

Employability and Achievement of Program Educational Objectives: A Graduate Tracer Study for Industrial Engineering (IE), Engineering Management (EMG), and Service Engineering Management (SEM) Programs of an HEI in the Philippines

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Abstract

This paper focuses on the achievement of program educational objectives (PEO) and graduate tracer study of industrial engineering (IE), engineering management (EMG), and service engineering and management (SEM) programs of a higher education institution (HEI) in the Philippines. The graduate tracer study covered the employment history and profile, skills and competencies, and career advancement endeavors of the graduates of the HEI. Using various descriptive statistics tools and analysis of variance (ANOVA), the skills, competencies, and values of the graduates were identified and compared. Results revealed that the university was able to provide the graduates with the necessary skills and competencies needed for professional practice and the graduates were highly employable in a wide range of industries, not only in manufacturing but also in other sectors. The study also verified that the university's teaching practices and methodologies were helpful in developing the graduates' work-related values and character. The graduates have also satisfactorily achieved the PEOs of the various programs which signified the graduates' high employability attribute.

Keywords

Graduate tracer study, Program Educational Objectives (PEO), employability, graduate attributes

1. Introduction

Engineering is a course about sustaining, developing, civilizing and maintaining infrastructures, goods and services needed in industry and community (Zaharim et al., 2009). Industrial Engineering (IE) is one of the many branches of engineering that is very broad yet interesting at the same time as it includes the study of a variety of subjects. The US Bureau of Labor Statistics (2020) identified IE as an interdisciplinary branch that combines engineering and management in a single course where the job occupations in IE will continue to grow 8% from 2018 to 2028. Engineering Management (EMG) is inclined in making decisions for strategic and operational leadership in emerging technologies and their impacts on correlated systems (Kocaoglu, 1990) while Service Engineering and Management (SEM) mixes technical engineering with a foundation of business and management to provide skills and knowledge to manage activities in engineering and competence in decision-making (MU, 2020). There are numerous higher education institutions (HEIs) to consider for an engineering school and ensuring that the graduates are highly employable is one of the most distinct characteristics that would set an HEI apart from the others. Conducting a graduate tracer study is an essential activity to identify the employment history and success factors of graduates. Schomburg (2016) defined a tracer study as a survey for graduates from educational institutions, which occurs in time after graduation or the end of the training. Through identifying the current employment and achievements of its alumni,

a university may be able to evaluate its performance and plan future activities at both institutional and national levels (Tertiary Education Commission, 2008). Tracer studies also determine the graduates' opinions regarding the institution's strengths and weaknesses, programs, and teaching competencies of its faculty to come up with policy and program interventions to increase employability and productivity (Baking et al., 2015). It also determines the extent of the impact of the curriculum among graduate students. Results of such studies become a relevant factor in the university's growth as the alumni serve as the best proof of a university's capability to provide a good education. Carrying out tracer surveys will enable universities and institutions to be aware of the betterment of quality education and services in their own respective countries (Schomburg, 2011).

The study's main objectives were to track the employment status of its IE, EMG, and SEM graduates in the last ten (10) years and determine the level of achievement of the program educational objectives (PEO) set by the HEI. It also assessed the personal and professional profiles, career and professional accomplishments, and the knowledge, skills, and attitudes that contributed to the graduates' professional readiness. Further, the study included developing action plans to improve the employment success of graduates of the HEI.

2. Methodology

The study considered the IE, EMG, and SEM graduates of the HEI for the past ten (10) years, from 2010 to 2019. The sample size of the graduates was computed using the Slovin's formula presented in Equation 1, the mathematical model also utilized by various researchers (German and Catabay, 2018; Huang et al., 2019; Joven et al., 2020).

$$n = \frac{N}{1+Ne^2} \quad (1)$$

Using a 5% margin of error, a total of 419 graduates were surveyed using Google forms. The survey questionnaire was comprised of five (5) parts: the general profile, educational background, post-college programs received, employment data, and achievement of the PEO. The weighted mean of responses was computed to interpret the data gathered from the respondents and a Likert scale was utilized to measure the qualitative information from the questionnaire. The analysis of variance (ANOVA) was used to prove if there are any significant differences among the responses of the graduates of the three (3) degrees in terms of their year of graduation, years of employment, and job position.

