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Evaluation approach of the mechanical engineering competency test certification using the assessment evaluability and performance monitoring model

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A B S T R A C T

This research aims to gain an overview of the evaluation results and the many challenges to implementing machining competency test certification (CTC) in Vocational High Schools (VHS). The research approach to evaluating this program is a qualitative method using the analysis of Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The program evaluation design in this study uses the Assessment Evaluability and Performance Monitoring (AEPM) model, which has four evaluation components: Context, Inputs, Activities, and Performance Monitoring. The subjects involved in data collection through the distribution of questionnaires of five VHS in the Special Capital Region of Jakarta. The technique of determining all subjects using the Purposive Sampling technique. The results showed the level of effectiveness of the implementation of the machining CTC program. Some dimensions need to be strengthened, especially for the "less and "very lacking" category. Finally, the approach presented in this research using the AEPM model is a step forward in the analysis of the CTC program. This approach can easily be replicated in other countries with similar aims as this research.

1. Introduction

Training is a systematic process that improves human resources, human behavior, knowledge and motivation, and compatibility between workers and individual characteristics (Stofkova & Sukalova, 2020). Vocational High Schools (VHS) is a professional training process tailored to the workforce's needs in the industrial field (Leckie & Fullerton, 1999). Rodriguez et al. clarify that, as a result, goals and engagement criteria are created during the organization's program implementation to evaluate program efforts that are carried out continuously (Rodríguez et al., 2020). A vocational training program begins the preparation of personnel for industry, allowing qualified personnel to work in areas related to their training subject. Digitalization and automation have recently been important components in industrial processes, especially in the era of Industry 4.0. Robots with artificial intelligence perform all types of work previously performed by humans (Billett, 2000). From this condition, professional training must meet the demands of changing professions (Mahmudah & Santosa, 2021). In addition, Boyce and McGowan pointed out that the planning sector needs to develop innovative strategies to encourage understanding and support of the objectives in the program plan (Boyce & McGowan, 2018).

In a skill certification program, the main purpose of skill certification is to increase connections. The second objective is to improve the quality of knowledge and skills so that it is expected that graduates can work in the current way (Cook, 2006). Therefore, as part of the completed professional test process, Sumbodo et al. determined that quality improvement was needed (Sumbodo et al., 2019). Muharam et al. research found the proficiency test certification program highlights the effect of the competency test certification (CTC) program on graduate performance (Muharam, 2022). In the implementation process, there are several shortcomings in facilities and infrastructure, including the number of tools and materials from test

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participants. In addition, Budiyanto and Suyanto stated that the psychomotor aspects of the test participants were worse than other aspects, which were influenced by their lack of theoretical knowledge related to the skill test certification material (Budiyanto & Suyanto, 2020)

Some research focused on analyzing success or failure in the pre-university stages. Set et al. study predicted outcomes of Turkish high school students in national examination national selection (Sen et al., 2012). Sara et al. predicted Danish students would abandon their studies in the next three months. This study collected data from students who have completed the first six months in secondary education institutes (Sara et al., 2015). Aguiar et al. investigated several high school students to find those at risk of abandonment. This data is collected from 11.000 and research purposes to take appropriate measures so that it does not happen (Aguiar et al., 2015).

Other research analyzes the possible relationship between student education and employability. Jackson investigated factors influencing graduate employment in Australian Bachelor's degrees between 2011 and 2012 (Jackson, 2013b). Meyburn et al. conduct a study demanding the extent of doctoral degree student skills and capability in the Australian employment market (Mewburn et al., 2018). Bharambe et al. investigated five skills of various Indian students to predict the probability of getting employment (Bharambe et al., 2017).

As mentioned above, numerous works in the educational field predict possible dropout and employability. Today, analysis of the VHS data is considered one of the foundations for implementing new VHS policies and maybe even more so in the future. Conejero et al. conducted a multi-criteria classification of VHS programs in Spain between 2009-2016 using TOPSIS (Conejero et al., 2021). However, a high level of professional expertise is one of the personal competencies required by the industry as a corporate investment strategy (Finegold & Soskice, 1988). Therefore, Amin's research explained that it is necessary to determine the program target in the evaluation model (Amin, 2018). Various studies use Assessment Evaluability and Performance Monitoring (AEPM) evaluation models (Wholey et al., 2013, Shippee et al., 2018). Wholey et al. investigated the medical field to examine work boundaries development, interdependence care guides and members of the primary care team, and acceptance by clinic workers of this new type of health employee (Wholey et al., 2013). Wholey et al. developed and validated teamwork in the assertive community treatment (TACT) scale (Wholey et al., 2012). Shippee et al. assess the effect of patient-centred medical home initiatives on the quality of care (Shippee et al., 2018).

Based on the mentioned above, the TOPSIS and AEPM elaborated could gain an overview of the evaluation results and the many challenges to implementing machining CTC in VHS. The subjects involved in data collection through the distribution of questionnaires of five VHS in the Special Capital Region of Jakarta. The technique of determining all subjects using the purposive sampling technique.

2. Method

2.1 Subject of Research

The research started from July to September 2022. The research target is a purposive sampling of five VHS in the Special Capital Region of Jakarta, Indonesia. This qualitative research approach emphasizes understanding the process of collecting data from filling out questionnaires and surveys conducted by researchers. Combines clustering, optimal matching, and multidimensional scaling techniques that are a way to view and summarize record data. Therefore, this method to inform adaptive surveys helps outlier data in improving survey data.

Edgar Rodríguez stating interviews as a tool for analysis shows that the emphasis on narratives is complex, not just comprehensive, about how people experience (Rodríguez-Dorans & Jacobs, 2020). Edwards stated that it needs a series of activities that occur in a specific context (Edwards & Holland, 2020). The dimensions and elements of the questions used in this study are as follows:

1. Context, which contains material: a) The urgency of competency test, b) Benefits of conducting competency tests, c) The need for support for competency test management personnel, and d) Support for all education laboratory institutions (PLP) and school lecturers for the preparation of equipment, materials, testers, and supporting component tools for the expertise competency test.

