

# The teaching factory (TEFA) pilot project of transportation system engineering as an opportunity in the department of engineering at Politeknik Negeri Jember

*by Risse Entikaria Rachmanita*

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## The teaching factory (TEFA) pilot project of transportation system engineering as an opportunity in the department of engineering at Politeknik Negeri Jember

A Irawan<sup>1\*</sup>, A W Pratama<sup>1</sup> and R E Rachmanita<sup>2</sup>

<sup>1</sup>Automotive Engineering, Engineering Department, Politeknik Negeri Jember, Jember 68101, Indonesia

<sup>2</sup>Renewable Energy Engineering, Engineering Department, Politeknik Negeri Jember, Jember 68101, Indonesia

\*e-mail: andik\_irawan@polije.ac.id

**Abstract.** The pilot project of Teaching Factory (TEFA) at the Department of Engineering, Politeknik Negeri Jember as an effort to realize TEFA in the field of transportation system engineering, including mapping the potential and opportunities for the realization of Technical TEFA by considering several product groups plans, including the production of spare parts (Y1), services (Y2) and bio-fuel production (Y3). The problem is the need to identify with potential mapping whether TEFA pilots in the Engineering Department can be recommended to be realized. Potential mapping aims to provide an output of consideration in realizing TEFA in the Department of Engineering through several stages of the process, the first method is GADM (Grid Analysis Decision Making) as a model for providing recommendations in realizing TEFA by giving a score from the questionnaire to partners, the second method with the CIPP stage (Context, Input, Process, Product) as a consideration of the service process chain flow and products that will be produced from the three products. Potential mapping is carried out by means of questionnaires to partners spread across 4 sub-districts, Jember Regency with consideration of the radius of the mapping distance of 5 km from the Politeknik Negeri Jember. Respondent partners are used as the basis for considering feasibility in establishing TEFA in the Engineering Department. The questionnaire to productive partners in the automotive sector grouped into four sub-districts obtained a mapping of a total of 100 partners from Sumbersari, Patrang, Kaliwates, Ajung with a number of 35, 14, 17 and 34 partner respondents respectively who were considered as candidates for collaboration in pioneering TEFA in the Department of Engineering. The GADM results provide a questionnaire score for each sub-district average from product groups Y1, Y2 and Y3 with a score of 3.2, 2.9 and 3.4. The partner's choice of the highest score is bio-fuel (Y3).

### 1. Introduction

Politeknik Negeri Jember is one of the polytechnics that has a Teaching Factory (TEFA) such as TEFA SIP POLIJE. TEFA was developed as an implementation of business and production-oriented learning concepts to answer the challenges of future modern industry. In addition, with TEFA, students can directly improve their competence before going directly to industries outside of polytechnics. Politeknik Negeri Lampung has at least 14 TEFA [1], through the PPPTV program, Politeknik Negeri Lampung concentrates on PUT (Center for Excellence in Technology) which is available for several Study



Programs. The Lampung State Polytechnic since 2018 has established TEFA as a production and business space with a production system using a foreign language [2].

Manpower is a problem that needs to be solved to overcome the suitability of the implementation of TEFA, through the concept of Context, Input, Process, Product (CIPP) in the DKI Jakarta Vocational School which is used for evaluation in the DKI Jakarta TEFA policy in realizing the entrepreneurial spirit to students as an opportunity after graduating from school [3]. The CIPP model is also used as a TEFA evaluation to examine every aspect of Context, Input, Process, Product in evaluating the program, more than 75% have a good response in the implementation system [4]. In general, link and match is not only for polytechnics, SMK is also part of the TEFA implementation. With the right learning design and TEFA, it really supports the implementation of the Competency Test [4].

Background studies as analysis in learning models, system evaluation, competency improvement, competency evaluation and assessment and various models to support TEFA implementation in each sector using various ASPECTS. Based [5] the above background, it is important that this research begins with a study for mapping TEFA pilots in the Department of Engineering, Politeknik Negeri Jember to see opportunities and potential through supporting data and available equipment, technological capabilities in the laboratory and HR competencies. The TEFA pilot model will be analyzed with the Context Input Process Product (CIPP) to analyze the pilot concept and use the Grid Analysis Decision Making (GADM) decision support method before TEFA is actually made. There are three groups that will be formed including the spare-part production group (Y1), services (Y2), and fuel production (Y3) through the CIPP analysis model to realize the TEFA Pilot of Transportation System Engineering at the Engineering Department, Politeknik Negeri Jember.

