

# Toward Enhancement of Higher Education Quality by Alumni Tracking Using Correspondence Analysis

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Higher education is a bridge connecting education to work, business and industry. When evaluating the higher education quality, the focus is commonly on the relevance of study and job. Indeed, the diversity of study programs at the institutes influences the job description 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 alumni 2009 at ITB is used. The results show that ITB has succeeded in organising high-quality education. It can be recognised by the association between the relevance of study and job for each study program. Based on the data, overall, the alumni job is compatible with their respective study programs.

**Key words:** *Correspondence Analysis, Higher Education, Tracer Study.*

## Introduction

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



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

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). ITB is also a bridge that connects education, business and industry. The relationship between education with business and industry leads ITB to give improvements, guarantees and improvement of curriculum programs, in addition to the quality of higher education institutions.

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 ITB in improving the quality of higher education is to hold the ITB tracer study. The tracer study is one of the methods in obtaining feedback from ITB alumni, expected to provide information about the success of higher education implemented at ITB. The results of the tracer study can help in assessing 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 study and their job is the focus. Drivers of study programs at ITB influenced the alumni job description category. The relevance of education to jobs and industry can be analysed by involving correspondence analysis. This study proposes to evaluate the success of higher education institutions (ITB) in organising education by investigating the associations (dependencies) between the relevance of study programs and alumni job descriptions. The association is presented graphically on the plot, known as the correspondence plot. This method is slightly different from previous research by the ITB Career Center Research Division in analysing tracer study data, as well as being a 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 3 explain the relevance of the study to the job and the job description of alumni 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. CA is a multivariate method for visualising categorical data presented in a two-way contingency table (Greenacre,

2017; Renchers & Christensen, 2012; Tufféri, 2011). In particular, CA displays rows and columns in the contingency table as coordinate points in low-dimensional space, also called 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 variables. Therefore, CA provides visualisation of the dependencies between variables at the category level.

CA uses the chi-squared statistic to measure the distance between points on the correspondence plot (Beh, 2001; Clausen, 1988; Pearson, 1904). This distance also measures the associations among categorical variables. The main issue of CA is how the existing plot can represent rows or columns of a contingency table in low-dimensional space (dimensions reducing) but can absorb as much as possible 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 variables (Ginanjar et al., 2014). It is important to note that each coordinate is of the same size (metric). Consequently, the distance between the row and the column coordinates are useless (Cuadras & Cuadras, 2006). Therefore, the focus on interpreting the correspondence map is the closeness between the coordinates.

The data was obtained from the Career Center Research Division of ITB, which held a tracer study of ITB alumni in 2009. The tracer study was organised in a structured and systematic manner, as illustrated in Figure 1. The questionnaire consists of 41 primary questions that contain personal data, alumni assessment of ITB, alumni competence, the alumni transition period to work, and alumni job profiles. In this article, the focus of discussion considers two aspects: 1) relevance of study and job, and 2) job description categories for each study program.

