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Successful implementation of teaching factory in machining expertise in vocational high schools

Bernardus Sentot Wijanarka [1] *, Fendy Wijarwanto [2], Patterson Nji Mbakwa [3]
[1] Universitas Negeri Yogyakarta, Indonesia.
[2] SMK St. Mikael Surakarta, Indonesia.
[3] University of Bamenda, Cameroon.
* Corresponding Author. Email: bsentot@gmail.com

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ABSTRACT

This research aims to (1) evaluate the application of the teaching factory (Tefa) in the field of machining expertise in Vocational High Schools (VHSs) and (2) identify the obstacles to the implementation of Tefa. The research uses the CIPP (Content, Input, Process, and Product) evaluation method. This research was carried out in four vocational schools on the competence of machining expertise with the criteria of having implemented Tefa for more than five years and as a pioneer in implementing Tefa. The four schools are Vocational High School (VHS) Mikael Surakarta, State Vocational High School (SVHS) 1 Magelang, SMK Warga Surakarta, and SMK Karya Teknika Colomadu Karanganyar. The research respondents are principals, vice principals, heads of competency skills, and managers of Tefa. The data collection was through interviews, observation, and document scrutiny. The instruments used are an interview guide, observation sheet, and document analysis guide. The qualitative data analysis used qualitative data processing software. The results are as follows. (1) The application of Tefa in VHSs based on the evaluation is the context component 98%, the input component 89.25%, the process component 87%, and the product component 82.5 %. The percentage of evaluating the implementation of Tefa as a whole for the CIPP component is 89.2%, or very good; and (2) The obstacles faced in implementing Tefa in vocational high schools include rules for product sales, rules for working hours for public teachers, setting practicum schedules, working hours that were not flexible, rapid technological changes, understanding of block schedules, and lack of human resource competence. The results of this study imply that schools that implement Tefa are expected to be well-managed because it impacts the progress of VHS processes and products.

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INTRODUCTION

One of the ways that the government has taken to improve the competitiveness of the Indonesian workforce is to improve the quality of vocational high schools (VHSs) and vocational higher education. VHS is a formal education that educates students to be ready to work at the operator level in the industry. It meets the qualification level in the Indonesian National Qualifications Framework (KKNI article 2). VHS is included in the operator position group, namely group level 1

to level 3 (President of the Republic of Indonesia, 2012). Vocational education is one of the secondary education systems which prepares students especially can work better in one particular field of work (Bakar, 2018). The development of vocational education is expected to be a way to improve the quality of human resources who can compete in the job market in Indonesia and abroad. This quality improvement is accompanied by collaboration with industry so that prospective workers are trained according to industry needs and are ready to work in their fields.

According to Prosser's theory, effective vocational education should pay attention to the working environment and learning facilities that are as similar as possible to those in the industry (Rojewski, 2002). Students must be interested in the field of work, competence, or work taught at school to be motivated to follow the learning process. The government supports improving the quality of vocational high schools (VHS) in Indonesia with the VHS revitalization policy, as stated in Presidential Instruction No. 9 of 2016 (President of the Republic of Indonesia, 2016).

The success of vocational revitalization is expected to improve prospective workers' quality, reducing the problem of unemployment of productive age. One of the revitalization steps set by the Directorate of Vocational Development is the implementation of the teaching factory (Tefa). Tefa is one of the steps in revitalizing VHS with the hope of (1) increasing the competence of teachers and students, (2) encouraging the creation of a quality culture, (3) creating an industrial culture, (4) creating a vehicle for creativity and innovation for students and teachers, and (5) creating entrepreneurship development facilities, internships and training places for graduates who have not worked in the industry.

Tefa was introduced in VHSs in 2000 under the name of a production unit. Tefa learning is a learning concept in production/service-based vocational schools that refers to the standards and procedures applicable in the industry and is carried out in an atmosphere like what happens in the industry (Khurniawan, 2016). Stavropoulos et al. (2018) also states that the Tefa paradigm creates an authentic environment for engineering students to develop skills and competencies through their direct involvement in the challenges faced by the industry. Based on this, the learning strategy in vocational schools is directed at forming student work competencies, for example, the application of problem-based learning, product-based learning, project-based learning, and industrial internships. The collaboration between learning at school and the application of products in the company is also a model for teaching Tefa in vocational schools (Djuhartono et al., 2021).

