



STUDY ON THE ESTABLISHMENT OF PROFESSIONAL ENGINEERING PROGRAM IN ENGINEERING FACULTY UNIVERSITAS NEGERI SEMARANG

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Abstract: In the era of globalization, reliable human resources are required to compete with human resources from other countries. If they cannot compete, Indonesian people only become spectators in their own country. For this reason, various efforts must be conducted. This study focuses on human resources in the field of engineering. The needs for professional human resources for engineers are required now and, in the future, both in terms of quantity and competency. With the issuance of the Engineering Law and followed by Government regulation No. 25 /2019, the professional engineer program can be established in the program can be established in universities which have fulfilled the requirements. Therefore, the question would be whether UniversitasNegeri Semarangis ready to establish an engineering profession program. This study is aimed at providing recommendation its establishment, and the aspects of improvement are necessary. The design of this study is a survey research, descriptive, with a mix approach. Data were collected by using documentation, observation, Delphi method, comparative studies. Data were analysed by using descriptive statistics and non-statistical analysis. Non-statistical analysis consisted of elasticity analysis, cohort analysis, supply and demand analysis, and criteria analysis. The output of study is a set of data for decision making led by Engineering Faculty UNNES. The result of the study showed that Engineering Faculty, UniversitasNegeri Semarang in 2019 was not ready to conduct the engineering profession program because it has not been able to meet the existing requirements, and is expected to be ready to carry out the engineering profession program in mid-2020. The suggestion of this study showed that full support is required from the heads of faculties and colleges for more realization.

Keywords: establishment; professional program; engineer; human resources;

I. INTRODUCTION

The Development and the Needs of Engineers

Development in infrastructure has an important role in the progress of a country. In 2018, the construction sector contributes 10.53% of GDP, the industrial sector contributes 17.63%, and the real estate sector 2.74% [1]. In period 2014 - 2018, toll and non-toll roads, ports, airports, power plants, and other infrastructure have built.

Those infrastructures are expected to be the basis for further development. In the coming years, infrastructure development will be continued. As a consequence, the issue of human resources regarding the engineering will be the main concern [2]. Human resource is one of the important components in all activities. They become planners, managers and implementers in development activities. In general, human resources are individuals who have been involved in organization, both institutions and companies, and they are driving force of the organization/institutions and companies, in achieving its objectives. An increase in GDP correlates with an increase in the demand of the human resources. An increase in the Gross Domestic Product (GDP) and priority infrastructure development in Indonesia lead to the increasing demand for engineering personnel, especially engineers. Quantitative needs for human resources in general can be predicted among others by means of elasticity techniques [3].

The needs for human resources are not only in quantitative, but also in qualitative. Qualitatively, our human resources' competencies are still below those of neighbouring countries. The World Bank states that the competitiveness of Indonesia's human resources is still below that of other countries in the same region [4], which ranks 87th out of 157 countries [5]. There are still many Indonesian human resources who do not yet have a certificate of either skill or expertise. Therefore, professional engineer programs are required to provide expertise / skill competency that can strengthen the nation's competitiveness. In the current era of globalization, reliable human resources are required to compete with human resources from other countries. If we cannot compete, we can only become spectators in our own country. For this reason, various efforts must be made. This study focuses on human resources in the field of engineering. Quantitative and qualitative maps of Indonesian human resources that still require attention especially in the engineering field. The number of engineers in the present time and in the future is still insufficient. The quality / competence of engineers still needs improvement. Therefore, The Ministry of Research, Technology, Higher Education has established a professional engineer program, and has appointed several universities to organize it. The implementation of the professional engineer program with 2 years duration of study is expected to answer the demands of quantity and quality of engineers. However, until the present time, only few of the designated universities have implemented the professional engineer program due to various obstacles. On the other hand, there may be other universities that have not been appointed but are able to meet the requirements of establishing the professional engineer program. Universitas Negeri Semarang (UNNES) as an innovative university has these following goals: to produce educators, educational staff, academics and professionals who have superior competence in the fields of science, technology, art, and sports with conservation spirit. Therefore, the establishment of professional engineer education is in accordance with the goals of UNNES.

With the issuance of the Engineering Law (Law No.11 of 2014) and followed Government Regulation no. 25 in 2019, the professional engineer program can be established at universities that have fulfilled the requirements. Therefore, the needs for professional human resources as engineers are required at the present time and future. This study examines the readiness of Engineering Faculty of UNNES in the establishment of professional engineer program. The question is whether Faculty of Engineering UNNES has fulfilled the requirements of establishing professional engineer program? If it meets the requirements, the research team recommends its establishment, and if it still does not meet the requirements, the research team will further examine the points that still need to be addressed.

