

Vocational Education Expansion: Identifying Vocational High Schools for Program Opening at State Islamic University of Sultan Aji Muhammad Idris Samarinda

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Abstract

This study examined the spatial and sectoral alignment between the supply of vocational secondary education and regional economic demand across 10 regencies/cities to provide an evidence base for vocational teacher-education development at the State Islamic University of Sultan Aji Muhammad Idris Samarinda (UINSI Samarinda). A quantitative descriptive design combined spatial-economic mapping and overlay gap analysis using 2020–2025 secondary data for 221 SMK/MAK, institutional status, accreditation, ISO 9001 adoption, vocational-program profiles, sectoral gross regional domestic product, and regional policy documents. Of the 221 schools, 60.6% were private, while 58.8% were concentrated in Samarinda, Kutai Kartanegara, and Balikpapan. Accreditation B predominated (51.6%), compared with Accreditation A (23.5%) and C (21.7%), and only 16.3% had adopted ISO 9001. The overlay identified critical horizontal and structural under-supply in construction, geomatics, mining-related technologies, industrial processing, and applied agribusiness in several IKN-buffer districts, alongside over-supply of conventional office-administration pathways in major urban centers relative to emerging digital-logistics demand. The findings support prioritizing vocational teacher-education concentrations in construction engineering, applied agribusiness and bio-industry, and digital technology and logistics, complemented by regional Vocational Professional Teacher Education (PPG). The study implies that program expansion in higher vocational education should be preceded by recurrent, region-specific spatial-economic demand mapping rather than enrollment trends alone.

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Introduction

Vocational education and training (VET) has become increasingly important in contemporary development policy because technological transformation, industrial restructuring, digitalization, and regional economic transition are continuously altering the types, locations, and combinations of skills demanded by labor markets. The relevance of vocational education therefore depends not merely on expanding student participation or increasing the number of vocational institutions, but on the capacity of educational systems to anticipate changing occupational structures and translate economic transformation into appropriate fields of study, curricula, teacher expertise, and work-based learning arrangements. Contemporary VET scholarship consequently emphasizes a transition from supply-driven expansion toward demand-responsive skills formation in which educational provision is continuously aligned with sectoral development, technological change, and regional labor-market conditions (Denham & Fairbrother, 2024; Han et al., 2023; Lopes et al., 2023; McGrath

& Yamada, 2023). From this perspective, vocational education constitutes part of a broader regional development infrastructure: its contribution to productivity and employment depends on whether training is located in the appropriate territories, directed toward relevant sectors, and supported by institutions capable of sustaining occupationally meaningful learning. Recent regional evidence confirms that mismatches between educational supply and economic demand can persist even where vocational participation is relatively extensive, indicating that numerical expansion alone is insufficient for establishing an effective regional skills system (Denham & Fairbrother, 2024; Han et al., 2023; Hwang et al., 2024).

This problem has particular significance in East Kalimantan, where the development of Indonesia's Nusantara Capital City (*Ibu Kota Nusantara*, IKN) is generating a large-scale spatial and economic transition. The transformation extends beyond the administrative relocation of the national capital because it is accompanied by infrastructure development, construction, logistics, industrial processing, digital services, urban expansion, and changing connections among metropolitan, resource-based, agricultural, coastal, and remote economies. In such a context, regional skill demand is unlikely to develop uniformly. Samarinda and Balikpapan have increasingly diversified service, trade, logistics, industrial, and digital functions, whereas other localities remain strongly associated with mining, forestry, plantations, agriculture, maritime activities, or the emerging IKN construction ecosystem. Consequently, a uniform model of vocational provision risks producing an institutional landscape in which programs are concentrated geographically and occupationally without corresponding closely to the economic specialization of particular districts. Regional VET research demonstrates that such territorial heterogeneity matters because educational opportunities, industrial structure, institutional quality, and employment demand often exhibit different spatial distributions (Ana et al., 2025; Denham & Fairbrother, 2024; Han et al., 2023; Lopes et al., 2023). A planning framework for East Kalimantan must therefore move beyond provincial aggregates and examine how educational supply and economic demand correspond at the regency/city level. Recent GIS-based Indonesian research similarly shows that spatial overlay between vocational schools and industries can reveal forms of misalignment that remain hidden when analysis is based only on total numbers of schools or students (Ana et al., 2025).

Theoretically, this study draws on the complementary perspectives of human-capital formation, skills mismatch, regional skills ecosystems, and spatial supply–demand alignment. From a human-capital perspective, vocational education represents an investment in productive capabilities that may improve employment transitions when learners acquire competencies valued within relevant occupational environments. However, the economic return to vocational education is conditional rather than automatic because occupationally specific competencies may lose value when the structure of training is disconnected from labor demand, technological change, or regional employment opportunities (Guo & Wang, 2020; Hwang et al., 2024; McGrath & Yamada, 2023). Skills-mismatch theory sharpens this argument by distinguishing several forms of discrepancy between education and employment. Vertical mismatch concerns inconsistency between educational level and occupational qualification requirements, whereas horizontal mismatch concerns inconsistency between field of education and field of employment; related conditions include skill shortages, skill gaps, and competency obsolescence (Brunello & Wruuck, 2021; Hakim et al., 2025; Khoiruddin et al., 2024). Regional skills-ecosystem perspectives further extend the analysis by emphasizing that skills are produced through interaction among schools, higher education institutions, firms, government

agencies, teachers, professional bodies, and local economic structures rather than by educational institutions in isolation (Denham & Fairbrother, 2024; Li & Pilz, 2023; McGrath & Yamada, 2023). Accordingly, “link and match” is better understood as a dynamic regional alignment process than as a simple institutional slogan.

Recent empirical evidence reinforces the importance of distinguishing educational expansion from effective matching. Han et al. (2023), examining the geographical distribution of higher vocational education in China, demonstrated significant spatial differences between educational supply and demand, indicating that educational equality and regional responsiveness require geographically differentiated planning. Lopes et al. (2023), using a regional case study in Portugal, similarly showed that identifying VET priorities requires the integration of labor-market data, employer evidence, and regional economic information rather than relying solely on education-side indicators. Hwang et al. (2024) extended this argument by distinguishing conventional employment outcomes from *skill-matched employment*, demonstrating that the effectiveness of vocational training cannot be adequately evaluated merely by whether graduates obtain jobs. Denham and Fairbrother (2024) further conceptualized vocational training as an important component of regional economic transition, highlighting its potential contribution when skills provision is coordinated with changing regional industries. Collectively, these studies suggest that vocational systems must answer not only “how much education is provided?” but also “where is it provided, in what fields, at what institutional quality, and in relation to which regional economic functions?” These questions are especially pertinent to regions experiencing accelerated economic transformation, where inherited vocational-program structures may not correspond to emerging sectoral priorities.

