



# Implementation of Six Sigma to Develop Teaching Factory Product Quality at SMK Islam 1 Blitar

Dani Irawan\*, Suhermanto Suhermanto, Erwin Komara Mindarta

*Automotive Engineering Education, Universitas Negeri Malang, Malang, Indonesia*

*\*Corresponding author. Email: [dani.irawan.ft@um.ac.id](mailto:dani.irawan.ft@um.ac.id)*

## ABSTRACT

The implementation of Six Sigma (define, measure, analyze, improve, and control) is rife both in research and implementation of product development and services in a company. Meanwhile, recently the development model has entered into the realm of vocational education, namely in the implementation of teaching factories (Tefa). One of them is the development of products and services in the light vehicle engineering expertise program by opening light vehicle service services like a workshop business. Even so, its use in developing teaching factory products in schools haven't looked into it yet. In addition, how to integrate it in the formulation of the plan do check and action (PDCA). the purpose of this study was to determine: (1) Career development planning at Tefa. (2) Implementation of career development at Tefa. (3) Evaluation of career development through Tefa. The method used is qualitative research. the research results are (1) at the planning stage of career development through recruitment and exploration. (2) at the implementation stage it is divided in the form of alternating work schedules (3). In the evaluation phase, students through Tefa at SMK Islam 1 Blitar after graduation will be recruited by companies that have collaborated with schools.

**Keywords:** *Teaching Factory, Six Sigma, TQM, PDCA, Islamic Vocational High School 1 Blitar.*

## 1. INTRODUCTION

Improvement and alignment of the SMK curriculum will strengthen the link and match model with DUDI. The curriculum is designed with an orientation towards combining instruction and construction so that the main approach in forming learning stages refers to the learning phase at school or practice in the industry and is oriented towards the desired learning process results. Currently the government is aligning the SMK curriculum which includes the development of a 4-year SMK which has a different competency name and graduate competency standard (SKL) from the 3-year SMK.[1], [2] that "SMK competency maps are often criticized because they are not flexible to change, have a single skill that wears out quickly, and are not able to develop themselves". This is motivated by the fact that the implementation of the curriculum has not met expectations, teachers are not yet optimal in transmitting vocational competencies that must be mastered by

students in accordance with their competency skills, and management of learning which is generally not based on the education and training system in competency-based SMKs.[3], [4].

Learning with a teaching factory has the goal of developing and cultivating the work ethic needed in the world of work, namely discipline, responsibility, honesty, cooperation, leadership). Also, teaching factory learning will improve the quality of learning outcomes from just competence results to learning that provides the ability to produce goods/services,[5], [6]. Not only does it improve the quality of students, but with teaching factory learning it can establish good cooperative and communication relationships with DU/DI in their learning patterns. Teaching factory learning has a positive impact so that the collaboration that is forged can run systematically and planned[7]. Another advantage of applying teaching factory learning is that there are checks and balances in the educational

process at SMKs to stabilize and maintain link and match with the needs of the labor market.

SMK Islam 1 Blitar is a school located in the city of Blitar which applies teaching factory learning. The learning model is to adopt the production and service processes found in the Daihatsu company. Of course, in improving the quality of students, meeting accreditation standards alone is not enough. Schools must continuously develop themselves to achieve the desired quality goals. One of the strategies used is the Total Quality Management (TQM) approach. TQM involves and empowers people within the organization to improve quality on an ongoing basis. Alexandre et al., (2017; & Hollingshed, (2021) explained that TQM can be carried out in the field of education by improving the teaching system. TQM cannot be achieved without a commitment to achieve the agreed goals with maximum performance[10], [11]

One of the methods to improve the quality or quality of institutions is through Six Sigma. This method is used to improve quality which focuses on customer satisfaction following a formal model, namely Define, Measure, Analyze, Improve, Control (DMAIC) and is associated with the world of education. According to[12], improving the quality of education, namely through improving the teaching system. Improvements in each school program are carried out by involving all school members, including stakeholders, parents, and the community. Based on this explanation, the purpose of writing this article is to (1) analyze Tefa's career development planning through a Six Sigma strategy. (2) Analyze the implementation of career development in Tefa through the Six Sigma strategy, and (3) analyze the evaluation of Tefa's career development through the Six Sigma strategy[13].

