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Article

Sustainable vocational education models for industrial revolution role in development of job market absorption in Tangerang City, Indonesia

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Abstract: The study's objective is to identify the challenges and limitations faced by the current vocational education system in preparing graduates in the era of the industrial revolution in the evolving job market in Tangerang, Indonesia. The study primarily examines vocational high schools and adopts a quantitative and quasi-experimental research approach, using control groups to conduct pre- and posttests. The experimental group experiences demonstrations, whereas the control group receives explanations. Instructors employ a blend of demonstration and explanation techniques to explain equipment operation before allowing students to engage in vocational training. The study, led by students in various engineering fields, evaluates technical competencies, work ethics, and foundational knowledge using tests and observations. Job preparation is assessed using the minimal completeness criteria (MCC), which focuses on the importance of proper knowledge, attitudes, and skills. The results indicate that vocational teachers have the potential to play a pivotal role in introducing cutting-edge, technology-based teaching methods, therefore enabling students to make well-informed decisions about their careers. This research enhances vocational education by incorporating practical skills and attitudes with academic knowledge, effectively addressing the changing requirements of the work market.

Keywords: sustainable; industrial revolution; job market; minimal completeness criteria; Indonesia

1. Introduction

The issue of unemployment is now affecting the workforce of several countries. Work readiness is closely linked to employment (Magagula et al., 2020). Proficiency in one's job and its correlation with technical and interpersonal skills are essential for being prepared for employment (Sever and İğdeli, 2018). Approximately 90% of enterprises in the fourth industrial revolution era have recognized soft skill competencies as a crucial determinant of employability for vocational school graduates in Indonesia (Indrawati and Kuncoro, 2021). It is essential to adequately prepare students for the fourth industrial revolution and the resulting sociocultural changes associated with society in Indonesia; it is crucial to revitalize vocational education by focusing more on soft skills in both the curriculum and among instructors. The fourth industrial revolution was a transformative era that integrated advanced technologies like artificial intelligence, automation, and the Internet of Things into various industries. This revolution significantly impacts the workforce, reshaping traditional job roles and necessitating new skill sets. As we navigate this technological evolution, understanding its implications becomes crucial for workers and educational institutions. These traits are sometimes called "soft skills" (Kavishe, 2022; Abang et al., 2023). Prospective regional employees must refine their soft

skills to remain competitive in the employment market. Possessing character excellence is an essential attribute for prospective workers.

Consequently, it will distinguish itself from its competitors (Rosak-Szyrocka et al., 2022). When recruiting, it is advantageous to seek applicants with robust character attributes and professional and academic proficiencies. Soft skills are more suitable in this context (Padhi, 2014). Jobs that necessitate hard skills in project administration include developing educational curricula, profiling future jobs, and executing highly sought-after technical functions by the business.

According to the American Management Association (AMA), hard skills contribute to just 25% of an employee's long-term effectiveness at work, but soft skills contribute to 75% (Murphy et al., 2023). A significant challenge in the contemporary labour force is the prevalent perception, or absence thereof, about the significance of vocational education in generating graduates with valuable skills (Anastasiu et al., 2020). Their status may indicate a graduate's employability in the open unemployment rate. An approach to assessing the quantity of unemployed individuals is by examining the open unemployment rate (OUR) (Ismail, 2011). For vocational high schools (VHS), the Ministries of Education and Cultural Affairs (MoEC) use a similar strategy, with a 75%:35% allocation ratio. The challenge vocational high schools face is providing students with the necessary skills for the future workforce while using the current school structures and infrastructure (Widyantoro, 2017).

Indonesia's vocational education offers multi-level programs like SMK (senior high school) and diplomas, focusing on skills and practical training through dual system partnerships with businesses. The competency-based curriculum aligns with national occupation standards (Rahman et al., 2021). Vocational education equips students with the necessary technical and pragmatic skills to enter the job immediately (Abang et al., 2023). It also helps develop their cultural competencies in the context of local, national, and international life orders (Okoye and Okwelle, 2013). Vocational education in Indonesia, as defined by Law No. 20 of 2003 on the National Education System of the Republic of Indonesia, refers to secondary education that aims to equip students with skills and knowledge for specific jobs. Vocational education is a dynamic level that adapts to changes in the labour market and improvements in science and technology (Hanushek et al., 2017). Industrial students must gain foundational knowledge, practical abilities, and a strong work ethic throughout their school experience (Rosak-Szyrocka et al., 2022). At a minimum, students at vocational schools must acquire fundamental competencies, including a comprehensive understanding of their industry, the proficiency to apply that knowledge, and a positive professional demeanour.

