Development Instruments and Formulas for Processing Data for Aligning Vocational Education

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ABSTRACT

The very rapid development of DUDI demand quality unit education vocation. Especially on the relevance in accordance with DUDI needs. SMK as printer graduates who are ready Work need do effort alignment for increase absorption graduates. Research objectives This is explore alignment on units education vocational, developing instrument alignment education vocation, and make guidelines alignment education vocational. The method used in study This is a mixed method design with exploratory sequential design approach. The results of the study show that results research data analysis qualitative explore related to 12 categorizations and 40 coding. Development instrument alignment education vocation FGD results consist of of 7 components / dimensions and 23 items. Instrument has tested in a way reliable through proof validity and reliability. Results of the proof validity Contents the 7 (seven) experts were analyzed use index Aiken V average 0.89 > 0.8 which means own validity high. Proof second using EFA with KMO value 0.956 > 0.5 and CFA has good fit criteria X2, GFI, AGFI, CFI, TLI, CMIN/DF, and RMSEA values > cut of value. Measurement results alignment education vocation with use results development instrument the to 77 vocational schools and their DUDI partners that is show quadrant 2, meaning that SMK and DUDI have do alignment in accordance with indicator development instrument.

Introduction

Quality human resources are a key factor in improving the graduates of vocational education units. One of the most important aspects of improving the quality of human resources is collective efforts as part of the journey toward an advanced Indonesia. Enhancing human resources requires a multi-faceted approach, with education playing a central role, especially vocational education. Vocational education is designed to prepare individuals to become competent, skilled, competitive, and resilient contributors to the workforce. As outlined by (Wijayanto and Mahmudah, 2022), the primary objective of vocational education is to produce high-quality graduates who are job-ready and possess skills that align with the needs of the business and industrial worlds. Furthermore, vocational graduates are not only prepared for the workforce but also have opportunities to pursue higher education and engage in entrepreneurial activities (Irawati & Istiqomah, 2023).

Vocational education aims to develop competent and character-driven graduates who meet the demands of the professional world or establish themselves as entrepreneurs (Ramadhan, Rusli, & Karlina, 2022). Synergies between vocational education and skill development are evident across multiple educational levels, such as vocational high schools, polytechnics, and course and training institutions. These institutions are pivotal in Indonesia's efforts to ensure sustainable development by creating a skilled workforce equipped to meet the challenges of an ever-changing economic landscape. The educational process within vocational units is focused on developing human resources that are not only relevant to the current needs of the business and industrial worlds but are also adaptable to future changes (Budiastuti, Damarwan, Triatmaja, & Damarsuri, 2022).

Alignment in vocational education refers to the synchronization between what is taught in vocational education units and the dynamic demands of the business and industrial worlds. This alignment is essential to bridge the gap between the curriculum and industry requirements, ensuring that graduates are equipped with the skills, knowledge, and attitudes necessary to excel in their careers (Mahmudah, Cahyono, Susanto, Suhendar, & Channa, 2021). Without proper alignment, the disparity between vocational education and the labor market widens, resulting in increased unemployment and underemployment among graduates.

Evaluating vocational education units is critical to identify gaps in educational practices and ensure the system aligns with industry standards. Such evaluations provide clarity on the competencies of vocational graduates, shedding light on their readiness to meet market demands. However, challenges remain. Low-quality competencies among graduates persist, causing industries to hesitate in recognizing vocational graduates' qualifications.

One of the underlying issues is the lack of soft skills, which are essential for workplace success but are often overlooked in traditional vocational curricula (Tobing & Manurung, 2021). Additionally, insufficient collaboration between vocational education units and industries further exacerbates this issue (Dardiri, 2022). Graduates frequently lack an integrated understanding of theoretical knowledge, practical skills, and professional attitudes, leading to competencies that fail to meet industry expectations (Sudarma & Budiastuti, 2024). Moreover, discrepancies in skill standards between vocational schools and industries pose additional challenges (Susatya, Triatmaja, Suratno, & Fachri, 2023).