The Indonesian evidence reveals a comparable problem. Research increasingly indicates that education–occupation alignment varies by educational pathway, sector, geography, and individual characteristics. Paramitasari et al. (2024), analyzing more than 100,000 employed Indonesian vocational-school graduates, showed that agglomeration economies influence job–education matching, emphasizing that local economic structure is central to understanding vocational outcomes. Putranto et al. (2024) demonstrated that vocational education can reduce the probability of vertical mismatch among Indonesian youth, while also showing that labor-market returns depend on the nature of the education–employment correspondence. Khoiruddin et al. (2024), using Indonesian labor-force data, found that education–job mismatch is shaped by demographic and regional characteristics, confirming that mismatch cannot be understood exclusively as an individual educational problem. More recently, Hakim et al. (2025) reported substantial horizontal educational mismatch among Indonesian graduates and found heterogeneous earnings consequences across fields of study. These findings collectively demonstrate that the key challenge is not simply insufficient education; rather, it is the configuration and allocation of educational competencies relative to labor-market structures. Nevertheless, most Indonesian mismatch research analyzes workers after they have entered employment. Much less attention has been paid to diagnosing mismatch upstream—at the point where vocational programs are geographically distributed and where higher education institutions decide which vocational teacher-education programs to establish.

A spatial perspective provides a means of addressing this upstream planning problem. Conventional provincial indicators may show how many vocational schools exist but cannot adequately reveal whether strategically important economic sectors are served by relevant

vocational specializations within particular localities. Ana et al. (2025), for example, developed a GIS-based model linking Indonesian vocational high schools with surrounding industrial needs and found uneven spatial alignment between schools and relevant industries. Their study demonstrates that geographic proximity and sectoral compatibility provide information that institutional counts alone cannot capture. Internationally, Han et al. (2023) similarly illustrate the analytical value of geographical representation in identifying disparities between vocational-education resources and regional demand, while Lopes et al. (2023) show that regional supply–demand matching can provide a systematic basis for determining program priorities. However, spatial proximity should not be interpreted as sufficient evidence of educational relevance. Institutional quality, program specialization, economic-sector structure, and future development trajectories must also be incorporated because a region can contain numerous vocational institutions while remaining deficient in strategically important technical fields. Thus, a spatial-economic framework must integrate both the geography and the substantive quality of vocational provision (Ana et al., 2025; Denham & Fairbrother, 2024; Han et al., 2023).

Institutional quality is particularly relevant because expanding vocational provision without adequate instructional capacity may simply reproduce mismatch in a different form. Vocational programs typically require specialized laboratories, equipment, industry-standard technologies, work-based learning opportunities, and instructors whose occupational knowledge remains current. Recent studies indicate that effective vocational learning emerges through sustained interaction among educational institutions, workplaces, teachers, and professional communities. Arinaitwe (2021) showed that collaboration between vocational teacher-training institutions and workplaces can enhance professional learning by connecting teacher education with authentic occupational practice. Jin et al. (2022) demonstrated that vocational teachers' professional development is strongly shaped by the relevance and contextual usefulness of expert feedback, while Murwaningsih and Fauziah (2022) identified continuing professional-development needs among Indonesian vocational-school teachers. These studies indicate that expanding technical programs without simultaneously considering the supply and development of vocational teachers can produce an implementation bottleneck. Consequently, shortages in construction, mining, agribusiness, industrial technology, logistics, or digital programs should be understood not only as shortages of student places but potentially as requirements for new teacher competencies, professional certification pathways, industry immersion, and university-based teacher preparation (Arinaitwe, 2021; Jin et al., 2022; Murwaningsih & Fauziah, 2022).

The urgency of such institutional adaptation is intensified by digital transformation. Technological change increasingly modifies occupational tasks across manufacturing, logistics, commercial services, administration, engineering, and communication, thereby weakening the assumption that long-established program nomenclature necessarily represents contemporary labor-market demand. Findeisen and Wild (2022) demonstrated heterogeneity in digital competence among beginning commercial VET trainees, while McGrath and Yamada (2023) emphasize that contemporary skills development increasingly requires attention to both demand-side economic change and the ways competencies are actually used. The relevance of imported or standardized vocational models is likewise dependent on local institutional adaptation rather than mechanical replication, as emphasized by Li and Pilz (2023). These findings are important for East Kalimantan because an apparent quantitative oversupply in fields such as conventional office administration

does not necessarily imply that all business-oriented vocational education should contract. Instead, such programs may require transformation toward digital commerce, supply-chain management, logistics technologies, data-enabled administration, automation, and other competencies associated with emerging urban and industrial ecosystems. Conversely, fields characterized by resource-intensive regional demand—such as construction technology, geomatics, heavy-equipment engineering, industrial processing, applied agriculture, and bio-industry—may require genuinely new vocational capacity.

This relationship between regional economic demand and teacher capacity has significant implications for higher education. Universities involved in teacher education occupy a strategic position because the opening of new vocational fields at the secondary level depends on a sustainable pipeline of professionally and occupationally competent teachers. Yet higher-education program expansion can itself become supply-driven when decisions are based primarily on enrollment expectations, institutional aspirations, or general policy trends without rigorous evidence concerning feeder-school distribution and regional economic demand. The problem is therefore recursive: poorly aligned secondary vocational provision may contribute to labor-market mismatch, while poorly aligned higher vocational teacher education may reproduce the same imbalance by producing teachers in fields for which demand is limited while leaving emerging technical specializations without adequate professional personnel. Research on VET policy transfer, teacher learning, and regional economic transition consistently emphasizes the importance of institutional context, workplace collaboration, local adaptation, and long-term capacity building (Arinaitwe, 2021; Denham & Fairbrother, 2024; Li & Pilz, 2023). For the State Islamic University of Sultan Aji Muhammad Idris Samarinda (UINSI Samarinda), this implies that prospective vocational teacher-education development should be justified through systematic evidence linking the existing SMK/MAK landscape, regional economic specialization, program-level shortages, institutional quality, and the likely need for professionally qualified vocational teachers.

Despite the growing literature, an important research gap remains. International studies have advanced regional supply–demand matching, geographical representations of VET, skills-ecosystem approaches, and skill-matched employment analysis (Denham & Fairbrother, 2024; Han et al., 2023; Hwang et al., 2024; Lopes et al., 2023). Indonesian studies, meanwhile, have provided increasingly sophisticated evidence on vertical mismatch, horizontal field-of-study mismatch, agglomeration effects, and the spatial relationship between vocational schools and industry (Ana et al., 2025; Hakim et al., 2025; Khoiruddin et al., 2024; Paramitasari et al., 2024; Putranto et al., 2024). However, these research strands remain largely disconnected. Worker-level studies usually diagnose mismatch after graduates have entered employment; spatial VET studies typically examine the correspondence between schools and industries; teacher-development studies concentrate on professional competence; and higher-education planning studies seldom integrate these domains into a single regional decision framework. In particular, there is limited evidence that simultaneously combines a province-wide inventory of vocational secondary institutions, their geographic distribution and institutional-quality characteristics, district/city economic specialization, program-level over-supply and under-supply, and the translation of these patterns into concrete vocational teacher-education priorities for a higher education institution. The original study was explicitly designed to address this intersection within the rapidly changing IKN buffer region.

The novelty of the present study therefore lies in developing an integrated spatial-economic-to-academic portfolio framework for vocational education planning. Rather than treating *link and match* as a simple comparison between school programs and employment sectors, the framework connects four analytically distinct levels: the spatial distribution and institutional characteristics of SMK/MAK provision; the sectoral structure and development priorities of regional economies; the identification of matched, over-supplied, and under-supplied vocational fields; and the translation of persistent or strategically significant gaps into evidence-based priorities for Vocational Teacher Education and Vocational Professional Teacher Education (PPG). This approach extends existing mismatch research upstream from graduate employment toward institutional program planning and positions the university as an active component of the regional skills ecosystem rather than merely as a provider responding to short-term enrollment demand. In doing so, the study complements GIS-based vocational mapping, regional VET matching, and Indonesian labor-market mismatch research while adding an explicit academic-planning dimension (Ana et al., 2025; Han et al., 2023; Lopes et al., 2023; Paramitasari et al., 2024).