The primary objectives of vocational education programs are to offer students with highly sought-after skills that are in demand by businesses. Businesses and industries actively seek graduates who possess advanced skills and are highly efficient. This need is particularly pronounced during the ASEAN Economic Community (AEC) era. Vocational schools need help addressing the needs of enterprises and industries due to insufficient funds for recruiting an adequate number of skilled instructors. To ensure that their children get the highest quality education, competent and efficient educators must actively seek out opportunities for

professional development. For students to get the essential knowledge, practical abilities, and favourable work mindsets needed for success in the job market, proficient teachers must include demonstration methods in their teaching methods (Saiyad et al., 2020). The study aims to identify the challenges and limitations faced by the current vocational education system in preparing graduates for the evolving job market in Indonesia. It is essential to provide training for a proficient workforce, focusing on vocational education and the vocational guiding methodology educators use. By adhering to the national qualification structure and job competence criteria, students will be equipped to enter the workforce upon graduation.

2. Literature review

Clark (2007) summarises industrial revolutions as a historical transformation marked by significant technological advancements, production, and societal changes. These revolutions represent distinct periods in which innovations, such as mechanization and automation, revolutionized industries, shaped economic structures, and altered the nature of work. Clark's work provides a foundational understanding of the sequential phases that characterize the industrial revolutions, laying the groundwork for comprehending their profound impact on global economies and job markets. The link between industrial revolutions and vocational education is pivotal in understanding how changes in industry and technology necessitate adaptations in the skills and education of the workforce, such as the First Industrial Revolution initiated in the late 18th to early 19th century. It shifted industry from agricultural and manual labour to mechanized production, increasing the demand for skilled workers (Katz and Margo, 2014). During the second industrial revolution (Late 19th to Early 20th Century) during this era, electricity was introduced, and mass production demanded more vocationally trained and skilled workers. Thus, a formal vocational education program was introduced for industry needs (Justman and Gradstein, 1999). The Third Industrial Revolution (Mid-20th Century) allowed the emergence of automation, computerization, and digital technologies needed for workers with advanced technical skills; vocational education adapted to include training in electronics, programming, and technical fields. Presently, the Fourth Industrial Revolution allows the Integration of advanced technologies like artificial intelligence (AI), Internet of things (IoT), and big data into various sectors, open demand for skills in data analytics, cybersecurity, AI programming, etc.; vocational education evolving to incorporate STEM (science, technology, engineering, and mathematics) fields (Mokyr, 2002; Kravchenko and Kyzymenko, 2019; Rosak-Szyrocka et al., 2022).

Irrespective of the kind of industrial revolution, vocational education's primary objective is to provide a training program and should prepare students for the workforce (Lee et al., 1995; Ahmad et al., 2019; Abang et al., 2023; Rosak-Szyrocka et al., 2022). Hiebert et al. (2002) argued that competence in one's profession requires a blend of academic knowledge, skills, and capacities. Kurikulum Kerangka Kualifikasi Nasional Indonesia (KKNI) (Indonesian National Qualifications Framework Curriculum) exemplifies Indonesia's commendable and authentic aspects as a nation, particularly its publicly-owned education institutions, vocational

training, and assessment of student achievement in learning outcomes. Within KKNI frameworks, being "job-ready" means possessing the appropriate mindset, expertise, and competencies relevant to one's chosen professional trajectory (Rahayu, 2022). Work preparation encompasses a set of essential attributes that vocational school students, especially those specializing in automotive engineering, should possess, such as technical knowledge, including comprehension of machine and equipment activities, interpretation of spreadsheets, and the ability to choose suitable tools for a specific job (Ab Aziz and Balraj, 2022). Secondly, there is the capacity to do tasks, which includes executing tasks, maintaining tools, ensuring cleanliness, following safety protocols, exercising self-control, adhering to regulations, and possessing collaboration skills.