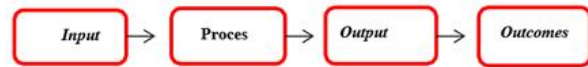
## 2. LITERATURE REVIEW

### 2.1. The Concept of Quality in Education

TQM is a philosophy of continuous improvement, which can provide any educational institution with a practical set of tools in meeting the needs, wants, and expectations of its customers over any period of time. "TQM a philosophy and set of guiding principles that represent the foundation of a continuously improving organization". TQM is considered to be a foundation that gives a large enough influence on the organization (school) to deal with changes that continue to increase according to the needs of society[9]. All existing resources in schools are integrated with management implementation, such as planning, preparation for effective and efficient technical implementation. So that the resulting product is useful for society[10].

TQM is one way to improve the quality of an organization (school) as a commodity that can be

measured to improve and assess the results of program implementation and all activities carried out by schools. TQM improves the quality of education by considering (1) Input aspects, namely students, staff, teachers, finance; (2) Process, namely learning and training; (3) Output, namely satisfaction, intelligence, change; and (4) Outcomes, namely getting a job, becoming a positive human being among the community.



**Figure 1** TQM Procedure

The quality concept outlines that there are several important things related to quality, namely (1) Conformity of the product with the standard specifications set by the company; (2) Fulfill customer satisfaction; (3) Continuous improvement and involvement of all members; and (4) Changes in culture and commitment to continuously improve quality. First, conformity of the product with the standard specifications set by the company. Conformity of the results of products and services with predetermined standards, then these products and services can be said to be of high quality. When connected with the world of education, student outcomes produced by schools are suggested to produce students who can compete in the world of work and open up employment opportunities.[9]

Meet customer satisfaction. Quality or quality to meet customer satisfaction or in other words customer oriented. From this statement, in the concept of quality, the customer is the main one. Fulfillment of customer needs and desires is the focus of quality improvement. Products or services produced by the organization must be in accordance with the needs. In relation to the world of education, schools, especially vocational schools, in this discussion, must be able to meet internal and external customer satisfaction. Internal customers are the students themselves, teachers and school staff. External customers are communities, companies, stake holders, and other parties who work with schools.

Continuous improvement and involvement of all members. Continuous or continuous improvement is one of the principles that can be applied in implementing quality. In the concept of quality, continuous improvement has a positive impact on the organization. For this reason, the involvement of all members is needed to support the improvement of organizational quality. The integrated involvement of internal and external members can improve and improve the quality of the organization

Cultural change and commitment to continuously improve quality. Improving quality in organizations can result in cultural changes and commitment of members

to improve organizational quality. In relation to the world of education, cultural changes and the commitment of school members need to be coordinated and initiated by the school principal. As a leader, the principal tries to improve the quality of the school which can be done through policies, work programs and habits.

## 2.2. Six Sigma

*Six sigmas* as a method that can be used to improve quality. Six sigma is a concrete step that can be used as a tool to facilitate analyzing data statistically or otherwise[8]. Six sigma can also be interpreted as a tool for improvement designed in a series of activities or programs to achieve the desired standard. It is based on the principles and theories of Deming, Juran, Shewart, and Ishikawa[14]. Six sigma is used as a repair tool in the Motorola company. This was done to the Motorola company which manufactures many products with electronic components with thousands of opportunities to fail due to the large number of components involved. Motorola succeeded in achieving the target of minimizing product defects so that the chances of failure were low. Motorola's Six Sigma Quality Program was implemented in 1987 which was pioneered by [11]. Then six sigma was further developed to improve product reliability and quality.

