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The Enhancement of Higher Education Quality by Alumni Tracking Using Correspondence Analysis

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Higher education is a bridge which connects education to work, business, and industry. When evaluating the higher education quality, the focus is commonly upon the relevance of the study, and job. Indeed, the diversity of study programs within institutes influences upon the job descriptions of their alumni. This paper explores the correspondence analysis method to evaluate the enhancement of higher education quality by performing the association between the relevance of study, job, and alumni job descriptions for the different study programs. The association is depicted graphically on the correspondence plot. As a case study, the tracer study data of 2009 alumni at Institut Teknologi Bnadung (ITB) is used. The results show that ITB has succeeded in organising a high-quality education. It is evident by the association between the relevance of the study, and job for each study program. Overall, and based on the data, the alumni's job is compatible with their respective study programs.

Keywords: *Correspondence analysis, Higher education, Tracer study.*

Introduction

Higher education, as one of the centres of national education, has an essential role in creating the smart generation for building the nation. This function leads universities to perform a role in developing science, and technology. The accomplishment of higher education must be suitable with the aim of national education development policies, which is to create equitable,

and quality education that is relevant to the needs of society. In facing an increasingly dynamic, and competitive workforce, every graduate is required to possess the ability to adapt. The actualisation of science, and the quality of graduates becomes a major consideration for each company when recruiting employees. Every higher education institution is required to provide empirical evidence that the education, and training which is organised develops in accordance with the demands of the working world.

The Institut Teknologi Bandung (ITB) is a research-based university that establishes the indicators of success by academic excellence in the fields of education, relevance, knowledge contribution, and empowerment (ITB Career Center, 2018). The ITB is also a bridge that connects education, business, and industry. The relationship between education with business, and industry leads the ITB to provide the guarantee, and improvement of curriculum programs, as well as the quality of higher education.

Quality in higher education is currently one of the most recognised issues in higher education institutes around the world (Kalayci & Basaran, 2010). One of the efforts attempted by the ITB in improving the quality of higher education is to hold the ITB tracer study. The tracer study, as one of the methods in obtaining feedback from the ITB alumni, is expected to provide information about the success of higher education which is implemented at the ITB. The results of the tracer study can provide a direction to assess the quality of education in a higher education institution. This information is used to make decisions related to study designs, and practical solutions (Schomburg, 2016).

When talking about alumni, and their jobs, the relevance of their study, and job, is of the greatest concern. The diversity of study programs at the ITB influence the alumni job description category. The relevance of education to job, and industry, can be analysed by utilising a correspondence analysis. This study proposes to evaluate the success of higher education institutions — specifically, the ITB — in organising education by investigating the associations or dependencies between the relevance of the study programs, and the alumni job descriptions. The association is presented graphically on a plot, which is commonly known as a correspondence plot. This method is slightly different from the previous research undertaken by the ITB Career Center Research Division in analysing the tracer study data, as well as being the novelty in this research.

The article is organised into four sections. The second section describes the method for data collections, and data analysis. The results and discussion in section three explains the relevance of the study to the job, and the job description of the alumni, and for each study program. The last section is the conclusion, which is the essence of the research.

Methodology

This study used correspondence analysis (CA) for the data analysis. Correspondence analysis is a multivariate method for visualising categorical data which is presented in a two-way contingency table (Greenacre, 2017; Renchers & Christensen, 2012; Tufféri, 2011; Lestari, *et.al.*, 2020). In particular, the CA displays rows, and columns in the contingency table as coordinate points in a low-dimensional space, which is also referred to as a biplot or correspondence plot (Beh & Lombardo, 2014; Doey & Kurta, 2011). The row, and column points are depicted on the same graphical display, allowing for a more straightforward visualisation of the associations among the variables. Therefore, the CA provides a visualisation of the dependencies between the variables at the category level.

The CA uses the chi-squared statistic to measure the distance between the points on the correspondence plot (Beh, 2001; Clausen, 1988; Pearson, 1904). This distance also measures the associations among the categorical variables. The main issue of CA is how the existing plot can represent the rows or columns of a contingency table in a low-dimensional space (dimensions reducing), but can also absorb as much as possible from the information of the association structure (Ginanjar, 2017). The correspondence plot constructed is based on the principal coordinates for each row, and column categories. The principal coordinate is a linear combination of eigenvectors of the association between the row, and column categories (Ginanjar, 2016).