2.1. Career guidance

The efficacy of high school vocational programs, designed to facilitate students' comprehension of the pragmatic implementation of their education, is contingent upon the instructors' proficiency and disposition towards vocational instruction (Haloul et al., 2024). Further research is needed to examine the teacher's deliberate planning and strategy in teaching methods, particularly in areas such as choosing the primary material to focus on, interpreting specific teaching tasks, and providing a curriculum that emphasizes achieving desired outcomes for students to gain comprehensive knowledge (Magagula et al., 2020).

Vocational advising in Germany encompasses several functions, such as offering guidance and support in labour demand, professional introductions, and training programs. Vocational high schools (VHS) prioritize the administration of vocational fields in their career guidance programs (Khilji and Roberts, 2022). The establishment of vocational counselling in VHSs may be enhanced by classroom teaching, hands-on experience, and participation in extracurricular and curricular activities. These elements can be included in the curriculum. Promoting student autonomy in all areas of their learning, including intimate, academic, and professional development, is crucial for cultivating a comprehensive and customized education. Occupational school professors are responsible for educating, leading, instructing, training, assessing, and evaluating students (Kavishe, 2022). The instructors of machining technology courses have a double duty to shape their pupils' intellectual and physical capabilities, both in the classroom and at the worksite, to tackle problems that need a combination of academic comprehension and practical skills.

2.2. Industrial revolution and vocational education

The rapid technological advancements of recent decades and the new labour market concept are associated. In the 4.0 industrial revolution era, a fresh organizational and value chain control model is introduced across the product life cycle and manufacturing systems. These advancements are facilitated by information technologies (Jiang et al., 2024). Companies and the country's education sector must comprehend these changes, along with the associated challenges and opportunities of the new labour market, as failure to do so may lead to a loss of market share (Nafea

and Toplu, 2021). The evolving conditions in the labour market are giving rise to novel professions connected to robotics, Big data utilization, the Internet of Things, cybersecurity, cloud computing, augmented reality, and more. Although the future will witness alterations in current professional trajectories due to shifts in labour demand, disciplines associated with (STEM) are anticipated to experience a minor decline (Jiang et al., 2024).

Evoh and Agu (2015) highlighted that unemployment graduate is attributed to inefficient national curriculum contents that fail to meet the needs of aspiring applicants. The report underscores that higher education institutions produce graduates who lack the essential skills required by the workforce and need more. Consequently, the curriculum content in Indonesia's education system is perceived to need more elements of entrepreneurial skills, hindering graduates from becoming employers instead of mere job seekers or unemployed individuals. The primary challenge lies in enhancing the awareness of training institutions regarding labour market demands to address the skills gap. Vocational schools in Indonesia have elevated their collaboration with international industries, such as Caterpillar, Cisco, Nivea, and Philips, and this collaboration extends to providing students with work internships, certifications, job opportunities, and the assessment of their practical skills (Moses et al., 2017). Vocational education in Indonesia has been running well; however, there needs to be more cooperation among the industrial players and vocational education schools and more resources to practice in the industry and, therefore, the job market. Vocational education in Indonesia has been in operation for a significant period. However, there needs to be more collaboration between industrial players and vocational education schools. More resources for students to gain practical experience within the industry exacerbate this issue, impacting their preparedness for the job market (Moses et al., 2017).

3. Methodology

3.1. Method

This research employs a statistical design, explicitly using the quasi-experimental research technique. This study used two separate methodologies for practical learning: the explanation method and the presentation method. Most instructors use the explanation method while teaching students hard skills. In this context, the instructor assumes the role of a demonstrator for the students by operating the machine and providing them with a visual representation of its functioning. Subsequently, the students engage in collaborative efforts, either in pairs or small groups, to imitate the procedure inside the laboratory setting. The research group was subjected to a demonstration method (class). In addition to pre- and post-inquiry sheets, the investigator also created observation sheets that evaluate attitude and abilities, two elements of job preparation. The questions and responses on the observing and evaluation sheets are derived from the Standard Kompetensi Kerja Nasional Indonesia (SKKNI, the Indonesian National Work Competence Standards) by the relevant laws and regulations in Makassar state. The researchers recorded their results by closely monitoring all practical activities in the machine lab while students completed the test and exam before and after execution (posttest). The

data obtained from the observations and tests underwent evaluations to determine their reliability, validity, and strict adherence to research ethics. Permission for the exploratory study was obtained from the Academic Research Committee of Hasanuddin University, Makassar.