The six sigma implementation process begins with identifying the need for quality improvement goals and targets. When the process of running six sigma begins, financial analysis must also be planned, by measuring the effectiveness of the amount of costs incurred with achievement targets. Six sigma is used to help companies minimize failure, reduce operational costs and increase customer needs and satisfaction. Six sigma can be successful depending on the strength of the leader[14]. Structured implementation and leader support will be very important for the success of six sigma. There are several six sigma principles, namely as follows: (1) Alignment of processes and customer needs with the company's strategic objectives; (2) Identify the main objectives of the program, the resources needed, the problem solving plan; (3) Creating measurement standards; and (4) Conducting training, empowering members of the organization, and setting goals for development[12]

In addition, there are six sigma process steps described [15] which was developed by Dahlgaard (2006) namely define, measure, analyze, improve, and control (DMAIC) as a development of Deming's PDCA cycle. The description is as follows: Define, as the phase of determining the problem, determining the needs and desires of customers (voice of customers), and empowering members of the organization. At this stage, it does not require much statistical data, tools or diagrams. Tools that can be used are cause effect charts

or pareto diagrams. These two tools are used to identify and determine priority issues.

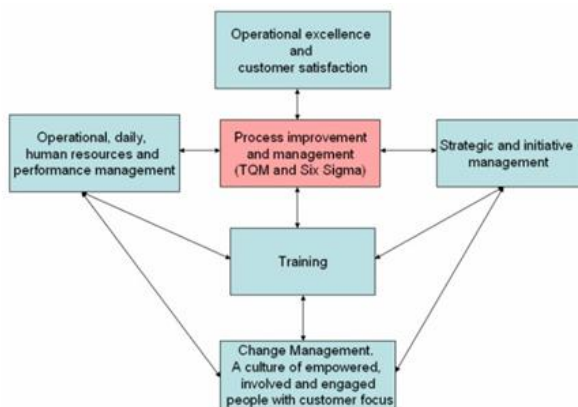
*Mease*, the measurement phase by determining product variation standards and the resulting product failure measurement variations. Standard setting used for each existing variation. Analyze, is a phase to determine the causes of existing problems using several quality tools including Pareto diagrams and cause and effect charts. Which is then grouped and produces a basis for the emergence of a problem. Improve, the development phase to improve targets or goals by trying to minimize or eliminate the causes of product failure. This development phase involves trial testing, so that the cause of the changes or failures experienced is known. Control, this monitoring phase is carried out to monitor performance and ensure that no failures occur.



**Figure 2** DMAIC Concept

Six sigma stated above is the steps and implementation of six sigma in a company or factory. If it is related to the world of education, it is different in its implementation. Six sigma was initially considered unsuitable for application in the world of education. In educational institutions there are no standards specified in the six sigma method such as production equipment, input, output, and inventory. Vice versa, education is related to humans which are difficult to predict and are not the same as production. Education is more on learning, performance and student satisfaction[16]. Many benefits can be drawn from implementing six sigma in education. Education itself has an iterative process which is also contained in the principle of six sigma. As with six sigma, education focuses on the needs and satisfaction of students. The adjustment of six sigma with education applies to the outcomes of students when they are in today's global competition which is required to produce students who are superior and have high performance. Therefore, six sigma can be used in educational institutions to improve the quality of students.

Not all substances in educational organizations or educational institutions can be applied to the six sigma method. There are several suitable substances, namely (1) Administration, the principle of six sigma which can reduce or minimize errors is very suitable to be used so that the administration process at the school runs smoothly. The principle of six sigma that can minimize these errors can be done through the procedure for receiving files, using information technology in every administrative activity, ease of certification, handling expenditures and receipts of funds; (2) Registration, in order to increase customer (student) enthusiasm and satisfaction in the registration stage at six sigma schools is suitable for preparing all matters related to convenience, fluency, and ease of registration; and (3) Academic, in this section six sigma can play an active role to improve students' abilities. Starting from creating a problem, determining the process, solving the problem, and making the benchmarks or standards needed for assessment. Based on the explanation above, six sigma is seen as a method that can improve quality. The explanation above shows that TQM and six sigma both focus on customer satisfaction (voice of customer).



**Figure 3** Integration of six sigma into TQM

*Six sigma* considered as a development of TQM by [8] by minimizing costs, focusing on using tools to achieve targets, integrating all organizational goals, and creating a commitment to change in performance and results. The six sigma method can be used in the education sector so as to enable educational institutions (schools) to apply the method as an effort to improve the quality of their students.

