International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 14, Issue 11, 2020

The Graduate Views on the Contribution of Higher Education to Future Careers

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Future jobs and careers are the main issues in the study of higher education graduates. This paper discusses both from graduates' perspectives: 1) by exploring associations between the departments and their contribution to future careers using correspondence analysis, 2) by clustering the departments according to the contribution level using agglomerative hierarchical clustering. This study's results provide a recommendation to the higher education institution to evaluate whether or not the course from the scientific field in the institution is appropriate.

Key words: *Cluster analysis, Correspondence analysis, Education research methodology, Higher education, Tracer study.*

Introduction

Higher education has an essential role in the job market in fulfilling the workforce by their fields. Every graduate is required to actualize the knowledge in their respective fields of work. On the other side, higher education institutions with various scientific fields are expected to produce graduates according to their respective fields of expertise. Accordingly, as a board for developing science and technology, higher education institutions should equip and prepare graduates to acquire specific jobs or competencies and map it to the job market. Graduates who are following the job market demands undoubtedly play a role in building the economic country.

When analyzing the graduates in the job market, the discussion mostly concerned the contribution of higher education institutions (which consists of departments) to future careers (Kalayci and Basaran, 2010; Schomburg, 2010; Pasaribu et al., 2020). As the job market becomes more dynamic and competitive, understanding the quality and suitability of graduates' competencies to the workplace is an absolute requirement for every university. On the other side, the fact that job prospects are not following the department undertaken during college often happens in the current era. The JobsDS, a job seeker portal, explained that more than 66 thousand bachelors in Indonesia are not absorbed by companies and potentially become unemployed. In contrast, the number of bachelors each year reaches around 250 thousand.

The difficulty for bachelors to get a job can be seen from Indonesia's educated unemployment rate, which increases every year. Based on the data in Statistics Indonesia (locally known as BPS or Central Agency on Statistics) in August 2014, there was 9.5% (688,660 people) of the total unemployed who are graduates of higher education. This is a percentage increase compared to the previous year, which was only 8.36% (619,288 people). It shows that more than 60 thousand bachelors in Indonesia are not absorbed in employment.

Based on the study by Willis Towers Watson (Saroh and Handayani, 2016) on Talent Management and Rewards since 2014, it is revealed that eight out of ten companies in Indonesia have difficulty getting bachelors who are ready to employ. In contrast, the growth rate for higher education graduates in Indonesia is always increasing every year, while the company demand for labor is always lower than the number of graduates. The difficulty of absorbing Indonesian higher education graduates is because they do not have the skills that companies demand. The working life is complex and dynamic; thus, it should be observed regularly and systematically. The higher education institution should respond to the job market on demands through the establishment of career centers. The career center activities include training, internships, online job fairs, job opportunity fairs, campus hiring, career counselling, and tracer studies.

On the other hand, input from graduates helps the higher education institution map the job market, narrowing the competency gap obtained in institutions and the demands of the job market. It is the basic idea for implementing a tracer study. The tracer study results provide feedback for higher education institutions in developing curriculum, holding activities to prepare students to enter a competitive job market, and evaluating the relevance of the academic world and the job market.

