2025). Therefore, although such competencies are acknowledged as drivers for career advancement, they are secondary in curriculum development and assessment mechanisms.

Incorporation of entrepreneurship and innovation competencies into China's TVET curriculum is an indication of the country's growing emphasis on self-employment, economic diversification, and startup culture. Creativity, business competencies, and risk management skills have been seen as the key to the innovation and adaptability of TVET graduates (Jamaludin et al., 2023). Interventions such as the "Entrepreneurial TVET" program are designed to develop entrepreneurial spirit through the addition of business skills training, entrepreneurial incubation, and money skills training in vocational learning pathways (George et al., 2023). Still, with programs such as these in

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existence, it is challenging to scale entrepreneurship education delivery to all TVET institutions. All these programs have poor access to seasoned instructors, funding sources for the initial capital outlay, and industry connections necessary for gaining practical entrepreneurial skills (Dahri et al., 2024). In addition, the priority given to formal employment streams at TVET institutions has a proclivity for deterring learners from entrepreneurial career streams, shortening the pragmatic impact of the skills. To close these gaps will need more of a structured strategy at the integration of entrepreneurial education into competency models and facilitation of access for students in becoming business owners. The competency indicators listed in Table 3 capture the multidimensional character of general education competencies in China's TVET system. Cognitive and academic competencies, such as literacy, numeracy, and analytical thinking, form the basis for critical thinking and problem-solving. Technical competencies, such as digital literacy and industry knowledge, capture the growing need for technologically competent graduates. Socio-emotional competencies, such as teamwork and cultural flexibility, are essential to workplace integration, while entrepreneurial and innovation competencies promote creativity and autonomy. Inclusion of such varied competencies in the TVET curriculum points towards an increasingly acknowledged need for comprehensive education, though their applicability and utility are still foremost challenges.

Table 3. Identified core competency indicators in China's TVET system.

Competency category	Key indicators	Relevance to TVET
Cognitive and academic competencies	Literacy, numeracy, scientific knowledge, analytical and critical thinking	Enhances problem-solving skills and theoretical understanding
Technical and vocational competencies	Digital literacy, technical problem-solving, industry-specific skills	Prepares students for job-specific roles in evolving industries
Socio-emotional and interpersonal competencies	Communication skills, teamwork, adaptability, cultural competency	Develops workplace collaboration and leadership abilities
Entrepreneurial and innovation competencies	Creativity, business skills, risk management, adaptability	Encourages self-employment and innovation-driven career paths

4.2. Trends in Competency Framework Development

Among the most prominent trends in shaping China's TVET competency framework is the increased emphasis on digital and AI competency. With rapid technological advancements in industries, TVET institutions are incorporating emerging technologies such as artificial intelligence, cloud computing, and big data analysis into their teaching programs (Alt et al., 2023). The trend of digital competency is visible in government strategies such as the "Smart Education Strategy," which promotes the use of AI-powered learning platforms, virtual labs, and digital simulation software in vocational training (Anderson-Levitt & Gardinier, 2023). The greatest challenge is resource disparity in the allocation of resources to institutions, however. While top-performing vocational colleges have been able to incorporate digital training modules, under-resourced and rural institutions lag behind due to legacy facilities and inadequate qualified personnel (McDonald & Korber, 2023). The digital divide is the issue of uneven access to quality vocational training, and it suggests the necessity of targeted policy measures to bridge the technology gap.

Another significant trend is the rising need for interdisciplinary capacity, particularly to address shifting industry demands that require a mix of technical, cognitive, and socio-emotional capabilities (Luo, 2023). Traditional TVET models are focused on discipline-specific knowledge, but emerging competency models advocate for a multidisciplinary focus that integrates elements of business, digital technology, and soft skills (Asad et al., 2023). For example, TVET training in green energy, smart manufacturing, and digital finance now requires graduates to possess a mix of engineering expertise, environmental awareness, and business acumen (Aldinucci et al., 2023). The shift towards interdisciplinary learning also aligns with international competency standards, particularly those by OECD and UNESCO, which advocate for the building of flexible skill sets to address rapidly evolving labor markets.

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Implementation challenges still exist, as most vocational teachers are educated in specialist, not interdisciplinary, pedagogies, which limit them from delivering cross-disciplinary material effectively (Tobback et al., 2023). To address this, capacity-building programs must be initiated to empower teachers with the capabilities to provide interdisciplinary competencies in an integrated manner.