2. Inputs contain material: a) Planning the organizational structure of the Competency Test manager, b) Planning the competency test program and Human Resources (HR) development, c) Planning student preparation activities in using workshop services, d) Planning for facilities and infrastructure preparation to support the Competency test organizer.

3. Activities contain material: a) Socialization of special characteristics of competency test workshops b) Cooperation with certification bodies c) Socialization of measurement/measurement devices needed by Competency test workshops.

4. Performance monitoring contains material: a) output description of the output results of program activities related to sources, results, and customers/participants of competency tests served, b) short-term outcomes results of competency tests based on applied knowledge literacy on new knowledge capabilities and competencies, and c) Medium-term outcomes application of new knowledge and competencies based on applied science results of short-term outcomes.

The samples selected were principals, vice principals for curriculum, vice principals for industrial relations, vice principals for facilities and infrastructure, heads of machining programs, workshop heads, and productive machining teachers. The questionnaire uses the Likert scale's weighting criteria for answer choices, as seen in Table 1.

Table 1
Likert scale for answer choices

Classification	Score
5	Fits Perfectly
4	Appropriate
3	Less Suitable
2	Not Compliant
1	Very Incompatible

2.2 Research Methods

The qualitative research on the collected questionnaire data was analyzed using the TOPSIS approach. Moreover, TOPSIS was subjected to the AEPM model (context, inputs, activities, and performance monitoring) for program evaluation designs that have been and are being carried out. This elaboration was conducted to determine the outputs/graduates and outcomes/impacts of the development program for implementing student CTC in VHS.

TOPSIS approach is commonly used for solving multi-criteria decision analysis of the problem (Li et al., 2011). The specific stages can be expressed as follows (Li et al., 2022) :

Stage 1: Normalized decision criteria matrix (r_{ij}), so that a normalized decision matrix (R) is obtained from the following formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{1}$$

where r_{ij} is the matrix element normalized (i=1,2…n and j=1,2…n), x_{ij} is the base matrix to be normalized, i line of the matrix, and j is the column of the matrix.

Stage 2: Define a normalized decision matrix using the following equation.

$$y_{ij} = w_i r_{ij} \tag{2}$$

where y_{ij} is the weighted rating matrix element, w_i is weight rating to i, and r_{ij} is matrix normalized results in the first stage (i=1,2…n and j=1,2…n).

Stage 3: Determine the matrix positive and negative ideal solutions using Eq. (3) and Eq. (4). Based on the normalized weight rating, it can determine the positive ideal solution and the negative ideal solution. To be able to determine the ideal solution, it must be determined whether the attribute is profit or cost.

$$A^+ = (y_1^+, y_2^+, \dots, y_n^+) \tag{3}$$

$$y_i^+ = \begin{cases} max._i\ y_{ij}\ is\ an\ attribute\ of\ profit \\ min._i\ y_{ij}\ if\ j\ is\ the\ cost\ attribute \end{cases}$$

where A^+ is a positive ideal solution

$$A^- = (y_1^-, y_2^-, \dots, y_n^-) \tag{4}$$

$$y_i^- = \begin{cases} min._i\ y_{ij}\ is\ an\ attribute\ of\ profit \\ max._i\ y_{ij}\ if\ j\ is\ the\ cost\ attribute \end{cases}$$

where A^- is a negative ideal solution

Stage 4: Calculates the determination of the range between the values of each alternative using a matrix of positive ideal and negative ideal solutions using the following formula.

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ - y_{ij}\right)^2}\ (= 1,2,\dots,n) \tag{5}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n}(y_{ij} - y_i^-)^2} \ (= 1,2,\dots,n) \quad (6)$$

Stage 5: Calculate the determination of the value of each alternative option using the following formula.

$$V_i = \frac{D_i^-}{D_i^- - D_i^+} \quad (7)$$

where V_i value of each alternative option.

The value of the effectiveness of each evaluated aspect converted into a classification of Guilford validity, as shown in Table 2 (Suyasa & Kurniawan, 2018).

Table 2
The effectiveness category refers to the Guilford classification of validity

Range of Effectiveness	Category
0.80 – 1.00	Excellent
0.60 – 0.79	Good
0.40 – 0.59	Enough
0.20 – 0.39	Less
0.0 – 0.190	Very Lacking

3. Results and discussion

3.1. Context

The context describes variables that affect the importance that needs to be done on the application of a program's innovation, such as institutional policies and the state of the learning environment. In this case, 5 VHS were evaluated with 12 alternative questions. The first stage calculation can be seen in Table 3 based on Eq. (1). Table 3 shows, the data obtained is normalized to obtain a normalized result from collecting data to R_{ij}. Based on the calculation results, the normalized value is entered into the matrix R_{ij}. The second stage is to insert data in Table 3 into Eq. (2). The calculation result can be presented in Table 4.

Table 3
Data normalized to into an R_{ij} matrix

0.2872	**0.3073**	**0.2833**	**0.3006**	**0.3097**
0.2991	0.3073	0.2957	0.2881	0.2968
0.2752	0.3073	0.2833	0.3006	0.2839
0.2752	0.2934	0.2833	0.2881	0.2968
0.2752	0.3213	0.2833	0.3006	0.2710
0.2752	0.3073	0.2957	0.2881	0.2710
0.2991	0.3492	0.3080	0.3131	0.1936
0.2991	0.1397	0.3080	0.3131	0.3227
0.2991	0.2095	0.3080	0.2505	0.3227
0.2892	0.2794	0.2566	0.2818	0.2581
0.2991	0.2910	0.2772	0.2714	0.3011
0.2892	0.2910	0.2772	0.2609	0.3119

Table 4
Weighted rating matrix element (y_{ij}).