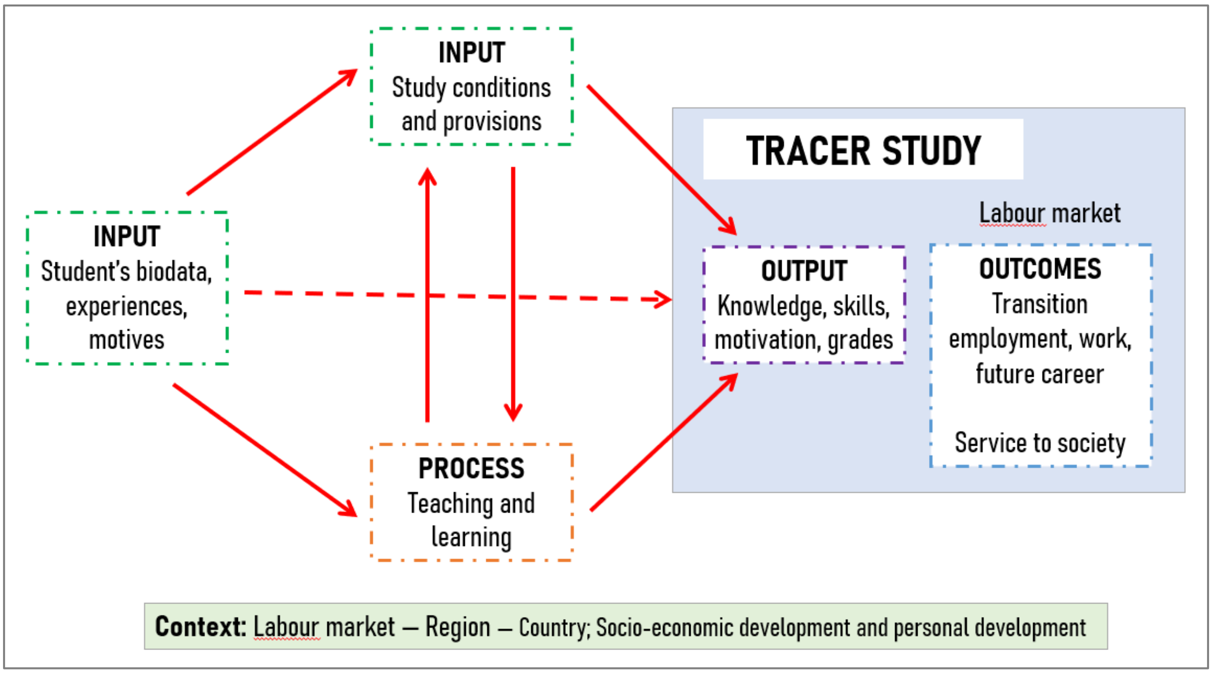
Based on the previous description, two main problems resolved in this study are 1) exploring associations between the departments and their contribution to future careers, and 2) grouping departments according to the contribution level. Generally, the results of this study aim to gather information about educational outcomes in the term of a transition from the academic world to the job market; the output of education in the form of an assessment of the mastery and acquisition of competencies, the educational process as an evaluation on the learning process, and the contribution of higher education to its graduate future careers.

This article is arranged into four sections. The second section explains the method of preparation and research planning, data collections, and data analysis. The third section's results and discussion interpret the association between the department and the contribution level using correspondence analysis, and grouping the departments into several clusters based on the contribution level using agglomerative hierarchical clustering. The last section is the conclusion, which summarises the essence of the research.

Methodology

This research used the tracer study method, that is, graduates of higher education institutions research. The method had been organised in many countries globally, including Germany, the Netherlands, Japan, Ethiopia, and no exception in Indonesia. The tracer study results provided information related to graduates and can be used as the evaluation or reference for assessing higher education institutions' quality. In the future, this information can also be used to make decisions regarding study designs and practical solutions to implement of higher education (Schomburg, 2010).

Figure 1. Conceptual framework of tracer study (Schomburg, 2010)



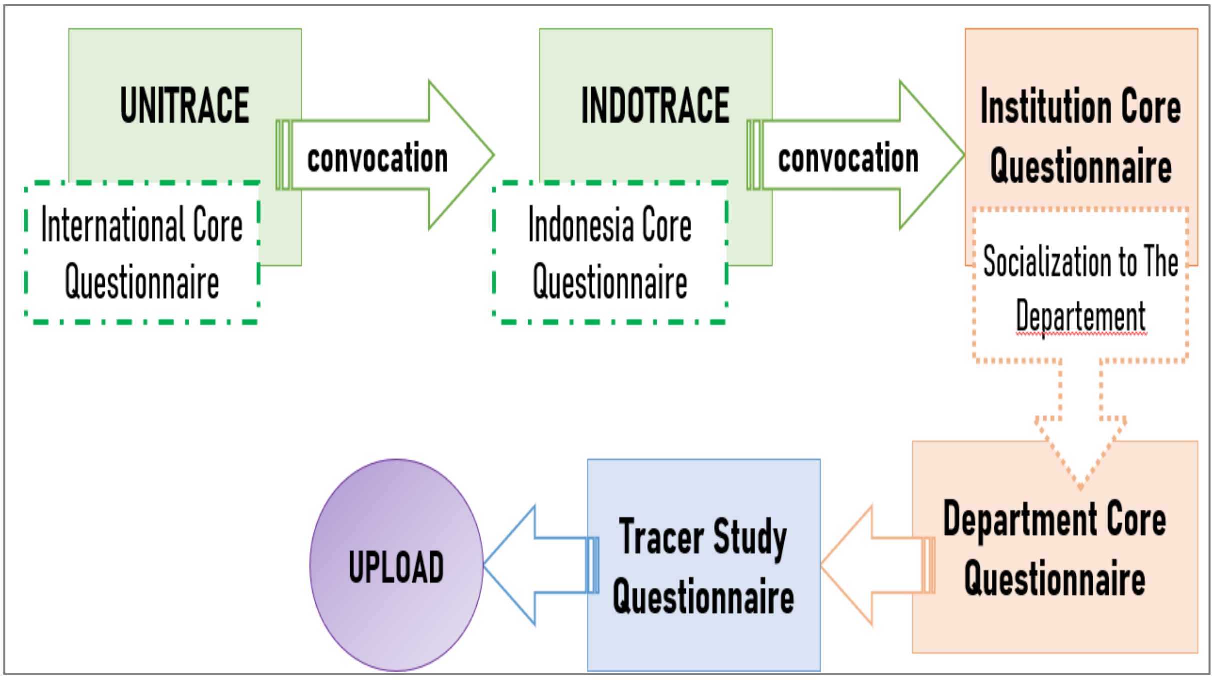
According to Figure 1, the tracer study obtains input in students' biodata, including experience, educational background, motives, and skills. The data obtained shows the characteristics of students in specific batches. Ideally, the learning and training processes such as lectures, research, practicum, workshops, laboratories, studios, or research are customised to students' characteristics in that batch.