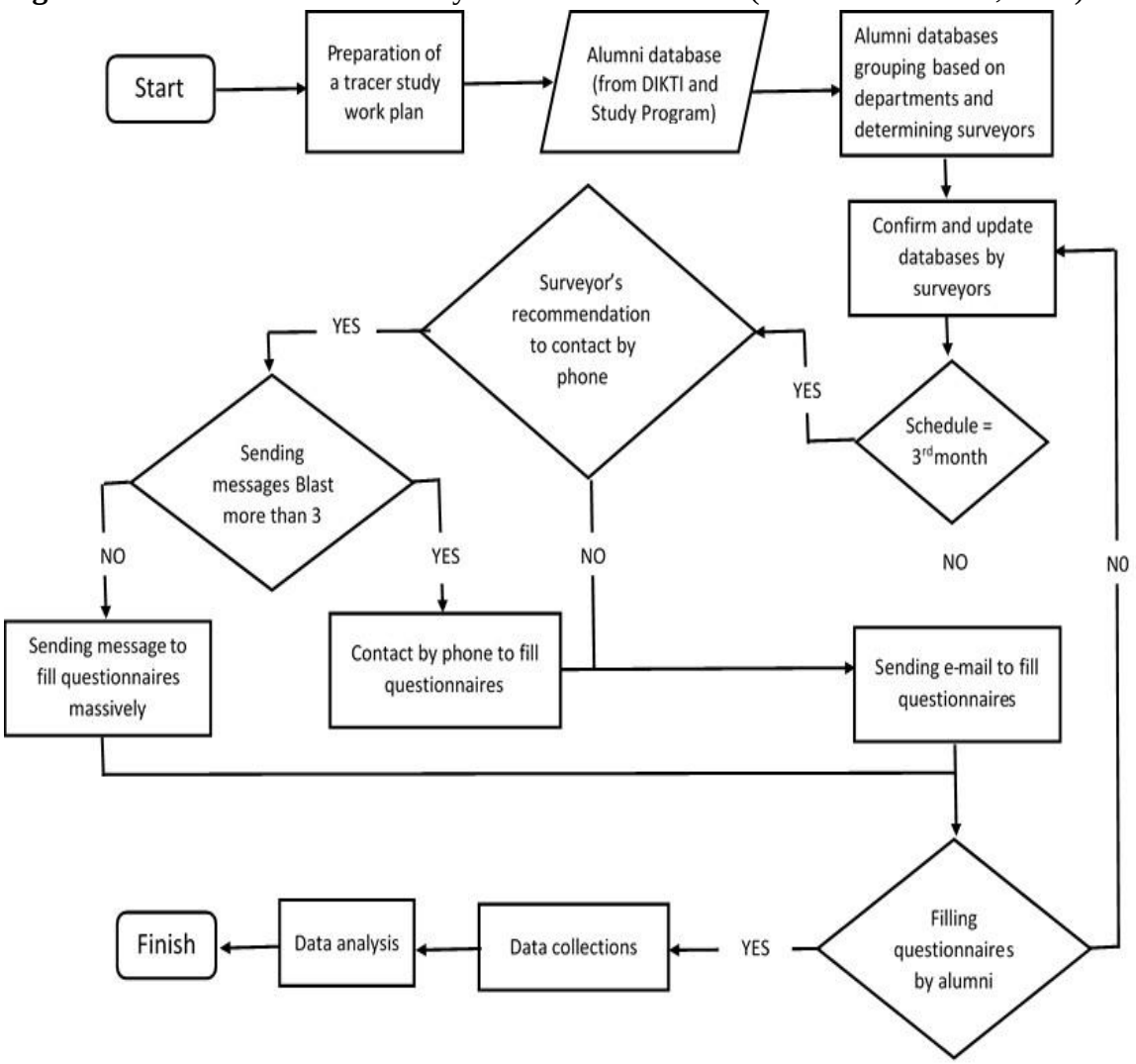
Two or more categories that are associated are mapped close together, and conversely. The category mapped close to the origin indicates that this category does not contribute to the association structure among the variables, and conversely (Ginanjar et al., 2014). It is important to note that each coordinate has the same size or metric. Consequently, the distance between the row, and the column coordinates are useless (Cuadras & Cuadras, 2006). Therefore, the focus in interpreting the correspondence map is emphaised upon the closeness between the coordinates.

The data was obtained from the Career Center Research Division of the ITB, which holds a tracer study of ITB 2009 alumni. The tracer study was organised in a structured, and systematic manner, as illustrated in Figure 1. The questionnaire consists of 41 primary questions, which contain personal data, alumni assessment of the ITB, alumni competence, the alumni transition period to work, and alumni job profiles. In this article, the focus of the discussion considers two aspects: the relevance of the study, and job; and the job description categories for each study program.

This analysis involves three categorical variables, which are: the study program; the relevance of the study, and job; and the job descriptions. The study programs consist of 39 categories, as follows: Aeronautics and Astronautics; Architecture; Astronomy; Biology; Chemical Engineering; Chemistry; Civil Engineering; Clinical and Community Pharmacy; Craft Design;

Electrical Engineering; Electrical Power Engineering; Engineering Physics; Environmental Engineering; Geodesy and Geomatic Engineering; Geological Engineering; Geophysical Engineering; Industrial Engineering; Informatics; Information System and Technology; Interior Design; Management; Management Engineering; Material Engineering; Mathematics; Mechanical Engineering; Metallurgical Engineering; Meteorology; Microbiology; Mining Engineering; Ocean Engineering; Oceanography; Petroleum Engineering; Pharmaceutical Science and Technology; Physics; Product Design; Regional and City Planning; Telecommunication Engineering; Visual Art; and Visual Communication Design. The relevance of the study, and job, is a binary variable consisting of 'yes', and 'no' categories. The job descriptions consist of 12 categories, including: controlling; distribution; ensuring; field engineering; maintenance; planning; process engineering; production; research and development; sales and marketing; service; and supply chain.