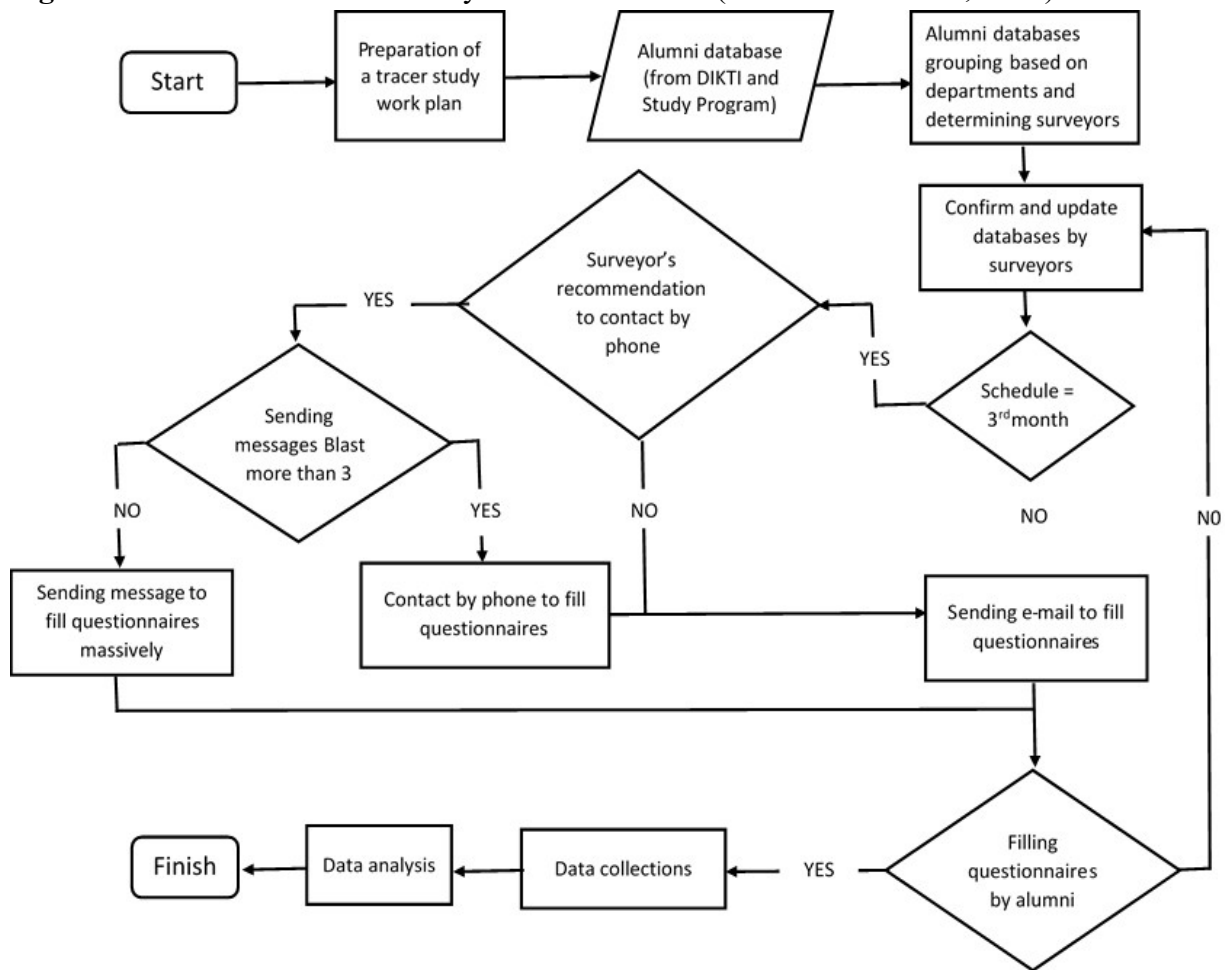
This analysis involves three categorical variables that are the study program, the relevance of study, job and job descriptions. Study programs consist of the categories 1) Aeronautics and Astronautics; 2) Architecture; 3) Astronomy; 4) Biology; 5) Chemical Engineering; 6) Chemistry; 7) Civil Engineering; 8) Clinical and Community Pharmacy; 9) Craft Design; 10) Electrical Engineering; 11) Electrical Power Engineering; 12) Engineering Physics; 13) Environmental Engineering; 14) Geodesy and Geomatic Engineering; 15) Geological Engineering; 16) Geophysical Engineering; 17) Industrial Engineering; 18) Informatics; 19) Information System and Technology; 20) Interior Design; 21) Management; 22) Management Engineering; 23) Material Engineering; 24) Mathematics; 25) Mechanical Engineering; 26) Metallurgical Engineering; 27) Meteorology; 28) Microbiology; 29) Mining Engineering; 30)

Ocean Engineering; 31) Oceanography; 32) Petroleum Engineering; 33) Pharmaceutical Science and Technology; 34) Physics; 35) Product Design; 36) Regional and City Planning; 37) Telecommunication Engineering; 38) Visual Art; and 39) Visual Communication Design.

The relevance of study and job is a binary variable consisting of yes and no categories.

Job descriptions consist of 12 categories: 1) controlling; 2) distribution; 3) ensuring; 4) field engineering; 5) maintenance; 6) planning; 7) process engineering; 8) production; 9) research and development; 10) sales and marketing; 11) service; and 12) supply chain.

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



## Results and Discussion

### *The Relevance of the Study and Job per Study Program*

The question about the relevance of study and job is the 12th of 41 questions. The questionnaire was filled out by 2706 alumni. A two-way contingency table of this data presented in Table 1.