0.1292	**0.0768**	**0.0425**	**0.0301**	**0.0155**
0.1346	0.0768	0.0443	0.0288	0.0148
0.1238	0.0768	0.0425	0.0301	0.0142
0.1238	0.0733	0.0425	0.0288	0.0148
0.1238	0.0803	0.0425	0.0301	0.0136
0.1238	0.0768	0.0443	0.0288	0.0136
0.1346	0.0873	0.0462	0.0313	0.0097
0.1346	0.0349	0.0462	0.0313	0.0161
0.1346	0.0524	0.0462	0.0250	0.0161
0.1301	0.0698	0.0385	0.0282	0.0129
0.1346	0.0728	0.0416	0.0271	0.0151
0.1301	0.0728	0.0416	0.0261	0.0156

The third stage can be seen in Table 5, which shows the determination of the value of the positive ideal solution (y_j^+) and the negative ideal solution (y_j^-) using equations (3) and (4), followed by calculating the values (D_i^+) and (D_i^-) using Eq. (5) and Eq. (6). After the values (D_i^+) and (D_i^-) are found, it is done to find the preference value (V_n) so that it can be ranked according to the value.

Table 5
Rank preference value according to value

y_1^+	**0.1238**	y_1^-	**0.1346**
y_2^+	0.0873	y_2^-	0.0349
y_3^+	0.0385	y_3^-	0.0462
y_4^+	0.0313	y_4^-	0.0250
y_5^+	0.0097	y_5^-	0.0097

D_1^+	**0.0138**	D_1^-	**0.0431**	V_1	**0.757**
D_2^+	0.0171	D_2^-	0.0424	V_2	0.712
D_3^+	0.0122	D_3^-	0.0439	V_3	0.783
D_4^+	0.0156	D_4^-	0.0406	V_4	0.722
D_5^+	0.0090	D_5^-	0.0472	V_5	0.839
D_6^+	0.0129	D_6^-	0.0436	V_6	0.772
D_7^+	0.0132	D_7^-	0.0528	V_7	0.799
D_8^+	0.0544	D_8^-	0.0090	V_8	0.141
D_9^+	0.0384	D_9^-	0.0186	V_9	0.326
D_{10}^+	0.0191	D_{10}^-	0.0363	V_{10}	0.655
D_{11}^+	0.0196	D_{11}^-	0.0386	V_{11}	0.663
D_{12}^+	0.0180	D_{12}^-	0.0388	V_{12}	0.683

Based on Table 5, the result will be presented in Fig. 1.

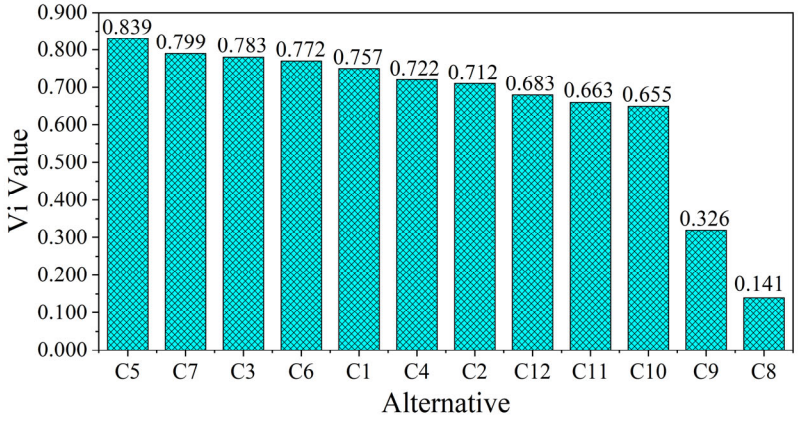

Fig. 1. The preferred value of each alternative in the context dimension.

The arrangement of the effectiveness category values for each question element on the context dimension is shown in Fig. 1. Generally, the average value of all question elements in the "good" category. Obtained a standard value of "very good" suitability for question elements C5, followed by "good" Category values for question elements C7, C3, C6, C1, C4, C2, C12, C11 and C10. This result needs to be maintained and improved. In addition, the value of the "less" category on the C9 question element, therefore, the implementing team of the CTC program, complements the infrastructure needs of the participants and the implementing team from the industrial field. C8 has a "very lacking" category; therefore, the implementing team for the CTC program from schools manages participants and partners from the industrial field.

Regarding question elements C9 and C8, certification bodies in VHSs must complete compliance and adequacy standards. Firstly by adding the number of qualified assessors for technical competency areas of expertise for lecturers due to the process of carrying out CTC, there are pairs of methodological and technical assessors. Methodological assessors related to documents and technical assessors related to expertise. In line with Ibrahim and Nashir's research, there is a need for an integrated conceptual framework and new findings to organize and categorize the adequacy of assessment of fulfillment of needs (Ibrahim, 2022). Secondly, partners from the industrial field must be qualified (senior mechanics, workshop heads, and machining mechanic instructors) in carrying out CTC. This statement, reinforced by Ni and Wang's research, is a feasible approach for institutions that generate practice-based evidence in organizational environments for increased lower human resources (Ni & Wang, 2022).

3.2 Inputs

Inputs include the resources and funds owned to be able to operate a program. The effectiveness of the input dimension was evaluated in 5 VHS using 12 alternative questions. The first stage calculation can be seen in Table 6 based on Eq. (1). Table 6 shows the normalized result from collecting data to R_{ij}. Based on the calculation results, the normalized value is entered into the matrix R_{ij}. The second stage is to insert data in Table 6 into Eq. (2). The calculation result can be seen in Table 7.