Addressing these issues requires comprehensive curriculum alignment with industry needs. Curriculum development should involve relevant stakeholders, including representatives from the business and industrial sectors, to ensure that learning objectives and competencies are tailored to the workforce's real-world demands. Establishing binding collaborations between vocational education units and industries is crucial for ensuring that the curriculum remains dynamic and industry-relevant (Santosa, Budiastuti, Purnawan, & Sayuti, 2021).

The implementation of innovative and performance-based learning models is another vital aspect of improving vocational education. By integrating institutional teaching with industry practices, vocational education can provide students with a holistic learning experience that combines theoretical knowledge with practical application. Such approaches not only enhance students' skills but also prepare them to navigate complex workplace environments confidently. The competence of vocational educators plays a pivotal role in bridging the gap between education and industry. Educators must possess a deep understanding of industry trends and actively participate in upskilling and reskilling programs to remain updated on workforce requirements (Mahmudah et al., 2021). Enhancing the capabilities of vocational educators ensures that they can effectively impart the knowledge, and skills students need to thrive in competitive industries.

Vocational education must also prioritize fostering essential 21st-century skills, including creativity, critical thinking, adaptability, and independence. These attributes are crucial for addressing the challenges of modern industries, which increasingly rely on technological advancements and innovation (Buhalis & O'Connor, 2005). By focusing on these skills, vocational education can equip graduates to contribute meaningfully to industries such as infrastructure development, machinery maintenance, service provision, and technological innovation. The misalignment between vocational education competencies and industry needs is a significant factor contributing to the high unemployment rates among vocational graduates. While retraining

programs can address this gap, they often require considerable resources, including time, energy, and costs, making them less attractive to industries. Thus, the alignment process must be proactive, involving consistent evaluation and improvement of educational practices to meet industry standards effectively. Collaboration between TVET institutions and industries plays a crucial role in enhancing employability skills (Hossain & Islam, 2014).

Establishing a shared understanding between vocational education units and industries is essential for setting and maintaining competency standards. This collaborative effort ensures that the curriculum remains relevant, minimizing competency gaps and enhancing the quality and capacity of human resources. By aligning vocational education with industry needs, stakeholders can foster a more innovative, adaptable, and competitive workforce that meets the demands of an evolving economic landscape. This document serves as a foundation for policymakers to formulate regulations that support alignment programs. It also provides valuable insights for vocational education leaders and industry stakeholders to strengthen their collaboration. The goal is to improve the quality of graduates, increase employability, and ensure that vocational education effectively meets the demands of the business and industrial worlds. The integration of employability skills into vocational education has been shown to improve job readiness (Romanova, 2021).

Method

This research employs a mixed-method design with an exploratory-sequential approach. The rationale for using this two-stage sequential method lies in the need to first explore issues related to the alignment of vocational education in various educational units, including Vocational High Schools, Polytechnics, and Course and Training Institutions. The findings from the qualitative phase are then utilized to develop a robust research instrument. The qualitative data collection phase is prioritized to uncover underlying theories and concepts that can serve as rigorous guidelines for subsequent quantitative testing. This approach ensures that the research is grounded in a comprehensive understanding of the subject matter, providing a strong foundation for the quantitative stage.

In the second stage, the study focuses on instrument development, ensuring that the process adheres to established procedures for creating reliable and valid tools. The development of a high-quality instrument follows best practices and aligns with the theoretical framework of vocational education alignment (Retnawati, 2016). The procedure for developing the alignment instrument involves several steps, as illustrated in Figure 1. These steps ensure that the instrument effectively

