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# From "Employment-Oriented Talent Cultivation" to "Human – Machine Collaborative Talent Development": An AI-Driven Reform and Exploration of the Government – School – Enterprise Collaborative Vocational Education Model in China – ASEAN Modern Craftsman College

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**Abstract:** The findings indicate that by 2025, the digital economy in Southeast Asia has exceeded USD 300 billion, while the shortage of digital talent across ASEAN has reached approximately 35 million. However, existing collaborative programs remain significantly constrained in terms of curriculum updating speed and technological synchronization capacity. Further analysis demonstrates that AI technologies can provide a critical driving force for addressing these challenges by enabling personalized learning, supporting virtual simulation-based training, and facilitating data-driven intelligent management. Building on these insights, this study proposes a four-dimensional collaborative mechanism characterized by government guidance, school-led development, enterprise-driven participation, and AI-enabled support. It advocates the co-construction of a cross-border intelligent education cloud platform, the development of a dynamic modular curriculum system, and the establishment of competency certification models based on digital profiling. These measures aim to achieve a fundamental transition from "bilateral human collaboration" to an ecosystem of human – machine collaborative talent development, thereby offering actionable pathways for building a resilient and dynamic China – ASEAN vocational education community in the intelligent era.

**Keywords:** Modern Craftsman Colleges, AI-driven, government – school – enterprise collaboration, vocational education, human – machine collaboration

## 1. Introduction

Amid the global wave of industrial digitalization and intelligent transformation, artificial intelligence (AI) is reshaping the form and ecosystem of vocational education with unprecedented depth and breadth. According to the 10th edition of the e-Conomy SEA Report jointly released by Google, Temasek, and Bain & Company, the gross merchandise value (GMV) of Southeast Asia's digital economy exceeded USD 300 billion in 2025—nearly doubling compared with 2019 and reaching 1.5 times the level projected in the inaugural report a decade earlier. Meanwhile, a report by the Asian Development Bank indicates that the shortage of digital talent in ASEAN alone is expected to reach approximately 35 million by 2025 (Google et al., 2025), spanning high-growth sectors such as artificial intelligence, data analytics, cloud computing, and intelligent manufacturing. This pronounced supply – demand mismatch has generated unprecedented urgency for China – ASEAN vocational education cooperation (Asian Development Bank, 2024).

In response to these emerging challenges, the General Office of the People's Government of Guangxi Zhuang Autonomous Region issued the Guidelines for the Development of China – ASEAN Modern Craftsman Colleges in October 2023, proposing the establishment of a number of such institutions to build an integrated platform combining industry, education, and think tank functions. In February 2024, the Department of Education of Guangxi announced the first batch of 17 China – ASEAN Modern Craftsman Colleges for project initiation. By November 2024, these initiatives had expanded to 12 ASEAN countries, forming a preliminary cooperation network covering major

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Southeast Asian economies (Guangxi Zhuang Autonomous Region Department of Education, 2024).

However, as these cross-national industry – education integration initiatives transition from planning to implementation, their traditional government – school – enterprise collaboration model—characterized by administrative coordination and labor-intensive operation under an employment-oriented talent cultivation approach—faces multiple structural challenges. These include fragmented coordination mechanisms, outdated teaching content, insufficient practice platforms, and static evaluation systems. Existing studies have noted that China – ASEAN vocational education cooperation remains at an early stage, with limited scale, loosely structured cross-regional governance, and uneven distribution of high-quality resources (Zhang & Ren, 2022). Against this backdrop, a critical question emerges: how can AI technologies be leveraged to overcome institutional constraints, reconstruct collaboration models, and enable a paradigm shift from employment-oriented talent cultivation to human – machine collaborative talent development?

## 2. Practical Dilemmas of the Traditional Employment-Oriented Talent Cultivation Model in China–ASEAN Modern Craftsman Colleges

### 2.1 Fragmented coordination mechanisms: ambiguous responsibilities and delayed actions

The 17 Modern Craftsman Colleges collectively form a complex transnational, multi-stakeholder, and cross-industry collaboration network. These initiatives involve 17 Chinese vocational institutions, more than 20 ASEAN partner institutions, and over 30 leading enterprises from China and abroad, spanning key sectors such as new energy vehicles, intelligent manufacturing, modern agriculture, construction technology, and green energy.