3. Results and Discussion

3.1 Graduate Profile

The profiles presented in Tables 1 and 2 showed that majority of the respondents belonged to the EMG program with 37.47%, followed by the IE program comprise of 36.52%, and last is the SEM program with 26.01%. Majority of the graduates, about 94.75% have not pursued any graduate programs yet while 5.01% or twenty-three (23) graduates have already sought or are currently enrolled in a master's program and only one (1) has completed a doctoral degree.

Table 1. Profile of Respondents

Degree	f	%
IE	153	36.52%
EMG	157	37.47%
SEM	109	26.01%
<i>Total</i>	<i>419</i>	<i>100</i>

Table 2. Graduate Program of the Respondents

Graduate Program	IE	EMG	SEM	f	%
None	143	150	104	397	94.75%
Master's Program	9	7	5	21	5.01%
Master's and Doctoral Program	1	-	-	1	0.24%
<i>Total</i>	<i>153</i>	<i>157</i>	<i>109</i>	<i>419</i>	<i>100</i>

3.2 Employment Profile

The employment profile indicated the present employment status, skills acquired by the graduates from the HEI, and the reasons why they are not employed during the period of study. Table 3 shows that among the graduates, 85.20% are employed, 8.59% are self-employed or running their own business, and the remaining 6.21% were unemployed. Graduates of the IE program posted the highest employment rating of 87% while graduates of the other two (2) programs posted an employment rating of 84%. The graduates have also identified 276 job titles including various titles for analysts, managers, and supervisors. The self-employed graduates, on the other hand, have been managing either their own business or their family's long-run company. The job titles of Industrial Engineer and Process Engineer were the most popular among all the titles.

Table 3. Present Employment Status

Present Employment Status	IE		EMG		SEM		Total	
	f	%	f	%	f	%	f	%
Employed	133	87%	132	84%	92	84 %	357	85.20%
Unemployed	12	8%	7	4%	7	6 %	26	6.21%
Self-employed	8	5%	18	11%	10	9 %	36	8.59%
<i>Total</i>	<i>153</i>		<i>157</i>		<i>109</i>		<i>419</i>	<i>100</i>

The employed and self-employed data were further expounded to identify employability of the graduates. Table 4 indicates the graduates' employment tenure during the period of study. It shows that majority of the respondents have been employed within one to four (4) years, with a total of 88.29%. This corresponds to the graduation time of the respondents were most have graduated in the last four (4) years. Consequently, it also signifies that that the graduates of the three (3) programs were able find a job and were hired right after their graduation.

Table 4. Current Employment Tenure

Years Employed	IE	EMG	SEM	f	%
less than one year	47	32	41	120	30.53%
1 to 2 years	48	45	48	141	35.88%
3 to 4 years	28	48	10	86	21.88%
5 to 6 years	11	17	2	30	7.63%
7 to 8 years	6	6	0	12	3.05%
9 to 10 years	1	2	1	4	1.02%
<i>Total</i>	<i>141</i>	<i>150</i>	<i>102</i>	<i>393</i>	<i>100</i>

Table 5 presents the result of ANOVA of the employment profile. The p-value of 0.122 for the years of employment of graduates of the three (3) programs suggests that there is no significant relationship between the employment years. With regards to year of graduation and job placement, the p-value of 0.000 signifies that the years of experience is significant to the year of graduation, indicating high employability of the graduates since they have been working in the same years that they have graduated. Finally, comparing the years of employment and job title with a p-value of 0.001 means that the number of years the graduates have been employed affected the level of their position signified by their job titles. The longer they are in the company, the higher their job level will be.