Several kinds of Tefa have been developed and investigated for their success. Chryssolouris et al. (2016) designed the Tefa learning with five stages, namely: presenting the problems faced by the industry, identifying the specifications for making product designs based on input from the industry, then making the initial design as a pilot project, analyzing in detail the product design, and presenting the solution to the problem faced collaboratively with industry. Maarof et al. (2019) states that a learning factory represents a simulation of a real factory environment where students can gain hands-on learning experience by conducting various projects. In line with this, Winarno and Sari (2019) argues that Tefa can improve students' skills in production.

Several researchers have seen that Tefa brings several advantages. Scheid (2018) reported that (1) new teaching-learning arrangements have to be developed according to the required specifications of the curriculum, (2) the learning situations should also be adaptable to the different types of learning factories, and also provide guidance to schools without a dedicated learning factory, and (3) the learning environment is not too complex and therefore discouraged the learners but at the same time foster the required competencies. Putra et al. (2018) reported that school and industry cooperation on machining engineering vocational competence could be done by making products in schools.

Product is discussed between the school and industry depending on the facilities owned by the school. Perdana (2019) reported that Tefa was effective in increasing student motivation to take part in learning activities and had a positive impact on improving the quality of student evaluation results. Tefa, with existing production units, can produce products/services worthy of sale to increase school income, which can help school operational costs and be used as a medium for school promotion to the community. The implementation of Tefa also has drawbacks, namely: limitations in accepting large or mass orders, weaknesses in business capital, and weaknesses in terms of timeliness (Handayani et al., 2018).

The ideal conditions for implementing Tefa include the following aspects: (1) learning, (2) human resources, (3) facilities, (4) practical activities, (5) cooperation networks, (6) products and services, (7) transparency, and (8) legal (Kasman, 2017). The ideal Tefa condition can be seen from the teaching materials that aim to achieve specific competencies and are multipurpose or marketable. For schools whose competency programs do not produce products/services, it can be directed to simulations of real work situations in the workplace. In addition, the assessment system is based on Tefa, and the learning system uses a block and continuous schedule.

Learning activities, especially learning practices, apply industrial culture, reflected in quality standards, work time standards, and occupational safety and health standards. Some research results also show that applying Tefa can improve vocational students' work readiness (Dewi & Sudira, 2018; Khoiron, 2016; Zutiasari et al., 2021), so applying this Tefa learning model needs to be continuously developed. Yunanto (2017) writes that the implementation of Tefa in schools needs to be improved in management, workshops/laboratory, learning patterns, marketing promotion, products, human resources, and industrial relations.

Different research results were presented by Handayani et al. (2018), who reported that the implementation of Tefa in schools was going well when viewed from human resources, partnerships with the industrial world, infrastructure, and products. Cooperation between schools and industry must be closely woven, especially in developing information and communication technology to support establishing a Tefa network between schools and industry (Mavrikios et al., 2019).

Based on several research reports, the implementation of Tefa in each vocational school will have different results and characteristics. Not all schools have succeeded in implementing Tefa, and several obstacles are faced. Thus, a thorough evaluation of the implementation of Tefa in schools from context, input, process, and output is essential to get an idea for improving the implementation of Tefa in schools.

RESEARCH METHOD

The research method used is the CIPP evaluation research method. The evaluation was carried out on the implementation of Tefa in VHSs, which included the evaluation of context, input, process, and product (CIPP). The evaluated components and aspects can be seen in Table 1.