Engineers and the Needs of Engineer

According to Law No. 11 of 2014 concerning engineering, an engineer is the title of one's profession. Engineering is Engineering activities by using the expertise and skills by mastering science, knowledge, and technology to increase the value-added and power sustainably by paying attention to the safety, health, welfare, and the welfare of society and the preservation of the environment. To obtain an engineer profession degree, a person must graduate from the Professional Engineer Program. Requirements to be able to join the Professional Engineer Program include a bachelor of engineering, a bachelor of education in engineering, a bachelor of science equivalent to a bachelor of engineering or an applied bachelor of engineering through an equalization program. Furthermore, the Professional Engineer Program is organized by the university by working together with related ministries, PII (Indonesian Engineers Association, and the industry to follow the standard of professional engineer program.

Quantitatively, an increase in Gross Domestic Product correlates with an increase in demand in human resources. An increase in the Gross Domestic Product (GDP) and the priority of infrastructure development in Indonesia result in an increase in the demand of engineers. Quantitative needs for human resources in general can be predicted among others by using elasticity technique [3]. If GDP increases, the demand of Human Resources in each sector can be expected to increase. On the other hand, the supply of human resources comes from schools & universities which can be calculated from the estimated number of graduates (graduation rate), and internal potential (in the form of employee promotions). The difference between demand vs. supply is a phenomenon that must be considered by the stakeholders in engineering and vocational education. The demand and the supply must be in balance in which the supply is slightly above of demand. According to Heru Dewanto, Vice Chairman of Indonesian Engineering Association, Indonesia is expected to experience a shortage of 280 thousands of engineers in the next five years. On the other hand, the number of engineers graduated from universities are not able to meet the amount of the increasingly growing needs of engineers [4].

The needs of human resources are not only in quantitative, but also in qualitative. Qualitatively, Indonesian human resources competencies are still below those of neighbouring countries. The World Bank states that the competitiveness of Indonesian human resources is still below that of other countries in the same region [5], which ranks 87th out of 157 countries [6]. There are still many Indonesian human resources who do not yet have a certificate for their skill or expertise. The coming year is a period to develop human resources [2]. An additional period of study is required along with adequate practice in the field to improve engineering graduates into professional engineers. This professional engineer program has been designed by Indonesian Engineering Association and various relevant stakeholders including The Ministry of Higher Education, Research and Technology and the implementation is up to the qualified universities.

Establishment of Professional Engineer Program in Faculty of Engineering, UNNES

According to Law No. 11 of 2014 regarding engineering, engineering education can be established at universities that have fulfilled the requirements. These requirements are stated in (1) Government regulation no. 25, 2019 concerning the implementation of the Engineering Law, (2) Decree of the Director General of Science and Higher Education Institution no. 1462 /C/Kep/ VI / 2016, (3) The regulation of Indonesian Ministry of Research, Technology and Higher Education No. 35 of 2016, BAN-PT Regulation No. 30 of 2018, and others. Universitas Negeri Semarang is one of the public universities with the A predicate. The Faculty of Engineering in this study is one of eight faculties. Based on the faculty documentation, human resources for the implementation of professional engineer program has fulfilled the requirements and the number of engineering study programs has also fulfilled the requirements, furthermore the room / building facilities are available. Furthermore, further study is required on how is the readiness to establish a professional engineer program at Faculty of Engineering, UNNES? Can other requirements be fulfilled? The study is based on a number of current conditions, such as the 2014 law, Government Regulation in 2019, a portrait of the condition in Engineering Faculty in 2019, and others. It all shows the novelty of this study. Historically, initiation of professional engineer program has long been conducted at UNNES. In 2014, the MoU was held between Engineering Faculty, UNNES and Indonesian Engineer Association in Central Java Region, in which the two sides would collaborate in various fields of engineering including professional engineer program. Furthermore, in 2015, Engineering Faculty, UNNES and Indonesian Engineer Association of Central Java Region held the first professional engineer course / workshop, followed by the second one in 2016 and the third in 2017. The professional engineer course / workshop for up to three batches showed the readiness of Engineering Faculty, UNNES in conducting professional engineer program. Meanwhile, the number of teaching staff who has met the teaching requirements of professional engineers from Engineering Faculty, UNNES is increasing. At present, it has met the minimum requirements. In addition, the potential / prospective students participating in education are highly available consisting of graduates from engineering program and engineering education program. Based on the description above, the readiness to establish a professional engineer at Engineering Faculty UNNES needs to be further investigated.