captures the dimensions of vocational education alignment while maintaining reliability and validity.
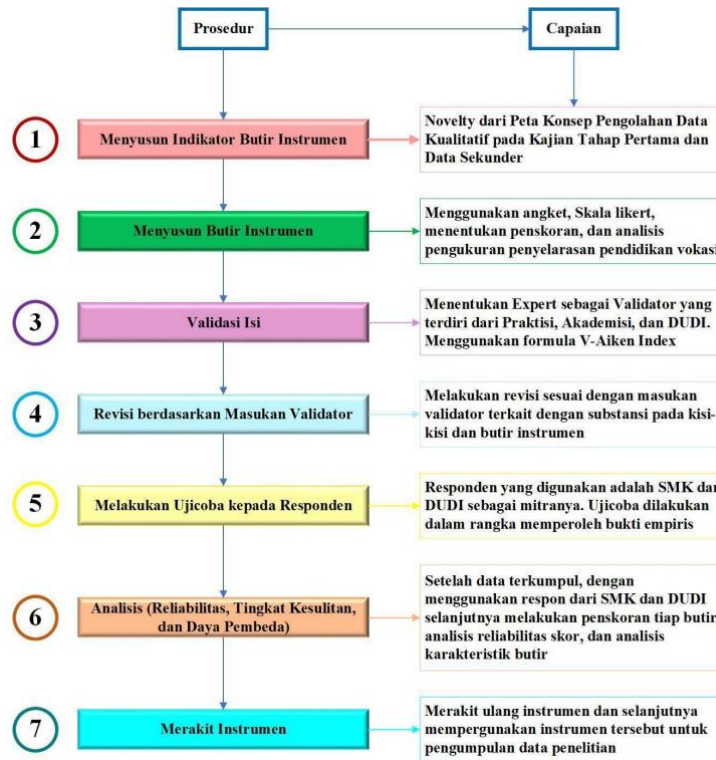

Fig 1: Procedure Development Instrument

The data analysis technique employed in this mixed-method study follows a sequential exploratory design. The analysis is guided by the Yin model (Yin, 2018), chosen for its ability to examine the implementation of vocational education alignment comprehensively.The rationale for using the Yin model lies in its suitability for addressing research questions framed as "how" or "why," which are essential for exploring contemporary phenomena, such as the alignment of vocational education. This model allows for an in-depth understanding of the processes, challenges, and outcomes related to vocational education alignment, making it an ideal strategy for this study.

The data analysis procedure involves systematically exploring qualitative findings to inform and refine the quantitative phase. This sequential process ensures that the insights from qualitative data provide a robust foundation for developing and analyzing quantitative instruments.The detailed data analysis procedure is presented in Figure 2. This figure outlines the step-by-step process, illustrating how the Yin model is applied to integrate qualitative and quantitative data for a comprehensive analysis.
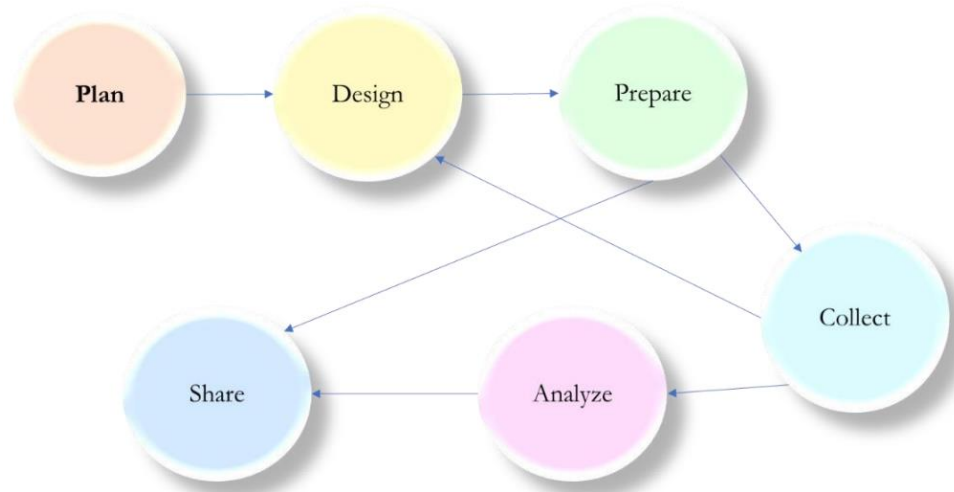
Fig 2: Procedure Data analysis