### 3. METHOD

The method used in this research is descriptive qualitative. analysis of teaching factory learning programs and trying to integrate Six Sigma into the school system alongside teaching factory learning programs. Writing this article is based on the results of interviews and observations carried out by researchers

which are then analyzed using existing literature reviews.

## 4. RESULTS AND DISCUSSION

### 4.1. Analysis of Student Career Planning Through Teaching Factory (Tefa) at SMK Islam 1 Blitar

The planning that has been planned from the start, starting from a survey of the location that will be used for the Teaching Factory (TEFA) production process, is the place feasible and meets the required requirements, besides that the electricity used at Islamic Vocational School 1 Blitar already has the right voltage. enough and others. The school also provides facilities in the form of safety equipment, health protocols such as masks and gloves. The survey was carried out by PT Daihatsu Motor who will work with TEFA SMK Islam 1 Blitar. After the observation of the place, the TEFA organized a TEFA learning program. that is, there are SOPs that have been set by the factory or PT Daihatsu Motor in collaboration with TEFA at SMK Islam 1 Blitar. After a survey conducted by PT Daihatsu Motor, then parties from SMK Islam 1 Blitar followed up by conducting student exploration activities aimed at recruiting students to carry out the TEFA program. Recruitment or screening of students at Islamic Vocational School 1 Blitar to enter tefa, that is, the school does recruit or work with students, especially those from the light vehicle engineering department.

According to [8], [17], [18] Career exploration is a time when individuals seek to have a deeper understanding, especially about job information, career alternatives, career choices, and careers to start working. The career planning of students through TEFA at SMK Islam 1 Blitar begins with student exploration which aims to introduce the TEFA program to students. Student career exploration is a basic introduction to students regarding the TEFA learning program at SMK Islam 1 Blitar. Where this introduction will be useful for students because students will know in advance what TEFA is and how the work system is carried out at TEFA.

In preparing the Teaching Factory (TEFA) program at SMK Islam 1 Blitar there is also the preparation of HR (Human Resources) or teachers at SMK Islam 1 Blitar, according to the opinion [8], [17]–[20] Human resources are services or work effort that can be provided in the production process. In this case, HR describes the quality of effort made by a person in a certain time to produce goods and services. The preparation of teachers or HR is also an important main step for the process of planning a learning program in which the teacher acts as an educator or guide. In preparing these human resources, teachers receive training before handling TEFA at SMK Islam 1 Blitar.

The training or training provided to teachers was carried out in the city of Karawang, to be precise at PT Daihatsu Motor for two months, after which they returned to TEFA SMK Islam 1 Blitar.

Stages in career exploration according to the career exploration center at Cornell University quoted by [2], [15], [21] is that socialization, socialization is the process of knowing, understanding, evaluating, about yourself as the basis for making career decisions. Exploration for students at Islamic Vocational School 1 Blitar begins with socialization, where the socialization is aimed at or specifically for children from the Mechanical Engineering (TP) major, in this socialization the students are told or introduced about what TEFA is, how does the system work in TEFA, what are the future prospects through TEFA, and so on. With this in mind, students will understand more about TEFA, so that when they are in TEFA, students will be able to understand the working system of the TEFA and use the machine properly and correctly according to predetermined procedures.

From the results of previous research, the first is Teaching Factory management in cosmetology workshops in an effort to develop the quality of learning which includes planning (planing), organizing, implementing, supervising and evaluating the Teaching Factory work program in cosmetology workshops. Both supporting and inhibiting factors. The supporting factors encountered were teachers who were competent according to the areas of competence that adhered to the Teacher and Lecturer Law. Meanwhile, the inhibiting factor is that time is considered less than optimal so that it cannot complete the work that occurs [22]–[24].

In the recruitment of students carried out by the school, the school cooperates with the competence of expertise from light vehicle engineering, the school prioritizes students from these majors to enter TEFA. In addition to recruiting students from majors other than mechanical engineering, the school offers students from other majors to enter TEFA. So from TEFA itself it does not limit students from other majors to be able to join TEFA, there are even students from outside who do internships or PKL (Field Work Practice) at tefa SMK Islam 1 Blitar.