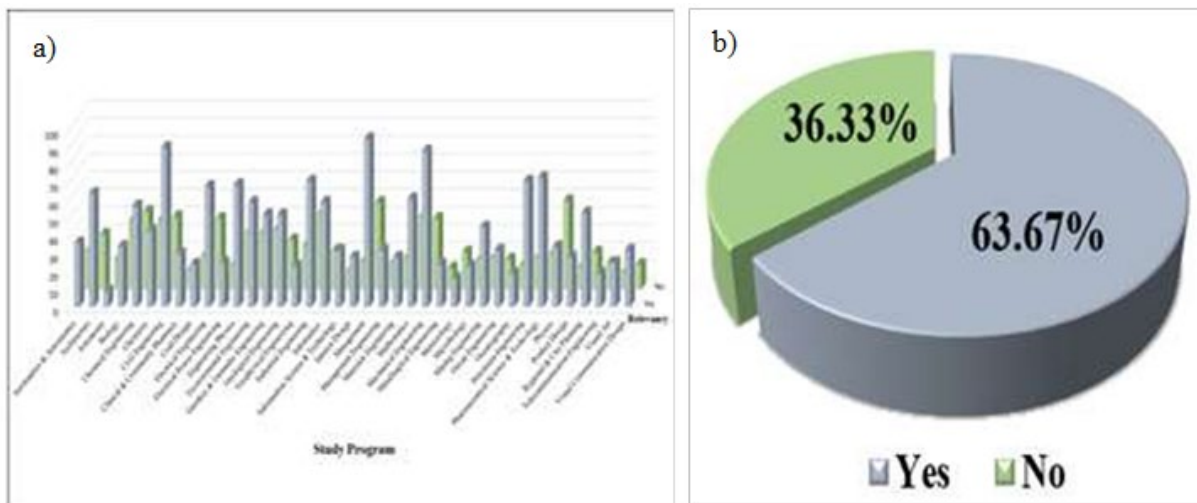
The frequency of each cell in the contingency table is illustrated in three dimensions, as in Figure 2a. Overall, the job relevancy of alumni and their field of study reached 63.67% (Figure 2b).

**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	36	22	58
Architecture	64	31	95
Astronomy	9	17	26
Biology	34	39	73
Chemical Engineering	57	44	101
Chemistry	43	39	82
Civil Engineering	90	41	131
Clinical and Community Pharmacy	30	11	41
Craft Design	24	19	43
Electrical Engineering	68	40	108
Electrical Power Engineering	25	14	39
Engineering Physics	69	32	101
Environmental Engineering	59	32	91
Geodesy and Geomatic Engineering	52	34	86
Geological Engineering	52	28	80
Geophysical Engineering	23	25	48
Industrial Engineering	71	43	114
Informatics	59	22	81
Information System and Technology	32	11	43
Interior Design	28	16	44
Management	95	49	144
Management Engineering	32	15	47
Material Engineering	28	18	46
Mathematics	61	41	102
Mechanical Engineering	88	40	128
Metallurgical Engineering	24	12	36
Meteorology	16	21	37
Microbiology	23	17	40
Mining Engineering	45	18	63
Ocean Engineering	32	17	49
Oceanography	19	14	33

Petroleum Engineering	71	18	89
Pharmaceutical Science and Technology	73	20	93
Physics	34	50	84
Product Design	28	13	41
Regional and City Planning	53	21	74
Telecommunication Engineering	19	15	34
Visual Art	25	10	35
Visual Communication Design	32	14	46
Total	1723	983	2706