## 2. Material and Method

In this study, there are several groups of sections as a discussion in the TEFA pilot, Table 1 contains the discussion of Context and Input. The use of plastic waste to make fuel is equivalent to premium, thermal energy from Liquid Petroleum Gas (LPG). Resin, catalyst and fiber as materials for making body parts and body variations. The questionnaire form as a data mapping includes the product of spare-part production groups (Y1), services (Y2), and bio-fuel production (Y3). The method in this study uses CIPP as a consideration of the production process and facilities, and uses GADM in the consideration of decisions on the TEFA pilot plan.

**Table 1.** Group Modelling Context and Input

Group	Context	Input	
		Material	Unit
Y1	Tech Roller Part Mounting	Rubber Sheet Smoke	kg
Y2	Tech Automotive	Car	pcs
	Dyno	Car-Motor	pcs
	Gas Emission Test		
Y3	Generator Tech	Polypropiline	kg
	Sample 1	Polypropiline	kg
	Sample 2	Polypropiline	kg
	Sample 3	Polypropiline	kg
	Sample 3	Polypropiline	kg

### 2.1. Context, Input, Process, Product (CIPP)

TEFA as a learning concept that emphasizes student competence and achieves the production of goods or services [6]. TEFA is also the development of a dual system-based learning method based on

competence and training-based production. Educational and research activities are part of innovation for single initiators to effectively involve industry and academia through direct practice models in realizing competencies based on production, quality and efficiency. The main purpose of the TEFA learning model is to improve the alignment of the skills, knowledge and attitude development process, through thematic alignment on normative, adaptive, and productive subjects [7]. TEFA learning adapts the concept of work-based learning. TEFA can improve cognitive competence, vocational competence, soft skills and hard skills that in the curriculum balance between knowledge, theory and analysis with manufacturing, design, business activities, and professional skills. The groups that will be formed in the TEFA Pilot of Transportation System Engineering include the production of spare parts (Y1), services (Y2) and bio-fuel (Y3) with CIPP analysis. Fuel production includes: gasoline motor fuel with the addition of an induction tube [8], EFI vehicle fuel misting system [9], pyrolyzed polypropylene plastic fuel with a premium mixture and octane booster [10], and biodiesel fuel from seed oil avocado [11]. The spare part production subsystem includes: industrial biosystem technology [12], Exhaust Pipe Fuel Preheating System (EP2FS) [13-14], and agrofiber composite rubber reinforced ramie fiber [15]. The service subsystem includes: maintenance of EFI vehicles based on diagnostic tools [16], increased efficiency and performance of the exhaust pipe fuel preheating system [17], increased fuel efficiency with engine manifold membrane engineering 2 [18-19], solar power plant installations [20]. In this case, the determination of CIPP is a stage of the process in looking at the parts of the TEFA pilot plan before implementation:

- a. Context  
By looking at the facilities and infrastructure currently available in every laboratory of the Engineering Department.
- b. Input  
Is the technology, human resources and raw materials available to support the pioneering TEFA Transportation System Engineering in the Department of Engineering.
- c. Process  
This stage is a process that includes a description of each flow of the three groups that will be initiated.
- d. Product  
Is a product that will be made and will be tested directly with consumers in the area around the Department of Engineering and Politeknik Negeri Jember.

## 2.2. Grid Analysis Decision Making (GADM)

GADM as a method to analyze decisions before the formation of a system model. Determination of the system can be based on the aspects to be studied. Various aspects are based in order to complete the stages through a questionnaire made in the form of a matrix, Table 2 shows a matrix of scoring criteria. The steps required include:

- a. Assessing Problems  
Includes identification of the problem, seeking information to be carried out before the activity is carried out by generating a temporary crisis, with this condition the determination to avoid or resolve the problem can be resolved and understanding of the conflict to be faced. In the pilot of TEFA in the Department of Engineering, in this case, the context of the problem is seen which emphasizes the three main subsystems to assess the characteristics of the existing problem.
- b. View Alternatives  
At this stage trying to seek input and information from those who have knowledge related to the problem and pay attention to relevant information in the mass media. The most important thing at this stage is openness and flexibility. Individuals are more interested in alternatives in the form of suggestions to solve problems. From the three subsystems, it will be obtained which context is an alternative to support the production, business, learning system which is the main basis as a support structure in the TEFA pilot system in the Department of Engineering.

c. Considering Alternatives

In considering alternative decision-making, begin to evaluate all available options based on the consequences and possibilities to do. Regarding the consequences of his actions, one sees the possible benefits and disadvantages that he must accept as well as the practicality of each alternative that he thinks is the best in his efforts to achieve the desired goal. When realizing that there is a possibility of regret in the future, this becomes the basis for careful consideration of the alternatives. This concept is to consider alternatives from the aspects studied for data to support decision making in the TEFA Pilot in the Department of Engineering.