#### ***4.2. Analysis of Student Career Implementation Through Teaching Factory (Tefa) at Islamic Vocational High School 1 Blitar.***

Based on the results of research at Islamic Vocational High School 1 Blitar, the process of implementing learning at TEFA is that students, before carrying out the production process, students are given briefing and directives in advance, namely dojo safety training which includes gymnastics, briving, K3 (safety, health and safety) or the use of clothes apd, production

systems, quality control and measuring instruments. So before carrying out production at TEFA, students must use safety equipment and health protocols such as APBD clothes, masks and gloves. In TEFA there is such a thing as fusion or the leader is indeed the one chosen who is suitable, so there are levels of students where there is skill ability or skill mapping there, maybe this is suitable to be the leader, he is suitable to be quality control, he is suitable to be the operator indeed there is a special designation seen from the abilities of the students. So they will learn to be leaders in a team.

According to [3], [4], [16] Standard Operating Procedures are guidelines or references for carrying out tasks in accordance with the functions and performance appraisal tools of government agencies. The way of working is based on technical, administrative and procedural indicators in accordance with work procedures, work procedures and work systems in the work unit concerned. the tefa at SMK Islam 1 Blitar, SOP is something that needs to be done, where the introduction of this SOP will be very useful for students, where students before practicing directly students can know the procedures and techniques in tefa, how to use machines correct, production results according to needs, what is the work system at Tefa, and others. So with the existence of SOP students will be able to understand more before students jump in or practice directly

In the process of implementing TEFA at SMK Islam 1 Blitar it is divided into three shifts in one day, namely the first shift starts at 08.00–16.00 WIB, the second shift starts from 16.00–24.00 WIB, and the third shift starts from 24.00–08.00 WIB. So students will enter TEFA alternately because the machine operates 24 hours a day. The TEFA learning process at Islamic Vocational School 1 Blitar, namely students who are in TEFA, work or carry out the production process according to the supervisor's directions and in accordance with predetermined SOPs. The activities carried out in TEFA are that students practice directly operating a machine called a hot press machine, then students mix the formula and pour it into the machine then wait about 8 minutes for the production of the brake pad lining. The production produced by TEFA is in the form of production of brake linings, where the brake linings are not yet 100% finished as brake linings. In making the brake pad lining, it depends on PT Daihatsu Motor. Brake lining covers standard Honda, 5mx and Suzuki, for total production from TEFA SMK Islam 1 Blitar, it also follows a request from the company, for example, in one month it is required to produce 4,000 pieces of brake lining.

From the results of research conducted by [2], [21], [22]. The results of this study indicate that the implementation of Teaching Factory in preparing graduate students to discuss the world of work is carried out in various stages including: the preparation stage,



the production stage, the marketing stage and the evaluation stage. TEFA's own contribution to students is that TEFA has a sizable contribution to student career development, where students while studying at TEFA will gain work experience that is applied as in an industrial or factory environment, such as a work system that is carried out the same as in a factory, shift change schedule and others. the implementation of student careers from the school is returned to each student, from TEFA only equip them with work experience similar to working systems in factories. The experience gained at TEFA can be used to apply for jobs. In the implementation of TEFA, there are obstacles that hinder the TEFA learning process, namely coming from the students themselves, each student has a different character, some are quick to understand, some are difficult to understand, besides that, there are those who do not attend because they play truant or are sick. For machines sometimes experience trouble because the machine is old.

#### ***4.3 Analysis of Student Career Evaluation Through Teaching Factory (Tefa) at SMK Islam 1 Blitar.***

Based on the findings of researchers at SMK Islam 1 Blitar, an evaluation was also carried out. This evaluation aims to find out how far the success of the program that has been compiled and implemented is then used as a reference for improvement in order to achieve a goal. In the process of evaluating the career development of students through TEFA at SMK Islam 1 Blitar, students after graduating from TEFA will be recruited by PT Daihatsu Motor which has collaborated with TEFA at SMK Islam 1 Blitar when the industry recruits new employees, it will prioritize students from TEFA. There are several graduate students who come from TEFA and have worked in Dhaihatsu, Yamaha and some are working outside the city. So far, the evaluation for the completion of TEFA has not reached 90%, maybe only a few percent of these children from Difa enter where there is no data collection as a whole but children who come from TEFA are given priority by themselves from special job exchanges and companies that work with TEFA. for students who have graduated from TEFA, there has been no detailed investigation of where students who graduated from TEFA worked and what company, because since the beginning of TEFA's establishment, the school has prepared students to be ready to work, not to job recruitment.