However, the traditional collaboration model relies heavily on periodic bilateral meetings, memoranda of understanding, and interpersonal coordination, resulting in lengthy decision-making and implementation processes. For instance, in the field of new energy vehicles, collaboration typically requires coordination among Chinese vocational colleges, regional government platforms, and multiple partners—including Thai Binh University (Vietnam), Guangxi Automobile Group, and BYD Company. Even basic tasks such as aligning curricula, mutual recognition of faculty certification standards, and cross-border procurement of training equipment may involve multiple rounds of negotiation over several months before reaching preliminary consensus.

Institutional constraints—including insufficient policy and legal frameworks and underdeveloped cooperation mechanisms—remain key barriers to effective China – ASEAN vocational education collaboration. Communication channels among stakeholders are often inefficient, and cooperation agreements tend to lack specificity (Sui & Liu, 2024). In the absence of permanent cross-regional coordination bodies and standardized decision-making procedures, many projects face the dilemma of "easy to sign, difficult to implement" (Li & Li, 2018).

### 2.2 Outdated teaching content: misalignment with local industrial upgrading

The program design of Modern Craftsman Colleges is strongly problem-oriented, aiming to support international industrial capacity cooperation and the integration of China – ASEAN industrial and supply chains. However, a structural time lag persists between curriculum provision and rapidly evolving industrial demands.

First, there is a lag in technological iteration. In fields such as intelligent manufacturing, industrial robotics technologies are evolving at an annual rate of approximately 15% – 20%, with continuous emergence of new sensors, edge computing nodes, and digital twin interfaces. Consequently, traditional textbooks may become partially outdated by the time they are formally implemented. Existing research has highlighted a structural mismatch between talent cultivation standards and industry needs, as well as the lag of curriculum content behind technological development (Huang et al., 2020).

Second, there is a lag—and in some cases, deviation—in localization. Effective curriculum design requires deep integration with the industrial realities, technical standards, and cultural contexts of partner countries. However, this remains a weak link in current practice. For example, in textile and garment programs, failure to align with local raw material characteristics, mainstream equipment specifications, workforce skill levels, and increasingly stringent environmental regulations in export markets such as the European Union may result in graduates who are unable to meet the actual needs of local industrial upgrading. Studies have also shown that vocational education materials oriented toward ASEAN often lack localized content, rely on

cases disconnected from local contexts, and face significant cultural and linguistic barriers.

**2.3 Weak practice platforms: coexistence of high-cost physical training and low-level virtual simulation**

Skill mastery is fundamentally grounded in experiential learning; however, Modern Craftsman Colleges face both physical and digital constraints in practical training.

At the physical level, establishing and operating high-standard training bases in ASEAN countries presents substantial challenges. For instance, constructing an intelligent construction training center in Cambodia — covering BIM technologies, prefabricated construction, and intelligent surveying — requires significant investment in land, infrastructure, and equipment. In addition, ongoing costs related to maintenance, technological upgrades, consumables, and the deployment of Chinese technical instructors remain high. Physical training is also constrained by time, space, safety regulations, and equipment availability, limiting the feasibility of large-scale, personalized, and high-frequency training. These constraints are particularly pronounced in high-risk fields such as photovoltaic power plant operation and high-voltage electrical work.

At the digital level, although policy frameworks encourage the application of VR, AR, and AI technologies, current implementations remain fragmented, low-level, and unsystematic. Individual institutions may adopt isolated simulation tools, but lack shared platforms that enable cross-institutional and cross-regional data interoperability. Research indicates that virtual simulation training in vocational education remains underdeveloped, with insufficient platform infrastructure, limited depth of technological application, and the absence of standardized systems. These "data silos" prevent effective aggregation of behavioral data generated during training, thereby limiting intelligent analysis and precise evaluation of learner performance. As a result, the full potential of virtual simulation technologies has yet to be realized.

**2.4 Static evaluation systems: inadequacy of single certification in representing dynamic competence**

Existing evaluation systems are insufficient for accurately measuring and guiding students' comprehensive competence development in complex, real-world work environments. Current approaches are heavily oriented toward summative, standardized assessments, such as "Chinese language + vocational skill level" certification examinations. Such systems exhibit structural limitations in aligning with industry needs and reflecting authentic competencies.