Figure 1. Flowchart of Tracer Study Execution at the ITB (ITB Career Center, 2018)



Result and Discussion

The Relevance of the Study and Job per Study Program

The question regarding the relevance of the study, and job, is the twelfth of 41 questions. The questionnaire was completed by 2,706 alumni. A two-way contingency table of this data is presented in Table 1. The frequency of each cell in the contingency table is illustrated in three dimensions, as in Figure 2. Overall, the job relevancy of the alumni, and their field of study reached 63.67 per cent (Figure 3).

Figure 2. 3D View of Contingency Table for Relevance of Study and Job

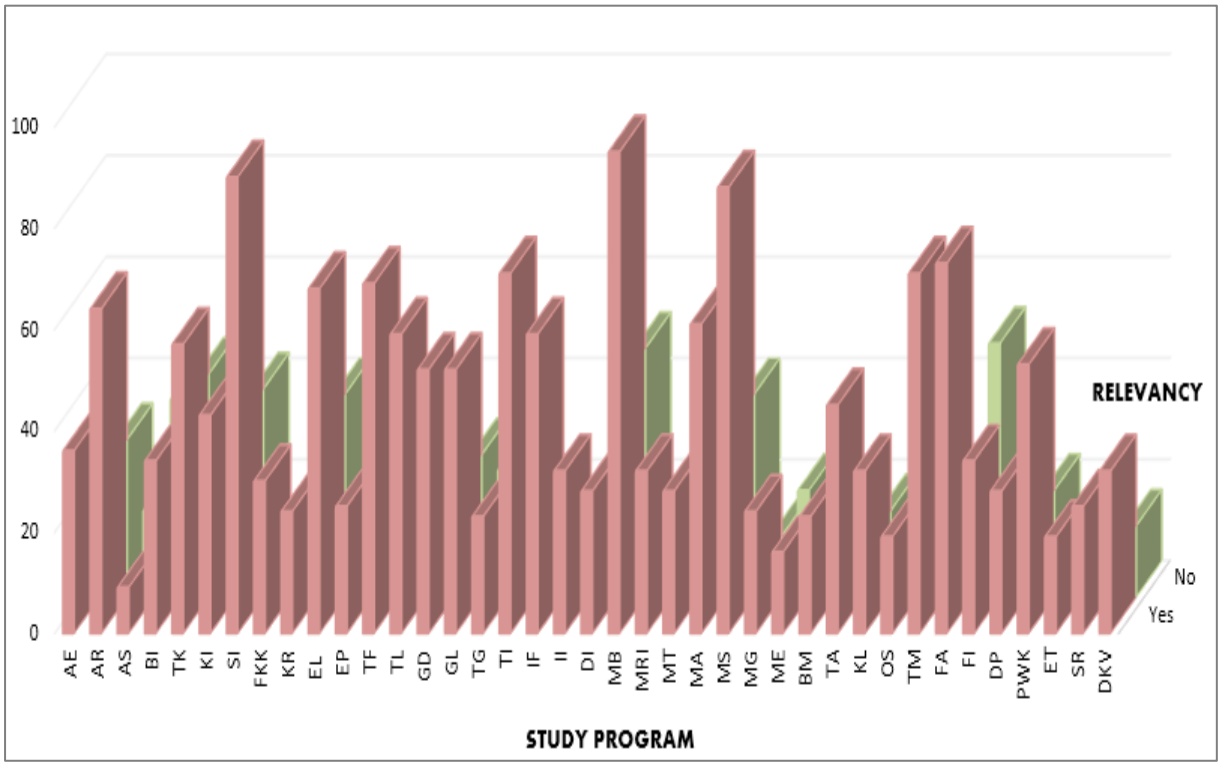


Figure 3. Percentage of the Relevance of Study and Job

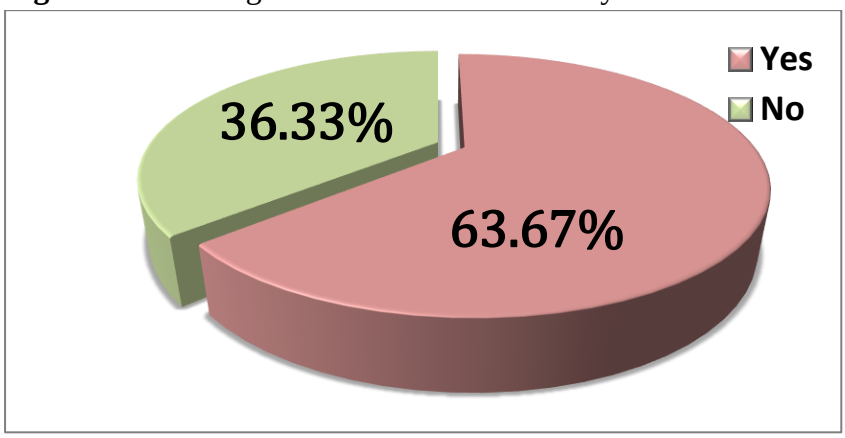


Table 1: Tracer Study ITB 2009 Data on Relevance of Study and Job

Study Program	The Relevance of Study and Job		Total
	Yes	No	
Aeronautics and Astronautics (AE)	36	22	58
Architecture (AR)	64	31	95
Astronomy (AS)	9	17	26
Biology (BI)	34	39	73
Chemical Engineering (TK)	57	44	101
Chemistry (KI)	43	39	82
Civil Engineering (SI)	90	41	131
Clinical and Community Pharmacy (FKK)	30	11	41
Craft Design (KR)	24	19	43
Electrical Engineering (EL)	68	40	108
Electrical Power Engineering (EP)	25	14	39
Engineering Physics (TF)	69	32	101
Environmental Engineering (TL)	59	32	91
Geodesy and Geomatic Engineering (GD)	52	34	86
Geological Engineering (GL)	52	28	80
Geophysical Engineering (TG)	23	25	48