In the process of carrying out the evaluation, namely the supervising teacher or other teachers who are involved in learning the TEFA program at SMK Islam 1 Blitar conducts an evaluation, this evaluation is carried out once a month or when students are about to graduate from TEFA. The evaluation carried out by the teachers involved was in accordance with the initial plans that

had been set. Where this evaluation covers the performance of the students themselves, besides that the production results produced are already on target or not within one month. The purpose of this evaluation is to improve or improve the quality of the students so that after graduating from TEFA the students are ready to work according to the wishes of the students.

From the results of the research findings, it can be concluded that process evaluation and outcome evaluation were carried out by the teachers involved in the TEFA program, namely as a follow-up to the existence of the TEFA learning program, namely that the school did not limit students after graduating from TEFA where to go, some want to study or go straight to work. From the school's side, it was sufficient to equip them while studying at TEFA, they have received sufficient provisions so that graduates from TEFA are ready to enter the world of work. If PT Daihatsu Motor opens the recruitment of new employees, children from TEFA will be prioritized first to be accepted for work. Students who have graduated from TEFA will also receive a certificate given by a company that collaborates with TEFA at SMK Islam 1 Blitar. Where the certificate is as legislation that can be used by students to be able to apply for work at the Chemko company. So the opportunity for students to be able to work at PT Daihatsu Motor has a great opportunity because students have studied at TEFA and TEFA has collaborated with PT Daihatsu Motor. Evaluate the learning process at TEFA, namely that students will acquire sufficient provisions and knowledge after graduating from TEFA, because the purpose of TEFA itself is to bridge or prepare students to be ready to work. Evaluation of the results of the TEFA learning program, namely that there were several students who came from TEFA graduates who had worked in large companies such as Dhaihatsu, PT Daihatsu Motor, Yamaha, Astra and some who worked outside So the opportunity for students to be able to work at PT Daihatsu Motor has a great opportunity because students have studied at TEFA and TEFA has collaborated with PT Daihatsu Motor. Evaluate the learning process at TEFA, namely that students will acquire sufficient provisions and knowledge after graduating from TEFA, because the purpose of TEFA itself is to bridge or prepare students to be ready to work. Evaluation of the results of the TEFA learning program, namely that there were several students who came from TEFA graduates who had worked in large companies such as Dhaihatsu, PT Daihatsu Motor, Yamaha, Astra and some who worked outside So the opportunity for students to be able to work at PT Daihatsu Motor has a great opportunity because students have studied at TEFA and TEFA has collaborated with PT Daihatsu Motor. Evaluate the learning process at TEFA, namely that students will acquire sufficient provisions and knowledge after graduating from TEFA, because the purpose of TEFA

itself is to bridge or prepare students to be ready to work. Evaluation of the results of the TEFA learning program, namely that there were several students who came from TEFA graduates who had worked in large companies such as Dhaihatsu, PT Daihatsu Motor, Yamaha, Astra and some who worked outside because the purpose of tefa itself is to bridge or prepare students to be ready to work. Evaluation of the results of the TEFA learning program, namely that there were several students who came from TEFA graduates who had worked in large companies such as Dhaihatsu, PT Daihatsu Motor, Yamaha, Astra and some who worked outside because the purpose of tefa itself is to bridge or prepare students to be ready to work. Evaluation of the results of the TEFA learning program, namely that there were several students who came from TEFA graduates who had worked in large companies such as Dhaihatsu, PT Daihatsu Motor, Yamaha, Astra and some who worked outside.