Accordingly, this study aims to (1) analyze the spatial distribution, institutional status, accreditation profile, and ISO 9001 adoption of 221 SMK/MAK institutions across the 10 regencies/cities of East Kalimantan; (2) identify the dominant and strategically important economic sectors represented in district/city regional economic structures; (3) assess the degree of alignment and identify patterns of over-supply and under-supply between vocational-program provision and regional economic demand; and (4) formulate evidence-based priorities for the development of Vocational Teacher Education programs and Vocational PPG at UINSI Samarinda. Through these objectives, the study seeks to provide a territorially differentiated evidence base for vocational governance in the IKN ecosystem and to demonstrate how spatial educational supply, institutional quality, regional economic demand, and vocational teacher preparation can be integrated into a coherent academic portfolio-planning framework.

Method

This study employed a quantitative descriptive design using spatial-economic mapping to examine the correspondence between vocational education supply and regional economic demand in East Kalimantan. The unit of analysis was the vocational secondary school, while the analytical context was the regency/city. The design was selected because the research objective was to construct an evidence-based regional profile and classify observable supply-demand gaps rather than estimate causal effects. Spatial-economic mapping combined institutional indicators with sectoral economic profiles so that the distribution and quality of vocational provision could be interpreted in relation to the dominant and emerging economic functions of each locality. Similar regional approaches have been used to assess geographic inequality in vocational provision and to align training fields with labor-market priorities (Ana et al., 2025; Han, Ni, et al., 2023; Lopes et al., 2023).

The study covered all 10 regencies/cities in East Kalimantan: Samarinda, Kutai Kartanegara, Balikpapan, Kutai Timur, Kutai Barat, Berau, Bontang, Paser, Penajam Paser Utara, and Mahakam Ulu. The population comprised all active SMK and MAK identified in the compiled provincial dataset, and total enumeration was applied rather than probabilistic sampling. Consequently, the analytical dataset contained 221 schools. This census-based strategy was used to minimize sampling error in the descriptive mapping and to permit direct comparison of school density and institutional characteristics across localities with substantially different population, accessibility, and economic

profiles. The study therefore reports population-level descriptive counts and proportions for the included school database, not sample-based inferential estimates.

Secondary data for 2020–2025 were compiled from the Ministry of Primary and Secondary Education’s Dapodik system, the East Kalimantan Provincial Education and Culture Office, Statistics Indonesia (BPS) at provincial and regency/city levels, the Directorate General responsible for teachers and education personnel, and IKN development-policy documents. The education dataset included school identity, public/private status, accreditation category, ISO 9001 certification, and vocational-program or concentration profiles. The demand-side dataset included sectoral gross regional domestic product (GRDP), sectoral contribution and growth information, development priorities, and policy documents relevant to construction, industrial processing, agribusiness, logistics, services, and other regional activities. Table 1 presents the original data types, indicators, period, and sources used in the study. Data from different sources were harmonized by locality and year, duplicate school entries were removed, and institutional characteristics were cross-checked against the available administrative records before analysis.

Table 1. Types of Data, Indicators, Time Periods, and Research Data Sources

Data Type	Measured Indicators	Time Period	Official Data Sources
Educational Institution Data (Supply)	School name, status (public/private), accreditation (A/B/C), ISO certification, program spectrum, and areas of specialization	2020–2025	Dapodik Kemendikdasmen & Disdikbud Provinsi Kaltim
Regional Economic Data (Demand)	Sectoral GRDP at Constant Prices, economic sector contributions, and regency/city economic growth rates	2020–2025	Badan Pusat Statistik (BPS) Kaltim & BPS Kabupaten/Kota
Policy and Employment Data	IKN regional spatial planning (RTRW), vocational high school revitalization documents, and projections of productive vocational teacher demand	2020–2025	Ditjen GTK Kemendikdasmen & Otorita IKN

The analytical framework comprised three dimensions: vocational supply, economic demand, and alignment. Vocational supply was operationalized through the number and status of schools, accreditation distribution, ISO 9001 adoption, and the presence of vocational fields or concentrations. Economic demand was represented by dominant and priority sectors in the local GRDP structure and by development-policy signals indicating expanding activities. Alignment represented the qualitative correspondence between the vocational fields supplied by schools and the economic sectors prioritized in each regency/city. Table 2 retains the study’s original operationalization of these variables. The framework follows the logic of skills-anticipation and regional matching research, in which the purpose is not to assume a one-to-one equivalence between a school program and an occupation, but to detect systematic areas of concentration, scarcity, and potential mismatch that merit further labor-market validation (Brunello & Wruuck, 2021; Lopes et al., 2023; McGuinness et al., 2018).

Table 2. Operationalization of Vocational Education Supply, Demand, and Alignment Variables in East Kalimantan

Research Variables	Operational Dimensions	Measurable Indicators	Data Categories / Units of Measurement
Vocational Education Supply	Institutional Quality and Distribution	Number of schools, public-to-private school ratio, proportions of accreditation levels (A/B/C), and ISO 9001 certification status	Number of schools, percentage (%), and quality criteria
Economic Demand	Regional Sector Structure	Dominant GRDP sectors and priority growth sectors (IKN construction, agribusiness, industry, and services)	Nominal GRDP value and growth percentage
Alignment (Link and Match)	Sectoral Alignment	Alignment matrix between vocational high school (SMK) skill concentrations and the needs of key regional economic sectors	Categories: Matched, Oversupply, and Undersupply

Data analysis proceeded in three complementary steps. First, descriptive statistics were calculated for school status, accreditation, ISO certification, and geographic distribution. Frequencies were converted to percentages using the number of schools in the relevant denominator. Second, a regional economic profile was produced for each regency/city by identifying dominant and priority sectors from GRDP and development-policy information. Third, an overlay gap analysis compared the vocational program spectrum with the economic profile of each locality. The overlay was used to assign one of three interpretive conditions: matched, over-supply, or under-supply. A matched condition indicated that the observed program portfolio was broadly consistent with major local economic functions; over-supply indicated strong concentration in a field for which local absorption appeared comparatively saturated or less strategically aligned; and under-supply indicated an economically important sector for which relevant vocational provision was limited or absent. The classification was therefore a structured regional diagnostic rather than a direct estimate of vacancies or occupational employment probabilities.

$$P = \left(\frac{f}{N} \right) \times 100\%$$

PfN In the percentage calculation retained in the original manuscript, P denotes the percentage of schools meeting a specified institutional indicator, f denotes the frequency of schools meeting that indicator within the relevant geographic unit, and N denotes the total number of vocational schools used as the denominator. The same denominator logic was applied consistently when reporting provincial proportions. For the overlay, vocational concentrations were grouped into sector-relevant categories and compared with the corresponding economic functions. Because program nomenclature and economic-sector classifications are not perfectly isomorphic, classifications were based on substantive correspondence rather than mechanical code matching. To reduce interpretive drift, the same coding logic was applied across all 10 localities, and ambiguous cases were treated conservatively as areas requiring strengthening rather than as proof of a causal labor shortage. The operational implications of each mismatch status are retained in Table 3.