Input, apart from students, was also obtained from institutional elements in the structure, conditions, curriculum, and learning behaviour in higher education. Both of these inputs can influence the teaching and learning process and determine the outcome. The output produced is in the form of knowledge, skills, motivation, values, and other aspects that can completely shape graduates' character and competence.

Regarding the job market, the tracer study tracks students' transition process after graduating to their job career crew, which is at an interval of 1-3 years after graduation, depending on their respective cohort. At this stage, students who are already working or entrepreneurial are considered sufficiently experienced to assess their field of work, and learning outcomes.

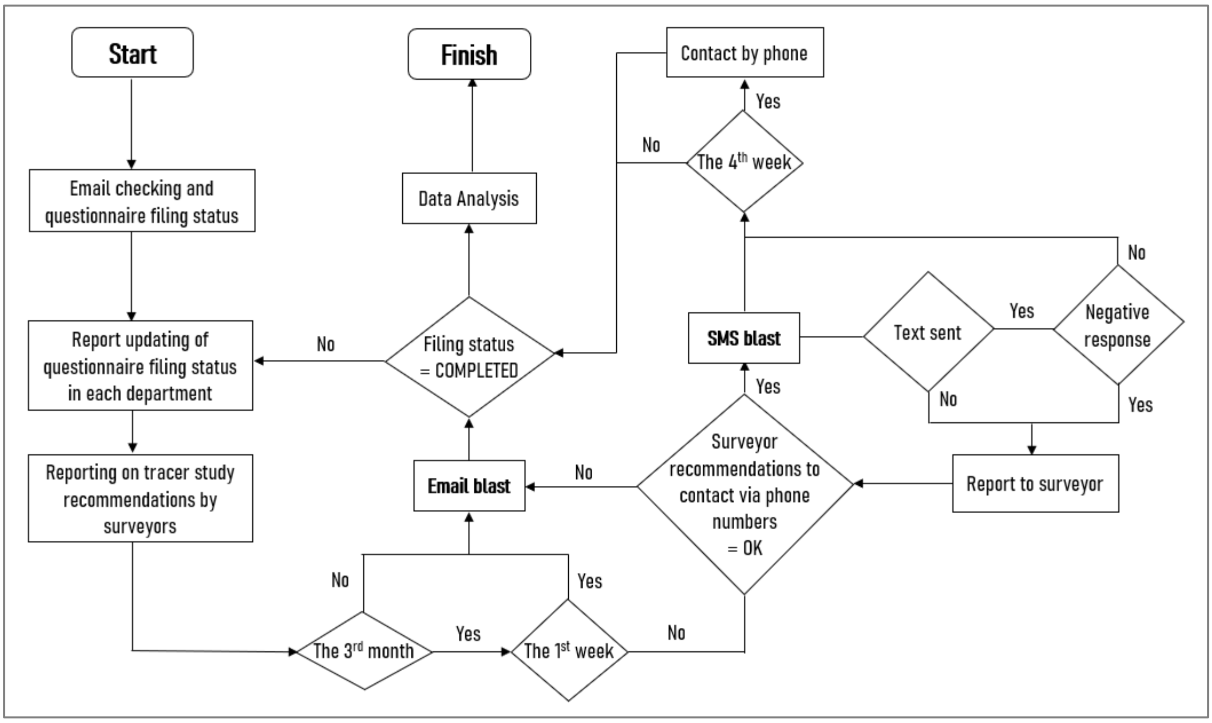
Furthermore, a tracer study should be implemented in a structured and appropriate methodology so that the results are measurable and comparable. In general, the implementation of a tracer study consists of three stages: preparation and planning, data collection, and data analysis. The initial steps taken during the preparation and planning include established survey objectives, target respondents, time for research and survey implementation techniques. A questionnaire was prepared by adopting several core questionnaires that are completely shown in Figure 2.