Table 6
Data normalized into an R_{ij} matrix

0.2913	0.2807	0.3016	0.2986	0.2926
0.3066	0.3070	0.3100	0.2986	0.3270
0.2989	0.2982	0.3016	0.3072	0.3270
0.3225	0.2982	0.2681	0.2389	0.2409
0.2606	0.2456	0.2514	0.2389	0.2754
0.3199	0.2456	0.2514	0.2389	0.2409
0.3066	0.2807	0.2681	0.2730	0.2754
0.3066	0.2807	0.2681	0.2730	0.2754
0.5261	0.2807	0.2681	0.3413	0.2754
0.2861	0.3275	0.3351	0.2958	0.2983
0.2861	0.3041	0.3128	0.3185	0.2983
0.2861	0.3041	0.3128	0.3185	0.3213

Table 7
Weighted rating matrix element (y_{ij}).

0.2913	0.2807	0.3016	0.2986	0.2926
0.3066	0.3070	0.3100	0.2986	0.3270
0.2989	0.2982	0.3016	0.3072	0.3270
0.3225	0.2982	0.2681	0.2389	0.2409
0.2606	0.2456	0.2514	0.2389	0.2754
0.3199	0.2456	0.2514	0.2389	0.2409
0.3066	0.2807	0.2681	0.2730	0.2754
0.3066	0.2807	0.2681	0.2730	0.2754
0.5261	0.2807	0.2681	0.3413	0.2754
0.2861	0.3275	0.3351	0.2958	0.2983
0.2861	0.3041	0.3128	0.3185	0.2983
0.2861	0.3041	0.3128	0.3185	0.3213

The third stage can be seen in Table 8, which shows the determination of the value of the positive ideal solution (y_j^+) and the negative ideal solution (y_j^-) using Eq. (3) and Eq. (4), followed by calculating the values (D_i^+) and (D_i^-) using Eq. (5) and Eq. (6). After the values (D_i^+) and (D_i^-) are found, it is done to find the preference value (V_n) so that it can be ranked according to the value.

Table 8
Rank preference value according to value

$\boldsymbol{y_1^+}$	0.1173	$\boldsymbol{y_1^-}$	0.2367
$\boldsymbol{y_2^+}$	0.0819	y_2^-	0.0614
$\boldsymbol{y_3^+}$	0.0377	y_3^-	0.0503
$\boldsymbol{y_4^+}$	0.0341	y_4^-	0.0239
$\boldsymbol{y_5^+}$	0.0120	y_5^-	0.0120

$\boldsymbol{D_1^+}$	0.0202	$\boldsymbol{D_1^-}$	0.1063	$\boldsymbol{V_1}$	0.840
$\boldsymbol{D_2^+}$	0.0238	D_2^-	0.1003	V_2	0.807
$\boldsymbol{D_3^+}$	0.0209	D_3^-	0.1035	V_3	0.831
$\boldsymbol{D_4^+}$	0.0307	D_4^-	0.0931	V_4	0.752
$\boldsymbol{D_5^+}$	0.0229	D_5^-	0.1201	V_5	0.839
$\boldsymbol{D_6^+}$	0.0352	D_6^-	0.0936	V_6	0.727
$\boldsymbol{D_7^+}$	0.0249	D_7^-	0.0997	V_7	0.800
$\boldsymbol{D_8^+}$	0.0249	D_8^-	0.0997	V_8	0.800
$\boldsymbol{D_9^+}$	0.1201	D_9^-	0.0169	V_9	0.123
$\boldsymbol{D_{10}^+}$	0.0179	D_{10}^-	0.1101	V_{10}	0.860
$\boldsymbol{D_{11}^+}$	0.0163	D_{11}^-	0.1093	V_{11}	0.870
$\boldsymbol{D_{12}^+}$	0.0165	D_{12}^-	0.1094	V_{12}	0.868

Based on Table 8, the result will be presented in Fig. 2. The results of the Inputs dimension are shown in Fig. 2, the arrangement of the effectiveness category values for each question element on the Inputs dimension. The “very good” category score question elements were obtained on the question elements I11, I12, I10, I1, I3, I5, I2, I7 and I8. In this question element, the category values must be maintained for the future. “Good” category scores obtained on question elements I4 and I6 on this element need further improvement. In addition, the score in the “very lacking” category on element question I9 is related to the process of learning and training programs to build an understanding of applied knowledge in theory related to the implementation of work practices in workshops. Several things must be done on the input dimension before the CTC. This was conducted to fulfill the first standard element of question I9 related to the process of learning and training programs to build an understanding of applied knowledge in theory related to the implementation of work practices in workshops. Firstly, the need to change policies and improve from the value category is “very lacking” to fulfillment of adequacy “good”. This agrees with Rodriguez; it is necessary to plan standards and involve organizational

assessment as a program initiative carried out on an ongoing basis as part of program fulfillment (Rodríguez et al., 2020). Secondly, VHS detail the need for a training program for PLP and lecturers in the field of productive studies to support increased knowledge and skills for members of the CTC implementation team in stages and continuously. Rusmulyani et al. research reinforce this statement, including plans for lecturers, organizational implementation tasks, institutions, facilities and infrastructure, and financing that need primary attention (Rusmulyani et al., 2022).

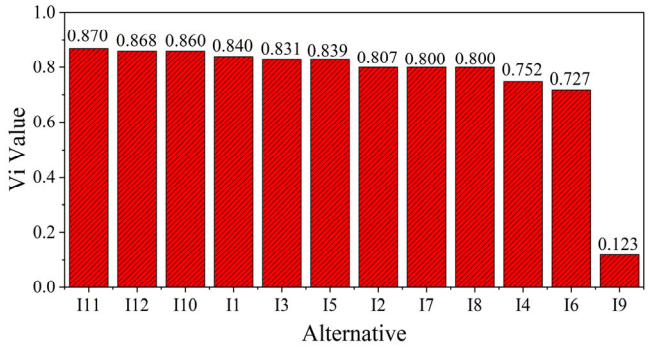

Fig. 2. The Choice/Preference Value of Each Alternative on the Inputs Dimension Inputs

3.3 Activities

Activities are the process of conducting competency tests and applications related to knowledge, attitudes, and skills. The effectiveness of the Activities dimension, the problem to be found is a component that needs to be improved in improving the effectiveness of the implementation of CTC in the Machining Mechanic Program in 5 VHS based on 9 alternative questions. The first stage calculation can be seen in Table 9 based on Eq. (1). Table 9 shows the normalized result from collecting data to R_ij. Based on the calculation results, the normalized value is entered into the matrix R_{ij}. The second stage is to insert data in Table 9 into Eq. (2). The calculation result can be seen in Table 10.