Table 3. Typology of Alignment Status and Policy Implications for Vocational Education Development in East Kalimantan

Alignment Status Typology	Operational Definition	Policy Implications for Vocational Education Development
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Matched Status (Aligned)	The provision of SMK/MAK skill programs is qualitatively and quantitatively aligned with the region's priority economic sectors.	Quality maintenance and the strengthening of structured industry partnerships.
Oversupply Status (Excess Concentration)	The number of graduates and skill programs is disproportionately high, while the absorption capacity of the local economic sectors has become saturated.	Moratorium on opening similar study programs, reskilling initiatives, and the redirection of specialization priorities.
Undersupply Status (Deficit)	Priority economic sectors require skilled workers and vocational teachers, but are not adequately supported by relevant vocational high school (SMK) skill programs.	Top priority for establishing new Vocational Education Study Programs and Vocational Teacher Professional Education (PPG) programs at UINSI Samarinda.

The research workflow consisted of four sequential stages, as summarized in Table 4. The initiation and data-cleaning stage consolidated the school and regional-economic datasets and checked locality identifiers. The spatial-quality stage tabulated the distribution of accreditation, certification, school status, and vocational fields. The overlay stage compared school-program supply with sectoral demand indicators and generated the locality-specific mismatch typology. The final academic-rationalization stage translated persistent or strategically important under-supply patterns into potential priorities for vocational teacher education and Vocational PPG at UINSI Samarinda. This final translation was deliberately treated as a planning recommendation rather than as automatic authorization to open programs; feasibility would still require regulatory review, prospective-student analysis, faculty and laboratory readiness, industry commitments, and subsequent employer-level validation.

Table 4. Research Implementation Stages, Key Activities, and Research Outputs

Research Stages	Key Activities	Key Outputs
Stage I: Initiation and Data Cleaning	Compilation of secondary data from 221 SMK/MAK institutions and sectoral GRDP data across 10 regencies/cities	Verified and Cleaned Database
Stage II: Spatial Quality Analysis	Tabulation of frequencies, accreditation percentages, ISO certification, and the distribution of skill programs	Map of Vocational Education Quality and Distribution in East Kalimantan
Stage III: Overlay Gap Analysis	Analyzing the alignment between the spectrum of SMK programs and the needs of regional GRDP sectors	Map of Mismatch Hotspots (Oversupply/Undersupply)
Stage IV: Academic Rationalization	Formulating proposals for the establishment of Vocational Education Study Programs and Vocational Teacher Professional Education (PPG) programs at UINSI Samarinda	UINSI Samarinda Academic Recommendation Matrix

The study used only institutional and aggregate secondary data and did not recruit human participants or process personally identifiable student or worker information. Analytical credibility was strengthened through source triangulation, census coverage of the compiled school database, transparent preservation of the original tabulated results, and explicit separation between descriptive observations and policy interpretation. Nevertheless, GRDP is an indicator of sectoral economic structure rather than a direct measure of occupational vacancies, and accreditation or ISO

certification should not be interpreted as complete measures of teaching quality. These design boundaries were considered when interpreting the results and are revisited in the discussion of limitations. The final gap matrix was therefore used as an evidence-screening tool to prioritize where more detailed feasibility studies, employer surveys, teacher-supply analysis, and graduate tracer data should be collected before program implementation.

Results and Discussion

Spatial Distribution and Institutional Quality of Vocational Schools

The provincial inventory identified 221 vocational secondary institutions (SMK/MAK) across the 10 regencies/cities of East Kalimantan. Of these, 87 schools (39.4%) were public and 134 (60.6%) were private. The predominance of private institutions indicates that non-state providers constitute a major component of vocational access in the province. However, numerical availability alone does not imply equitable spatial access because schools are unevenly distributed among urban centers, peri-urban districts, and remote areas.

A strong spatial concentration was observed in three localities. Samarinda contained 52 schools, Kutai Kartanegara 45, and Balikpapan 33; together, these 130 schools represented 58.8% of all SMK/MAK in the dataset. By contrast, Penajam Paser Utara had 10 schools, Paser 12, and Mahakam Ulu only two. This distribution suggests that learners and employers in more remote or sparsely served areas operate within a substantially narrower vocational-education ecosystem than those in the major urban and metropolitan centers. Table 5 preserves the original school-level aggregation by locality, institutional status, accreditation category, ISO 9001 version, and total number of schools.

The institutional-quality profile in Table 5 should be read together with the spatial distribution because the number of schools and the concentration of quality indicators do not follow the same pattern in every locality. The table therefore provides the empirical basis for distinguishing simple quantitative access from institutional capacity. In particular, the accreditation and ISO columns make it possible to identify localities in which the vocational network is relatively large but still contains substantial numbers of mid- or lower-accreditation institutions, as well as localities where quality-management certification is scarce.

Table 5. Sebaran SMK di Kalimantan Timur Berdasarkan Kota Tahun 2025

No	Regency/City	Status		Accreditation			ISO		Total
		Public	Private	A	B	C	9001:2000	9001:2008	
1	Kota Samarinda	22	30	16	27	8	0	6	52
2	Kab. Kutai Kartanegara	17	28	6	28	9	1	4	45
3	Kota Balikpapan	6	27	10	12	9	4	11	33
4	Kab. Kutai Timur	13	12	5	15	5	1	0	25
5	Kab. Kutai Barat	7	7	2	7	5	0	0	14
6	Kab. Berau	8	6	2	7	4	0	0	14
7	Kota Bontang	4	10	3	9	2	0	3	14
8	Kab. Paser	4	8	5	4	2	0	2	12
9	Kab. Penajam Paser Utara	6	4	3	5	2	0	3	10
10	Kab. Mahakam Ulu	0	2	0	0	2	0	1	2
Total		87	134	52	114	48	6	30	221

Across the province, Accreditation B was the dominant recorded category, accounting for 114 schools (51.6% of the 221-school denominator), while 52 schools (23.5%) were recorded as Accreditation A and 48 (21.7%) as Accreditation C. Accreditation A was concentrated most strongly

in Samarinda (16 schools) and Balikpapan (10 schools). At the same time, Table 5 records nine Accreditation C schools in Kutai Kartanegara and nine in Balikpapan, illustrating that high school density does not eliminate within-region quality variation. The three accreditation counts shown in the original table sum to 214 rather than 221, so the percentages should be interpreted as reported against the full school denominator while recognizing that seven cases are not represented in the A/B/C columns.

ISO 9001 adoption was limited. The original table records 36 certified schools, comprising six schools under ISO 9001:2000 and 30 under ISO 9001:2008, equivalent to 16.3% of the 221-school database. Balikpapan accounted for 15 of these certifications, followed by Samarinda with six, Kutai Kartanegara with five, and Bontang with three. Kutai Barat and Berau recorded no ISO-certified schools in the table. The pattern reinforces the broader finding that formalized quality-management capacity is concentrated in selected urban or industrial locations rather than distributed evenly across the province. Because ISO certification is an organizational-management indicator, it is treated here as complementary to, rather than a substitute for, accreditation and direct measures of instructional quality.

Sectoral Alignment and Regional Mismatch

The overlay between vocational-program supply and the dominant or priority economic sectors shown in the regional GRDP profiles revealed a locality-specific pattern of structural and horizontal mismatch. The principal issue was not a universal shortage of vocational schools; rather, several localities displayed a mismatch between the fields most frequently offered and the technical capabilities associated with their regional economic functions. Table 6 retains the original mapping of priority sectors, dominant vocational-program characteristics, and the identified mismatch for each regency/city.