Table 1. Components and Aspects Evaluated

Component of evaluation	Aspects evaluated
Context	Background, understanding, purpose
Input	Curriculum and teaching, management, infrastructure, human resources
Process	Implementation of learning and production, monitoring of implementation and products, collaboration with industry
Product	Achievement of goals, product quality, graduate employment, competency certificate for students

This research was carried out in four vocational high schools (VHS) and state vocational high schools (SVHS) on the competence of machining expertise with the criteria of having implemented Tefa for more than five years and as a pioneer in implementing Tefa. The schools are: SMK Mikael Surakarta, SMKN 1 Magelang, SMK Warga Surakarta, and SMK Karya Teknika Colomadu Karanganyar. These schools were chosen because they pioneered Tefa in VHS (see Table 2). The Tefa products produced by the VHSs are 3d printer machines, CNC milling machine simulators, manual lathes (assembling), CNC milling machines (assembling), machine tool components, waste processing machines, and products ordered from national companies. Research respondents from each vocational school are the principal and the Tefa manager in each school. Complete respondents for each school can be seen in Table 2.

The data collection was through interviews, observation, and document analysis. The research instruments used were: interview guides, observation sheets, and document checklists. Interview guides were used to obtain data on Tefa management from school principals, vice principals, heads of competency skills, heads of production units, Tefa coordinators, and teachers.

Observation sheets were used to obtain data on the process of applying Tefa. Document analysis is used to obtain data regarding the implementation of Tefa. The instrument's validity was measured with content validity and expert judgment involving three experts. The data analysis technique used is qualitative data analysis, including data reduction, data presentation, and conclusion drawing. Data processing also uses qualitative data processing software QSR Nvivo 11 and spreadsheet software for data visualization.

Table 2. Data on VHSs Research Subjects, Implementation of Tefa, and Respondents

No.	VHS Name	Implementation of Tefa	Respondent
1	SMK Mikael Surakarta	Pioneer school implementing the Tefa learning model	Principal, head of the skill competency, head of the production unit, vice principal of public relations, productive subject teacher.
2	SMKN 1 Magelang	Implemented Tefa since 2014 with assistance from GiZ SED TVET or SMK Pilot Project Tefa	Principal, deputy principal for curriculum, head of skills competence, manager of the school job market, teacher of productive subjects, and tefa coordinator.
3	SMK Warga Surakarta	Vocational schools assisted by the Tefa Pilot Project Vocational School	Principal, deputy principal for curriculum, head of competency of expertise, vice principal for public relations, head of production unit, and teacher of productive subjects.
4	SMK Karya Teknika Colomadu Karanganyar	Independently implement Tefa (a pioneer in implementing Tefa in private schools)	Principal, head of expertise competence, coordinator of production units, and teacher of productive subjects.

FINDINGS AND DISCUSSION

Findings

Context Evaluation

Context evaluation includes background, understanding, and objectives of Tefa implementation. The implementation background of each school is different. There are two main background factors, namely, internal school factors and external school factors. Internal factors are more towards the needs of schools for improving the quality of vocational education and as a way to save expenses and increase school income. Based on data analysis conducted at SMK Mikael, SMK Warga Surakarta, and SMK Karya Teknika Karanganyar, there are four backgrounds for implementing Tefa: meeting demands from the government, improving graduate achievement, becoming a superior school, and having limited income. SMKN 1 Magelang has three implementation backgrounds: meeting government demands, improving graduate achievement, and becoming a superior school.

Based on the evaluation of Tefa's understanding, it can be concluded that every school already has the correct and the same understanding. Tefa is understood not only as a production unit or only producing products but also as a learning process that produces products. The product is used as a learning tool following the existing essential competencies. Based on this research, the purpose of implementing Tefa is closely related to the implementation background. Based on data analysis conducted by SMK Mikael Surakarta, SMK Warga Surakarta, and SMK Karya Teknika Karanganyar, there are four objectives of implementing Tefa: increasing student competence, maintaining teacher competence, impacting school finances, and increasing collaboration with industry. Meanwhile, SMKN 1 Magelang has three goals: increasing student competence, maintaining teacher competence, and increasing collaboration with the industry.