Table 9
Data normalized into an R_{ij} matrix

0.3537	**0.3560**	**0.3648**	**0.3842**	**0.3982**
0.2948	0.2966	0.3040	0.3041	0.3153
0.3537	0.3560	0.3040	0.3041	0.3153
0.3685	0.3708	0.3800	0.3201	0.3318
0.3685	0.3708	0.3800	0.3201	0.3318
0.3685	0.3708	0.3800	0.4002	0.3318
0.3500	0.3337	0.3420	0.3802	0.3941
0.2579	0.2596	0.2660	0.3001	0.2696
0.2579	0.2596	0.2470	0.2601	0.2904

Table 10
Weighted rating matrix element (y_{ij})

0.1592	**0.0890**	**0.0547**	**0.0384**	**0.0199**
0.1326	0.0742	0.0456	0.0304	0.0158
0.1592	0.0890	0.0456	0.0304	0.0158
0.1658	0.0927	0.0570	0.0320	0.0166
0.1658	0.0927	0.0570	0.0320	0.0166
0.1658	0.0927	0.0570	0.0400	0.0166
0.1575	0.0834	0.0513	0.0380	0.0197
0.1161	0.0649	0.0399	0.0300	0.0135
0.1161	0.0649	0.0371	0.0260	0.0145

The third stage can be seen in Table 11, which shows the determination of the value of the positive ideal solution (y_j^+) and the negative ideal solution (y_j^-) using Eq. (3) and Eq. (4), followed by calculating the values (D_i^+) and (D_i^-) using Eq. (5) and Eq. (6). After the values (D_i^+) and (D_i^-) are found, it is done to find the preference value (V_n) so that it can be ranked according to the value.

Table 11
Rank preference value according to value

$\boldsymbol{y_1^+}$	0.1161	$\boldsymbol{y_1^-}$	0.1658
$\boldsymbol{y_2^+}$	0.0927	y_2^-	0.0649
$\boldsymbol{y_3^+}$	0.0371	y_3^-	0.0570
$\boldsymbol{y_4^+}$	0.0400	y_4^-	0.0260
$\boldsymbol{y_5^+}$	0.0135	y_5^-	0.0135

D_1^+	0.0472	D_1^-	0.0287	V_1	0.378
D_2^+	0.0281	D_2^-	0.0366	V_2	0.565
D_3^+	0.0452	D_3^-	0.0279	V_3	0.381
D_4^+	0.0543	D_4^-	0.0286	V_4	0.345
D_5^+	0.0543	D_5^-	0.0286	V_5	0.345
D_6^+	0.0537	D_6^-	0.0313	V_6	0.368
D_7^+	0.0453	D_7^-	0.0251	V_7	0.356
D_8^+	0.0297	D_8^-	0.0528	V_8	0.639
D_9^+	0.0312	D_9^-	0.0536	V_9	0.632

Based on Table 10, the result will be presented in Fig. 3.

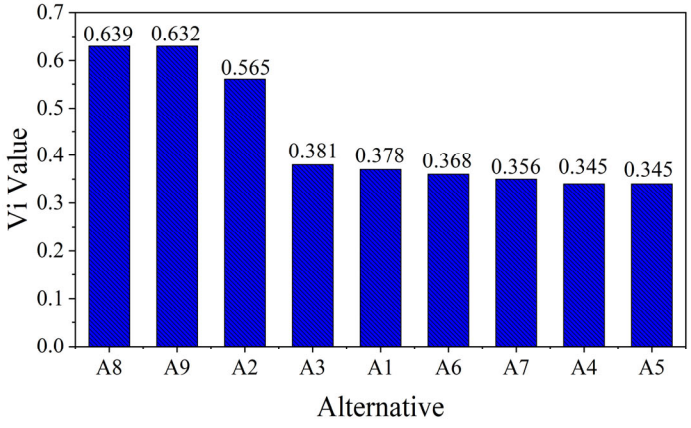

Fig. 3. The value of each alternative's choice/preference in the activities dimension

The activity dimensions results are shown in Fig. 3. Question elements A8 and A9 obtained a "good" category value. In question element A2, it gets the value of the "enough" category. Elements of the A2 question need to be further improved when implementing the CTC program. This increase was carried out by arranging the job sheet to the processing stages as a procedural consideration for machining work. Moreover, the question elements A3, A1, A6, A7, A4 and A5 get a "less" category value. Question elements that get a "less" category value need to be further improved to get a better category value. Firstly, examining aspects of applied knowledge and skills is necessary to help determine how to solve the various steps and methods more efficiently. Rahdiyanta stated that a school organization's effectiveness is determined by culture, which includes process design, performance climate, values and norms that habituation and culture bring success in teaching and learning (Rahdiyanta et al., 2019). Secondly, evaluating the implementation of CTC that has been carried out by interpreting the findings of the problem for future improvement. In addition, several recommendations for obstacles in implementing the program need to be repaired periodically to achieve adequacy standards (Suyasa & Kurniawan, 2018). Thirdly, the CTC program must combine applied conceptual knowledge and practice to become a priority value system. Fourthly, technical competency partners for carrying out the CTC need partners related to positions such as: workshop head, service advisor, foreman, senior mechanic, and mechanic instructor. Fively, partnerships with the industrial field, according to the expertise program, need improvement and sustainability. This statement aligns with Nuphanudin et al. reporting that the main purpose of CTC is to increase link and match, and the secondary goal is to improve quality regarding knowledge and skills (Cook, 2006) .