The table differentiates three broad situations. First, some localities show pronounced under-supply in technical specializations associated with rapidly expanding or resource-intensive sectors. Second, urban centers show concentration in conventional business and administrative pathways despite stronger demand signals from digital commerce, logistics, automation, and applied information technology. Third, Balikpapan and Bontang are comparatively better aligned with their industrial and service structures, although targeted gaps remain. This differentiation is important because the policy response to under-supply should not be identical to the response to over-concentration in mature or conventional programs.

Table 6. Mapping of Economic Sectors, Vocational Programs, and Skilled Labor Demand Gaps
Across Regencies/Cities in East Kalimantan

Regency/City	Key Economic Sectors and Regional Priorities	Characteristics of Dominant Vocational Programs	Identification of Gaps (Mismatch)
Samarinda City	Trade, Financial Services, Information, and Communication	Accounting, Office Automation, Computer and Network Engineering (TKJ), and Visual Communication Design (DKV)	Oversupply in Conventional Administrative Programs; Shortages in Digital Commerce and Logistics Programs
Kutai Kartanegara Regency	Mining, Agriculture, Energy, and Construction	Agribusiness, Automotive Engineering, Electrical	Shortage of Specializations in Heavy Equipment

Regency/City	Key Economic Sectors and Regional Priorities	Characteristics of Dominant Vocational Programs	Identification of Gaps (Mismatch)
Balikpapan City	Manufacturing, Transportation, and Warehousing	Engineering, and Accounting Digital Business, Hospitality, Visual Communication Design (DKV), and Automotive Engineering	Engineering and Postharvest Technology Generally Aligned; Further Strengthening of Manufacturing Engineering and Maritime Technology Is Needed
East Kutai Regency	Coal Mining, Manufacturing, and Plantations	Plantation Agribusiness, Welding Engineering, and Software Engineering (RPL)	Critical Shortage in Mining Geology, Heavy Equipment Engineering, and Industrial Chemistry Specializations.
Penajam Paser Utara Regency	IKN Building Construction and Real Estate	Office Administration, Computer and Network Engineering (TKJ), Automotive Engineering, and Maritime Studies	Severe Shortage in Construction Engineering, Geomatics, and Urban Planning Specializations.
Berau Regency	Marine Tourism, Fisheries, and Plantations	Fisheries Agribusiness, Hospitality, and Light Vehicle Engineering (TKR)	Insufficient Capacity in Ecotourism and Marine Product Processing.
Paser Regency	Oil Palm Plantations, Agriculture, and Manufacturing	Computer and Network Engineering (TKJ), Crop Agribusiness, Light Vehicle Engineering (TKR), and Welding Engineering	Limited Availability of Agricultural Mechanization and Industrial Waste Processing Programs
West Kutai Regency	Forestry, Agriculture, and Government Services	Automotive Engineering, Agribusiness, and Office Administration	Absence of Programs in Sustainable Forest Product Technology and Ecotourism
Bontang City	Petrochemical Industry, Natural Gas, and Maritime Sector	Industrial Chemistry, Automation, Nautical Studies, and Automotive Engineering	Aligned; Further Expansion of Renewable Energy Competencies and Laboratory Instrumentation Is Needed
Mahakam Ulu Regency	Forestry, Subsistence Agriculture, and Social Services	Limited to Accounting and Computer and Network Engineering (TKJ) Programs (2 Vocational High Schools)	Comprehensive Structural Deficit Across All Technical and Applied Agricultural Sectors

Penajam Paser Utara exhibits the clearest construction-related gap in the original mapping. Although its priority economy is characterized by IKN-related building construction and real estate, its dominant vocational provision is reported in office administration, computer/networking, automotive, and shipping fields. Table 6 therefore identifies a severe deficit in construction engineering, geomatics, and urban-planning-related provision. In planning terms, this is a horizontal mismatch between the fields supplied by local vocational education and the competencies associated with the locality's most visible structural transformation.

Kutai Timur and Kutai Kartanegara display a different form of under-supply. Their economic structures are strongly linked to mining, energy, plantations, agriculture, and related processing, yet the original program map indicates limited provision in mining geology, heavy-equipment engineering, industrial chemistry, and post-harvest technology. These gaps are particularly

important because the relevant sectors require specialized equipment, safety practices, laboratories, and technically qualified teachers; expanding such programs therefore involves higher institutional requirements than opening low-capital classroom-based fields.

Samarinda and Balikpapan illustrate the urban dimension of the mismatch. Samarinda's large vocational network includes substantial provision in accounting and conventional office administration, while the regional economy increasingly emphasizes trade, finance, information, communication, logistics, and related services. The original analysis consequently classifies conventional administration as over-supplied relative to emerging digital-trade and logistics needs. Balikpapan is assessed as comparatively aligned because its vocational portfolio includes digital business, hospitality, design, and automotive fields, but Table 6 still identifies a need to strengthen manufacturing engineering and maritime technology.

The remaining districts show more specialized gaps. Berau requires greater capacity in marine ecotourism and fishery-product processing; Paser shows limited provision in agricultural mechanization and industrial-waste processing; Kutai Barat lacks programs associated with sustainable forest-product technology and ecotourism; and Mahakam Ulu faces the broadest structural deficit, with only two vocational schools and a program spectrum restricted in the original table to accounting and computer/networking while the locality depends heavily on forestry, agriculture, and social services. Bontang is the strongest example of broad sectoral alignment because industrial chemistry, automation, nautical studies, and automotive provision correspond relatively well to its petrochemical, natural-gas, and maritime profile, although renewable-energy and laboratory-instrumentation competencies remain development priorities.

Taken together, the findings show that East Kalimantan contains multiple vocational sub-systems rather than one homogeneous provincial market. The primary planning challenge is therefore selective rebalancing: expanding strategically scarce technical fields where regional demand is strong, modernizing conventional programs in urban areas, maintaining and deepening relatively well-aligned industrial programs, and addressing the extreme access and specialization constraints of remote localities. These patterns provide the empirical basis for considering which vocational teacher-education fields could generate the greatest regional leverage from UINSI Samarinda.

Discussion

The findings demonstrate that vocational-education development in East Kalimantan is characterized not by a generalized shortage of provision, but by a more complex combination of spatial concentration, uneven institutional quality, and sector-specific mismatch between vocational-program supply and regional economic demand. Of the 221 SMK/MAK included in the provincial inventory, 58.8% are concentrated in Samarinda, Kutai Kartanegara, and Balikpapan, whereas Mahakam Ulu contains only two institutions. Institutional capacity is similarly uneven: Accreditation B dominates the provincial profile, while Accreditation A and ISO 9001 certification are disproportionately concentrated in selected urban and industrial locations. More importantly, the spatial-economic overlay identifies qualitatively different mismatch configurations. Penajam Paser Utara exhibits substantial deficits in construction engineering, geomatics, and urban-planning-related competencies; Kutai Timur and Kutai Kartanegara show shortages in mining, heavy-equipment, industrial, and post-harvest technologies; Samarinda displays over-concentration in conventional administrative programs relative to emerging digital-commerce and logistics needs;

and Mahakam Ulu experiences a broader structural deficit in technical and applied agricultural provision. These findings directly address the study objectives by showing that vocational planning must simultaneously consider where schools are located, their institutional capacity, the economic specialization of each locality, and the type of vocational expertise that is insufficient or over-concentrated.