**Table 2.** The Criteria of Scoring

Score	Criteria
4	Agree to realize TEFA in the Department of Engineering
3	Agree but consider the target and reach of market segments
2	Hesitate in realizing TEFA in the Engineering Department
1	Do not agree in realizing TEFA in the Department of Engineering

Scores are given by respondents, out of a total of 30 questions and divided into 10 questions in each product group. Researchers give weight to consider the decisions of respondents and produce a final score that will be decided as a sequence of decision considerations. Table 3 describes the scoring groups and the elements of the scoring model. Table 4 shows the scoring matrix and Table 5 shows the scoring weights.

**Table 3.** Element and Symbol

Symbol	Element	Description
R	Respondent	100 Partnership
Q <sub>Yn</sub>	Questionnaire	Production Questionnaire
SQ	Score Questionnaire	1 - 4
AS <sub>Yn</sub>	Average Score	Mean Production
TWR	Total Weighted Researcher	Weighted Score
FS	Final Score	Total Weighted

$$Q_{Yn} = Q_{Y1}; Q_{Y2}; Q_{Y3}$$

Assessment of scores from respondents in each production group Y1:

$$Q_{Y1} = q^{1Y1} + q^{2Y1} + q^{3Y1} \dots \dots \dots + q^{ny1} \tag{1}$$

Assessment of scores from respondents in each production group Y2:

$$Q_{Y2} = q^{1Y2} + q^{2Y2} + q^{3Y2} \dots \dots \dots + q^{ny2} \tag{2}$$

Assessment of scores from respondents for each production group Y3:

$$Q_{Y3} = q^{1Y3} + q^{2Y3} + q^{3Y3} \dots \dots \dots + q^{ny3} \tag{3}$$

Average score:

$$AS_{Yn} = \frac{Q_{Yn}}{10} \quad (4)$$

Total Weighted Score from author:

$$TWR = \frac{WR_1 + WR_2 + WR_n}{\sum WR} \quad (5)$$

Final Score to consider decision:

$$FS = AS_{Yn} \times TWR \quad (6)$$

**Table 4.** Matrix Scoring

Number	$q^{1Y1}$	$q^{2Y1}$	$q^{nY1}$	$Q_{Yn}$
$R_1$	q1	q2	q3	Qn
$R_2$	q1	q2	q3	Qn
$R_n$	q1	q2	q3	Qn
$AS_{Yn}$				$Qn/10$

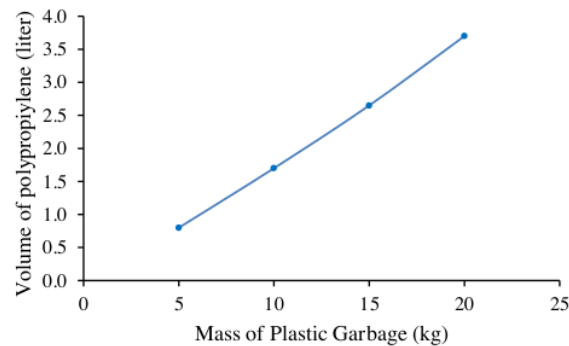
**Table 5.** Matrix Weighted

Production	Wr1	Wrn	TWR (a)	$AS_{Yn}$ (b)	FS
Y1	w Score	w Score	w TWR	$AS_{Y1}$	$(a + b)/2$
Y2	w Score	w Score	w TWR	$AS_{Y2}$	$(a + b)/2$
Y3	w Score	w Score	w TWR	$AS_{Y3}$	$(a + b)/2$

### 3. Results and Discussion

Data taken from the Jember Regency Environmental Service, in Jember Regency there are 31 sub-districts, 22 urban villages and 221 villages which is one of the largest piles of waste in the Jember city area, with a population in 2020 of 2,519,000 people, waste production in Jember Regency is fairly large and has increased to now reach 1,300 m<sup>3</sup> which is a factor in environmental pollution which will eventually cause environmental damage. Based on the analysis of each urban village, the average daily composition of plastic waste is 6%. Whereas, the production of plastic waste fuel is very potential in utilizing plastic waste at the Politeknik Negeri Jember in particular and the environment around the campus in general. The average plastic waste disposal on campus is 2 kg per day, while outside the campus a radius of 2 km is more than 30 kg per day.