**Figure 2.** a) The 3D View of Contingency Table. b) Percentage of the Relevance of Study and Job



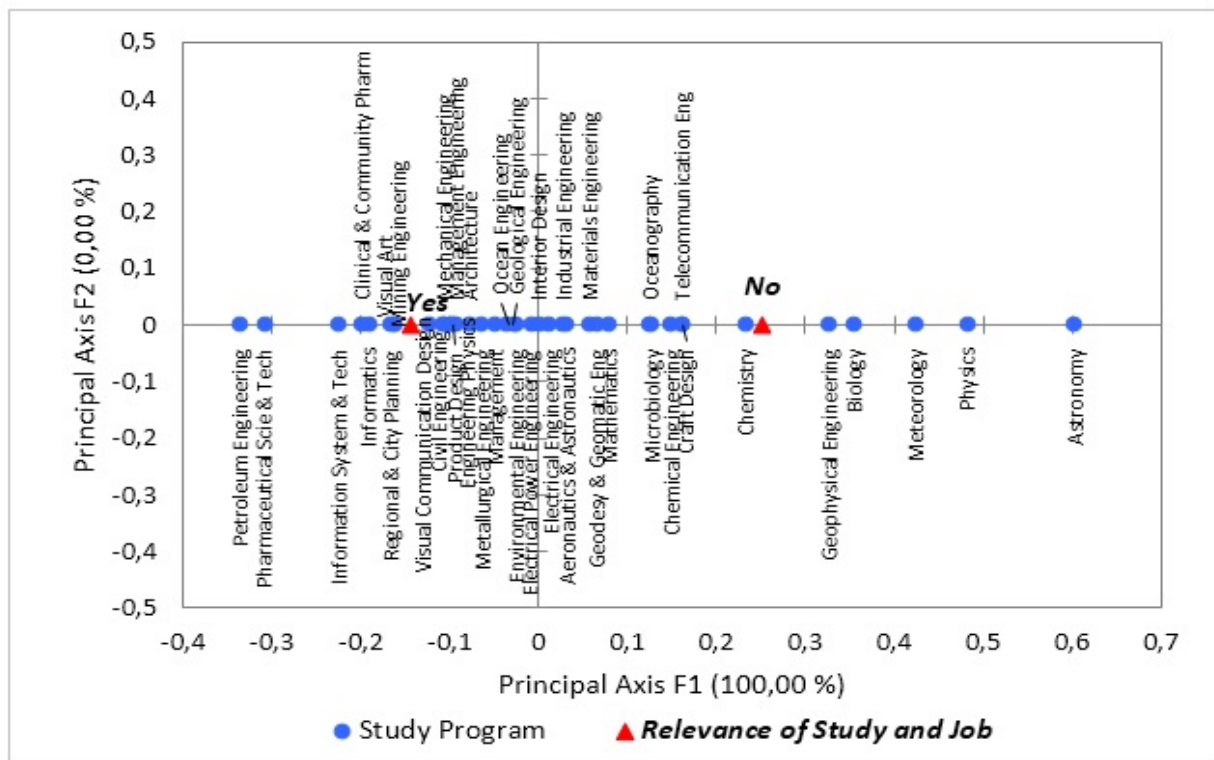
Based on the data, the “Petroleum Engineering” study program has the highest percentage of study relevant to alumni jobs, which is 79.78%. The percentage came from 71 of the alumni. However, in terms of numbers, the “Management” study program contributed 95 out of 144 alumni whose jobs were following their field of study, the most when compared to other study programs. On the other hand, the level of relevance of the study to the job of alumni at “Astronomy” study programs is under 35%. However, it requires to note that there are still 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
<i>p</i> -value	< 0.0001
Alpha	0.05

Table 2 presents Pearson's chi-squared statistical test results. This test is used to determine whether there is an association between study programs (rows) and the relevance of study and job (columns). According to equation 2, Pearson's chi-squared statistics 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,  $H_1$  accepted. The risk of rejecting the  $H_0$ , while it is true, is lower than 0.01%. Thus, there is evidence suggesting that there is a statistically significant association between the study program and the relevance of study and job.

**Figure 3.** Correspondence Plot of the Principal Coordinates in Two Dimensions



The association between rows and columns can be recognised based on the proximity of each category through row profiles or column profiles. In case row categories consists of more than three categories, the column profile is not feasible to draw in low-dimensional plots. However,

these points still exist in a multidimensional space, also called as *a cloud of points*. While the correspondence plot simultaneously depicts the association among the study programs and the relevance of study and job. Figure 3 graphically depicts 100% of the association that exists between the study program and the relevance of study and job. It shows that the “Chemistry” study program is closely associated with the non-relevance of study and job. Likewise, the relevance of study and job is associated with the “Mining Engineering” and “Visual Communication Design” study program.