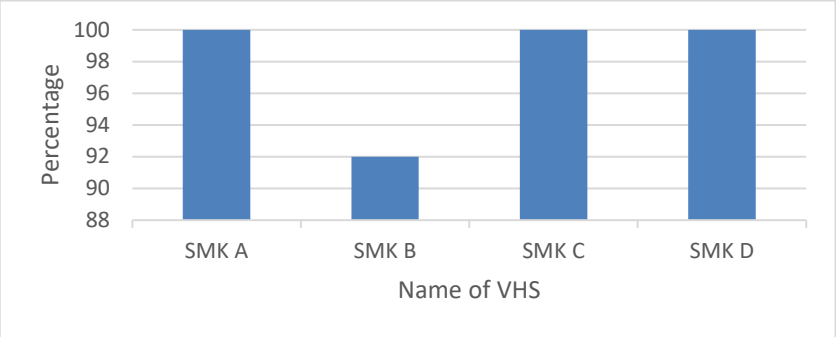

Figure 1. Bar Chart of Achievement Context Aspects of SMK Mikael Surakarta (A), SMK Magelang (B), SMK Warga Surakarta (C), and SMK Karya Teknika Karanganyar (D)

Quantitative analysis of the above data is processed and made in the form of a percentage found the results of the achievement of the context aspect. This achievement was obtained 100% by SMK Mikael Surakarta, 92% by SMK N 1 Magelang, 100% by SMK Warga Surakarta, and 100% by SMK Karya Teknika Karanganyar (Figure 1). From the four schools, SMKN 1 Magelang, in context analysis, especially for the background and purpose of implementing Tefa, was different from the other three VHSs, namely in the background of limited funds, so to implement Tefa, it also did not target income. SMKN 1 Magelang is a public school whose operational costs have been met by the Government Regulation No. 48 of 2008 concerning education funding. Based on the results of this analysis, all VHSs from the context aspect have achieved 98% and can be categorized as very good.

Input Evaluation

Input evaluation includes the evaluation of three aspects, namely: curriculum and learning, infrastructure, and human resources. The percentage comparison for each component in each school is shown in Figure 2. Based on this data, it can be illustrated that the achievement of the fulfillment of facilities and infrastructure has the lowest score among the other two aspects. Indicators of curriculum and learning aspects are (1) schedule planning, (2) job sheet planning (job sheet work drawings, job sheet value formats, job sheet process sequences, product-based job sheets used internally by schools, product-based job sheets which are orders from industry, job orders project work), (3) determination of competency standards, (4) the team involved, and (5) planning the implementation of the curriculum.

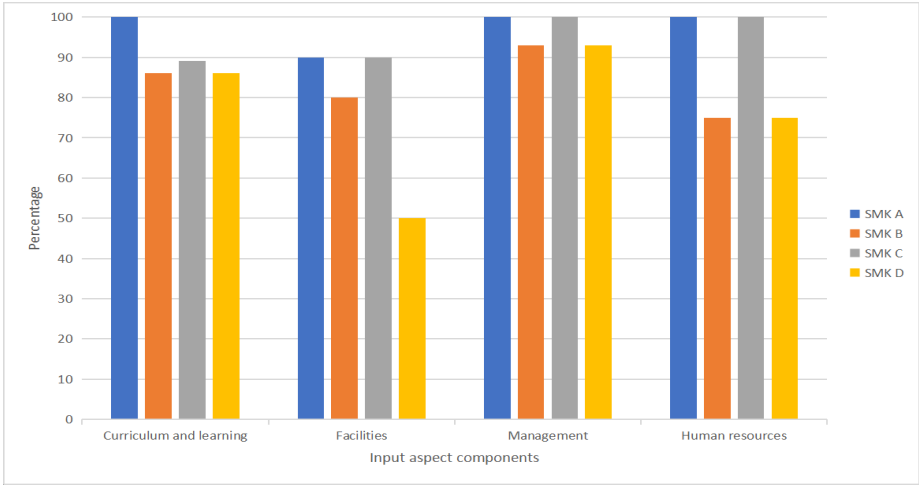

Figure 2. Bar Chart of the Percentage of Achievement Evaluation of Input Aspects from SMK Mikael Surakarta (A), SMK Magelang (B), SMK Warga Surakarta (C), and SMK Karya Teknika Karanganyar (D)

The evaluation achievements of the input aspects are a combination of evaluation of the components of curriculum planning and teaching, management of Tefa, infrastructure, and human resources. The percentage of each VHS is SMK Mikael Surakarta 98%, SMKN 1 Magelang 86%, SMK Warga Surakarta 92%, and SMK Karya Engineering Karanganyar 81%. Based on these results, the achievement of input evaluation is outstanding, with the average score of all schools at 89.25%. The components of facilities and human resources could be improved. In terms of the aspects of infrastructure facilities, in all schools, there are shortcomings because the facilities owned are practical facilities that already exist. Most of them are old tools and machines that need to add new facilities.