At the international level, this pattern corroborates recent research questioning uniform or supply-led VET expansion. Han, Ni, et al. (2023) demonstrated that the geographical supply of higher vocational education can remain poorly aligned with regional demand even within a rapidly developing national system, while Lopes et al. (2023) showed that regional VET planning becomes more informative when educational supply is assessed against labor-market structure rather than enrollment volume alone. Ana et al. (2025) similarly demonstrated the analytical value of spatial mapping for identifying discrepancies between vocational-school locations and industrial needs. The present findings extend this literature because East Kalimantan does not merely display uneven school density; it simultaneously exhibits field-specific and institution-quality mismatches within a region undergoing unusually rapid geo-economic restructuring associated with IKN development. Zhao (2024), for example, found that higher vocational major groups may lag behind emerging industrial clusters when program structures adapt more slowly than the regional economy. East Kalimantan exhibits a comparable dynamic, but one intensified by the coexistence of metropolitan service economies, mining districts, plantation areas, coastal economies, remote inland communities, and a newly developing capital-city construction ecosystem. Thus, mismatch is not a static discrepancy between qualifications and jobs but a territorially differentiated process produced by different rates of economic and educational adaptation.

The Indonesian evidence provides an equally important point of comparison. Paramitasari et al. (2024), Khoiruddin et al. (2024), Wicaksono et al. (2023), and Hakim et al. (2025) show that education–occupation correspondence in Indonesia varies according to field of study, regional economic structure, worker characteristics, and agglomeration conditions. Ariansyah et al. (2024) further demonstrate that vocational graduates can possess advantages in transitions into first employment without this necessarily resolving the broader problem of labor-market alignment. The present study advances this national literature by moving the analytical point upstream: instead of diagnosing mismatch only after graduates enter employment, it identifies potential mismatch while program portfolios and teacher-education capacities are still being planned. This interpretation is reinforced by recent Indonesian vocational evidence. Larasati et al. (2026) found that teacher pedagogical competence and school–industry partnerships were positively related to vocational-graduate employability in Kendal Regency, indicating that occupational alignment depends not only on program availability but also on the institutional relationships that connect schooling to industry. Likewise, Gazali et al. (2026) found that principal leadership and school climate explained only a limited proportion of perceived vocational-school productivity, implying that wider factors—including teacher expertise, resources, occupational relevance, and external partnerships—remain consequential. Together, these studies support the present finding that spatial program availability cannot be treated as an adequate proxy for an effective vocational ecosystem.

A further contribution of the results concerns the need to differentiate policy responses according to the type of mismatch. Under-supply in construction engineering, geomatics, mining technologies, heavy-equipment engineering, industrial chemistry, agricultural mechanization, and

applied agribusiness cannot be addressed through the same intervention used for over-concentration in conventional office administration. The former requires investments in specialized teachers, laboratories, equipment, industry certification, and technically authentic learning environments; the latter calls for curriculum modernization, reskilling, and selective restraint on further expansion. This interpretation is consistent with Brunello and Wruuck (2021), Hwang et al. (2024), and recent international research on industry–education integration. Yu et al. (2025), using evidence from vocational education in Shenzhen, identified incomplete policies, weak prior university–industry collaboration, insufficient enterprise participation, unclear institutional responsibilities, and limited teacher involvement as interconnected constraints on effective industry–education integration. Accordingly, opening additional programs alone would be unlikely to resolve East Kalimantan's deficits unless institutional capacity and partnership structures develop simultaneously. A portfolio-management strategy is therefore preferable: programs should be expanded where strategic under-supply exists, modernized where technological change has transformed occupational requirements, consolidated where provision is saturated, and strengthened where industry alignment already exists but technical depth remains insufficient.

Teacher capacity is central to this portfolio logic. Vocational teachers must mediate between pedagogical knowledge and continuously changing occupational practices; therefore, technically intensive programs cannot be sustainably established without teachers who possess both teaching expertise and recent workplace competence. Lensjø (2024) demonstrates that vocational teachers' professional knowledge includes embodied and tacit craft knowledge accumulated through working-life experience, while Ahn and Nyström (2023) show how teachers' professional expertise remains central when authentic occupational environments are reproduced through simulation-based training. Similarly, Messina Dahlberg and Gustavsson (2025) illustrate that sophisticated simulation environments do not replace vocational pedagogy; teachers must actively connect simulated tasks with occupational knowledge and professional practice. In the Indonesian context, Rokhman et al. (2024), including Muhammad Sufian, demonstrate that structured academic supervision can strengthen supervisor competence and support teacher professionalism, suggesting that professional capacity requires systematic institutional development rather than isolated training. More specifically to vocational education, Waluyo et al. (2025), also involving Muhammad Sufian, developed an electronic teacher-performance assessment system intended to shift vocational teacher evaluation from administrative compliance toward professional development and closer alignment with industry competencies; the reported implementation improved assessment efficiency and inter-rater reliability. These findings strengthen the rationale for establishing a regional Vocational PPG mechanism alongside any new UINSI vocational concentration, with industry placements, specialty-specific certification, professional supervision, and recurring competency assessment embedded in the model.

Digital transformation further complicates the conventional distinction between program shortage and program surplus. The observed concentration of office-administration pathways in urban East Kalimantan should not be interpreted as evidence that commercial vocational education has become obsolete; instead, its competency architecture must evolve toward digital commerce, supply-chain technologies, data-enabled business processes, automated administration, and logistics systems. This interpretation is consistent with Sawiji's (2024) Indonesian study showing that vocational teachers' willingness to adopt web-based learning platforms is shaped by factors

influencing technology acceptance, and with Xin et al. (2024), who found that TVET teachers' digital competence encompasses not simply technical skills but digital pedagogy, collaboration, professional development, and supportive practices. Cattaneo et al. (2025) similarly found that technology use among vocational teachers is associated with perceived digital competence and perceived usefulness, highlighting the interaction between individual capability and institutional teaching contexts. At the classroom level, Zhao and Ko (2024a) demonstrate the importance of adaptive instruction and collaborative learning in vocational environments, while Zhao and Ko (2024b) show how workplace learning and collaboration with specialized professionals can facilitate students' professional engagement. Evidence from *Digital Learning, Social Science, and Life-course Studies* provides complementary Indonesian context: Rasyid et al. (2025) reported that interactive multimedia increased vocational students' learning interest relative to conventional presentation-oriented instruction, whereas Hariandini et al. (2026) found that the educational value of digital technology depends on teachers' pedagogical beliefs, digital competence, and institutional support rather than technology availability alone. Consequently, the transformation recommended for Samarinda and other urban centers should encompass both program nomenclature and pedagogical capacity.

These findings have interconnected theoretical, pedagogical, and policy implications. Theoretically, they extend human-capital and skills-mismatch perspectives by embedding them within a regional skills-ecosystem framework: correspondence between education and work cannot be conceptualized exclusively at the individual graduate level, because the spatial configuration of institutions, teacher capacity, industry collaboration, and regional sectoral change conditions the production of relevant competencies before labor-market entry. Evidence that university–industry collaboration can strengthen perceived employability further supports the relational nature of vocational quality (Li et al., 2024). Pedagogically, new or redesigned programs should prioritize authentic projects, work-based learning, simulation, industry-supported laboratories, collaborative problem solving, digital competence, and teacher industry immersion rather than transferring conventional classroom models into newly named programs. Policy-wise, provincial and university decision makers should institutionalize recurrent spatial-economic mapping that combines school distribution, accreditation, vocational concentrations, teacher supply, employer demand, vacancy information, graduate tracer evidence, and sectoral growth rather than relying on enrollment trends or GRDP alone. New programs should also be framed within sustainable regional transformation, particularly because IKN development requires education policy to accommodate economic growth, environmental responsibility, and long-term human-capital development simultaneously. This broader sustainability orientation is consistent with Febriani et al. (2026), who emphasize the need to integrate educational policy with sustainability agendas rather than treating them as independent governance domains.