After obtaining the components of vocational education alignment through qualitative data analysis, the next step involved developing the instrument, starting with validity testing, reliability testing, data analysis, and trials to measure vocational education alignment. The validity used in the instrument development process includes content validity and construct validity. The results of content validity, conducted with 23 questionnaire items evaluated by experts, yielded an average validity index of 0.89. This indicates an agreement index > 0.8, signifying that the instrument possesses high validity.

For construct validity, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were utilized. The EFA results for the Vocational High School Education Unit showed a Chi-square value in the Bartlett test of 2955.254, with 406 degrees of freedom and a p-value < 0.01. These results confirm that the sample size of 250 used in this factor analysis was adequate. This conclusion is further supported by the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, which was 0.962 > 0.5.

Similarly, the EFA results for the Business and Industry (DUDI) data showed a Chi-square value in the Bartlett test of 2175.952, with 253 degrees of freedom and a p-value < 0.01. The sample size of 250 was deemed sufficient, as indicated by a KMO value of 0.956 > 0.5. The results of the CFA confirmed that all Goodness of Fit Index indicators met the Good Fit criteria. Following the successful construct validity testing and the achievement of the required criteria, the instrument was deemed ready for use in further measurements.

The next step involved reliability testing to measure the consistency of the questionnaire, which served as an indicator of vocational education alignment. A questionnaire is considered reliable if

the respondents' answers remain consistent and stable over time. The total Cronbach's Alpha value was 0.746, which is greater than the threshold of 0.361, indicating that the measurement instrument is reliable (consistent). This measurement of vocational education alignment involved 77 vocational schools, which were also assessed by their respective 77 business and industry (DUDI) partners.

Result and Discussion

The results of this study were derived from data collected using questionnaires and open-ended questions during the alignment data retrieval process in the fourth stage, conducted in the Jabodetabek area. This stage aimed to support the development of instruments and conceptual frameworks for vocational education alignment.

In addition, qualitative data were obtained through direct fieldwork using interview guidelines with participants from vocational education units, including Vocational High Schools (SMK), Polytechnics, Course and Training Institutions (LKP), and Business and Industry (DUDI). The findings are presented in two parts, reflecting the mixed-method approach used in this study:

1. Qualitative Analysis Results: This describes the findings from qualitative data collected during field visits.
2. Instrument Development and Measurement Results: These results are based on data collection during the fourth stage of vocational education alignment in the Jabodetabek area.

Qualitative Analysis and Concept Mapping

The concept map for this qualitative study involved data collection from participants in vocational education units, including vocational schools, polytechnics, and LKPs. The collected data, processed using Atlas.ti software version 23, revealed the relationships between various themes and indicators. These are visually represented in Figure 3 and Figure 4 below.