Besides, competency framework building in China's TVET system is also fueled by globalization and international benchmarking. Chinese policymakers increasingly utilize international TVET competency models, such as ASEAN, OECD, and UNESCO, to improve national competency standards and harmonize them with international labor market requirements (Ye et al., 2024). International cooperation with countries like Germany, Singapore, and Australia has led to the implementation of dual-education models, industry-linked apprenticeships, and competency-based assessment approaches in Chinese vocational schools (Ngware, Ochieng', Kiroro, Hungi, & Muchira, 2024). However, even though such international models provide valuable lessons, complete integration is challenging due to differences in economic systems, cultural orientations towards vocational training, and regulatory contexts (Michaelis & Findeisen, 2024). Moreover, there is a fierce debate on how to balance localized competency development and international standardization, as policymakers seek to ensure TVET graduates satisfy both domestic and foreign employer demands (Okolie et al., 2023). In the future, China's competency frameworks must be streamlined with a context-sensitive approach applying international best practices towards the country's unique demands for an emerging labor market. Table 4 summarizes key trends in competency-based education in TVET, focusing on the transformation towards digital and AI literacy, interdisciplinary competencies, and more collaboration between institutions and industries. The embrace of international competency frameworks, like those suggested by OECD, ASEAN, and UNESCO, reflects China's resolve to upgrade its TVET system. Yet, efforts are needed to ensure these frameworks are realized through effective curriculum changes. The focus on lifelong learning and upskilling also underscores the requirements for dynamic, responsive educational frameworks that cater to ongoing professional growth. Altogether, all these trends underscore the imperative for policy reforms, curriculum adaptability, and greater industry connections to produce a more responsive and future-proof TVET system in China.

Table 4. Summary of trends in competency-based education in TVET.

Trend	Description	Impact on China's TVET system
Shift towards digital and AI literacy	Greater emphasis on integrating digital tools and AI-driven learning	Requires curriculum updates to incorporate technology-based competencies
Growing demand for interdisciplinary competencies	Blending technical and cognitive skills for holistic education	Encourages flexible learning pathways and skill diversification
Increased focus on industry collaboration	Strengthening ties between TVET institutions and industries for hands-on training	Enhances job readiness and reduces skill mismatch
Emphasis on lifelong learning and upskilling	Promoting continuous education and workforce adaptability	Supports employability in dynamic labor markets
Adoption of global competency frameworks	Aligning China's TVET with international standards like OECD, ASEAN, and UNESCO models	Improves global competitiveness of TVET graduates

4.3. Comparative Analysis of TVET Competency Models

China's TVET competency frameworks converge with international frameworks in some areas of relevance but diverge significantly because of contextual, economic, and policy-driven factors. Similar to the OECD Learning Framework 2030 and ASEAN TVET competency frameworks, China's framework prioritizes a mix of cognitive, technical, socio-emotional, and entrepreneurial competencies. For instance, the mix of literacy, numeracy, and analytical thinking converges with the OECD's priority on lifelong learning foundational skills, while digital literacy and technical problem-solving converge with ASEAN's priority on industry-specific training. China has also

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integrated elements of the German dual-education framework, such as work-based training, apprenticeship, and industry partnerships, in vocational programs (Yang & Welch, 2023). Divergences arise in competency integration depth and flexibility. While OECD and ASEAN frameworks prioritize interdisciplinary and transferable skills, China's framework remains sector-based, focusing more on direct applications of skills than cross-industry flexibility (Luo, 2023). This can compromise the ability of graduates to change industries, particularly in rapidly changing labor markets where flexibility is critical. Moreover, China's TVET competency assessment frameworks remain rigid and examination-based, contrary to competency-based, performance-based assessment in international frameworks (Jalilov Olimjon, 2023).