Process Evaluation

Process evaluation includes evaluating the implementation of the learning process, monitoring, and industrial cooperation. The data and comparison of the achievement of each VHS can be seen in Figure 3.

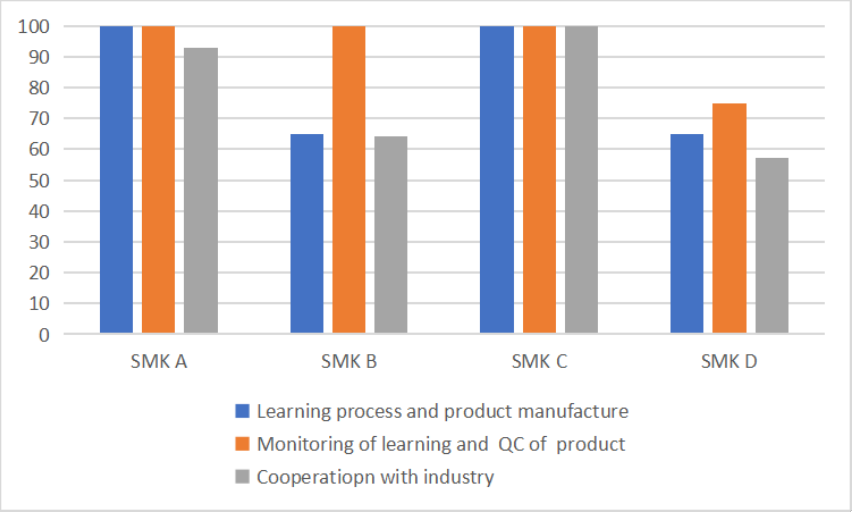

Figure 3. Bar Chart of the Percentage of Achievement Evaluation of Process Aspects of SMK Mikael Surakarta (A), SMKN Magelang (B), SMK Warga Surakarta (C), and SMK Karya Teknika Karanganyar (D)

Figure 3 shows that the achievement of each component for each school is different from each other. The learning implementation component still needs to be fully achieved, while industrial cooperation has the lowest score. The achievements of each of these sub-components were then calculated for the process aspects of each school. Figure 3 shows that the percentage of achievement of the process aspect in applying Tefa above is 75%. The lowest achievement is at SMKN 1 Magelang, 77%.

The evaluation results for the process aspects of each school are as follows: at SMK Mikael Surakarta, 98% of aspects that need to be improved are the components of cooperation with industry, especially in the sub-component of cooperation between schools and industry. The score of SMKN 1 Magelang is 77%. The aspects that need to be improved are components of implementing learning and product manufacturing, especially in sub-components of block schedules, implementation of job sheets, implementation of industrial culture, and components of cooperation with industry in the sub-component of the type of cooperation with industry.

At SMK Warga Surakarta, 94% of the aspects that need to be improved are the components of the implementation of learning, especially in the sub-components of implementation of block schedules, implementation of job sheets, and implementation of industrial culture. The percentage of SMK Karya Teknika Karanganyar is 79%. The aspects that need improvement are learning aspects, including job sheet implementation, industrial culture, and cooperation with industry. Based on the data, the implementation of product manufacturing and product quality control at all VHSs is good.

In other words, mechanical engineering vocational schools can make or produce products or goods. The average process component achievement is 87% which can be grouped into a very good category.

Product Evaluation

Product evaluation is carried out for goal achievement, product quality, graduate employment, and student graduation indicators in the competency test. Based on the evaluation data of the components in the product aspect, it can be concluded that the achievement of the product aspect is as shown in Figure 4.

