

## A supply and demand analysis of engineering teachers

Purnomo<sup>†</sup>, Slamet Ph<sup>‡</sup> & Soenarto<sup>‡</sup>

State University of Malang, Malang, Indonesia<sup>†</sup>  
State University of Yogyakarta, Yogyakarta, Indonesia<sup>‡</sup>

**ABSTRACT:** The study presented in this article was aimed at revealing the supply and demand gaps for mechanical and automotive engineering teachers. A quantitative descriptive-comparative approach was adopted for the research and, as a sample, four engineering schools (SMKNs) were chosen in Malang, Indonesia. Data were collected by questionnaire and documentation. A chi-squared test with a significance level of 0.05 was performed on teacher supply and demand data. The result of the research showed that sample schools SMKN 1 and SMKN 11 had no significant shortage of teachers, while SMKN 6 and SMKN 12 had a significant shortage of automotive engineering teachers. However, the supply of vocational mechanical engineering and automotive engineering teachers resulting from the programmes is still very low.

### INTRODUCTION

Graduates of mechanical engineering (ME) and automotive engineering (AE) often have a long wait before finding their first job. This shows that there is a disconnect between government policy and the Institution of Educational Personnel Suppliers for Indonesia (LPTK). The government policy is no recruitment of new public teachers and a zero-growth policy in appointing candidates for civil servants (CPNS). On the other hand, LPTKs recruit their students without learning market needs. Furthermore, LPTKs do not readily open new programmes or close unneeded ones. As a result, LPTK graduates can have difficulty finding employment.

The shortcomings of engineering teachers need to be considered, because the government through the Directorate of Vocational Secondary Education (PSMK) increased the proportion of vocational high school (SMK) students to senior high school (SMA) students from 50:50 in 2009-10 to 67:33 in 2014-15 [1].

Supply and demand analysis is needed to address the teacher supply and demand imbalance. This will involve schools, education offices and local governments as the institutions that use graduates and LPTK as the teacher supplier. Supply and demand analysis is expected to reduce the teacher surplus or shortage.

The teacher supply should fulfil the demand. The first step is to assess or evaluate the capability of the LPTKs. The evaluation can be used to measure the ability of LPTKs to meet the demand for teachers. According to Gaffar, the components that must be evaluated include: the number of pre-service teachers or enrolled students in LPTKs; LPTK trends in the production of graduates over six years; types and level of available programmes; the production capacity of each programme; and the available resources for possible future developments [2].

The average new increase per year, the number of repeaters per year and the dropout rate per year, can be used to project the number of teachers produced in the next few years. Since LPTK graduates should meet teacher demands in the field, a target should be set for the projected supply of teachers, i.e. determining the number of graduates to meet the needs. For the ideal balance, the demand for teachers should be the same as the supply of graduates who act as pre-service teachers. Comparison of the trends of LPTK graduates in the past six years and the trend of teacher needs in the same period can inform academic development.

### METHODS

This research used a quantitative descriptive-comparative approach. The research was conducted in four engineering schools (SMKNs) in Malang. The subject of the research was the supplier of teachers viz. the Mechanical Engineering Department of the Universitas Negeri Malang (State University of Malang - UM), which runs ME and AE programmes.

There were two research variables; namely, the demand and the supply of engineering teachers. Factors affecting the demand for engineering teachers are:

1. reduction in the number of teachers (reach pension age, illness, death, promotion);
2. existing teachers;
3. teaching hours for teachers;
4. curriculum structure and number of hours per week of training;
5. student enrolment.

The factors that affect the supply of engineering teachers are:

1. cohort of graduates;
2. productivity;
3. curriculum structure;
4. existing lecturers;
5. student enrolment.

Questionnaires were issued in this study, the content and reliability of which were validated (i.e. content validity) using expert validation (i.e. expert opinion).

Quantitative data on teacher demand and teacher supply were processed and analysed. The data concerned the recent and next five years' demand for engineering teachers in Malang. By studying the factors of demand, a model was developed for the demand for SMKN teachers. A chi-squared test at a significance level of 0.05 was applied to the data of difference between teachers supplied to the SMKNs.

## RESULT AND DISCUSSION

### Teacher Supply and Demand Analysis

The number of graduates majoring in mechanical engineering from the Faculty of Engineering (Fakultas Teknik) UM between 2012 and 2016 is shown in Table 1. This shows that there are slightly more AE than ME graduates, with an average of about 20 graduates per year.

Table 1: Graduates of the Mechanical Engineering Department of UM, from 2012 to 2016.

Year	ME programme	AE programme	Total graduates
2012	20	18	38
2013	19	18	37
2014	26	25	51
2015	17	18	35
2016	11	19	30
Average	19	20	38

Table 2 shows the demand against the number of available teachers, and whether there is a sufficiency or insufficiency. This shows that mainly the number of engineering teachers is insufficient. This deficiency is despite the schools being supplied by two types of engineering teacher: civil servants (PNS) who enjoy good conditions, and teachers who are privately contracted by the school (GTT) and whose conditions are not as good. The SMKN 1 is the biggest engineering school in the city and is the only school with an adequate number of teachers.

Table 2: Demand versus the number of available teachers.