Table 5. Summary of ANOVA on Employment Profile

Variable	P value	Remarks
Years of employment vs. program	0.122	Not Significant
Years of graduation vs. Employment tenure	0.000	Significant
Years of employment vs. Job title	0.001	Significant

The bachelor's degree attained by the graduates and job title of the graduates have no correlation with one another as the Pearson correlation value obtained was less than 0.3 as shown in Table 6. A study by Masdonati et al. (2017) stated that there are several factors as to why an individual wish to choose a different career path. Such factors can be personal growth, the wish to engage to different projects, and better conditions of employment. The significance of knowing and understanding the subjective reasons behind career as well as the need to adjust career interventions accordingly was emphasized by the results.

Table 6. Correlation Analysis: Bachelor's Degree Attained, Job Title

Correlation	
Pearson Correlation	0.014
P-value	0.788

In contrast to being employed, the twenty-six (26) graduates who were currently out of job have also identified the reasons for their unemployment. Nineteen (19) or 73% of them said that they are currently looking for a job, two (2) are unavailable for work due to some personal/family issues, one (1) graduate is currently pursuing a graduate degree, two (2) are currently taking another bachelor's degree, and another two (2) were unemployed because of the current pandemic.

The results acquired in Pearson Correlation is shown in Table 7. The r value 0.077 means that there is not enough evidence to suggest that a certain correlation between the respondents' job title and year graduated does exist within the population.

Table 7. Correlation Analysis: Year Graduated, Job Title

Correlation	
Pearson Correlation	0.077
P-value	0.125

Table 8. Unemployment Status

Reasons of Employment	IE	EMG	SEM	f	%
Unemployed and looking for a job	9	4	6	19	73 %
Unemployed and unavailable for paid work due to personal/family issues	1	1	0	2	8%
Unemployed and will pursue a graduate degree	1	0	0	1	4%
Unemployed for the moment due to the pandemic	0	2	0	2	8%
Unemployed taking another bachelor's degree	1	0	1	2	8%
<i>Total</i>	<i>12</i>	<i>7</i>	<i>7</i>	<i>26</i>	<i>100</i>

During the period of study, the Covid19 pandemic (UNDP, 2020) is still present all around the world. It is inevitable that unemployment (Table 8) rate will continue to increase not only in the Philippines, making it more difficult for the unemployed graduates to find a job. In addition, several graduates have also indicated that the lack of professional advancement or further study was also one of the reasons of unemployment. This made them realize that pursuing a higher level of study such as a graduate degree will improve their skills and competencies and make them more employable.

3.5 The HEIs Contribution

3.5.1 Institutional Attributes

Most of the graduates believed that having an excellent personal skills and abilities were the reason why they got their first job. Skills and abilities are tasks that a person can do well which can be natural or acquired and improved through practice over time. These factors are one of the primary attributes that employers look for when filling a job vacancy. Personal skills and abilities will allow the new employee to perform well to bring value to their employer. The fresh graduates need to have a clear understanding of their skills and abilities when seeking a first job since employers expect graduates to possess skills and technical knowledge from their attained degree (Lowden et al., 2011). Table 9 presents the attributes for being employed in their first job that were identified by the graduates. The top three (3) attributes include personal skills and abilities (33.17%), personality (31.26%), and school reputation/image (10.26%) while the least were scholastic standing (1.91%), experience (2.39%), and other skills (5.01%). Apart from personal

attributes such as personality and skills and abilities, the school's reputation/image played a vital role in the graduates' employability. Employers nowadays usually relate brand imaging with quality and performance in the job which is made possible by observing the work accomplishments of its current employees and identifying the schools they have graduated from.