Figure 2. Stages of arranging a tracer study questionnaire.



The next step is to collect the graduate database by email and SMS blasts methods. The data collection process was undertaken for three months. The complete technical response database collection is presented in Figure 3.

Figure 3. Flowchart of email and SMS blast method for data collection.



Scheduled email blasts are sent once a month. Additional email deliveries were made according to the surveyor's request if deemed necessary. The graduate database is continuously updated throughout the data collection process. The approach to respondents is slightly different when entering the third month. Graduates who have not filled out the questionnaire in the month get an SMS blast in the second, third, and fourth weeks. The time lag for the execution of the SMS blast is considered so that it does not overlap with the email blast sending. If the respondent's target has not been fulfilled in the last week, the graduates will be contacted by telephone. Contact by telephone was made based on the surveyor's recommendation.

The data collection stage obtained the data regarding the graduate views on each department's contribution to a future career. To simplify the further analysis, the data is presented in cross-tabulation consisting of rows and columns, called contingency tables. These rows represent the department (referred to as the row categorical variable), while the columns represent the contribution to the future career (referred to as the column categorical variable).

When analysing contingency tables, the focus is commonly on the association between the row and column categorical variables (Beh and Lombardo, 2014). The appropriate categorical data analysis technique for this problem is correspondence analysis (Benzècri, 1992; Greenacre, 2017; Lestari et al., 2019). This technique visualised the association between variables in a low-dimensional plot. Furthermore, Lestari et al. (2020) show that the correspondence plot is more accurate if the eigenvalues regarding as scale factor in the plot are obtained analytically.

In order to determine whether the association between these variables is statistically significant, it is measured based on the chi-square statistic (Pearson, 1904).

After obtaining a description of the associations between the departments and their contribution to future careers, further analysis was carried out by grouping the departments according to the level of their contribution. For this reason, agglomerative hierarchical clustering was performed using Ward's method. In cluster analysis, rows of the matrix data (the departments) are seen as the observation vector, and the column (the contribution level) corresponds to a variable (Yudhanegara and Lestari, 2019). This analysis attempted to identify the observation vectors that are similar and group them into the cluster. A convenient measure of proximity is the distance between two observations. Since distance increase as two units became further apart, distance is a measure of dissimilarity (Renchers and Christensen, 2012; Yudhanegara et al., 2020a). The two analysis techniques are part of the data analysis as the final stage of the research.

Result and Discussion

The data used is the tracer study data of one of the top universities in Indonesia 2018. Tracer studies were held from June to August 2018. The batch of 2011 was chosen as the respondent. They were considered appropriate as respondents because they are at intervals 1-3 years after graduation, thus providing an assessment and experience during the transition period to work. It recorded 3088 graduates from 40 departments have filled out the questionnaire. These departments come from 7 faculties and 5 schools, as follows: Faculty of Earth Sciences and Technology (FITB), Faculty of Mathematics and Natural Sciences (FMIPA), Faculty of Fine Art and Design (FSRD), Faculty of Industrial Technology (FTI), Faculty of Mechanical and Aerospace Engineering (FTMD), Faculty of Mining and Petroleum Engineering (FTTM), Faculty of Civil and Environmental Engineering (FTSL), School of Architecture, Planning and Policy Development (SAPPK), School of Business and Management (SBM), School of Pharmacy (SF), School of Life Sciences and Technology (SITH), and School of Electrical and Informatics Engineering (STEI).

The questionnaire consists of 47 main questions containing: 1) graduate profile, 2) graduate assessment of higher institutions, 3) graduate competence, 4) transition to the job market, and 5) employment. Based on these 47 questions, the 20th question will be analyzed regarding how much each department contributes to graduates' future careers. There are four options that are arranged ordinally, and labelled as 1 = Low, 2 = Middle-Low, 3 = Middle-Strong, and 4 = Strong. Cross-tabulation of the department by contribution level yields the 40 × 4 contingency tables, as in Table 1.