○ Aksesabilitas	○ Kejelasan Pedoman
○ Asesmen	○ Kelas Industri
○ Berstandar Industri	○ Keterbukaan Informasi
○ Competencies Need Analysis	○ Keterserapan Lulusan
○ Developing Student	○ Komitmen
○ Digital Inclusion	○ Komitmen Kerjasama
○ Evaluasi Industri	○ Komunikasi Efektif
○ Evaluasi Kebutuhan Kompetensi	○ Magang Bersertifikat
○ Evaluasi Program	○ Magang Guru
○ Expert	○ Media Pembelajaran
○ Identifikasi Kompetensi	○ Metode Pembelajaran
○ Industrial Teacher	○ Monitoring
○ Inovasi Kerjasama	○ Mutualisme
○ Jangka Waktu Pengembangan	○ Partisipasi Aktif
○ Karakter Kerja	○ Pedoman Pengembangan Keterampilan
○ Kebekerjaan	○ Pemadanan Dana
○ Pengembangan Program	○ Pemetaan Kompetensi Guru
○ Penyelarasan Kurikulum	○ Pendekatan Kerjasama
○ Peran Industri	○ Pengembangan Kerjasama
○ Pola Kerjasama	○ Sharing Selection
○ Program Kerjasama	○ Skill Passport
○ Selection of Prospective	○ Skill Set
○ Kesesuaian Kurikulum	○ Skills Update
○ Kessuaian Standar Kerja	○ Skills Upgrede
○ Menjalin Kerja Sama	○ Standar Pelatihan
○ Pemutakhiran Kurikulum	○ The Best Potential
○ Peninjauan Kurikulum	○ Dukungan untuk Berkembang
○ Perencanaan Pembelajaran	○ Evaluasi Pembelajaran
○ Program Kecakapan Wirausaha	○ Forum Pengembangan Kurikulum
○ Relevansi Kurikulum	○ Peningkatan Kompetensi Pendidik
○ Revitalisasi Alat	○ Peningkatan Metodologi Pembelajaran
○ Sertifikat Keahlian	

Fig 3: Atlas.ti software coding version 23

The concept map in Figure 4 illustrates that vocational education alignment involves 12 themes (dimensions) and 49 codes (indicators). These findings serve as a foundation for the development of dimensions and indicators used to construct the vocational education alignment instrument.

Fig 4: Concept Map Study Qualitative

Dimensions and Indicators for Vocational Education Alignment

The process of developing dimensions and indicators involved both primary and secondary data obtained from the study results. The key dimensions and their respective indicators are as follows:

1. Curriculum

    The Curriculum dimension includes the following indicators:

    a. Identification of competencies

    b. Curriculum preparation

    c. Curriculum updating/review

    d. Alignment with DUDI

    e. Curriculum evaluation

2. Learning

    The Learning dimension comprises these indicators:

    a. Learning plan development

    b. Preparation of learning facilities with DUDI

    c. Learning strategies

d. Learning methods

e. Learning process implementation

f. Learning assessments

3. Educator Competence

The Educator Competence dimension includes the following indicators:

a. Educational qualifications

b. Educator competencies

c. Professional certification

d. Communication skills

e. Internship experience

4. Graduate Competence

The Graduate Competence dimension focuses on students' skill competencies.

5. Infrastructure and Facilities

The Infrastructure and Facilities dimension includes:

a. Completeness of facilities

b. Facility standardization

c. Resource sharing

d. Technology updates

6. Leadership

The Leadership dimension emphasizes collaborative leadership practices.

7. Total Quality Management

The Total Quality Management dimension includes both internal and external quality management processes.

Alignment Framework

The vocational education alignment framework was constructed by categorizing the identified dimensions and indicators into quadrants. The categorization and alignment processes are detailed in Table 1, which provides a comprehensive overview of the alignment components.

These results demonstrate a systematic approach to aligning vocational education with the needs of the business and industrial sectors, ensuring that the competencies taught are relevant and meet market demands.

Table 1. Vocational Education Alignment Formula

Quadrant	Category
1	X≤Mi & Y>Mi or X≤Mi <Y
2	X>Mi & Y>Mi or X>Mi<Y
3	X≤Mi & Y≤Mi or X≤Mi≥Y
4	X≤Mi & Y≤Mi or X≤Mi≥Y