### ***Job Description per Study Program***

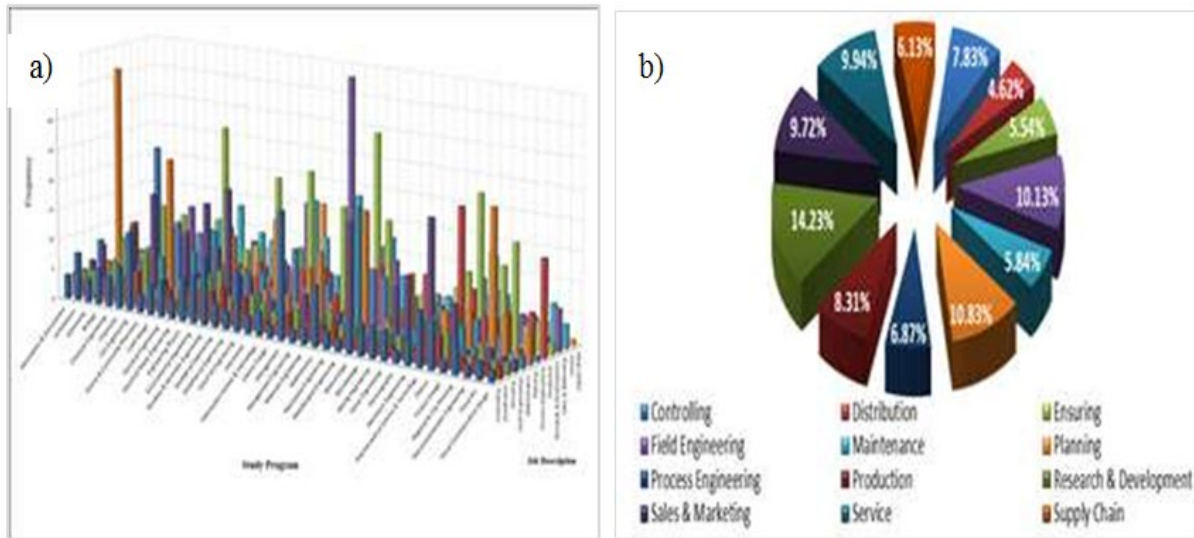
In the previous section, the results show that many alumni work in sectors that are not relevant to their study. However, their job remains connected to the field of education. Therefore, it is also necessary to recognise a job description done by alumni. Generally, the most job description done by alumni is in the “research and development” division (14.23%). It is reasonable, considering that several companies including educational institutions under the Ministry of Research and Higher Education are actively encouraging research and development. In addition to research and development, other categories of interest to alumni are “planning” (10.83%) and “field engineering” (10.13%). See Figure 4b.



**Table 3:** Tracer Study ITB 2009 Data on Job Description

Study Program	Job Description												Total
	Controlling	Distribution	Ensuring	Field eng	Maintenance	Planning	Process Eng	Production	R&D	Sales & Marketing	Service	Supply Chain	
Aeronautics & Astronautics	4	4	4	5	8	4	4	5	9	4	4	3	58
Architecture	8	3	4	8	3	37	8	10	4	4	3	3	95
Astronomy	4	1	2	2	2	3	2	1	5	1	1	2	26
Biology	6	4	6	6	3	4	4	5	13	9	6	7	73
Chemical Eng	5	3	10	12	6	6	24	5	8	9	6	7	101
Chemistry	7	5	5	7	4	6	4	5	12	13	8	6	82
Civil Eng	13	6	9	18	7	23	12	10	6	8	9	10	131
Clinical & Com Phar	3	2	3	4	1	3	3	3	2	3	11	3	41
Craft Design	5	2	2	2	2	4	2	5	2	3	10	4	43
Electrical Eng	6	4	3	12	9	4	8	6	28	9	14	5	108
Electrical Pwr	3	3	3	6	4	2	2	3	5	2	3	3	39
Engineering Physics	7	5	6	18	13	7	5	6	8	9	10	7	101
Environmental	8	5	7	11	7	12	5	4	9	5	9	9	91
Geodesy & Geomatic	11	5	8	21	3	7	3	7	4	7	6	4	86
Geological Eng	4	6	4	7	7	6	6	4	21	6	4	5	80
Geophysical Eng	3	4	2	7	4	4	4	1	3	6	8	2	48
Industrial Eng	10	5	5	3	3	16	6	6	10	17	17	16	114
Informatics	3	2	4	4	4	4	11	7	23	5	11	3	81
Information Sys & Tech	4	2	3	2	2	3	5	3	6	6	5	2	43
Interior Design	2	2	2	3	2	9	2	8	2	4	4	4	44
Management	21	4	4	6	4	12	6	4	18	39	19	7	144
Managemet Eng	2	2	2	2	2	4	2	3	6	12	6	4	47
Material Eng	3	6	3	3	2	3	2	6	7	3	4	4	46
Mathematics	10	3	5	4	3	6	3	7	31	12	13	5	102
Mechanical Eng	3	4	3	19	21	20	10	10	17	10	7	4	128
Metallurgical	2	2	3	3	2	1	9	2	3	2	4	3	36
Meteorology	5	2	2	3	1	3	3	2	9	3	2	2	37
Microbiology	4	2	2	2	3	3	3	2	6	4	5	4	40
Mining Eng	4	2	3	10	3	11	2	10	5	4	5	4	63
Ocean Eng	5	2	33	12	3	4	6	2	4	2	4	2	49
Oceanography	2	1	2	7	2	2	2	2	8	1	3	1	33
Petroleum Eng	4	2	3	10	3	11	2	10	5	4	5	4	89
Pharmaceutical	9	5	7	3	3	7	3	9	24	7	13	3	93
Physics	8	5	5	9	5	7	5	5	15	8	7	5	84
Product Design	2	2	2	2	2	2	2	5	13	5	2	2	41
Regional & City Plan	5	2	2	2	2	24	3	6	17	5	4	2	74
Telecomm Eng	2	2	3	3	1	7	1	1	4	5	2	3	34
Visual Art	3	2	2	2	1	2	1	7	5	2	7	1	35
Visual Comm	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