II. METHOD OF THE STUDY

This design of this study is a survey research, descriptive, with a mix -approach. The study was conducted in the Faculty of Engineering, Universitas Negeri Semarang. The method of data collection consisted of documentation, observation, Delphi technique by asking the opinions of several sources, and the daccum technique by conducting a comparative study to several universities that are proposing the professional engineer program or which have carried it out. Data analysis used descriptive statistics and non-statistical analysis. Statistical analysis included description of Engineering Faculty data, calculation of the mean, median, and time series. Non-statistical analysis included elasticity analysis for prediction of needs of the engineer, cohort analysis for prediction of engineer supply, and supply demand analysis. Analysis of elasticity was conducted by using this following formula:

$$e = \frac{\Delta N / N}{\Delta Y / Y}$$

Where e = elasticity as a job opportunity
N = number of job opportunities
 ΔN = Increase in employment opportunities
Y = GDP
 ΔY = GDP increase (Simanjuntak, 1985)

The data collection of this study was conducted in August - September 2019. Before collecting the data, a preliminary survey was conducted to the subjects of the study. The data were collected at the Central Java Central Statistics Agency, Universitas Negeri Semarang, Jakarta Trisakti University, Universitas Negeri Yogyakarta (UNY), and Soegijapranata Catholic University (UNIKA) Semarang, by using observation, interviews and documentation. The collection of other data was conducted by the method of documentation: literature, books, and relevant journals.

III. THE RESULTS OF THE STUDY

The Needs of Engineer

The results of collecting the data from literature / books / journals / freelance / expert statements were compiled in a complementary manner so that it is understandable to answer the research problem. The results of data collection are as follows. The description of engineering personnel in Indonesia based on the human resource in engineering field as a whole, the data from Indonesian Engineer Association in 2015 can be seen in Table 1.

Table 1- The number of engineers per 1,000,000 residents of several countries in 2015

No	Country	Number of engineers/1,000,000 residents	Information
1	Singapura	28,235 engineers/1,000,000 residents	
2	Vietnam	8,917 engineers/1,000,000 residents	
3	Filipina	5,170 engineers/1,000,000 residents	
4	Thailand	4,121 engineers/1,000,000 residents	
5	Myanmar	3,844 engineers/1,000,000 residents	
6	Indonesia	2,671 engineers/1,000,000 residents	Source: Kompas 6/2/2016

Indonesia has the lowest number of engineers/ 1,000,000 residents. This is exacerbated by the growth of engineering graduates in Indonesia, which is only 162 per one million populations each year compared to Malaysia's 350 engineering graduates per one million population [7]. Based on the data above, it can be said that the needs of human resources in engineering in Indonesia require immediate solution. So that, various projects in Indonesia can be managed. The needs of engineers in the future in Indonesia is expected to experience a shortage of 280 thousand engineers in the next five years. On the other hand, the number of engineers graduating from the higher education was not able to meet the amount of the increasingly growing needs of engineers. In fact, in the present time, this country is undergoing a major development of infrastructure. The gross domestic product of Indonesia is included in the tenth position in the world. Therefore, Indonesia becomes one of the destinations for overseas engineers. "Some countries have already lobbied PII (Indonesian Engineers Association) to work in the various projects of development in Indonesia," Therefore, the Deputy Chairman of PII, Ir. Heru Dewanto, M. Eng., IPM., In the inauguration of 30 new engineers for the professional engineer program at Gadjahmada University period I in 2018, Wednesday (7/3 / 2018) at the Senate Hall said that in ten years, approximately 650 thousands of engineers are required. The number of graduates each year cannot meet those needs. He said the number of graduates of universities high in the field of engineering is only about 14 percent. On the other hand, only half of that percentage works in the field of engineering. From the statement above, it can be seen that the needs of engineers in the next five to ten years are still quite high so that the establishment of the professional engineer program is still feasible.

Demand and supply of engineers in Indonesia in 2016 - 2019

In this present time, Indonesia still lacks of many engineers. Based on the data from the Directorate General of Science and Technology, Indonesia in 2016 needed 34,000 engineers, 2017 needed 72,000 engineers, 2018 needed 87,000 engineers and 2019 needed 96,000 engineers. On the other hand, in 2015, the total number of engineering graduates was only 15,258 people, in 2016, the number was 17,092 people, in 2017, the number was 18,273, in 2018, the number was 19,454 and in 2019, the number was 20,635 [8]. To meet the needs of engineers, the government has mandated 40 State and Private Universities to hold professional engineer programs. However, only few of all universities that have received the mandate can implement it.