Despite these variations, China's competency-based TVET system has some positive strengths that explain its overall performance. One of its most significant positive features is its close alignment with national industrial policies, which ensures competency frameworks are firmly linked with the country's economic development agenda (Alt et al., 2023). Programs such as Made in China 2025 and the Smart Education Strategy have propelled the incorporation of AI, automation, and digital skills into TVET curricula so that the education system remains compatible with national technology development (Ab Hamid et al., 2023). The centralized policy structure of China also facilitates a consistent national approach, unlike some ASEAN nations where competency frameworks are relatively diversified across regions (Zhang, 2023). Moreover, China's focus on technical and vocational skills competence guarantees that graduates have robust domain knowledge, which matches employers' demands in manufacturing, engineering, and services (Aldinucci et al., 2023). However, the rigidity of competency models is an issue, considering the necessity for frequent technological updates that require frequent upgrading of skills beyond narrowly defined competencies (Szulewski et al., 2023). Compared to OECD models centered on constant learning streams, however, China's TVET system is still structured around rigid curriculums and is therefore difficult to shift into new and emerging industries.

5. DISCUSSION

The findings of this systematic review offer the most significant data about the evolution, strengths, and limitations of China's TVET general education core competency models. The findings are contrasted against literature and world competency-based models to provide an inclusive examination of how far China's TVET system differs from international best practices and yet faces special challenges. This chapter addresses the implications of the identified competencies, the dynamic nature of competency-based learning, and areas for improvement in the competency framework.

Among the most powerful implications and takeaways of the study is the systematic categorization of general competencies in China's TVET system of general education. Giving priority to cognitive and scholastic competencies like literacy, numeracy, and critical thinking aligns with international competency standards such as the OECD Learning Framework 2030 and ASEAN TVET competency frameworks (Aldinucci et al., 2023). This shows that China's TVET model recognizes the importance of foundational learning competencies for preparing the learner for work. Contrary, however, to the Western competency models that extend cross-disciplinary cognition development, China's is still heavily specialist-oriented in competency emphasis, even though it is more industry-sensitive in a straightforward manner (Ye et al., 2024). This rigid structuring, though effective in producing technically qualified graduates, may prevent students from applying skills across industries or engaging in higher-order intellectual activities. The literature also shows that OECD and UNESCO frameworks place great emphasis on adaptability in knowledge application, while China's model remains biased towards a structure of fixed knowledge transfer (Asad et al., 2023). One of the most significant reform recommendations, therefore, is enhancing the adaptability and interdisciplinarity of cognitive training in TVET courses.

The study also identifies the growing emphasis on technical and vocational skills, i.e., digital literacy, problem-solving, and industry-specific skills. This is consistent with the broader global trend of digital and AI literacy in

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TVET curricula, a trend observed in ASEAN, European, and North American vocational education systems (Dahri et al., 2024). China has incorporated the cultivation of digital and technical capabilities into its TVET system, particularly under initiatives like Made in China 2025 and the Smart Education Strategy (Ayanwale et al., 2023). However, comparative studies suggest that China leads in technical knowledge and direct skill application but lags behind in the delivery of interdisciplinary and transferable skill sets (Li & Li, 2023). Compared to the German dual-education system, where ongoing integration between theoretical education and practical industry applications is prioritized, China's TVET system is slow to respond to new technological advances in real-time (Ayanwale et al., 2023). Therefore, a major reform action would be to implement more dynamic and responsive competency training, facilitating students' development of multi-industry digital competencies over narrowly defined skill sets.

One of the biggest issues with China's TVET competency framework is the low degree of emphasis on socio-emotional and interpersonal competencies. Studies indicate that communication skills, teamwork, and leadership, as a priority identified competency, are not systematically addressed in TVET courses (Ye et al., 2024). This is compared to the OECD Future of Education and Skills 2030 framework, where equal emphasis is given to soft skills and technical competencies. Studies prove that productive team performance, adaptability, and leadership directly contribute to productivity and career development in the workplace, yet China's TVET graduates are not formally trained in these competencies (Halik Bassah et al., 2023). Additionally, Chinese employers report that TVET graduates lack interpersonal collaboration and work communication skills, proving a gap between education and industry needs (Jamaludin et al., 2023). ASEAN and EU models have integrated experiential learning and competency-based testing for socio-emotional competencies, yet China's framework is test-based and knowledge-based (Szulewski et al., 2023). Strengthening project-based learning, peer collaborative work, and interactive competency testing would fill this gap, ensuring graduates possess not only technical knowledge but also social awareness for workplace success.