3.2. Research design

In engineering's eighth final semester, students were designated as the experimental group, whereas 6th semester was designated as the control group. Both the reference and experiment groups had a pretest to assess the suitability of the cohort setting before participating in the experiment group. The posttest was conducted on both the control and experiment groups to evaluate the state of each group. The control group was given an explanation approach at professional high schools, while the experiment group received vocational training integrating explanation and demonstrations. To calculate an assessment score to evaluate how effectively the vocational program satisfies the demands of the labour market. This might include contrasting the competencies required by regional employers with those taught in the curriculum.

As shown in **Table 1**, the comprehensive vocational assistance framework offers a systematic method for providing career assistance across various stages. During the creating phase, the framework prioritizes components such as an initial invocation, student attendance, allocation of worksheets or tasks, and guidance on professional trajectories. Additionally, it incorporates factors related to the national character and the distinctive qualities of the final output. Active involvement is fostered by highlighting assignments for students to work on during all activities. The framework promotes student-teacher interactions, focusing on providing career advice via guidance, support, and evaluation.

The final thoughts phase emphasizes the significance of student attendance, evaluates the quality of educational and career services, and contemplates the nature of the country and the characteristics of the work produced. The presence of equipment, instrumentation, and tidiness highlights the importance of having a well-equipped and structured workplace in the guiding process. This framework offers a complete structure that combines spiritual, practical, and evaluative elements to promote a holistic approach to vocational coaching.

Table 1. Comprehensive vocational guidance framework.

Phase	Experience with shoptalk	Perspective
Creating	Opening prayer and student presence Worksheet or task division Advice on Career Paths	Character of the nation the personality of the work product
All of the tasks	Assignments for students to work on engagements with students and teachers	The execution of career guidance, directing, accompanying, and reviewing
Final thoughts	Student presence Assessment of educational and career services Final words	Equipment, instruments, and tidiness Character of the nation The personality of the work product

3.3. Approach to demonstrating

The first step in adopting integrated vocational guiding processes with

demonstration techniques involves assembling all the equipment and materials required for learning lathe machining. The second step involves administering the prior test to the experiment group, using problem material designed explicitly by researchers in the field of engineering. The third step is disseminating engineering tool workbooks. The fourth step involves observing the comprehensive vocational guiding process, where students are equipped for employment via effective instructors' guides and presentations. Lastly, the fifth stage involves doing a posttest.

The research included several methods of observation and evaluation. KKNI are referenced in the observational sheet. The researchers used the KKNI observations sheet in the verified machining competence program to assess the students' work conduct, views, and technological skills. The mechanical engineering mindset observations sheet evaluates work readiness based on several key aspects: Work attitude involves meticulousness, thoroughness, and respect for others' cutting processes. Work personality, which entails punctuality, productivity, and accountability. Human resources leadership in the workplace focuses on safely operating machinery—work ethics, which includes maintaining clean tools. Toughness refers to the ability to accept critique and persist in one's work. The investigators in this study closely watched and documented students' attitudes and actions while working and the results they achieved while acquiring lathe manufacturing skills. The observations were conducted between May and June of 2022. The event commenced with a 20-minute opening session, during which students expressed their appreciation, received worksheets, and received vocational guidance. A 120-minute core/practicum session occurred, where students engaged in practical tasks involving engineering tools and techniques.

3.4. Analysis and techniques

This study employs parametric statistics for data analysis, focusing on the numerical scale of the measured data. The interpretation of data involves describing the significance behind the numerical values. Work readiness profiles are formulated by calculating the average values of basic knowledge (pretest-posttest), technical skills (observation), and work attitudes (observation) for each class. The effectiveness of integrated vocational guidance is assessed through the average difference test or t-test between the experimental and control classes.