The novelty and principal contribution of the study therefore lie in integrating four analytical levels that are usually treated separately: (1) the spatial distribution and institutional quality of secondary vocational education, (2) district/city economic specialization, (3) field-level over-supply and under-supply, and (4) translation of the resulting mismatch pattern into a higher-education vocational teacher-program portfolio. Previous Indonesian mismatch research has primarily evaluated education–job correspondence among workers, whereas spatial VET research generally assesses school–industry alignment without extending the diagnosis into university program planning. The present spatial-economic-to-academic portfolio framework connects those traditions

and recasts UINSI Samarinda from a passive recipient of regional demand into a potential capacity-building institution within East Kalimantan's regional skills ecosystem. On this basis, Construction Engineering Education, Applied Agribusiness and Bio-Industry Education, Digital Technology and Logistics Education, and a regional Vocational PPG pathway emerge not simply as prospective academic programs, but as differentiated institutional responses to identifiable spatial and sectoral deficits.

Several limitations qualify these conclusions and identify priorities for future research. First, the analysis relies on institutional and aggregate secondary data; consequently, sectoral GRDP represents economic structure rather than actual occupational vacancies, while accreditation and ISO certification cannot capture the full quality of vocational teaching. Second, the overlay identifies plausible horizontal and structural mismatch but does not directly observe employer recruitment, wage premiums, graduate mobility, or teacher shortages. Third, seven institutions are not represented in the reported A/B/C accreditation counts, requiring clarification in subsequent database validation. Fourth, the analysis is restricted to East Kalimantan during an exceptional period of IKN-related transition, limiting straightforward generalization to other Indonesian provinces. Future studies should therefore combine longitudinal GIS analysis with employer surveys, vacancy-data analytics, teacher-workforce projections, graduate tracer studies, wage and employment outcomes, and accessibility measures. They should also examine the feasibility of the proposed UINSI programs through prospective-student demand, faculty expertise, laboratory requirements, industry commitments, financial sustainability, and regulatory approval. Repeated spatial-economic mapping would be particularly valuable because a program classified as under-supplied today may become balanced or over-supplied as IKN construction and regional industrial structures evolve.

Conclusion

This study demonstrates that vocational education in East Kalimantan is characterized by both spatial inequality and sector-specific mismatch within the rapidly changing IKN buffer economy. Across the 221 SMK/MAK analyzed, 60.6% are private and 58.8% are concentrated in Samarinda, Kutai Kartanegara, and Balikpapan; Accreditation B is the dominant recorded category (51.6%), while Accreditation A and C account for 23.5% and 21.7%, respectively, and ISO 9001 adoption remains limited to 16.3%. The spatial-economic overlay shows critical under-supply in construction, geomatics, mining-related technologies, industrial processing, and applied agribusiness in several districts, alongside urban over-concentration in conventional administrative pathways relative to growing digital-logistics and technology demand. These findings provide an empirical rationale for prioritizing Vocational Education in Construction Engineering, Applied Agribusiness and Bio-Industry, and Digital Technology and Logistics at UINSI Samarinda, supported by a regional Vocational PPG pathway. The study's contribution is an integrated spatial-economic-to-academic portfolio framework that links secondary-school supply and quality, regional economic structure, mismatch diagnosis, and vocational teacher-education planning. Its policy value lies in shifting program expansion from trend-driven decisions toward recurrent, region-specific evidence, while recognizing that employer validation, teacher-supply analysis, graduate tracking, and feasibility assessment remain necessary before implementation.

References

- Ahn, S.-E., & Nyström, S. (2023). The professional bodies of VET teachers in the context of simulation-based training for vocational learning. *Vocations and Learning*, 16, 141–156. <https://doi.org/10.1007/s12186-023-09312-3>
- Ana, A., Dwiyantri, V., Sari, A. R., Saripudin, S., & Muktiarni, M. (2025). A geographical information system-based mapping model for aligning vocational high schools with industrial needs. *Journal of Technical Education and Training*, 17(2), 229–244. <https://doi.org/10.30880/jtet.2025.17.02.016>
- Ariansyah, K., Wismayanti, Y. F., Savitri, R., Listanto, V., Aswin, A., Ahad, M. P. Y., & Cahyarini, B. R. (2024). Comparing labor market performance of vocational and general school graduates in Indonesia: Insights from stable and crisis conditions. *Empirical Research in Vocational Education and Training*, 16, Article 5. <https://doi.org/10.1186/s40461-024-00160-6>
- Arinaitwe, D. (2021). Practices and strategies for enhancing learning through collaboration between vocational teacher training institutions and workplaces. *Empirical Research in Vocational Education and Training*, 13, Article 13. <https://doi.org/10.1186/s40461-021-00117-z>
- Brunello, G., & Wruuck, P. (2021). Skill shortages and skill mismatch: A review of the literature. *Journal of Economic Surveys*, 35(4), 1145–1167. <https://doi.org/10.1111/joes.12424>
- Cattaneo, A. A. P., Antonietti, C., & Rauseo, M. (2025). How do vocational teachers use technology? The role of perceived digital competence and perceived usefulness in technology use across different teaching profiles. *Vocations and Learning*, 18, Article 5. <https://doi.org/10.1007/s12186-025-09359-4>
- Denham, T., & Fairbrother, P. (2024). Vocational education for regional health: The role of training in economic transitions. *Journal of Vocational Education & Training*, 77(3), 746–767. <https://doi.org/10.1080/13636820.2024.2302173>
- Febriani, E., Woods, R., Madkur, A., & Hasanah, U. (2026). Implementation of the Sustainable Development Goals (SDGs) in the education and environmental sectors: A comparative study of Indonesia and Australia. *Gender, Islamic Law, and Sustainability*, 1(2), 102–116. <https://doi.org/10.70211/gils.v1i2.547>
- Findeisen, S., & Wild, S. (2022). General digital competences of beginning trainees in commercial vocational education and training. *Empirical Research in Vocational Education and Training*, 14, Article 2. <https://doi.org/10.1186/s40461-022-00130-w>
- Gazali, H., Hadiyanto, Syahril, & Nellitawati. (2026). Principal leadership, school climate, and perceived school productivity in Indonesian vocational high schools: Evidence from Solok Regency. *JPI: Jurnal Pustaka Indonesia*, 6(3), 17–29. <https://doi.org/10.62159/jpi.v6i3.2875>
- Guo, D., & Wang, A. (2020). Is vocational education a good alternative to low-performing students in China? *International Journal of Educational Development*, 75, Article 102187. <https://doi.org/10.1016/j.ijedudev.2020.102187>
- Hakim, D. R., Disman, D., & Dahlan, D. (2025). Horizontal educational mismatch among Indonesian graduates: Is there any earnings penalty? *Education Economics*, 33(5), 747–774. <https://doi.org/10.1080/09645292.2024.2401998>
- Han, Y., Ni, R., Deng, Y., & Zhu, Y. (2023). Supply and demand of higher vocational education in China: Comprehensive evaluation and geographical representation from the perspective of educational equality. *PLOS ONE*, 18(10), Article e0293132. <https://doi.org/10.1371/journal.pone.0293132>
- Hariandini, Y., Yuda, I. B., & Ahmed, W. (2026). Implementing digital integrated learning in schools: Evidence from classroom practices. *Digital Learning, Social Science, and Life-course Studies*, 2(1), 46–56. <https://doi.org/10.70211/disolife.v2i1.348>
- Hwang, I., Park, Y., & Choe, C. (2024). Analysis of the matching effectiveness of vocational training for the unemployed: Evidence from the Republic of Korea. *International Labour Review*, 163(4), 631–651. <https://doi.org/10.1111/ilr.12442>
- Jin, X., Tigelaar, D., van der Want, A., & Admiraal, W. (2022). Novice teachers' appraisal of expert feedback in a teacher professional development programme in Chinese vocational education. *Teaching and Teacher Education*, 112, Article 103652. <https://doi.org/10.1016/j.tate.2022.103652>
- Khoiruddin, M. A., Setyanti, A. M., Suman, A., Prasetyia, F., & Susilo, S. (2024). Exploring determinants of education-job mismatch among educated workers in Indonesia. *Jurnal Ekonomi Pembangunan: Kajian Masalah Ekonomi dan Pembangunan*, 25(2), 263–281. <https://doi.org/10.23917/jep.v25i2.23994>