Results of Data Collection in Faculty of Engineering, UNNES

Data collection at Faculty of Engineering, UNNES was carried out throughout the study between August 2019 and November 2019. Some of the data taken included the condition of human resources who would be able or have competency in teaching in engineering program, institutional, hard ware and software. The condition of the human resources in the Faculty of Engineering, UNNES prepared to manage the professional engineering program as in August 19, 2019 was as follows: The number of Lecturers Prepared for the Professional Engineer Program was 17 people, 11 people with doctoral degrees, 6 with master degree, 11 people with Senior professional engineer certificates, and 6 people with professional engineer certificates. Furthermore, 4 people from the Department of Civil Engineering, 4 people from the Department of Mechanical Engineering, 5 people from the Department of Electrical Engineering, 1 person from the Department of Chemical Engineering and Agricultural Engineering. Engineering Faculty has sufficient educational facilities such as lecture rooms in E1, E2, E5, E6 buildings. While the practicum room / workshop in E3, E4, E6 buildings. The number of learning equipment is quite adequate. With the opening of the professional engineer program at several universities that have been mandated by the government, and with the increasing requirements for teaching the professional engineer program, there are several lecturers who undertook the professional engineer program at several universities that have already implemented it. The numbers of the lecturers were as follows a person Mechanical Engineering, 2 persons from Electrical Engineering, 1 person from Electrical Engineering, 3 persons from Civil Engineering. With the participation of those lecturers in the professional engineer program, it is expected that they are able to meet the latest requirements in the establishment of professional engineer program in Indonesia.

IV. RESEARCH RESULTS AND DISCUSSION

The research results can be arranged as follows. (a) Projection of the needs for engineers in the next 5 years (2023) is 280,000 and in 2028 of 650,000 people. In Indonesia, the proportion of engineers in one million population is far behind that of other Southeast Asian countries. (b) Of the 40 universities that have been mandated to open the professional engineering program, it turns out that there are only a few new programs that have been opened, including: Bandung Institute of Technology, Diponegoro University, Universitas Negeri Yogyakarta, Gadjahmada University, Surakarta Muhammadiyah University, Hasanuddin University. It is estimated that the universities opening professional engineer program can reach 10 universities in 2019. With an average number of graduates of these study programs are 30 people and each year can hold 3 batches, each year 900 engineers can be produced. If the growth rate is estimated at 30%, then the projected productivity of the engineer program in 2023 can be 7,032 people. However, this figure is still far from the total needs. (c) By comparing the number of needs and the number of engineers available, the establishment / opening of a professional engineer program is still feasible to be carried out by universities outside the mandate that has fulfilled the requirements for implementation. (d) UNNES is a university that has a major in engineering (non-educational). It has an A accreditation. And it possesses adequate human resources which would be sufficiently feasible to carry out an professional engineer program. (e) Assuming several lecturers will take part in the professional engineer program and they graduate, the Faculty of Engineering, Universitas Negeri Semarang is ready to carry out the professional engineer program, estimated in mid-2020. Provided that the requirements of the establishment of the professional engineer program does not change. The requirements for establishing the professional engineer program are always updated and increasingly difficult, which aims to improve the process and product of the professional engineer program in the future. (f) The requirements of establishing the professional engineer program in accordance with the requirements in the year 2019 are (i) the minimum amount of teaching staffs are 5 people who have graduated from a program engineer and a certified IPM (Senior Professional Engineer), (ii) the minimum amount of the administrative staffs are 4 people to serve a Professional Engineer Program, the minimum education of the staffs is diploma, one of which must have a librarian certificate, the minimum age is 56 (fifty six) years old, and is willing to work full time for 37.5 (thirty seven point five) hours per week. Other requirements are as follows: (iii) the Higher Education must be accredited A, (iv) having at least five (5) engineering programs, the minimum accreditation of the engineering programs is B or Good, at least 50% (fifty percent) of the all engineering programs, (v) the teaching staffs must have a working experience in the industry for at least 2 (two) years as evidenced by a letter of practical engineering working experience), (vi) for prospective teaching staffs determined at the request of assistance from the Higher Education to PII, a recommendation from PII is needed, (vii) having a cooperation agreement with the relevant ministries, PII, and / or industry circles, a set of engineering expertise that has been accredited by the PII. (g) Outside universities which have the mandate from the Directorate of Higher Education to carry out professional engineering programs can carry out this professional program provided it meets the existing requirements. (h) The existing condition (2019) regarding the potential of FT UNNES in the effort to establish an engineer profession program has not yet fulfilled the requirements. However, in the mid-2020 FT UNNES is estimated to have fulfilled the current requirements for carrying out the professional engineering program.

V. CONCLUSION

The conclusions of this study are (a) FT UNNES in 2019 is not ready to carry out the profession engineer program because it cannot meet the existing requirements. The obstacle is that the prepared lecturers have not gone through the profession engineer program in tertiary institutions. (b) FT UNNES expected to be ready to held a joint engineering profession program in mid-2020 because it will be able to meet the existing requirements, if no change / improvement requirements that apply at this time. Suggestions that can be submitted are (a) Required support from faculty and university leaders for the implementation of the profession engineer program at FT UNNES. (b) It takes a strong enthusiasm and motivation from the lecturers who are members of the engineering profession group to realize the implementation of the engineering profession program at FT UNNES.

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