Table 1: Cross-tabulation of 2864 graduates according to their views on each department's contribution level to a future career.

Faculty or School	Department	Contribution to future career				Total
		Low (1)	Middle-Low (2)	Middle-Strong (3)	Strong (4)	
FITB	Meteorology (ME)	6	17	15	2	40
	Oceanography (OS)	5	18	12	4	39
	Geodesy & Geomatic Engineering (GD)	5	23	40	14	82
	Geological Engineering (GL)	3	18	46	19	86
FMIPA	Astronomy (AS)	6	8	18	4	36
	Physics (FI)	8	40	54	8	110
	Chemistry (KI)	3	27	65	15	110
	Mathematics (MA)	2	21	64	30	117
FSRD	Desain Interior (DI)	0	6	21	7	34
	Visual Communication Design (DKV)	0	4	23	10	37
	Product Design (DP)	2	15	17	6	40
	Craft Design (KR)	2	12	17	8	39
	Visual Art (SR)	3	11	16	5	35
FTI	Management Engineering (MRI)	0	9	27	13	49
	Engineering Physics (TF)	5	12	56	21	94
	Industrial Engineering (TI)	3	13	60	33	109
	Chemical Engineering (TK)	2	12	63	28	105
FTMD	Aeronautics & Astronautics (AE)	1	13	28	9	51
	Material Engineering (MT)	7	13	31	10	61
	Mechanical Engineering (MS)	1	21	75	31	128
FTTM	Geophysical Engineering (TG)	3	21	24	4	52
	Metallurgical Engineering (MG)	0	7	19	8	34
	Petroleum Engineering (TM)	4	20	37	15	76
	Mining Engineering (TA)	0	8	40	14	62
FTSL	Ocean Engineering (KL)	3	23	27	13	66
	Environmental Engineering (TL)	0	15	45	15	75
	Civil Engineering (SI)	2	18	98	41	159
SAPPK	Architecture (AR)	1	29	70	12	112
	Regional & City Planning (PWK)	3	25	48	15	91
SBM	Management (MB)	0	9	39	25	73
SF	Clinical & Community Pharmacy (FKK)	0	12	31	10	53
	Pharmaceutical Science & Technology (FA)	0	11	66	26	103
SITH	Biology (BI)	7	21	38	6	72
	Microbiology (BM)	1	11	17	11	40
	Biological Engineering (BE)	4	9	21	5	39
STEI	Information System & Technology (II)	0	3	28	16	47
	Electrical Engineering (EL)	2	31	88	20	141
	Informatics (IF)	0	5	39	29	73
	Telecommunication Engineering (ET)	0	7	16	11	34
	Electrical Power Engineering (EP)	2	10	36	12	60
Total		96	608	1575	585	**2864**

The table above shows that most (40.8%) of the graduates viewed that each department had a strong contribution to graduates' future careers. Graduates from Civil Engineering chose a middle-strong and strong category with the largest number of students among other departments, that is 82 and 41 graduates, respectively. On the other side, most respondents who choose the middle-low and low category came from graduates of the Physics Department, respectively, 8 and 20 graduates. Furthermore, considering its relative frequency, the department that most contributed strongly to future careers, was the Informatics Engineering (39.7%), and the most middle-strong contribution was the Mining Engineering (54.8%), while Oceanography had the most middle-low contribution (25.6%), and Astronomy with the lowest contribution (16.7%).

Contribution of each department to graduates future career

Association between categorical variables analyzed inferentially used the chi-square test. This test compares the observed frequencies and the expected frequencies. The observed frequencies are presented in Table 1, which is known as a contingency table. The expected frequencies under the assumption of H_0 are obtained by multiplying each cell probability by the total number of observations (Walpole et al., 2012). The null and alternative hypotheses are:

H_0: The row and the column categorical variables are independent.
H_1: There is a link between the row and the column categorical variable.

Table 2: Chi-square independence test between the department and its contribution to future careers.