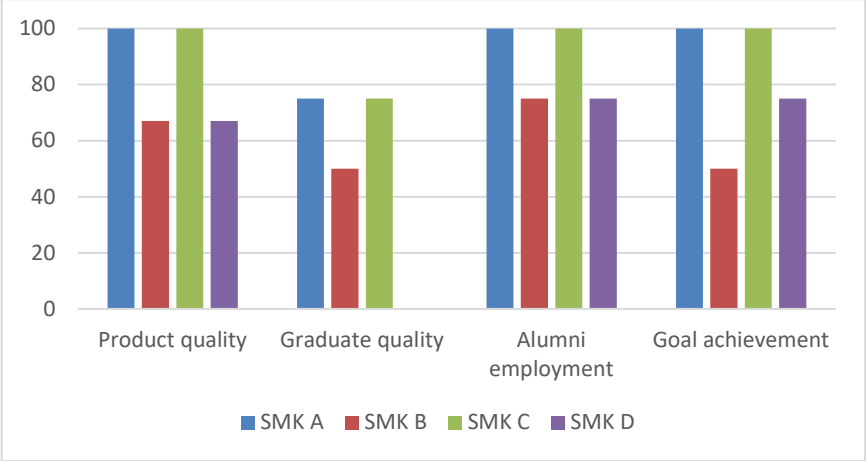

Figure 4. Bar Graph of Product Aspect Evaluation Achievements of SMK Mikael Surakarta (A), SMKN Magelang (B), SMK Warga Surakarta (C), and SMK Karya Teknika Karanganyar (D)

Based on these data, the product aspects that have yet to be maximized are in SMKN 1 Magelang and SMK Karya Teknika Karanganyar. These two VHSs must improve the quality of students and product quality. The product quality, in this case, the type of product made, should be increased to a machine product or component with high precision. The evaluation results on the production aspects of the two VHSs were excellent, reaching 100%, and the other two were not good because they only reached 65%.

Machines and tools produced by SMK Mikael Surakarta and SMK Warga Surakarta have standardized quality so that external parties have used them. Meanwhile, SMKN Magelang and SMK Karya Teknika produce more for internal purposes and orders where the sustainability of the production process still needs to be guaranteed. Based on the percentage score of the product aspect, an average score of 82% or an excellent level is obtained.

Discussion

The application of Tefa, which is a must for vocational schools, can improve the quality from the CIPP aspect. Improvement is from students and teachers as measured by increased competency and the products produced, and it can improve the learning climate and guarantee the quality of learning (Purnami et al., 2021). The application of Tefa can also increase student competency because they can be directly involved in the production process (Nurtanto et al., 2017; Stavropoulos et al., 2018).

Implementing teaching factories in vocational schools raises several challenges because the conditions and obstacles usually differ from those at the academic level (Scheid, 2018). Based on interviews with principals, vice principals, and heads of competency skills, the obstacles faced by each vocational school are different. At SMK Mikael Surakarta, from the implementation side, Tefa is running well with a few obstacles, namely schedule variations, especially the theoretical schedule that was adjusted to the block practice schedule. The implementation of block learning will cause the

implementation of theoretical learning, which is usually scheduled per week, to be disrupted by many block practice implementations.

At SMKN 1 Magelang, from the implementation side, Tefa is running with several obstacles, namely: (1) Inadequate or incompetent human resource competencies or lack of industrial experience; (2) Facilities that do not keep up with technological developments; and (3) Government regulations regarding income from product sales and teacher working hours that make public schools unable to be flexible in managing them. Income generation can be obtained through Tefa (Mentari et al., 2021), but regulations regarding state school finance still need to be flexible in managing non-tax state income outside education costs. The fulfillment of Tefa's demands with the teacher's mandatory workload caused the increase in competence to support Tefa not to go smoothly because most of the teacher's time is spent on teaching. Obstacles to the existence of a model of cooperation with industry and the existence of government regulations are also experienced by Tefa managers in other schools (Pradipta et al., 2021; Yoto & Marsono, 2020).