#### 4. CONCLUSION

1. In the career development process students certainly require proper planning, planning must start with setting goals to be achieved and determining the steps that must be taken to achieve these goals. The planning that has been planned from the start, starting from a survey of the location that will be used for the Teaching Factory (TEFA) production process, is the place feasible and meets the required requirements, besides that the electricity used at SMK Islam 1 Blitar already has the right voltage. enough and others. The school also provides facilities in the form of safety equipment, health protocols such as masks and gloves. The survey was carried out by PT Daihatsu Motor who will work with TEFA SMK Islam 1 Blitar.
2. The planning that has been planned from the start, starting from a survey of the location that will be used for the Teaching Factory (TEFA) production process, is the place feasible and meets the required requirements, besides that the electricity used at Islamic Vocational School 1 Blitar already has the right voltage. enough and others. The school also provides facilities in the form of safety equipment, health protocols such as masks and gloves. The survey was carried out by PT Daihatsu Motor who will work with TEFA SMK Islam 1 Blitar.
3. In the process of carrying out the evaluation, namely the supervising teacher or other teachers who are involved in learning the TEFA program at SMK Islam 1 Blitar conducts an evaluation, this evaluation is carried out once a month or when students are about to graduate from TEFA. The evaluation carried out by the teachers involved was in accordance with the initial plans that had been set. Where this evaluation covers the performance of the students themselves, besides that the production results produced are already on target or not within one month. The purpose of this evaluation is to improve or improve the quality of the students so that after graduating from TEFA the students are ready to work according to the wishes of the students.

#### REFERENCES

- [1] A. A. Perwiranegara, Teaching Factory Management in the Industrial Era 4.0 in Indonesian, *int. J. Sci. Soc.*, 4(3), 2022, pp. 151–62.
- [2] Y. Rinawati, A. Suriansyah, School Partnership Management in Improving Vocational School Education Quality with Teaching Factory in Tabalong District, South Kalimantan Province, *J. K6 Educ. Manag.*, 4(1), 2021, pp. 37–50. DOI: 10.11594/jk6em.04.01.04.
- [3] P. Ghanim, S. Habiba, B. Sujanto, and N. Karnati, Evaluation of Implementation of Teaching Factory Programs in State Vocational School, South Jakarta, *int. J. Educ. Res.*, 8(1), 2020, pp. 157–164.
- [4] A. Haris, Learning system management based on teaching factory in Indonesia, *J. Adv. Res. Soc. sci. Humanite.*, 2(4), 2017, pp. 237–248. DOI: <https://dx.doi.org/10.26500/JARSSH-02-20170402> Learning.
- [5] I. N. Saputro, S. Soenarto, H. Sofyan, M. C. Riyanita, P. S. Rebia, and A. Listiana, The Effectiveness of Teaching Factory Implementation in Vocational Education: Case Studies in Indonesia, *Universe. J. Educ. Res*, 9(11), 2021, p. 1841–1856. DOI: 10.13189/ujer.2021.091104.
- [6] S. Wahjusaputri and B. Bunyamin, Development of teaching factory competency-based for vocational secondary education in Central Java, Indonesia, *int. J. Eva. Res. educ.*, 11(1), 2022, pp. 353–360. DOI: 10.11591/ijere.v11i1.21709.
- [7] L. Rentzos, M. Doukas, D. Mavrikios, D. Mourtzis, and G. Chryssolouris, Integrating Manufacturing Education with Industrial Practice using Teaching Factory Paradigm: A Construction Equipment Application, *Procedia CIRP*, 17, 2014, pp. 189–194. DOI: 10.1016/j.procir.2014.01.126.
- [8] P. Alexandre, D. A. Marques, and R. Matth e, Six Sigma DMAIC project to improve the performance of an aluminum die casting operation in Portugal, *int. J. Qual. Reliab. Manag.*, 34(2), 2017, pp. 307–330. DOI: 10.1108/IJQRM-05-2015-0086.