4. Results and discussion

4.1. Normality test

The results of the normality tests, evaluated using asymptotic significance (2-tailed), provide information on the distribution of data within each technique and group in the research in **Table 2**. The *p*-values for the initial assessment, process, personality traits, product, assessment following, and total worth data in the experimental-and-control group are all high, ranging from 0.067 to 0.959. The high p-values indicate that the data in each category conforms to a normal distribution since the significance level exceeds the standard threshold of 0.05. In the experimental methods group using the case study technique, the normality test

findings likewise show non-significant *p*-values (range from 0.177 to 0.959), suggesting that the data in each analyzed category will likely have a normal distribution. These results indicate that the data in both the command and control and experimental methods groups meet the assumption of normalcy across multiple evaluation categories. Adhering to normalcy is essential to ensure the validity of future statistical studies that depend on this assumption.

Table 2. Outcomes of the regularity information test.

Groups	Model	Information	Regularity
			Assumption Sig. (2-tailed)
Control	Explanation	Initial assessment	0.807
		Process	0.536
		Personality traits	0.067
		Product	0.926
		Assessment following	0.467
Experimental methods	Demonstration	Initial Assessment	0.644
		Process	0.177
		Personality traits	0.445
		Product	0.916
		Assessment following	0.597

4.2. Homogeneity test

The homogeneity test findings, evaluated using Levene's statistics, provide insights into the uniformity of data across several categories in the research in **Table 3**. The data for initial assessment, process, personality traits, product, assessment following, and total worth show low Levene's statistics, suggesting a consistent distribution of scores within each category. The *p*-values associated with each category are significantly high, ranging from 0.139 to 0.737. This indicates no statistical significance in the variations in variances across the groups.

Table 3. Test results for homogenization of information.

Data	Homogeneity	
	Statistics by Levene	Sig
Initial assessment	1.817	0.146
Process	0.297	0.585
Personality traits	0.185	0.676
Product	2.326	0.139
Assessment following	0.124	0.727
Total value	0.117	0.737

The absence of significance suggests that the premise of equal variances is satisfied across these categories. Researchers often use homogeneity tests to verify that the compared groups' variances are similar. In this instance, the findings indicate that the data meets this assumption. Consequently, the following analyses

that depend on the assumption of homogeneity may be carried out with certainty, enhancing the dependability of the study's results.

4.3. Hypothesis test results

The t-tests on randomly chosen samples offer valuable insights into comparing the "regulated" and "very skilled" groups across many evaluation phases and categories in **Table 4**. During the initial assessment process, there was no notable disparity in the mean scores between the two groups for the regulated and very skilled conditions (t = 0.167, p = 0.909). Upon analyzing personality traits in products, it is seen that the control group has a much lower average (62.502) compared to the highly competent group (94.533), with a big t-value of 9.946 and a very significant p-value of 0.002. This indicates significant differences in the evaluations of personality traits between the two groups in the beginning stage. Furthermore, within the assessment context, it becomes evident that similar patterns arise upon analyzing the process. The group that adheres to regulations regularly exhibits lower average scores and substantially distinct outcomes in the initial assessment process (t = 20.417, p = 0.001) and personality traits in the product (t = 3.419, p = 0.001). These results emphasize clear performance trends and the need to consider evaluation phases and particular categories when analyzing disparities between the regulated and very skilled groups.

Table 4. These results were from a t-test for randomly selected samples.

Information	Group	Average	Standard deviation	*t*	df	Sig.
Initial assessment Process	Control	46.224	7.247	0.167	33	0.909
	Experimental	45.559	11.002			
Personality traits Product	Control	62.502	10.207	9.946	33	0.002
	Experimental	94.533	7.166			
Assessment following	Control	62.849	4.254	21.417	33	0.001
	Experimental	95.485	4.112			
Initial assessment Process	Control	62.849	4.853	20.412	33	0.001
	Experimental	95.485	4.113			
Personality traits Product	Control	88.877	4.657	3.419	33	0.001
	Experimental	93.744	3.275			
Assessment following	Control	77.204	3.309	4.902	33	0.002
	Experimental	82.904	3.629			

The t-tests on distinct samples from the control and experimental categories provide significant conclusions in **Table 5**. The control group achieved a mean score of 57.18 using the explanation method, which was considerably lower than the mean control condition (MCC). This difference was shown by a t-value of 10.481 and a p-value of 0.000, demonstrating statistical significance. These findings indicate that the regulatory strategy used significantly influenced the measured parameter. In contrast, using the examination approach, the experimental group achieved an average score of 79.51.451, exceeding the minimum completeness criteria (MCC). Regrettably, the absence of the particular t-value, degrees of freedom, and significance threshold for

this group hinders a thorough investigation.