The most common type of plastic waste produced is polypropylene. The tool used to melt plastic waste is an incinerator designed in previous studies [10]. Figure 1 informs that to burn 5 kg of polypropylene plastic material to produce 0.8 liters of liquid Polypropylene fuel it takes 120 minutes at a temperature of 220°C and to burn 10 kg of plastic waste it takes 145 minutes at a temperature of 240°C also to produce 2.65 liters fuel require 15 kg waste it takes 220 minutes at 250°C. Meanwhile, to produce 3.7 liters of Polypropylene liquid fuel, it takes 20 kg of plastic waste and takes 310 minutes with a temperature of 280°C.



**Figure 1.** Volume of Polypropylene Fuel from Burning Plastic Waste

Repair of two-wheeled vehicles around the 5 km radius campus - an average of 3 to 5 vehicles per day in each workshop, a total of questionnaires spread over 100 workshops in Summersari, Patrang, Kaliwates and Ajung sub-districts, respectively 35, 14, 17 and 34. While four-wheeled vehicles from 100 workshops, only 20 four-wheeled workshops were recorded. Table 6. Shows the distribution of the questionnaire in four sub-districts with an average of 2 vehicles per day for each sub-district. The service potential (Y2) in pioneering TEFA is very high. When viewed from fuel consumption, each vehicle requires 1 liter of fuel equivalent to 14 km of travel in the city. If services (Y2) require an average of 1 liter of fuel per vehicle, then 500 liters will be consumed in 4 sub-districts, this will greatly affect the fuel production plan (Y3). While in the manufacture of vehicle parts, from 4 sub-districts only 10 workshops are engaged in vehicle modification services, so the daily average spare part production rate is 1 part for complex parts and more than 3 parts for simple parts.

**Table 6.** Partner District

District	Quantity
Sumbersari	35
Patrang	14
Kaliwates	17
Ajung	34
Total Partnership	100

### 3.1. CIPP Analysis

The inventory of CIPP results in the TEFA pilot project at the Department of Engineering, Politeknik Negeri Jember is described in Tables 7 which this table is the result of an inventory to support each group, and Tables 8 is the calorific value of the results of testing the tool in group Y3 based on the calorific value. The results of the calorific value can be used as a reference for previous research in accordance with this research method. Technical data and specifications to support CIPP as a starting point for mapping the potential of supporting equipment and human resources.



**Table 7.** Group Modelling of CIPP

Group	Context	Input		Process	Product	
	Incinerator Tech	Raw Material	Unit (Kg)	LPG (Kg)	Fuel (Litre)	Char (Kg)
Y3	Sample 1	Polypropylene	5	3	0.8	0.5
	Sample 2	Polypropylene	10	6,5	1,7	0,9
	Sample 3	Polypropylene	15	10	2,65	1,45
	Sample 4	Polypropylene	20	13,5	3,7	2,4
Group	Tech Automotive	Material	Unit (pcs)	Procedure	Measure	-
Y2	Dyno	Car	2	SOP	HP; Nm	-
	Gas Emission Test	Car-Motor	2	SOP	Emission	-
Group	Tech Roller	Raw Material	Unit (Kg)	Compound (Kg)	Part (pcs)	-
Y1	Part Mounting	Rubber Sheet				
		Smoke	2	2	12	-

Y1 (Spare Part), Y2 (Service), Y3 (Bio Fuel)

**Table 8.** Fuel Calorie

Fuel Mixed	Cal/g
PP 85% + Peralite 15%	10,86
PP70% + Peralite 30%	10,83
PP 50% + Peralite 50%	10,71
PP 100%	10,96

PP = Polypropylene

### 3.2. GADM Analysis

The questionnaire is used as a decision consideration from the results of the CIPP analysis to provide recommendations on whether the TEFA pilot can be considered for implementation. Table 8 is a description of the recommendations from the results of the questionnaire and the results of the research team's considerations in realizing the TEFA pilot at the Department of Engineering Politeknik Negeri Jember.

**Table 9.** Matrix Final Score

Production	Wr1	Wr2	Wr3	TWR (a)	AS <sub>Vn</sub> (b)	FS
Y1	2.9	2.8	2.8	2.8	3	2,9
Y2	3.1	3	3.2	3.1	3.3	3,2
Y3	3.2	3.3	3.5	3.3	3.5	3,4

#### 4. Conclusion

Based on the results of this study, it was concluded in this study with the CIPP model and GADM considerations recommendations resulted in feedback from respondents as follows  $Y3 > Y2 > Y1$  with a score of 3.4; 3.2 and 2.9. The production of fuel (Y3) from plastic waste is recommended using 20 kg of plastic with a constant temperature of 310° C capable of producing 3.7 liters of fuel. Services (Y2) recommend performance tests and exhaust emissions, while product manufacturing (Y1) results in the manufacture of automotive components.

2

#### 5. Acknowledgments

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