No.	Engineering school	Demand	Available teachers		Sufficient (+) or insufficient (-)
			PNS	GTT	
1	SMKN 1	10	14	2	+ 6
	Mechanical Engineering				
	Automotive Engineering	21	17	11	+ 7
2	SMKN 6	11	6	2	- 3
	Mechanical Engineering				
	Automotive Engineering	35	8	9	- 18
3	SMKN 11	10	3	2	- 5
	Automotive Engineering				
4	SMKN 12	13	1	3	- 9
	Automotive Engineering				

Table 3 shows the results of a chi-squared test. For SMKN 1, there was no significant difference between available teachers in ME or AE and the teacher demand. The surplus of engineering teachers in SMKN 1 was within the tolerance limits and the surplus can easily be absorbed by assigning additional tasks to teachers who teach less than 24 hours a week.

For SMKN 6, the results showed no significant difference for ME, even though the number of available teachers was less than the demand, i.e. the shortage of teachers was within the tolerance limits. However, the SMKN 6 AE results showed a significant shortage of teachers, which should be addressed by recruiting new teachers.

Although there is a shortage of teachers for AE in SMKN 11, the shortage is not significant. This means that the shortage of teachers can be addressed by increasing the number of teaching hours to at least to between 24 and 30 hours a week.

At SMKN 12 Malang, there is a significant shortage of teachers of AE. This means that the shortage of teachers at SMKN 12 Malang should be addressed by new teacher recruitment.

Table 3: Results of a chi-squared test analysis of the SMKNs.

No.	Engineering school	Demand	$\chi^2_h$	$\chi^2_{tbl(0,05)}$	Significance
1	SMKN 1				
	Mechanical Engineering	10	1.384	3.841	not significant
	Automotive Engineering	21	0.532	3.841	not significant
2	SMKN 6				
	Mechanical Engineering	11	0.474	3.841	not significant
	Automotive Engineering	35	6.230	3.841	significant
3	SMKN 11				
	Automotive Engineering	10	1.666	3.841	not significant
4	SMKN 12				
	Automotive Engineering	13	4.764	3.841	significant

#### Factors Affecting Teacher Demand and Supply

The demand for technical teachers is not only determined by the number of classes, but also by the curriculum structure. This is in accordance with economic theory that the most dominant factor affecting demand is price and income. In earlier studies, the authors calculated the total teacher demand as equal to the number of students divided by the student to teacher ratio [3][4].

Gaffar states that the factors affecting demand are enrolment and the curriculum [5]. The study of Bruce et al also found that the number of teachers required depends on the teacher to pupil ratio [6]. The results of SMKN 1 and SMKN 11 show that there is no significant affect on the number of teachers required and the existing teacher cohort. The result is in line with the study by Shan et al, where it was found that in Sichuan province, Peoples Republic of China, by 2020, there would be an extra 65,000 teachers at elementary level and 70,000 at junior level [4].

The Mechanical Engineering Department of the UM is a teacher supplier institution for ME and AE programmes for engineering schools. The Department from 2012 to 2016 had an average of 19 ME graduates per year and 20 AE graduates per year. The productivity for the programmes was 0.27 for both the ME and AE, which is low. The required teachers for the four SMKNs were 22 ME and 71 AE. Judging from the requirement, the ME graduates were less needed than were AE graduates. This is due to the Malang City Council, between 2000 and 2009, opening new engineering schools with an emphasis on automotive engineering, such as the techniques to repair light vehicles and motorcycles.

The number of pre-service engineering teachers from the UM show that LPTK productivity is very low. If not handled properly, Indonesia may face a similar situation to that in South Africa [7]. The South African study found that higher education graduates prefer to become scientists or engineers rather than to work as teachers. Another finding, on the economic boom in Western Australia, found that with excellent employment opportunities in non-education areas many teachers took early retirement [8].

#### Achieving an Equilibrium in the Supply and Demand of Teachers

The gap between the demand and supply of ME and AE teachers is emphasised by the quantitative results (2016) in Table 2, which relate to the surplus and shortage of teachers in the four sample SMKNs in Malang. There are differences in the demand for teachers in SMKN 1, SMKN 6, SMKN 11 and SMKN 12 Malang. SMKN 1 has the advantage of having both ME and AE. Two of the SMKNs have a significant lack of AE teachers. The gap between the

demand and supply of engineering teachers can be addressed by a change in the number of the UM's engineering department graduates.

The economic law of supply and demand also applies to SMKN teachers. Equilibrium occurs when the demand is equal to the supply [9] i.e. in this case, the number of teachers demanded by engineering schools is the same as the graduates from LPTKs. An equilibrium condition is difficult to achieve, because there are various factors that are difficult to control both on the supply and demand side. The surplus or shortage of teachers in an SMKN should be addressed urgently. A school principal is responsible for the conditions of teachers and these conditions may reduce an SMKN's performance in teaching and learning. The principal needs to develop solutions to staffing problems without disrupting the operation of the SMKN.

Excess teachers may be offered relocation to another school where there is a shortage. This solution may involve adjusting teaching hours to meet the minimum required of a teacher. Where a school needs more teachers, the principal should immediately make a request to the local education office. If the problem cannot be solved, the local education office should report to the regional education office. A discussion with related parties should be undertaken to produce an agreement at the provincial level.

## CONCLUSIONS

Results of a chi-squared test found that there was a significant shortage of automotive engineering teachers at SMKN 6 and SMKN 12. In those schools, the lack of AE teachers should be addressed urgently. The UM Engineering Department is able to meet the demand for ME and AE teachers.

Supply and demand analysis of technical teachers is still limited in Malang. Further study at the regional and national level using a qualitative approach or with a mixed method is recommended.

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