The second major weakness is the poor integration of entrepreneurial and innovation capabilities into China's TVET curriculum. Entrepreneurial skills like business acumen, risk management, adaptability, and creative problem-solving are increasingly becoming central in international competency profiles (Asad et al., 2023). China has done little to integrate basic innovation training and has fallen behind in systematic streams for entrepreneurial training, startup incubation, and industry-academia collaboration (Abd Majid et al., 2024). In contrast, nations like Germany and Singapore emphasize entrepreneurial competencies through experiential training, business simulation projects, and startup mentorship schemes (Aldinucci et al., 2023). The report indicates that China's emphasis remains largely on job readiness and not on developing self-reliance and entrepreneurial mindsets (Luo, 2023). To assert this, TVET programs need to incorporate entrepreneurial learning modules, genuine startup incubation partnerships, and industry mentorship programs to align with international trends.

One of the trends in the research is the global trend towards interdisciplinary competency models, in this case, increased demands for digital competency and AI competencies. China's TVET has also evolved to include digital competency as part of its global best practice (Ayanwale et al., 2023). Nevertheless, the research points out that China's digital training remains industry-focused compared to OECD and ASEAN models emphasizing cross-disciplinary applications of AI, coding, and automation. While technical skills development is emphasized, interdisciplinary digital studies such as the integration of AI with humanities, ethics, and global digital citizenship are underdeveloped (Michaelis & Findeisen, 2024). In contrast, TVET programs in European models embrace digital sustainability and interdisciplinary applications to equip students with future-proofed competencies (OECD, 2020). Therefore, further advancing interdisciplinary AI studies, ethical tech studies, and digital adaptability training would equip China's TVET graduates to compete in a more globalized labor market.

The study also reveals some profound implications of implementing competency-based systems into the Chinese TVET system. A key challenge among these is the inflexibility of the curriculum and a lack of interdisciplinary flexibility, which makes it difficult to infuse new competencies with ease (Ye et al., 2024). While other OECD models

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feature TVET curricula with approval of modular training and industry-cross certification, China's system is prescriptive and allows little leeway for individual courses of study (Jamaludin et al., 2023). This does not allow students to alter their courses in response to evolving industry requirements. The compatibility of the competency training program with industry requirements has also been a constant problem. Evidence supports that China's TVET graduates are technologically skilled but lack business, adaptability, and problem-solving skills (Halik Bassah et al., 2023). Such weaknesses call for greater convergence among educational institutions and industries where competency markers are still relevant and market-responsive.

In addition, proof confirms that too little focus on digital and innovation competencies is still lacking in China's TVET competency models. Even while attempting to integrate digital literacy, the rhythm of automation, blockchain, and AI innovation necessitates TVET systems to continuously revise digital competency indicators (George et al., 2023). In contrast to ASEAN and OECD continuous digital upskilling and reskilling models, China's TVET schemes remain grounded in static digital competence frameworks, which do not prepare graduates to respond to technology disruption (Dahri et al., 2024). Upscaling continuous digital training programs, AI-based reskilling modules, and industry-specific digital credentials would bridge this gap, rendering TVET graduates competitive in the digital economy.

6. IMPLICATIONS

6.1. Implications for TVET Curriculum Design

The findings from the research show that China's TVET system should be competency-based and have adaptive curricula. In today's era, most vocational programs still persist in a rigid form with pre-set sequences of courses that are hard to modify to cater to new demands from industries. With the trajectory of technological upgrades and the speedup of industries' digitalization, the TVET institutions need to accommodate modular and multidisciplinary teaching frameworks that can enable learners to customize their paths of learning. This can be done with a competency-based education (CBE) framework, which enables learners to progress based on skill attainment rather than on programmed academic schedules. It is of immediate necessity that blended learning systems, fusing traditional hands-on training with technological and AI-managed learning environments, be embraced. The adoption of virtual laboratories, AI-driven simulations, and interactive learning platforms would enable the acquisition of theoretical knowledge along with practical skills. Industry involvement has to be included directly in the planning of curricula so that students are exposed to real-world projects, internships, and industry guides from the early stages of education. Through developing a dynamic learning environment, China's TVET system can construct a workforce that is not only technically qualified but also capable, innovative, and able to run complex global industries.