3.4 Performance Monitoring

Performance monitoring evaluation has several emphases, such as output is a description of the output of program activities. In the dimension data of the performance monitoring program, the problem to be found is what components need to be improved in improving the effectiveness of the implementation of CTC in the machining mechanical program. In this case, five VHS were evaluated based on six alternative questions. The first stage calculation can be seen in Table 12 based on Eq. (1). Below shows the data obtained normalized, to obtain the normalized result from collecting data to R_{ij}. Based on the calculation results, the normalized value is entered into the matrix R_{ij}. The second stage is to insert data in Table 12 into Eq. (2). The calculation result can be seen in Table 13.

Table 12
Data normalized into an R_{ij} matrix.

0.4279	**0.4558**	**0.4302**	**0.5035**	**0.4166**
0.3766	0.4143	0.4097	0.3986	0.4339
0.4108	0.3936	0.4507	0.3776	0.3819
0.4108	0.4143	0.3278	0.3567	0.4166
0.4108	0.3936	0.3892	0.3986	0.3992
0.4108	0.3729	0.4302	0.3986	0.3992

Table 13
Weighted rating matrix element (y_{ij})

0.1926	**0.1139**	**0.0645**	**0.0504**	**0.0208**
0.1695	0.1036	0.0615	0.0399	0.0217
0.1849	0.0984	0.0676	0.0378	0.0191
0.1849	0.1036	0.0492	0.0357	0.0208
0.1849	0.0984	0.0584	0.0399	0.0200
0.1849	0.0932	0.0645	0.0399	0.0200

The third stage can be seen in Table 14, which shows the determination of the value of the positive ideal solution (y_j^+) and the negative ideal solution (y_j^-) using Eq. (3) and Eq. (4), followed by calculating the values (D_i^+) and (D_i^-) using Eq. (5) and Eq. (6). After the values (D_i^+) and (D_i^-) are found, it is done to find the preference value (V_n) so that it can be ranked according to the value.

Table 14
Rank preference value according to value

$\boldsymbol{y_1^+}$	**0.1695**	$\boldsymbol{y_1^-}$	**0.1926**
$\boldsymbol{y_2^+}$	0.1139	y_2^-	0.0932
$\boldsymbol{y_3^+}$	0.0492	y_3^-	0.0676
$\boldsymbol{y_4^+}$	0.0504	y_4^-	0.0357
$\boldsymbol{y_5^+}$	0.0191	y_5^-	0.0191

$\boldsymbol{D_1^+}$	**0.0278**	$\boldsymbol{D_1^-}$	**0.0256**	$\boldsymbol{V_1}$	**0.479**
$\boldsymbol{D_2^+}$	0.0194	D_2^-	0.0265	V_2	0.577
$\boldsymbol{D_3^+}$	0.0313	D_3^-	0.0095	V_3	0.233
$\boldsymbol{D_4^+}$	0.0237	D_4^-	0.0226	V_4	0.487
$\boldsymbol{D_5^+}$	0.0260	D_5^-	0.0138	V_5	0.346
$\boldsymbol{D_6^+}$	0.0318	D_6^-	0.0093	V_6	0.226

Based on Table 14, the result will be presented in Fig. 4.

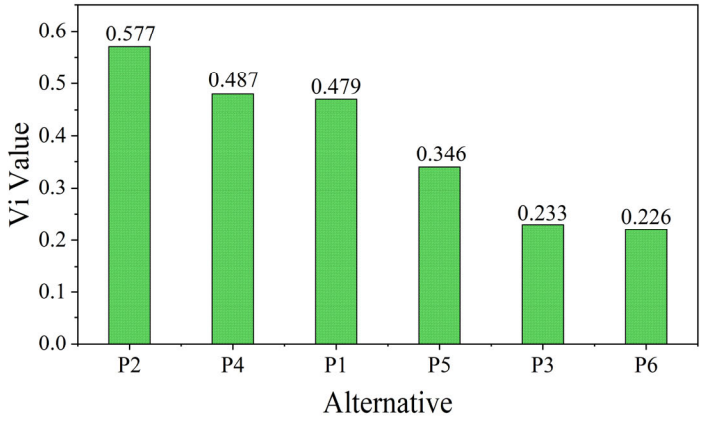

Fig. 4. The value of each alternative's choice/preference in the performance monitoring dimension

The dimensions of performance monitoring are shown in Fig. 4. The question elements P2, P4 and P1 obtained an “enough” category value. In the future, it needs to be upgraded to a “good” or “excellent” category. In the element aspect of question P2 related to schools implementing CTC, it is customary to record absorption in the share of the labour market for CTC graduates in the field of machining skills. Nurtanto et al. research stated that improving the performance aspects of general and academic governance is necessary as human resources are not optimum, and the work culture of teachers and employees is not yet under the quality management system (Nurtanto et al., 2020). Elements of question P4 related to the assessment and evaluation of the results of CTC graduates related to job absorption are carried out by educational institutions that carry out CTC programs. Li's study stated that evaluation is needed to obtain and ensure cross-border characteristics of extensions and interactions related to the quality of the programs implemented (Li, 2018). Elements of question P1 related to CTC program organizers measure the performance improvement of the results of implementing the CTC program based on progress criteria or standards. Asplund and Kilbrink's research stated the need to realize bringing back into the mainstream of professional theory and practice as a psychomotor aspect of learning that can enhance the status of professional studies as a whole (Asplund & Kilbrink, 2020). The composition of the “less” category values is obtained in the question elements P5, P3 and P6; for this reason, it is necessary to increase the value categories in future programs to become “enough”, “good” or “excellent” value categories. In the element of question P5 related to the school institution administering the CTC program has data proving the relevance of the work of CTC graduates and related to the integration of all value systems that have been owned. P3 related to the implementation of the CTC program can receive input for improvement from

graduate users regarding the performance of CTC graduates to complete deficiencies in implementing CTC in the future. Schwenger stated that it is necessary to include the development of applied knowledge skills as an academically useful and effective process that helps students to be more focused and stimulates thinking processes in classroom practice (Schwenger, 2017). P6 related to school institutions administering the CTC program to develop a tracing study of CTC graduates to obtain information on graduates' job absorption data. This agrees with Wahyuni's research which states that it is necessary to emphasize that in order to develop knowledge and competence, it is necessary to track performance based on competency requirements (Wahyuni et al., 2020).