**Figure 4.** a) The 3D View of Contingency Table. b) Alumni Job Percentage by Job Description



Back to the data, the majority of alumni jobs follow their respective study programs. For example, “Planning” was mostly attended by alumni from “Architecture” (38.95%), “Regional and City Planning” (32.43%), and “Interior Design” (20.45%). “Process Engineering” was mostly attended by alumni from the “Oil Engineering” (24.72%), “Marine Engineering” (24.49%), and “Geodesy and Geomatic Engineering” (24.42%). Furthermore, “Maintenance” had a lot of interest from alumni from “Mechanical Engineering” (16.41%), “Aeronautics and Astronautics” (13.79%), and “Electrical Power Engineering” (10.26%). However, there is a job description that had a lot of interest from alumni, which was unrelated to their study program. For example, “Controlling” had a lot of interest from alumni from the “Astronomy” study program (15.38%).

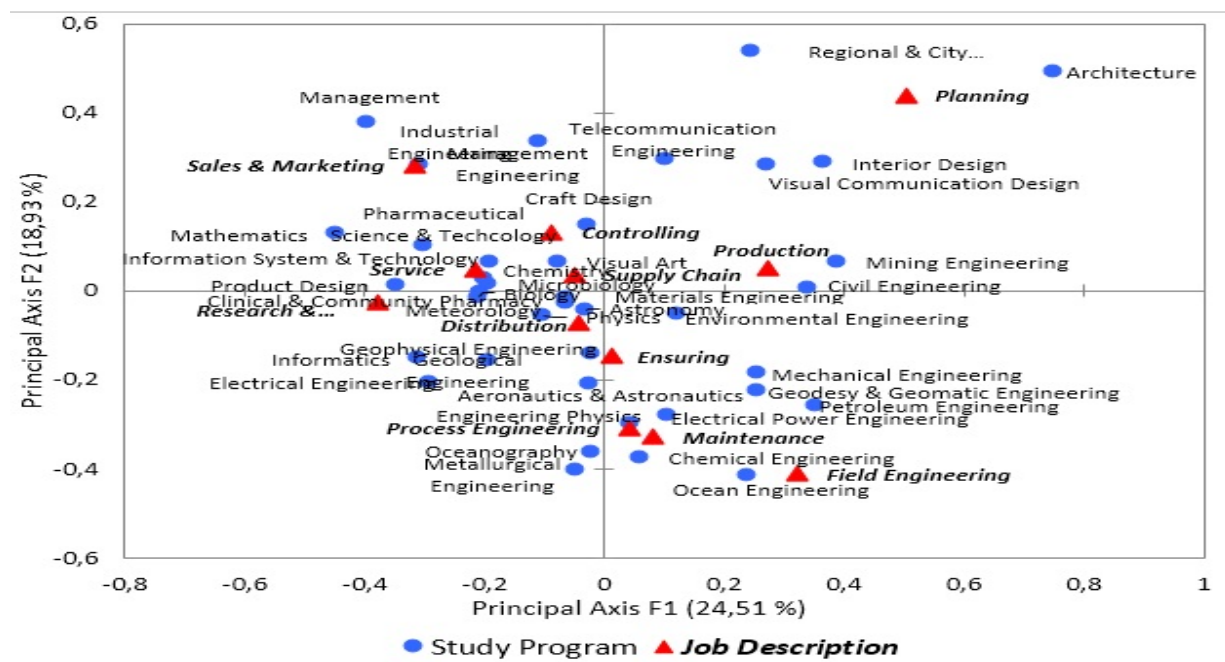
Pearson's chi-squared test was performed to determine whether there is an association between the study program and the job description. The test results obtained by the Pearson chi-squared statistics are 886.334 with a p-value of less than 0.0001. As the computed p-value is lower than the significance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