Table 5. Findings from a t-test conducted on separate samples from the control and experimental.

Group	Model	Average	Findings	Standard deviation	*t*	df	Sig.
Control	Explanation	57.18	<MCC	2.120	10.481	10	0.000
Experimental	Examination	79.51	>MCC	2.280			

Note: Minimum completeness criteria (MCC): 75.00.

4.4. Discussion

Within vocational high schools, students rely on their lecturers to guide the form of regulations and methodologies to adhere to during class exercises that meet future job requirements. Vocational educators are responsible for facilitating their students' transition from school to the workforce by equipping them with hands-on job experience and comprehensive vocational knowledge (Kintu et al., 2019). Therefore, vocational guidance at vocational high schools assists students in acquiring valuable skills by establishing specific rules and protocols for doing job-related activities with accuracy and efficiency. Scientific presentations promote active participation and increased student attention, supporting the generalization process (Nafea and Toplu, 2021). Study findings indicated that using a demonstration method instead of an explanation approach is more effective for providing vocational training to technical students. Thus, the study findings align with Rojewski (2002), who stated that the demonstration technique aims to enhance students' content retention by simplifying the concepts into concrete examples, such as physical objects, particular actions, or events.

This is logical since students learn more consistently when instructors use the demonstration approach, enabling them to see practical applications of the subjects being taught and facilitating direct inquiry when encountering difficulties (Modrakee, 2005).

Students are required to implement the knowledge they acquire in a real-world context. Vocational schools aim to provide students with the requisite knowledge, attitudes, and competencies to enter the workforce or pursue employment in a particular industry. Employing several instructional methodologies to optimize the learning process might provide superior outcomes (Jiang et al., 2024; Abang et al., 2023).

The findings indicate that the method used in integrated vocational assistance, which involves demonstrating specific information, objects, actions, or events, may impact students' readiness for employment, particularly in engineering machine tools operations. The assessment of work practice learning and students' knowledge, attitudes, skills, and technical abilities determine their readiness for employment after completing vocational school. Via active engagement and thoughtful contemplation of the knowledge they have gained, students may completely actualize their emotional, cognitive, and psychomotor abilities via hands-on learning (Jung et al., 2004). This study found that vocational schools exemplify their teachings via structured experiential learning (Stephenand Festus, 2022). These

teachers play a crucial role in assisting students in acquiring the essential technical skills, work attitudes, and basic knowledge. Through demonstration-based education, students may actively acquire the necessary knowledge, attitudes, and abilities.

5. Conclusion and recommendations

Study findings concluded the significance of being prepared for a job regarding understanding, attitude, and competency using the explanatory technique based on the minimum completeness criteria (MCC). The study shows a significant difference between the explanation and demonstration methods of vocational learning. For the sustainable industrial workforce, vocational learning plays a significant role. The demonstration method enables teachers to effectively illustrate various aspects of machining to students, such as job selection, machine utilization, teamwork, adherence to safety protocols, work ethic, and maintaining a positive attitude in the workplace. Experienced teachers or instructors in the sector may use the demonstration approach to impart knowledge to pupils about lathe engineering abilities, work attitudes, and the intricacies of the lathe workplace. It solely focuses on the initial semester of the mechanical engineering and technology expertise program; accidents still occurred in the workshop despite utilizing the explanation method for research, the processing time for machining products exceeded the anticipated duration, and future researchers may propose a theory regarding professional learning and operations in vocational schools before student involvement. The results of this research indicate the need for career guidance to participate in the industrial development in the framework of occupational education, the implementation of new technology in classrooms, and the incorporation of virtual reality, cyber-physical systems, the Internet of things (IoT) and other developing technologies.

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