These forms of evaluation function as static "snapshots," capturing learners' mastery of prescribed knowledge at a specific point in time, but failing to reflect critical developmental processes, including cognitive progression, collaborative competence, problem-solving strategies, and innovative thinking. Moreover, the scope of evaluation remains narrow, focusing primarily on discrete operational procedures and theoretical knowledge, while lacking effective tools to assess composite competencies required in the AI era and cross-national work contexts — such as data literacy, human – machine collaboration capability, cross-cultural project management, sustainability awareness, and innovation capacity.

As a result, static evaluation systems neither provide fine-grained guidance for pedagogical improvement nor offer enterprises a comprehensive, dynamic, and credible assessment of talent capabilities. This leads to significant information asymmetry in recruitment, forcing enterprises to invest substantial additional resources in screening and pre-employment training. Estimates from human resource service agencies suggest that such costs may account for more than 30% of total recruitment expenditures. This high "trust cost" in turn weakens enterprises' intrinsic motivation to participate in industry – education integration.

## 3. Mechanisms and Feasibility of AI-Driven Transformation in Modern Craftsman College Models

**3.1 Core technological enablement: the transformative role of AI in personalized learning, virtual simulation training, and intelligent management**

Artificial intelligence (AI) should not be regarded merely as an auxiliary teaching tool, but as a systemic enabler that reshapes the entire chain of "teaching – learning – training – management" through data-driven intelligence. Existing studies have identified four primary application domains of AI in vocational education: intelligent teaching evaluation, personalized learning, talent development planning, and the construction of virtual learning environments.

In the domain of personalized learning, adaptive learning systems leverage machine learning algorithms to continuously analyze learners'

interaction data — including response accuracy, time-on-task, resource preferences, and error patterns — to construct dynamic models of individual knowledge states. These systems can diagnose knowledge gaps in real time and deliver tailored learning content, calibrated practice difficulty, and adaptive feedback pathways, thereby enabling genuinely individualized instruction.

In the domain of practical training, the integration of "AI + Extended Reality (XR)" creates an intelligent training environment. AI-driven virtual environments can simulate high-fidelity, interactive workplace scenarios and embed cognitively capable "AI tutors." These tutors can monitor learners' operational processes in real time, evaluate procedural compliance and logical consistency, provide immediate multimodal feedback, and dynamically adjust task complexity, enabling highly individualized training trajectories.

In terms of intelligent management, AI technologies significantly enhance the operational efficiency and decision-making capacity of cross-national educational initiatives. Natural language processing (NLP) techniques can automatically analyze industrial policies, technical standards, and labor market trends across ASEAN countries, generating forward-looking insights for curriculum design and program adjustment. In addition, data-driven early warning systems can identify learners at risk of academic difficulty or dropout, enabling timely intervention and improving retention and completion rates.

### 3.2 Paradigm innovation: from project-based collaboration to a platform-based ecosystem

The deep integration of AI technologies drives a fundamental transformation in collaboration models — from discrete, bilateral, project-based cooperation to a platform-based ecosystem coordinated through data flows and intelligent algorithms. This transformation aligns with calls for building multi-stakeholder collaborative networks and long-term mechanisms in China – ASEAN vocational education cooperation.

At the core of this new paradigm is a co-constructed, shared, and jointly governed China – ASEAN Intelligent Education Cloud Platform for Modern Craftsman Colleges. This platform serves both as a digital infrastructure and as a value exchange marketplace. Governments can issue policy guidance, quality standards, and regulatory frameworks through the platform; educational institutions become contributors of modularized educational resources rather than isolated resource holders; and enterprises function as both demand-side actors and technology providers by publishing real-world technical challenges, competency models, and industrial standards.

### 3.3 Regional adaptation logic: aligning with ASEAN industrial priorities and China's technological strengths

In the field of new energy vehicles, ASEAN countries are actively promoting transportation electrification. Indonesia, which possesses the world's largest nickel reserves, is accelerating the development of a full industrial chain from mining to battery manufacturing and vehicle assembly, while introducing new technical standards and localization requirements in 2023. Meanwhile, China holds a globally leading position across the entire new energy vehicle value chain, with production and sales exceeding 12 million units in 2024 and accounting for over 60% of the global market.

Through AI-enabled approaches, advanced technologies—such as battery management systems, electric drive systems, and intelligent connectivity—can be transformed into digital curricula and intelligent training systems tailored to local workforce development needs.