6.2. Implications for Educational Policy

At an education policy level, the research identifies the necessity of government support and policy regimes for competency-based training and lifelong learning. As much as China has invested in vocational education reform, there remains a gap between policy and its implementation that assures widespread uptake of new competency models. Government agencies need to channel focused funding, incentives, and policy support to institutions embracing competency-based training models compatible with Industry 4.0 and AI work environments. Policies that promote lifelong learning and upskilling initiatives are also essential in ensuring a resilient workforce. Skills obsolescence is common in most industries due to the rate of change in technology, and policymakers must therefore develop retraining programs, micro-credentialing programs, and online learning platforms accessible to students and working professionals. China can leverage global best practices and incentivize collaborations between TVET institutions, online education institutions, and industry leaders to develop continuous learning environments. Public-private partnerships and policy support for vocational education innovation will be critical in making China's workforce competitive in the global digital economy.

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6.3. Implications for Industry and Workforce Development

The findings of the research also underscore the need for TVET-industry collaboration in building workforce competencies. Although China's vocational education system has close alignment with domestic industrial policies, increased participation of private sector industries in determining skill needs, competency evaluation, and work-based learning is necessary. Joint training initiatives, apprenticeship frameworks, and co-developed curricula would ensure highly relevant industry skills among TVET graduates, along with fostering a culture of innovation and entrepreneurship. Additionally, expanding the focus on digital literacy, AI integration, and innovation-led competencies will be essential to long-term economic sustainability. Most global TVET models, e.g., Singapore and Germany, have been successful in operationalizing dual-education frameworks, where students alternately transition between classroom and workplace-based education. China's TVET system would also benefit from the same framework, with industries taking an active role in mentoring and upskilling human capital. As automation and artificial intelligence increasingly redefine conventional job roles, a culture of continuous skill development will become essential to future-proofing China's workforce and its position as a global high-tech industry leader.

7. LIMITATIONS AND FUTURE DIRECTIONS

While this study is enlightening about China's TVET general education core competency frameworks, there are some limitations that should be pointed out. Firstly, the study is largely dependent on secondary data sources like current literature, policy documents, and competency models, which might limit the depth of empirical validation. The absence of primary data collection, for instance, stakeholder interviews or direct competency measures, prevents the capture of real-time competency concerns and institutional knowledge regarding competency implementation. The study also omits technical training-specific competencies from consideration, which are equally essential for workforce readiness. The scope limitation, thus, enables the study to highlight the importance of cognitive, socio-emotional, and entrepreneurial skills but does not perform an in-depth analysis of industry-specific technical training. Future research can bridge these gaps by conducting longitudinal studies tracing the learning process of TVET students and applying competencies in actual workforce settings, and providing more robust evidence of competency-based learning outcomes. Expansion of research to examine regional differences in China's TVET system would also be helpful, as provinces might have different policy agendas, industrial requirements, and educational concerns. Lastly, comparative research on TVET competency frameworks in other Asian countries, like Singapore, South Korea, and Malaysia, which are also fast-growing economies, might provide insights into best practices and replicable models for China's TVET reforms. Bridging these gaps, future research can enable improvement in overall competency-based education and its evolving role in vocational training and workforce preparation.

8. CONCLUSION

This study provides an authoritative evaluation of China's TVET general education core competency frameworks, highlighting the pressing need for cognitive, technical, socio-emotional, and entrepreneurial competencies to build a future-proof workforce. Through a systematic review of competency indicators, the study highlights strengths and gaps in China's current TVET system, with calls for greater flexibility, digital literacy, and interdisciplinary skill integration. Competency-based education in China has made significant progress, but comparisons with ASEAN, UNESCO, and OECD frameworks overseas identify areas for closer alignment and development, such as confronting Industry 4.0 challenges and learning for innovation. The study also highlights critical implementation challenges, such as curriculum inflexibility, industry needs misalignment, and insufficient focus on emerging competencies such as AI literacy and digital adaptability. Closing these gaps requires active policy intervention, such as government incentives for competency-based learning, TVET-industry partnership reinforcement, and lifelong upskilling. Future research should also focus on longitudinal studies of competency acquisition, regional variations in TVET implementation, and comparative studies with other Asian economies. By

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building competency-based education in TVET, China can build workforce resilience, economic competitiveness, and innovation capacity, making vocational graduates highly competitive in an increasingly dynamic and technology-intensive global labor market.

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