Industrial Engineering (TI)	71	43	114
Informatics (IF)	59	22	81
Information System and Technology (II)	32	11	43
Interior Design (DI)	28	16	44
Management (MB)	95	49	144
Management Engineering (MRI)	32	15	47
Material Engineering (MT)	28	18	46
Mathematics (MA)	61	41	102
Mechanical Engineering (MS)	88	40	128
Metallurgical Engineering (MG)	24	12	36
Meteorology (ME)	16	21	37
Microbiology (BM)	23	17	40
Mining Engineering (TA)	45	18	63
Ocean Engineering (KL)	32	17	49
Oceanography (OS)	19	14	33
Petroleum Engineering (TM)	71	18	89
Pharmaceutical Science and Technology (FA)	73	20	93
Physics (FI)	34	50	84
Product Design (DP)	28	13	41
Regional and City Planning (PWK)	53	21	74
Telecommunication Engineering (ET)	19	15	34
Visual Art (SR)	25	10	35
Visual Communication Design (DKV)	32	14	46
Total	1723	983	**2706**

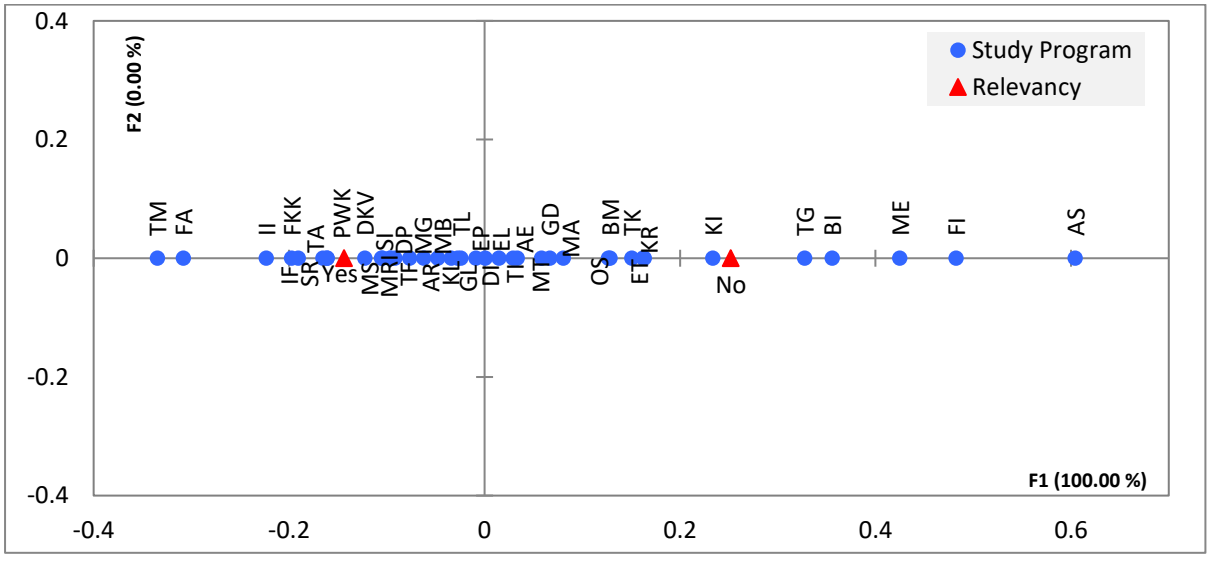
Based on the data, the 'Petroleum Engineering' study program has the highest percentage of study that is relevant to the alumni jobs, and at a rate of 79.78 per cent. The percentage was attained came from a total of 71 alumni. However, in terms of the numbers, the 'Management' study program contributed 95 out of 144 alumni, whose jobs followed their field of study, which was the most when compared to other study programs. On the other hand, the level of relevance of the study to the job in the 'Astronomy' study program was under 35 per cent. However, it is important to note, there are very few jobs in this sector, in Indonesia.