At SMK Warga Surakarta, from the point of view of the implementation of Tefa, Tefa is going well; the obstacle faced was the arrangement of work orders, especially during school holidays. SMK Karya Teknika Karanganyar's implementation of Tefa generally went well, at a simple level and just starting. Some of the obstacles faced are: (1) facilities where almost 75% of the equipment used is old machines, (2) competent human resources meet only the standards for teachers who do not meet, and (3) limited funding for a phased development plan with revenue and efficiency of Tefa. The results of this study follow what is stated by Sudiyono (2020) that the application of Tefa faces obstacles in management, the learning process, namely scheduling, and a need for more facilities.

Based on the discussion of the evaluation results that have been described, the results of the evaluation of the application of Tefa in vocational schools from the context, input, process, and product aspects can be seen in Figure 5. The summary results of the achievements of these aspects for the four vocational high schools are: (1) component context of all SMK has been achieved 98% and can be categorized as very good, (2) the input component is very good with an average percentage of 89.25%, (3) the achievement of the process component is 87% which can be grouped in a very good category, and (4) the achievement of product components 82.5% can be classified as very good. Based on these four data, the overall evaluation result of the implementation of Tefa is 89.2%, which is in the excellent category.

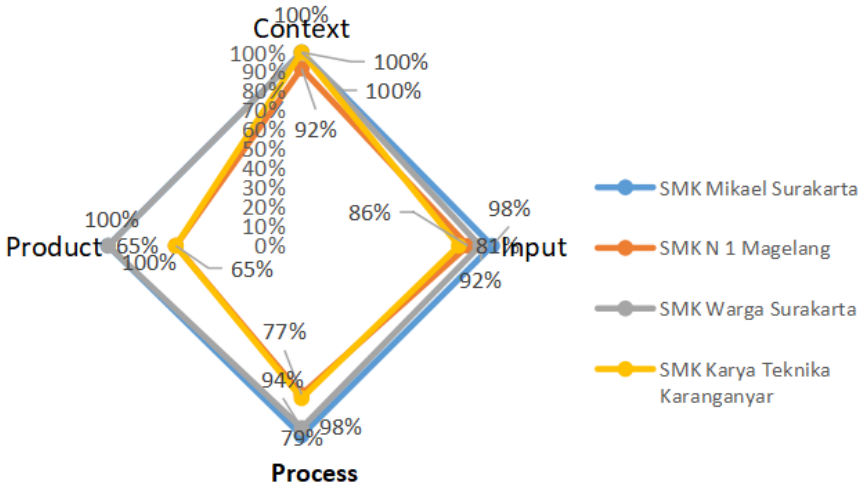

Figure 5. The Results of the CIPP Evaluation of the Application of Tefa at the Mechanical Engineering Vocational School

The obstacles to implementing Tefa found in the four VHSs include (1) Government regulations and rules, especially for public schools related to product sales; (2) Government regulations and rules relating to working hours of public school teachers, related to setting practice schedules and inflexible working hours; (3) Rapid technological changes, especially to meet product

demands from customers; (4) Different understanding of block schedules among educators, especially among adaptive, normative, and productive teaching teachers; and (5) Lack of competent human resources in terms of industry experience and teacher competency standards.

CONCLUSION

Based on the results of research on the evaluation of the implementation of the Tefa program in VHSs, conclusions can be drawn. The application of Tefa in mechanical engineering vocational schools for context components is 98%. The input components are 89.25%, process components are 87%, and product components are 82.5%. The result of the evaluation of the Tefa application, on average, for all CIPP components is 89.2% or in the excellent category. Obstacles faced in implementing Tefa in vocational schools include government regulations, especially for public schools relating to product sales, government regulations relating to working hours for public teachers, setting practice schedules and inflexible working hours, rapid technological changes, a different understanding of the block schedule among educators, and the lack of human resource competence in terms of industry experience and teacher competency standards. The results of this study imply that schools will maintain the existence of Tefa in order to support efforts to improve student competence, improve teacher competence, increase income generating, and improve the quality of graduates. In addition, vocational schools' working climate can approach the industry's working climate.

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