Pearson's Chi-square Statistics Test	**Value**
Chi-square (Observed value, χ^2)	339.74
Chi-square (Critical value, $\chi^2_{\alpha,\nu}$)	143.25
Degree of freedom	117
p-value	< 0.0001
Alpha	0.05

The table above presents the statistical inference results for the independence test; the Pearson chi-square statistic is 339.74. As the computed p-value is lower than the significance level $\alpha = 0.05$, one should reject the H_0. The risk to reject the H_0 while it si true is lower than 0.01%. It implies that there is a statistically significant association between the department and the level of its contribution to the graduate's future careers. In order to see how this association is graphically, it is presented by a correspondence plot. This plot is obtained by performing the CA procedure and is depicted as in the Figure below:

Figure 4. Correspondence plot in two dimensions. It naturally depicts the association between the department and its contribution to their graduate future careers.

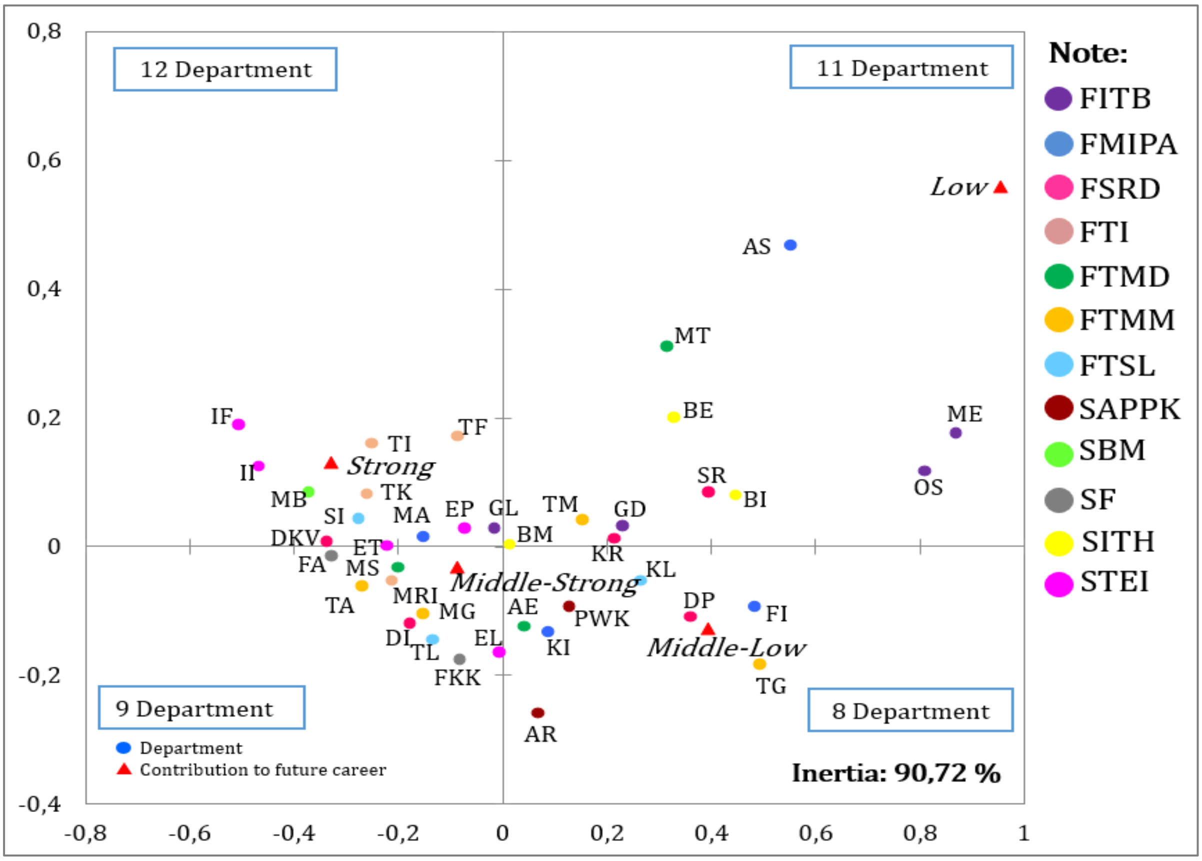


Figure 3 graphically depicts 90.72% of the association that exists between the department and the contribution level. Some interesting information obtained from this plot are:

1. The departments from FMIPA (AS, FI, KI, MA: blue-circle marked) and FTSL (KL, TL, SI: light blue-circle marked) have different characteristics in terms of their contribution to future careers. It can be seen from the position of the coordinates of each department, which are spread over on different quadrants.