After measuring the indicators used to analyze the alignment of vocational education, the final results can be visualized through the quadrants shown in Figure 5.
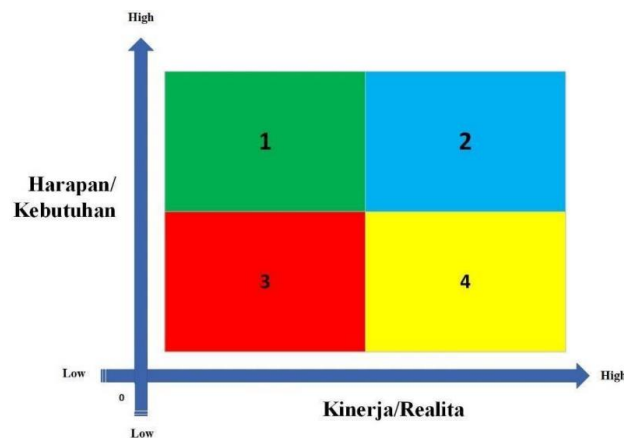

Fig 5: Quadrants Alignment of Vocational Education

Explanation of Quadrant Analysis

Based on Figure 5, the quadrants can be interpreted as follows:

Quadrant 1: Indicates that both DUDI (business and industry) and SMK (vocational high schools) recognize the need for alignment, but the realization is low.

Quadrant 2: Demonstrates that DUDI and SMK both identify the need for alignment and have successfully realized it, indicating effective alignment.

Quadrant 3: Suggests that DUDI and SMK have a low level of alignment need, and the realization is also low.

Quadrant 4: Reflects that DUDI and SMK have a low level of alignment need, but the realization is high.

Qualitative Data Findings

The qualitative data analysis explored 12 categorizations and 40 codings, which formed the basis for developing the vocational education alignment instrument. These draft findings were further refined through focus group discussions (FGDs) to gather input on components and indicators for instrument development.

Instrument Development and Validation

The final version of the vocational education alignment instrument, refined after the FGDs, consists of 7 components/dimensions and 23 items. The instrument underwent rigorous validity and reliability testing:

1. Content Validity:

- Evaluated by 7 experts and analyzed using the Aiken V Index, yielding an average value of 0.89 (> 0.8), indicating high content validity.

2. Construct Validity and Reliability:

- Tested using Exploratory Factor Analysis (EFA) with a KMO value of 0.956 (> 0.5), demonstrating sample adequacy.

- Confirmed using Confirmatory Factor Analysis (CFA), showing good fit criteria with values for χ^2, GFI, AGFI, CFI, TLI, CMIN/DF, and RMSEA exceeding the cut-off values.

Measurement Results

The vocational education alignment instrument was applied to 77 vocational schools and their respective DUDI partners. The results predominantly fell into Quadrant 2 (colored blue), indicating that SMKs and DUDI have successfully implemented alignment according to the developed instrument indicators. This outcome signifies effective collaboration and alignment between vocational education units and industry partners, addressing the demands of the job market while enhancing the relevance and quality of vocational education.

Conclusion

The development of vocational education alignment instruments has been conducted effectively and follows appropriate procedures. The process involves compiling indicator instrument items, constructing the items, validating content, revising based on validator feedback, conducting trials with respondents, analyzing reliability, difficulty levels, and discriminative power, and assembling the instrument.

The development process produced components/dimensions and measurement aspect indicators. These components include curriculum, learning, educator competency, graduate competency, infrastructure and facilities, leadership, and total quality management. vThe alignment of vocational education is represented in four quadrants. Quadrant 1 indicates that DUDI and SMK recognize a need, but realization is low. Quadrant 2 shows that DUDI and SMK identify a need and have achieved good realization, demonstrating effective alignment. Quadrant 3 reflects a low alignment need with low realization, while Quadrant 4 shows a low need but high realization.

The development of the instrument was supported by qualitative data analysis, which explored 12 categorizations and 40 codings. The finalized instrument was validated and tested for reliability. Content validity, analyzed by seven experts, showed an average Aiken's V index of 0.89, indicating high validity. Further validation using Exploratory Factor Analysis (EFA) yielded a Kaiser-Meyer-Olkin (KMO) value of 0.956, confirming sample adequacy, while Confirmatory Factor Analysis (CFA) results showed all goodness-of-fit indices met the required thresholds, confirming the instrument's reliability and validity.

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