Table 2: Test of Independence between Study Program and the Relevance of Study and Job

Pearson's Chi-squared Statistics Test	Value
Chi-square (Observed value)	97.995
Chi-square (Critical value)	53.584
Degree of freedom	38
p-value	< 0.0001
Alpha	0.05

Table 2 presents the Pearson's chi-squared statistical test results. This test is used to determine whether there is an association between the study programs (rows), and the relevance of the study, and job (columns). According to Equation 2, the Pearson's chi-squared statistic is 97.995, with a *p*-value less than 0.0001. As the computed p-value is lower than the significance $\alpha = 0.05$, H_0 should be rejected, and the H_1 accepted. The risk to reject the H_0, while it is true, is lower than 0.01 per cent. Thus, there is evidence suggesting that there is a statistically significant association between the study program, and the relevance of the study, and job.

Figure 4. Correspondence Plot of the Principal Coordinates in Two Dimensions for Relevance of Study and Job



The association between the rows, and columns can be recognised based on the proximity of each category through the row profiles or column profiles. The case row categories consist of more than three categories, and the column profile is not feasible to draw in low-dimensional plots. However, these points still exist in a multidimensional space, which is also referred to as '*a cloud of points*'. Meanwhile, the correspondence plot simultaneously depicts the association among the study programs, and the relevance of the study, and job. Figure 4 graphically depicts 100 per cent of the association that exists between the study program, and the relevance of the study, and job. It shows that the 'Chemistry' study program is closely associated with the 'non-relevance' of the study, and job. Likewise, the 'relevance' of the study, and job is associated with the 'Mining Engineering', and 'Visual Communication Design' study programs.

Job Description per Study Program

In the previous section, the results show that many alumni work in sectors that are not relevant to their study. However, their job remains connected to the field of education. Therefore, it is also necessary to recognise a job description of the alumni. Generally, the most frequent job description of the alumni is in the 'research and development' division, at a rate of 14.23 per cent. It is reasonable, considering that several companies are also educational institutions under the Ministry of Research and Higher Education, that they are actively encouraging the undertaking of research and development. In addition to research and development, other categories of interest to alumni are 'planning' (10.83 per cent), and 'field engineering' (10.13%), see Figure 6.