- [9] M. Hollingshed, Standardizing Six Sigma Green Belt training: identification of the most frequently used measure phase DMAIC tools, *int. J. Lean Six Sigma*, 13(2), 2021, pp. 276–294. DOI: 10.1108/IJLSS-12-2020-0220.
- [10] E. V. Gijo, S. Bhat, and N. A. Jnanesh, Application of Six Sigma methodology in a small-scale foundry industry, *int. J. Lean Six Sigma*, 5(2), 2014, pp. 193–211. DOI: 10.1108/IJLSS-09-2013-0052.
- [11] R. K. B. Navas, R. P. Akash, G. Sathish, J. M. Azharudeen, Six sigma in education: Examination result analysis using six sigma-a case study, in: 2016 IEEE 4th International Conference on MOOCs, Innovation and Technology in Education (MITE), 2016, pp. 245-250.
- [12] P. Kaushik and D. Khanduja, Developing a Six Sigma Methodology to Increase the Passing Rate of Student in Engineering Education, *J.Eng. educ.*, 2006, pp. 23–30.
- [13] J. E Guerrero and S. Leavengood, Applying Lean Six Sigma in the Wood Furniture Industry: A Case Study in a Small Company, *Qual. Manag. J. ISSN*, 24(3), 2017, pp. 6–21. DOI: 10.1080/10686967.2017.11918515.
- [14] L. Ramanan, M. Kumar, and K. Ramanakumar, SIX SIGMA - DMAIC Framework for Enhancing Quality in Engineering Educational Institutions, *int. J. Bus. Manag. Invent.*, 3(1), 2014, pp. 36–40.
- [15] J. A. H. Karaminas, Critical Assessment on the Six Sigma Black Belt Roles/ Responsibilities, Skills and Training: A Global Empirical Study, *int. J. Qual. Reliab. Manag.*, 16(3), 2016, pp. 11–29. DOI: <http://dx.doi.org/10.1108/IJQRM-08-2014-0106>.
- [16] P. Mishra, A hybrid framework based on SIPOC and Six Sigma DMAIC for improving process dimensions in supply chain network, *int. J. Qual. Reliab. Manag.*, 31(5), 2014, pp. 522–546. DOI: 10.1108/IJQRM-06-2012-0089.
- [17] D. S. K. Wong, H. M. Zaw, Z. J. Tao, Additive manufacturing teaching factory: Driving applied learning to industry solutions: This paper reviews the past and current status of AM technology at Nanyang Polytechnic in Singapore, *Virtual and Physical Prototyping*, 9(4), 2014, pp.205-212.
- [18] A. Purwanto, D. Novitasari, and M. Asbari, The Role of Leadership, Teaching Factory (TEFA) Program, Competence of Creative Products and Entrepreneurship on Entrepreneurial Interest of the Vocational School Students, *int. J. Soc. Manag. Studs.*, 03(5), 2022, pp. 58–64.
- [19] K. Srinivasan, S. Muthu, S. R. Devadasan, and C. Sugumaran, Enhancement of sigma level in the manufacturing of furnace nozzle through DMAIC approach of Six Sigma: a case study, *Production Planning & Control*, 27(10), 2016, pp.810-822.
- [20] D. Mourtzis, N. Panopoulos, J. Angelopoulos, N. Panopoulos, and J. Angelopoulos, A hybrid teaching factory model towards personalized education 4.0, *int. J. Comput. Integr. Manuf.*, 2022, pp. 1–21. DOI: 10.1080/0951192X.2022.2145025.
- [21] B. Q. Pradipta, F. B. Hirawan, and S. K. Ragamustari, Evaluation of policy in the vocational education system revitalization in Indonesia: Examining the teaching factory radiance of industry, *J. Educator. Vocational*, 11(1), 2021, pp. 68–77.
- [22] D. A. Puspita, M. Muchlas, T. Kuat, The implementation of teaching factory to improve student interest in entrepreneurship at multimedia competencies, *Journal of Technology and Humanities*, 1(2), 2020, pp. 42-50.
- [23] R. K. Dhani, K. Kristiani, The Effectiveness of Creative Products and Entrepreneurship Learning and Teaching Factory to Prepare for Job Creator in the Industrial Revolution Era 4.0, *International Journal of Multicultural and Multireligious Understanding*, 8(7), 2021, pp.285-292.
- [24] A. S. Purnami, M. Mulyanto, S. Utomo, Teaching factory, internal quality assurance system, and vocational teacher quality culture, *Journal of Education and Learning (EduLearn)*, 15(3), 2021, pp. 406-413.



**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