In case the study program and job description consist of more than three categories, the row and column profiles for this data is not feasible to depict on 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. In quadrants II and IV, respectively, it shows that the “Management Engineering” is closely associated with “Sales and Marketing,” and the “Engineering Physics” is closely associated with “Process Engineering.”

**Figure 5.** Correspondence Plot Using the First Two Principal Coordinates



Several categories have little contribution to the association between variables, for example, “Biology,” “Microbiology,” and “Astronomy,” as well as the “Supply Chain.” It can be recognised from the location of these coordinates close to the origin (0.0). Conversely, “Architecture,” “Region and City Planning,” and “Planning” have a significant contribution where the location of the coordinates is far from the origin. Besides describing the associations between variables, the correspondence plot provides information on which categories have similar structures. Two or more categories are similar if their coordinates are close together. For example, from the plot, it is recognised that “Microbiology” and “Biology” have a similar structure. In contrast, “Regional and City Planning” and “Ocean Engineering” are not similar in structure.

Figure 5 graphically depicts 43.431% of the association that exists among the study program and job description. Thus, the plot in the two dimensions is not optimal in describing associations between variables (less than 65%). 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 reach 100% on eleven-dimensional plots. In other words, the information will reach 100% 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	13.600	8.448	6.191	4.979	3.876	2.081	1.252	0.700
Cumulative (%)	24.505	43.431	58.871	72.472	80.920	87.111	92.091	95.967	98.047	99.300	100

## Conclusion

Overall evaluation results on the quality of higher education institutions (specifically ITB), and based on the tracer study data 2009, show that ITB had succeeded in providing high-quality education. It can be recognised by the association between the relevance of study and job for each study program. Based on the data, overall, the job suitability of alumni by their field of study reached 63.67%. Moreover, the majority of alumni jobs follow their respective study programs. For example, "Planning" was mostly attended by alumni from "Architecture" (38.95%), "Regional and City Planning" (32.43%), and "Interior Design" (20.45%). "Process Engineering" was mostly attended by alumni from "Oil Engineering" (24.72%), "Marine Engineering" (24.49%), and "Geodesy and Geomatic Engineering" (24.42%). Additionally, the correspondence plot shows that "Chemistry" is closely associated with the non-relevance of study and job. Similarly, the relevance of study and job is associated with "Mining Engineering" and "Visual Communication Design." Furthermore, "Architecture" and "Regional and City Planning" are associated with the "Planning" job description. "Management Engineering" is closely associated with "Sales and Marketing," and "Engineering Physics" is closely associated with "Process Engineering."

On the other hand, the level of relevance of the study to the job of alumni at "Astronomy" study programs is under 35%. However, it requires to note that there are still very few jobs in this sector in Indonesia. This finding is expected to be conveyed by the ITB Career Center Research Division to ITB policymakers and universities in Indonesia to manage programs to improve student quality. Thus, graduates from universities in Indonesia not only can compete in the world of work but also can create jobs independently. In future work, we will conduct a tracer study data analysis using three-way correspondence analysis, so that the association between the three categorical variables, i.e. the study program, the relevance of study and job, and job descriptions can be presented simultaneously in a correspondence plot (Lestari et al., 2019).



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