Figure 5. 3D View of Contingency Table for Job Description

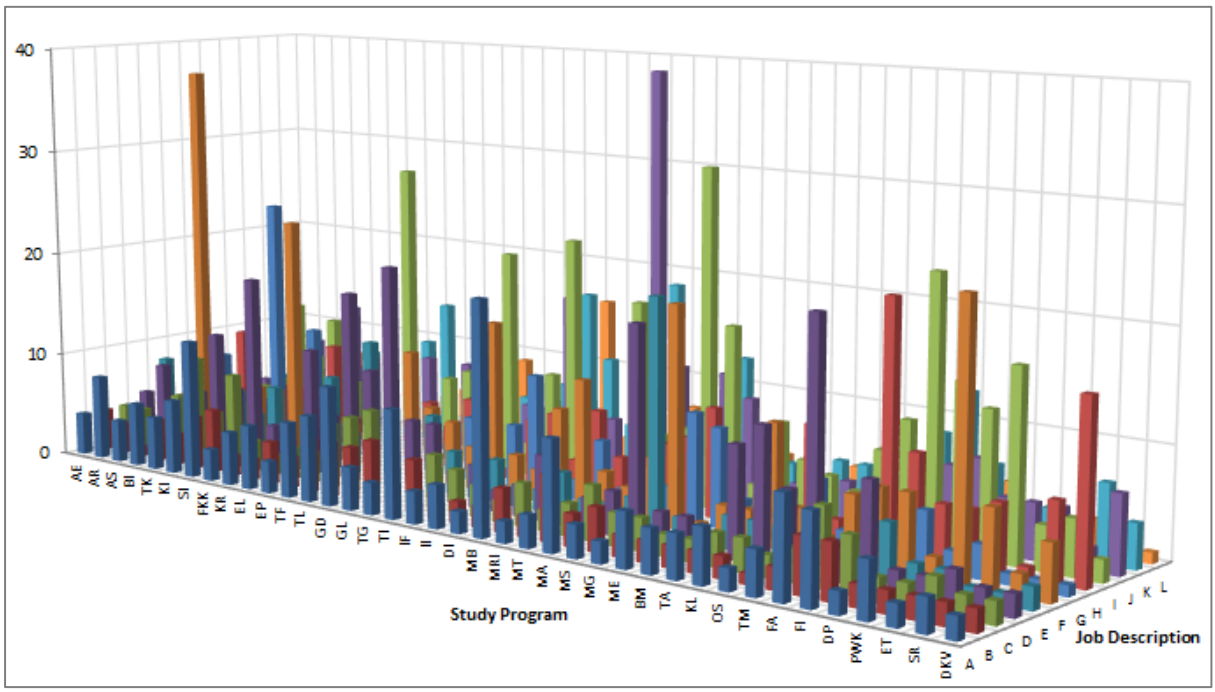


Table 3: Tracer Study ITB 2009 Data on Job Description

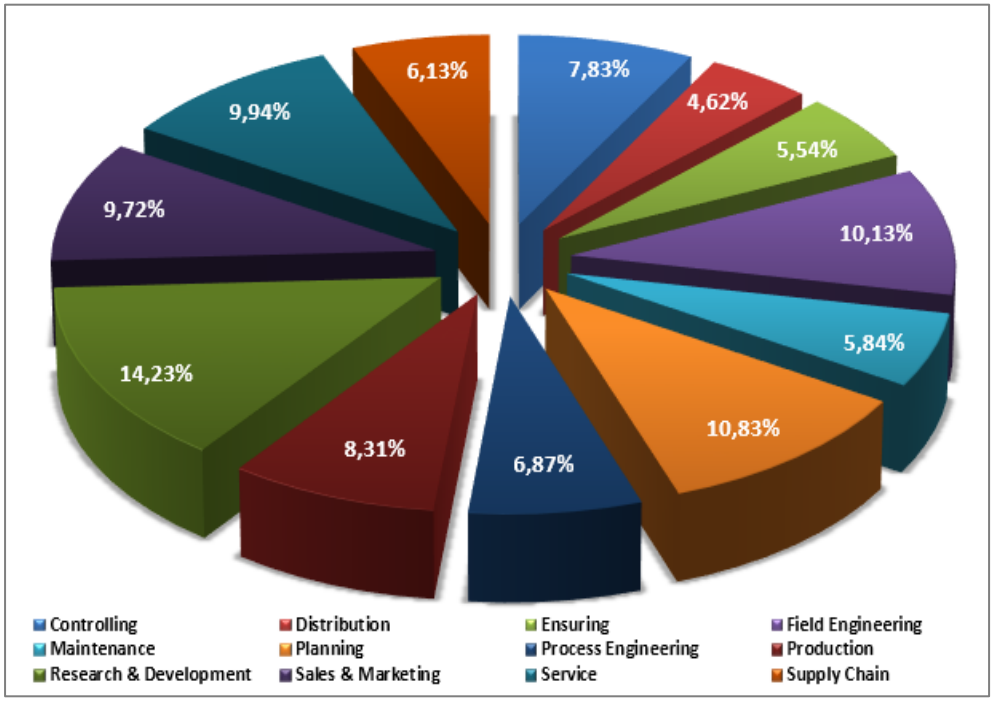
Study Program	Job Description												Total
	A	B	C	D	E	F	G	H	I	J	K	L	
AE	4	4	4	5	8	4	4	5	9	4	4	3	58
AR	8	3	4	8	3	37	8	10	4	4	3	3	95
AS	4	1	2	2	2	3	2	1	5	1	1	2	26
BI	6	4	6	6	3	4	4	5	13	9	6	7	73
TK	5	3	10	12	6	6	24	5	8	9	6	7	101
KI	7	5	5	7	4	6	4	5	12	13	8	6	82
SI	13	6	9	18	7	23	12	10	6	8	9	10	131
FKK	3	2	3	4	1	3	3	3	2	3	11	3	41
KR	5	2	2	2	2	4	2	5	2	3	10	4	43
EL	6	4	3	12	9	4	8	6	28	9	14	5	108
EP	3	3	3	6	4	2	2	3	5	2	3	3	39
TF	7	5	6	18	13	7	5	6	8	9	10	7	101
TL	8	5	7	11	7	12	5	4	9	5	9	9	91
GD	11	5	8	21	3	7	3	7	4	7	6	4	86
GL	4	6	4	7	7	6	6	4	21	6	4	5	80
TG	3	4	2	7	4	4	4	1	3	6	8	2	48
TI	10	5	5	3	3	16	6	6	10	17	17	16	114
IF	3	2	4	4	4	4	11	7	23	5	11	3	81
II	4	2	3	2	2	3	5	3	6	6	5	2	43
DI	2	2	2	3	2	9	2	8	2	4	4	4	44
MB	21	4	4	6	4	12	6	4	18	39	19	7	144
MRI	2	2	2	2	2	4	2	3	6	12	6	4	47
MT	3	6	3	3	2	3	2	6	7	3	4	4	46
MA	10	3	5	4	3	6	3	7	31	12	13	5	102
MS	3	4	3	19	21	20	10	10	17	10	7	4	128
MG	2	2	3	3	2	1	9	2	3	2	4	3	36
ME	5	2	2	3	1	3	3	2	9	3	2	2	37
BM	4	2	2	2	3	3	3	2	6	4	5	4	40
TA	4	2	3	10	3	11	2	10	5	4	5	4	63
KL	5	2	33	12	3	4	6	2	4	2	4	2	49
OS	2	1	2	7	2	2	2	2	8	1	3	1	33
TM	4	2	3	10	3	11	2	10	5	4	5	4	89
FA	9	5	7	3	3	7	3	9	24	7	13	3	93
FI	8	5	5	9	5	7	5	5	15	8	7	5	84
DP	2	2	2	2	2	2	2	5	13	5	2	2	41
PWK	5	2	2	2	2	24	3	6	17	5	4	2	74
ET	2	2	3	3	1	7	1	1	4	5	2	3	34
SR	3	2	2	2	1	2	1	7	5	2	7	1	35
DKV	2	2	2	2	2	5	1	16	2	7	4	1	46
Total	212	125	150	274	158	293	186	225	385	263	269	166	**2706**