In the field of green energy, Cambodia aims to increase the share of renewable energy generation to 60% by 2030. China's extensive experience in photovoltaic manufacturing, hydropower development, and smart grid construction provides a strong foundation for cooperation, with approximately 80% of global photovoltaic module production capacity located in China.

This "technology – education synergy" model goes beyond conventional forms of product export or engineering contracting, representing a deeper form of "soft connectivity" focused on long-term human capital development and the integration of regional industrial and supply chains.

## 4. Constructing a Government – School – Enterprise Pathway for Human – Machine Collaborative Talent Development

### 4.1 Reconstructing governance mechanisms: a data-driven quadrilateral framework

A fundamental step is to redefine the roles and responsibilities of four key actors: government, educational institutions, enterprises, and digital platforms. Governments should transition from "approvers" and "direct administrators" to "strategic coordinators," "rule-makers," and "data regulators,"

focusing on policy incentives, cross-border data governance, and international skill standard alignment.

Educational institutions should serve as core agents of pedagogical innovation and implementation, responsible for developing and delivering AI-driven curricula and training programs. Enterprises must evolve into demand-driven and co-creative actors, actively participating in competency standard development and providing real industrial projects as teaching cases.

A key institutional innovation is the establishment of a "China – ASEAN Modern Craftsman Colleges Digital Governance Committee," functioning as a standing executive body. Decision-making should shift from periodic reporting and subjective judgment to real-time, verifiable, and auditable data dashboards generated by the intelligent platform, enabling evidence-based governance.

**4.2 Co-constructing an intelligent platform: a digital resource hub**

The intelligent cloud platform should serve as the core infrastructure, comprising three key modules:

**4.2.1 Intelligent learning and resource center**

This module integrates multilingual AI assistants for real-time translation and contextual explanation, while establishing a large-scale, tagged digital resource repository supported by blockchain technology for intellectual property protection and resource sharing.

**4.2.2 Virtual simulation training hub**

As the core engine, this module provides configurable training scenarios across key industries. For example, in modern agriculture programs, it can simulate smart irrigation systems and drone-based operations. All training data are recorded and analyzed to generate detailed learner skill profiles.

**4.2.3 Digital talent marketplace and career gateway**

Enterprises can publish digital job profiles, while the platform matches them with anonymized learner skill profiles using machine learning algorithms. At the same time, the platform provides personalized lifelong learning pathways based on industry trend analysis.

**4.3 Developing dynamic resources: a modular curriculum system**

An "Industry Data Radar and Demand Sensing System" should be established to monitor global and ASEAN developments in patents, research outputs, policy changes, and labor market trends, providing data-driven guidance for curriculum updates.

A micro-modular curriculum approach should be adopted, decomposing traditional programs into fine-grained knowledge – skill modules. For example, "New Energy Vehicle Maintenance" can be divided into modules such as high-voltage safety protocols, battery management system monitoring, and motor fault diagnostics. Each module integrates theoretical content, interactive simulations, self-assessment tools, and AR-based operational guidance.

**4.4 Innovating evaluation systems: a "digital skills passport"**

A comprehensive multi-modal data collection system should capture learners' behaviors across the platform, including learning trajectories, training performance, collaboration activities, and innovation outputs. These data form the basis for constructing dynamic competency profiles.

Based on these profiles, learners can obtain digital credentials and skill badges recognized by industry. These credentials can be integrated into professional platforms and recruitment systems, enabling a shift from credential-based to data-driven talent evaluation. This system addresses cross-national trust and recognition challenges, providing a credible and portable "digital skills passport" for global workforce mobility.

## 5. Conclusion

The establishment and progressive implementation of the first cohort of 17 China – ASEAN Modern Craftsman Colleges represent a significant milestone in advancing regional vocational education cooperation. This study has systematically examined the structural limitations of the traditional employment-oriented talent cultivation model in terms of coordination mechanisms, curriculum relevance, practice platforms, and evaluation systems.

It demonstrates that AI technologies — through personalized learning, virtual simulation, and data-driven management — provide both a technological lever and a pathway for systemic innovation. The proposed human – machine collaborative talent development framework offers a practical and scalable solution for building a resilient, adaptive, and future-oriented vocational education ecosystem in the China – ASEAN region.

## Conflict of Interest

The author declares that she has no conflicts of interest in this work.

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