- Larasati, S., Ginting, R. B., & Ariyanto, L. (2026). Enhancing vocational graduate employability: The roles of teachers' pedagogical competence and school-industry partnerships in Kendal Regency. *JPI: Jurnal Pustaka Indonesia*, 6(2), 28–41. <https://doi.org/10.62159/jpi.v6i2.2292>
- Lensjø, M. (2024). Vocational teachers' craft knowledge and working-life experiences in building and construction: A narrative study of embodied and tacit learning. *Vocations and Learning*, 17, 333–350. <https://doi.org/10.1007/s12186-024-09344-3>
- Li, H., Khattak, S. I., & Shamim, M. A. (2024). Quality culture, university-industry collaboration, and perceived employability among vocational students in China: A Yanpei Huang perspective. *Frontiers in Psychology*, 15, Article 1439097. <https://doi.org/10.3389/fpsyg.2024.1439097>
- Li, J., & Pilz, M. (2023). International transfer of vocational education and training: A literature review. *Journal of Vocational Education & Training*, 75(2), 185–218. <https://doi.org/10.1080/13636820.2020.1847566>
- Lopes, A. S., Rebelo, I., Santos, R., Costa, R., & Ferreira, V. (2023). Supply and demand matching of VET skills—A regional case study. *Cogent Education*, 10(1), Article 2200550. <https://doi.org/10.1080/2331186X.2023.2200550>
- McGrath, S., & Yamada, S. (2023). Skills for development and vocational education and training: Current and emergent trends. *International Journal of Educational Development*, 102, Article 102853. <https://doi.org/10.1016/j.ijedudev.2023.102853>
- McGuinness, S., Pouliakas, K., & Redmond, P. (2018). Skills mismatch: Concepts, measurement and policy approaches. *Journal of Economic Surveys*, 32(4), 985–1015. <https://doi.org/10.1111/joes.12254>
- Messina Dahlberg, G., & Gustavsson, S. (2025). Keeping worlds apart to put them back together: VET teachers' instructional patterns in simulation-based training. *Instructional Science*, 53, 787–820. <https://doi.org/10.1007/s11251-025-09714-x>
- Murwaningsih, T., & Fauziah, M. (2022). The problem and need for continuing professional development of vocational school teachers. *Jurnal Pendidikan Teknologi dan Kejuruan*, 28(1), 76–92. <https://doi.org/10.21831/jptk.v28i1.42860>
- Paramitasari, N., Khoirunurrofik, K., Mahi, B. R., & Hartono, D. (2024). Charting vocational education: Impact of agglomeration economies on job-education mismatch in Indonesia. *Asia-Pacific Journal of Regional Science*, 8(2), 461–491. <https://doi.org/10.1007/s41685-024-00333-x>
- Putranto, F. G. F., Natalia, C., & Pitriyani, N. K. D. (2024). Closing the gap between education and labor market requirement: Do vocational education matter? *The Journal of Indonesia Sustainable Development Planning*, 5(3), 181–191. <https://doi.org/10.46456/jisdep.v5i3.614>
- Rasyid, F. R., Puja Kesuma, T. A. R., & Karsiwan. (2025). Design and development of Flash-based learning media for enhancing students' learning interest. *Digital Learning, Social Science, and Life-course Studies*, 1(1), 52–67. <https://doi.org/10.70211/disolife.v1i1.259>
- Rokhman, R., Diana, N., Etek, Y., Koderi, K., & Sufian, M. (2024). The development of a scientific-based academic supervision management model. *AL-ISHLAH: Jurnal Pendidikan*, 16(2), 1383–1398. <https://doi.org/10.35445/alishlah.v16i2.4626>
- Sawiji, H. (2024). Determining factors influencing teachers' intention to use web-based e-learning platforms in vocational secondary schools in Indonesia. *Cogent Education*, 11(1), Article 2355830. <https://doi.org/10.1080/2331186X.2024.2355830>
- Waluyo, S. D., Rustanto, A. E., Winanti, Y. K., Onn, C. W., Sufian, M., & Mesina, J. R. (2025). Digital transformation in teacher performance assessment: Development and implementation of E-PKG system for enhancing vocational education quality and industry alignment. *Journal of Educational Technology and Learning Creativity*, 3(2), 348–366. <https://doi.org/10.37251/jetlc.v3i2.2490>
- Wicaksono, P., Theresia, I., & Aufa, B. A. (2023). Education-occupation mismatch and its wage penalties: Evidence from Indonesia. *Cogent Business & Management*, 10(3), Article 2251206. <https://doi.org/10.1080/23311975.2023.2251206>
- Xin, Y., Tang, Y., & Mou, X. (2024). An empirical study on the evaluation and influencing factors of digital competence of Chinese teachers for TVET. *PLOS ONE*, 19(9), Article e0310187. <https://doi.org/10.1371/journal.pone.0310187>
- Yu, B., Li, R., Zhang, S., Mao, P., Xu, C., Shi, J., & Wu, G. (2025). Constraints, mechanisms, and strategies for industry-education integration in vocational education: An empirical study. *PLOS ONE*, 20(12), Article e0339158. <https://doi.org/10.1371/journal.pone.0339158>

- Zhao, X. (2024). Study on the matching degree of major groups and industrial groups in higher vocational colleges. *Heliyon*, 10(8), Article e29945. <https://doi.org/10.1016/j.heliyon.2024.e29945>
- Zhao, Y., & Ko, J. (2024a). Orchestrating vocational education classrooms for adaptive instruction and collaborative learning. *Cogent Education*, 11(1), Article 2351238. <https://doi.org/10.1080/2331186X.2024.2351238>
- Zhao, Y., & Ko, J. (2024b). Vocational teachers' perceptions on workplace learning in facilitating students' professional engagement in the context of industry-university collaboration in China. *Journal of Workplace Learning*, 36(4), 282–297. <https://doi.org/10.1108/JWL-12-2023-0197>