Furthermore, pilots are needed to fulfill an adequacy of the performance monitoring dimension, such as schools administering CTC programs needing to conduct searches to obtain work relevance data for each graduation year. CTC program administrators need to receive input from graduates or industrial field users. It is necessary to initiate and build a traceability study of CTC graduates in order to obtain information on sustainable graduate job absorption data every year.

4. Conclusion

The evaluation approach to machining the CTC program using the AEPM model on each dimension has been carried out. The CTC concerns and targets various things in the VHS education program. There is a need for strengthening related to applied understanding whose implementation covers various aspects of program governance related to the quality of graduates who could understand applied knowledge and skills. The strengthening especially for “less and “very lacking” categories. In the context dimension, some improvement should be conducted, such as complementing the infrastructure needs of the participants and the implementing team from the industrial field and the implementing team for the CTC program from schools manage participants and partners from the industrial field. For the input dimension, it is necessary to plan standards and involve organizational assessment as a program initiative that is carried out on an ongoing basis as part of program fulfillment, and VHS detail the need for a training program for PLP and lecturers in the field of productive studies to support increased knowledge and skills for members of the CTC implementation team in stages and continuously. For the activity dimension, some improvement should be conducted, such as: solving the various steps and methods more efficiently, evaluating the implementation of CTC that has been carried out by interpreting the findings of the problem for future improvement, combining applied conceptual knowledge and practice to become a priority value system, technical competency partners for carrying out the CTC need partners related to positions, and partnerships with industrial field according to the expertise program need improvement and sustainability. For the performance monitoring dimension, it is necessary to include the development of applied knowledge skills as an academically useful and effective process that helps students be more focused and stimulates thinking processes in classroom practice to emphasize that to develop knowledge and competence.

Finally, the approach presented in this research using the AEPM model is a step forward in the analysis of the CTC program, where the questionnaire data related to the CTC program are related to the contributors in its implementation. In addition, because the CTC program in VHS is implemented throughout Indonesia, this approach can easily be replicated in other countries with similar aims as this research.

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References

Aguiar, E., Lakkaraju, H., Bhanpuri, N. H., Miller, D. P., Yuhas, B. P., & Addison, K. L. (2015). Who, when, and why. *ACM Int. Conf. Proceeding Ser, 16*(20), 93–102. https://doi.org/10.1145/2723576.2723619

Amin, M. S. (2018). Pendekatan Alternatif Sebagai Strategi Evaluasi Program Daur Ulang Sampah Dengan Metode Takakura. *Jurnal Kiprah*. https://doi.org/10.31629/kiprah.v6i1.582

Asplund, S., & Kilbrink, N. (2020). Lessons from the welding booth: theories in practice in vocational education. *Empirical Research in Vocational Education and Training, 12*(1). https://doi.org/10.1186/s40461-020-0087-x

Bharambe, Y., Mored, N., Mulchandani, M., Shankarmani, R., & Shinde, S. G. (2017). Assessing employability of students using data mining techniques. *2017 Int. Conf. Adv. Comput. Commun. Informatics, 2017*, 2110–2114. https://doi.org/10.1109/icacci.2017.8126157.

Billett, S. (2000). Defining the demand side of vocational education and training: industry, enterprises, individuals and regions. *Journal of Vocational Education & Training, 52*(1), 5–31. https://doi.org/10.1080/13636820000200104.

Boyce, A. S., & McGowan, B. L. (2018). An exploration of two novice evaluation educators’ experiences developing and implementing introduction to evaluation courses. *American Journal of Evaluation, 40*(1), 119–136. https://doi.org/10.1177/1098214018778812

Budiyanto, B., & Suyanto, W. (2020). The evaluation of competency certification program through the LSP P-1 at vocational high school. *Jurnal Pendidikan Vokasi, 10*(1). https://doi.org/10.21831/jpv.v10i1.30155

Conejero, J. M., Preciado, J. C., Prieto, A. E., Bas, M., & Bolós, V. J. (2021). Applying data driven decision making to rank vocational and educational training programs with TOPSIS. *Decision Support Systems, 142*, 113470. https://doi.org/10.1016/j.dss.2020.113470

Cook, J. A. (2006). Employment barriers for persons with psychiatric disabilities: Update of a report for the President's Commission. *Psychiatric Services, 57*(10), 1391–1405. https://doi.org/10.1176/ps.2006.57.10.1391

Edwards, R., & Holland, J. (2020). Reviewing challenges and the future for qualitative interviewing. *International Journal of Social Research Methodology, 23*(5), 581–592. https://doi.org/10.1080/13645579.2020.1766767

Finegold, D., & Soskice, D. (1988). The failure of training in britain: analysis and prescription. *Oxford Review of Economic Policy, 4*(3), 21–53. https://doi.org/10.1093/oxrep/4.3.21

Ibrahim, A. B. (2022). Trends and patterns of needs assessments in technical and vocational education: A thematic review. *International Journal of Evaluation and Research in Education, 11*(1), 88. https://doi.org/10.11591/ijere.v11i1.21940

Jackson, D. (2013). Factors influencing job attainment in recent Bachelor graduates: evidence from Australia. *Higher Education, 68*(1), 135–153. https://doi.org/10.1007/s10734-013-9696-7

Leckie, G. J., & Fullerton, A. M. (1999). Information Literacy in Science and Engineering Undergraduate Education: Faculty attitudes and pedagogical practices. *College & Research Libraries, 60*(1), 9–29. https://doi.org/10.5860/crl.60.1.9