Column description:

A = Controlling
B = Distribution
C = Ensuring
D = Field Engineering
E = Maintenance
F = Planning
G = Process Engineering
H = Production
I = Research and Development
J = Sales and Marketing
K = Service
L = Supply Chain

The majority of alumni jobs followed their respective study programs. For example, 'planning' was mostly occupied by alumni from the 'Architecture' (38.95 per cent), 'Regional and City Planning' (32.43 per cent), and 'Interior Design' (20.45 per cent) programs. The 'process engineering' career was mostly occupied by alumni from the 'Oil Engineering' (24.72 per cent), 'Marine Engineering' (24.49 per cent), and 'Geodesy and Geomatic Engineering' (24.42 per cent) programs. Furthermore, the 'maintenance' career was mostly occupied by alumni from 'Mechanical Engineering' (16.41 per cent), 'Aeronautics and Astronautics' (13.79 per cent), and 'Electrical Power Engineering' (10.26 per cent) programs. However, there was a job description which was much-interested by the alumni, and which was unrelated to their study program. For example, the 'controlling' work position was much-interested by alumni from the 'Astronomy' study program (15.38 per cent).

Figures 6. Alumni Job Percentage by Job Description



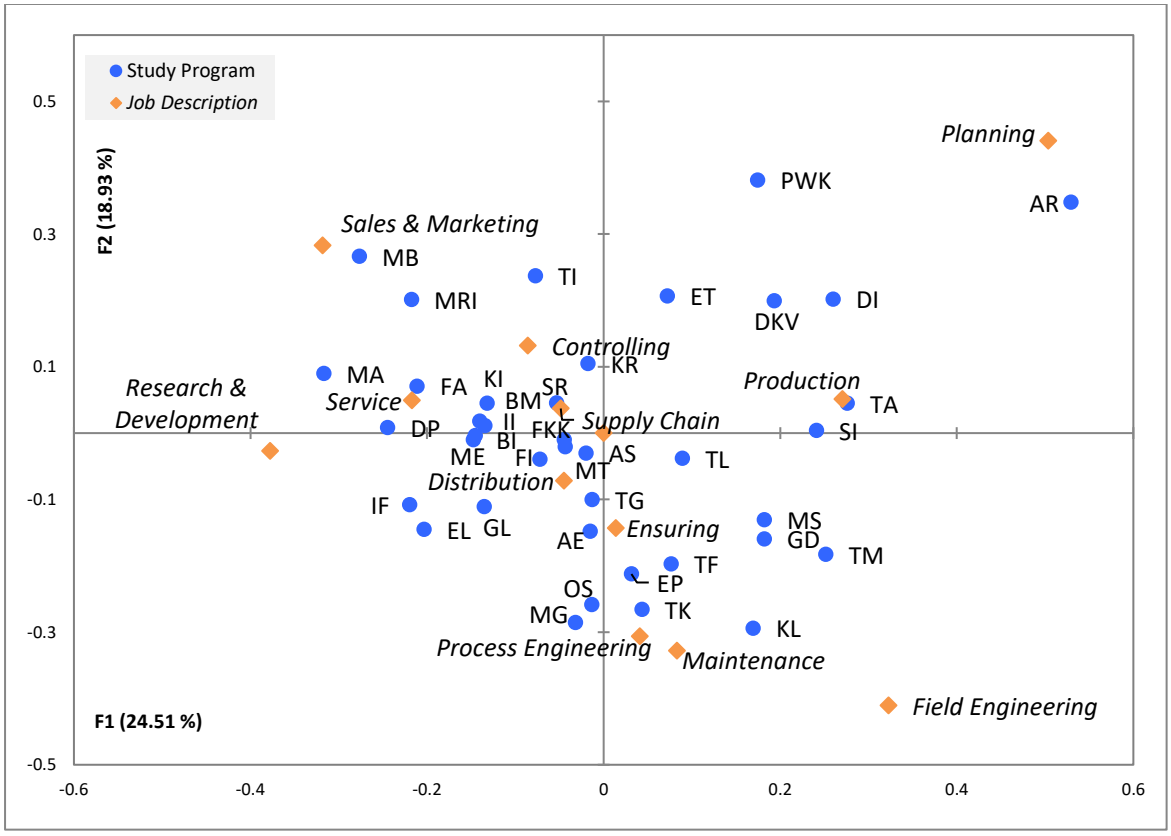
The Pearson's chi-squared test was performed to determine whether there is an association between the study program, and the job description. The test results obtained by the Pearson chi-squared statistics was 886.334, with a p-value of less than 0.0001. As the computed p-value is lower than the significance α=0.05, the H_0 should be rejected, and the H_1 accepted. The risk to reject the H_0, while it is true, is lower than 0.01 per cent. Thus, there is evidence suggesting that there is a statistically significant association between the study program, and job description.