2. Departments from the same faculty or school with similar characteristics in terms of their contribution to future careers come from SF and SITH. The coordinates that represent the department of SF (BI, BM, BE: grey-circle marked) lie on the third quadrant. At the same time, the coordinates that represent the departments of SITH (BI, BM, BE: yellow-circle marked) are located on the first quadrant.

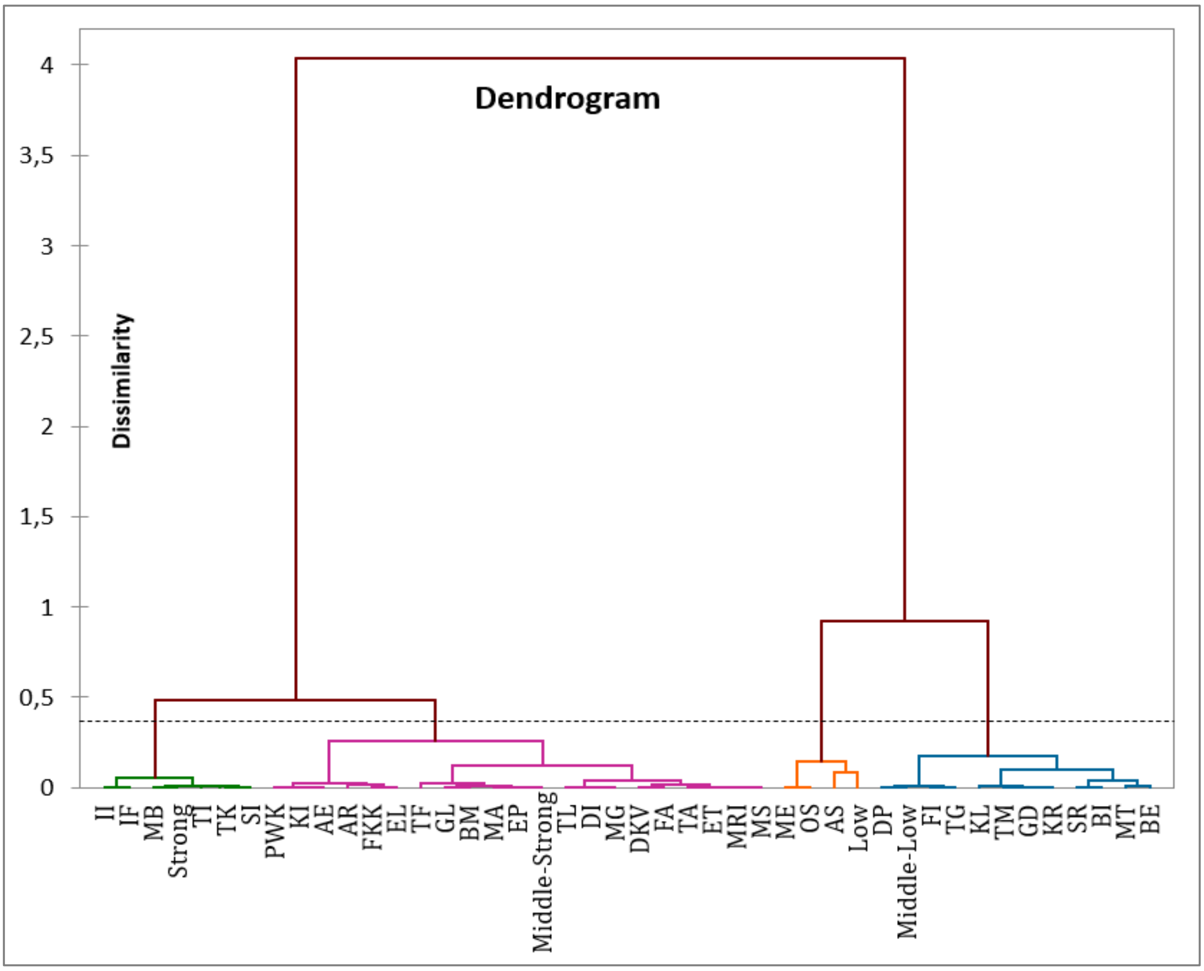
3. The coordinate of Microbiology (BM) close to the origin (0.0) almost does not contribute to the association between the department and its contribution level, since it only makes a relatively small contribution to the total inertia. On the other hand, the coordinate of the low category level is far from the origin and does make such a contribution.

Overall, the plot divides the departments into four quadrants based on their level of contribution. This grouping is discussed by cluster analysis in the next section.