Li, C. (2018). The Building of Teaching Quality Evaluation System of Higher Vocational Education under the New Situation. *No. Iceemr, 182*, 309–313. https://doi.org/10.2991/iceemr-18.2018.71

Li, P., Wu, J., & Qian, H. (2011). Groundwater quality assessment based on rough sets attribute reduction and TOPSIS method in a semi-arid area, China. *Environmental Monitoring and Assessment, 184*(8), 4841–4854. https://doi.org/10.1007/s10661-011-2306-1

Li, Z., Luo, Z., Wang, Y., Fan, G., & Zhang, J. (2022). Suitability evaluation system for the shallow geothermal energy implementation in region by Entropy Weight Method and TOPSIS method. *Renewable Energy, 184*, 564–576. https://doi.org/10.1016/j.renene.2021.11.112

Mahmudah, F. N., & Santosa, B. (2021). Vocational school alignment based-on industry needs. *Journal of Vocational Education Studies (JOVES), 4*(1), 36. https://doi.org/10.12928/joves.v4i1.3611

Mewburn, I., Grant, W. J., Suominen, H., & Kizimchuk, S. (2018). A machine learning analysis of the non-academic employment opportunities for Ph.D. graduates in Australia. *Higher Education Policy, 33*(4), 799–813. https://doi.org/10.1057/s41307-018-0098-4

Muharam, Y. A. (2022, February 17). Evaluation of the competency certification program of the national professional certification board in vocational high school. https://conference.loupiasconference.org/index.php/icogemt2/article/view/288

Ni, Z., & Wang, F. (2022). Quality Assessment of Vocational Education Teaching reform based on Deep learning. *Computational and Mathematical Methods in Medicine, 2022*, 1–11. https://doi.org/10.1155/2022/1499420

Nurtanto, M., Sofyan, H., Pardjono, P., & Suyitno, S. (2020). Development model for competency improvement and national vocational qualification support frames in Automotive technology. *International Journal of Evaluation and Research in Education, 9*(1), 168. https://doi.org/10.11591/ijere.v9i1.20447

Rahdiyanta, D., Nurhadiyanto, D., & Munadi, S. (2019). The effects of situational factors in the implementation of Work-Based Learning Model on vocational education in Indonesia. *International Journal of Instruction, 12*(3), 307–324. https://doi.org/10.29333/iji.2019.12319a

Rodríguez, R. S., Svensson, G., & Wood, G. (2020). Assessing corporate planning of future sustainability initiatives in private healthcare organizations. *Evaluation and Program Planning, 83*, 101869. https://doi.org/10.1016/j.evalprogplan.2020.101869

Rodríguez-Dorans, E., & Jacobs, P. (2020). Making narrative portraits: a methodological approach to analysing qualitative data. *International Journal of Social Research Methodology, 23*(6), 611–623. https://doi.org/10.1080/13645579.2020.1719609

Rusmulyani, K., Yudana, I. M., Natajaya, I. N., & Divayana, D. G. H. (2022). E-Evaluation based on CSE-UCLA Model Refers to Glickman Pattern for Evaluating the Leadership Training Program. *International Journal of Advanced Computer Science and Applications, 13*(5). https://doi.org/10.14569/ijacsa.2022.0130534

Sara, N., Halland, R., Igel, C., & Alstrup, S. (2015). High-School dropout prediction using machine Learning: a Danish large-scale study. The European Symposium on Artificial Neural Networks. https://dblp.uni-trier.de/db/conf/esann/esann2015.html#SaraHIA15

Schwenger, B. (2017). Research on training wheels – embedding academic literacy and numeracy in vocational pedagogy through action research. *Educational Action Research, 26*(2), 288–300. https://doi.org/10.1080/09650792.2017.1310053

Sen, B., Uçar, E., & Delen, D. (2012). Predicting and analyzing secondary education placement-test scores: A data mining approach. *Expert Systems With Applications, 39*(10), 9468–9476. https://doi.org/10.1016/j.eswa.2012.02.112

Shippee, N. D., Finch, M., & Wholey, D. R. (2018). Using statewide data on health care quality to assess the effect of a Patient-Centered Medical Home Initiative on quality of care. *Population Health Management, 21*(2), 148–154. https://doi.org/10.1089/pop.2017.0017

Stofkova, Z., & Sukalova, V. (2020). Sustainable development of human resources in globalization period. *Sustainability, 12*(18), 7681. https://doi.org/10.3390/su12187681.

Sumbodo, W., Yudiono, H., Salim, & Setiadi, R. (2019). The role of industry partners to improving student competency of vocational high school. *Journal of Physics, 1387*, 012031. https://doi.org/10.1088/1742-6596/1387/1/012031

Suyasa, P. W. A., & Kurniawan, P. S. (2018). Pemberdayaan Model CSE-UCLA Dalam Pelaksanaan Evaluasi Program Blended Learning di SMA Negeri 1 Ubud. Wacana Akademika. https://doi.org/10.30738/wa.v2i2.2627.

Wahyuni, D. S., Agustini, K., Sindu, I. G. P., & Sugihartini, N. (2020). Analysis on vocational high school teacher competency gaps: implication for VHS teacher training needs. *Journal of Physics, 1516*(1), 012051. https://doi.org/10.1088/1742-6596/1516/1/012051

Wholey, D. R., White, K., Adair, R., Christianson, J. B., Lee, S., & Elumba, D. (2013). Care guides. Health Care Management Review. https://doi.org/10.1097/hmr.0b013e31825f3df9

Wholey, D. R., Zhu, X., Knoke, D., Shah, P. P., Zellmer-Bruhn, M. E., & Witheridge, T. F. (2012). The teamwork in Assertive Community Treatment (TACT) scale: development and validation. *Psychiatric Services, 63*(11), 1108–1117. https://doi.org/10.1176/appi.ps.201100338