Table 4: Test of Independence Between Study Program and Job Description

Pearson's Chi-squared Statistics Test	Value
Chi-square (Observed value)	886.334
Chi-square (Critical value)	466.668
Degree of freedom	418
p-value	< 0.0001
Alpha	0.05

The study program, and job description consist of more than three categories, and the row, and column profiles for this data is not feasible to depict upon low-dimensional plots. For this reason, the associations between these variables are described simultaneously in the correspondence plot, as presented in Figure 5. The first quadrant shows that the 'Architecture', and 'Regional and City Planning' study programs are associated with the 'planning' job description. The quadrants II, and IV, respectively, show that the 'Management Engineering' program is closely associated with the 'sales and marketing' job description, and the 'Engineering Physics' program is closely associated with the job description of 'process engineering'.

Figure 7. Correspondence Plot Using the First Two Principal Coordinates



Several categories provide little contribution to the association between the variables. For example, 'Biology', 'Microbiology', and 'Astronomy' programs, as well as the 'supply chain' job description. This can be recognised from the location of these coordinates, being close to the origin (0.0). Conversely, 'Architecture', and 'Region and City Planning' programs, and the 'planning' job description have a significant contribution, where the location of the coordinates is far from the origin. Besides describing the associations between the variables, the correspondence plot provides information on which categories have similar structures. Two or more categories are similar, if their coordinates are close together, and vice versa. For example, from the plot, it is recognised that 'Microbiology', and 'Biology' programs have a similar structure. In contrast, 'Regional and City Planning', and 'Ocean Engineering' programs are not similar in their structure.

Figure 7 graphically depicts 43.431 per cent of the association which exists among the study programs, and job descriptions. Thus, the plot in the two dimensions is not optimal in describing the associations between the variables (less than 65 per cent). In other words, this plot permits some information to be lost or not described. The information about the inertia contained in each dimension is summarised in Table 5. Based on the table, the plot correspondence will be optimal on four-dimensional plots, and will reach 100 per cent on eleven-dimensional plots. In other words, the information will reach 100 per cent on the L^*-dimension, where $L^* = \min\{I, J\} - 1$.

Table 5: Eigenvalues and Percentage of Inertia

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
Eigenvalues	0.080	0.062	0.051	0.045	0.028	0.020	0.016	0.013	0.007	0.004	0.002
Inertia (%)	24.505	18.926	15.441	13.60	8.448	6.191	4.979	3.876	2.081	1.252	0.700
Cumulative (%)	24.51	43.43	58.871	72.47	80.92	87.11	92.09	95.97	98.05	99.30	100

Conclusion

Overall, the evaluation results on the quality of higher education institutions — specifically the ITB — and based on the tracer study 2009 data, show that the ITB had succeeded in providing high-quality education. This is evident by the association between the relevance of the study, and job for each study program. Based on the data, the job suitability of alumni by their field of study reached 63.67 per cent. Moreover, the majority of alumni jobs follow their respective study programs. For example, the 'planning' job description was mostly attended by alumni from the 'Architecture' (38.95 per cent), 'Regional and City Planning' (32.43 per cent), and 'Interior Design' (20.45 per cent) programs. The 'process engineering' job description was mostly attended by alumni from the 'Oil Engineering' (24.72 per cent), 'Marine Engineering' (24.49 per cent), and 'Geodesy and Geomatic Engineering' (24.42 per cent) programs. Additionally, the correspondence plot shows that the 'Chemistry' program is closely associated

with a ‘non-relevance’ between the study, and job. Conversely, the ‘relevance’ of the study, and job was associated with the ‘Mining Engineering’, and ‘Visual Communication Design’ programs. Furthermore, the ‘Management Engineering’ program was closely associated with the ‘sales and marketing’ job description, and the ‘Engineering Physics’ program was closely associated with the ‘process engineering’ job description.

On the other hand, the level of relevance of the study to the job of the alumni in the ‘Astronomy’ study program was under 35 per cent. However, it is worth noting that there are few jobs in this sector, in Indonesia. It is anticipated that this finding will be conveyed by the ITB Career Center Research Division to the ITB policymakers, and universities in Indonesia, to manage higher education programs to improve student quality. Thus, the graduates from universities in Indonesia can not only compete in the world of work, but also can create jobs independently. In a future study, the researchers will conduct a tracer study data analysis using a three-way correspondence analysis, so that the association between the three categorical variables — the study program; the relevance of study, and job; and the job descriptions — can be presented simultaneously in a correspondence plot (Lestari et al., 2019).

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