Clustering the departments according to the contribution level

In cluster analysis, a pattern is sought in the data set by grouping observations (the departments) into clusters (based on the contribution level). The goal is to find an optimal grouping for which the departments within each cluster are similar, but the clusters are dissimilar (Renchers and Christensen, 2012: Yudhanegara et al., 2020b). The dendrogram in the figure below shows that the cluster groupings used Ward's method's agglomerative hierarchical clustering.

Figures 5. Dendrogram for Ward's method applied to group the department based on the contribution level.



The dendrogram above shows the hierarchical relationship between the department and the contribution grade. The vertical axis of the dendrogram represents the distance or dissimilarity between clusters. The horizontal axis represents the objects (members) and clusters. Cutting the tree (line dashed) lead to grouping the departments into four clusters based on the contribution grade. The membership of each group is presented in Table 3.

Table 3: Cluster membership based on the contribution level using Ward's method.

Cluster 1 (Low: 3 members)	**Cluster 2** (Middle-Low: 11 members)	**Cluster 3** (Middle-Strong: 20 members)	**Cluster 4** (Strong: 6 members)
Meteorology	Geodesy & Geomatic Eng	Geological Engineering	Industrial Eng
Oceanography	Physics	Chemistry	Chemical Eng
Astronomy	Product Design	Mathematics	Civil Engineering
	Craft Design	Desain Interior	Management
	Visual Art	Visual Communication Design	Information System & Tech.
	Material Engineering	Management Engineering	Informatics
	Geophysical Engineering	Engineering Physics	
	Petroleum Engineering	Aeronautics & Astronautics	
	Ocean Engineering	Mechanical Engineering	
	Biology	Metallurgical Engineering	
	Biological Engineering	Mining Engineering	
		Environmental Engineering	
		Architecture	
		Regional & City Planning	
		Clinical & Community Pharmacy	
		Pharmaceutical Science & Technology	
		Microbiology	
		Electrical Engineering	
		Telecommunication Eng	
		Electrical Power Eng	

Some interesting information obtained from the clustering above:

1. The cluster with the most members (20 members) is Cluster 3, which consists of the departments grouped as middle-strong contribution levels. On the other hand, Cluster 1 has the fewest members (3 members), and consists of the departments with a low level of contribution to future careers.
2. The Architecture and Regional & City Planning (from SAPPK), and the Clinical & Community & Pharmacy and Pharmaceutical Science & Technology (from SF) are the departments that come from the same faculty or school, which are grouped in the same cluster (Cluster 3: middle-strong).
3. Departments that are grouped as a low contribution to future careers have a rare employment space in Indonesia. In contrast, departments that are grouped as strong contributions mostly have wide employment and are required by many fields.

Furthermore, Ward's method is related to the centroid method, where the distance between two clusters is defined as the Euclidean distance between mean vectors of the two clusters.

Compared to the centroid method, Ward's method is more likely to join smaller clusters or clusters of equal size (Renchers and Christensen, 2012). The distance between clusters is summarised in Table 4.

Table 4: Distance between clusters using Ward's method.

Cluster	1	2	3	4
Sum of weights	4	12	21	7
Within-class variance	0.076	0.032	0.026	0.013
Minimum distance to centroid	0.171	0.087	0.032	0.025
Average distance to centroid	0.235	0.161	0.145	0.094
Maximum distance to centroid	0.280	0.294	0.262	0.170

Based on the table above, Cluster 1 has the largest within-class variance, which is 0.076. It shows that the dissimilarity between the objects (the departments) in Cluster 1 is greater than the other clusters. It implies that the variance between objects in this cluster is large, as can be seen from the larger average distance to centroid than the other clusters, which is 0.235. In comparison, the smallest variance falls in Cluster 4, followed by Cluster 3 and Cluster 2.

Conclusion

Overall, this study concludes that: 1) there is a statistically significant association between the department and the level of its contribution to graduate's future careers, and 2) the departments are divided into four clusters based on the contribution level. Additionally, the lack of broad employment that hiring graduates from specific departments is one factor that causes differences in the contribution level of one department to another. The result becomes a recommendation to the departments of each scientific field. Departments with a strong contribution require to maintain existing programs, while departments with a low contribution certainly require evaluating existing programs and identifying aspects that affect their graduates' job prospects.

Acknowledgment

This research was supported by LPDP from the Ministry of Finance Republic Indonesia, through the scheme of BUDI-DN. The authors would like to thank LPDP for providing the scholarship.

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