Table 9. Attributes of Graduates on First Job Employment

Attribute	IE	EMG	SEM	f	%
Personality	51	50	30	131	31.26%
Personal skills and abilities	57	46	36	139	33.17%
Area of specialization	10	13	8	31	7.40%
Scholastic (Academic) standing	5	2	1	8	1.91%
School reputation/image	13	19	11	43	10.26%
Referral	5	19	12	36	8.59%
Experience	8	0	2	10	2.39%
Others	4	8	9	21	5.01%
Total	153	157	109	419	100

The relevant attributes of the HEI that helped in the graduates' employability were also identified in the tracer study. These include the range of courses offered (curriculum), number of optional courses concerning the program, number of compulsory (core) course, student workload, teaching quality, inter-disciplinary learning, facilities, research capacity, labor market relevance, industry linkage, and cost (of education). These were rated by the graduates to identify the strengths and weaknesses of the HEI, with 3 as the highest and 1 being the lowest. Among the attributes, the dominant strengths of the HEI include strong curriculum, quality of teaching, interdisciplinary learning, no. of compulsory (core) courses, and labor market relevance. The other attributes were also rated as significantly valuable except for cost of education which was identified as a weakness of the institution.

3.5.2 Program Attributes

Aside from the institutional attributes, the skills, competencies, and work-related values specific to the programs were also determined in this study. This refer to the attributes and characters of the graduates that were also developed upon their enrollment in the program.

3.5.2.1 Skills and Competencies

The skills and competencies identified in the tracer study include communication, human relation, research, entrepreneurial, information technology, problem-solving, critical thinking, creative thinking, leadership skills, ability to work independently, decision making, ability to work under pressure, time management, and initiative/risk taking. The respondents were asked to rate these attributes from 1 to 4, 4 being the highest. Table 10 exhibits the scale range and degree of measurement to evaluate the rating of attributes while Table 11 illustrates a summary of the ratings.

Table 10. Likert Scale (Skills and Competencies, and Work-related Values)

Scale	Scale Range	Degree of Measurement	Verbal Interpretation
4	3.01-4	Very Much	Program of study greatly contributed to the factor
3	2.01-3	Much	Program of study contributed to the factor
2	1.01-2	A Little	Program of study poorly contributed to the factor
1	0-1	Not at All	Program of study never contributed to the factor

Table 11. Mean Ratings of Skills and Competencies by Program

Skills and Competencies	IE	EMG	SEM
Communication	2.50	2.63	2.92
Human Relation	2.68	2.82	3.00
Research	2.70	2.80	2.96
Entrepreneurial	2.29	2.62	2.99
Information Technology	2.34	2.29	2.40
Problem-solving	3.39	3.55	3.49
Critical Thinking	3.51	3.64	3.61
Creative Thinking	3.15	3.37	3.43
Leadership Skills	2.85	3.22	3.06
Ability to work independently	3.49	3.61	3.61
Decision Making	3.83	3.86	3.88
Ability to work under pressure	3.42	3.51	3.53
Time Management	3.51	3.52	3.55
Initiative/Risk Taking	3.29	3.46	3.40

For the IE, EMG, and SEM programs, the decision-making ability posted the highest mean of 3.83, 3.86, and 3.88, respectively. This demonstrates that the core competency of graduates of the three programs are their conceptual skills or decision-making capability. Apart from decision making, graduates have also identified that the IE program have developed their problem-solving, critical thinking, creative thinking, ability to work independently, ability to work under pressure, time management, and initiative/risk taking. For EMG and SEM, the graduates have identified many similarities with the IEs including leadership skills and human relation.

Findings in Table 12 indicated the respondents' ability to communicate, think critically, think creatively, and work independently is not directly related to their job titles. This initiates that their job positions have nothing to do with how they possess the said skills. On the other hand, their decision making and initiative/risk taking skills have weak correlation on their job titles, while their information technology and time management skills were determined to have moderate effect. Lastly, the respondents' skills that were identified to have strong relationship with their job titles are human relation, research, entrepreneurial, problem solving, leadership skills, and ability to work under pressure. Thus, suggesting that how he/she develop these skills may strongly affect their job title. There are certain skills that are not directly learned and developed within the premises of the classroom. However, such skills can also be managed and adapted through course materials and outcomes. Companies should be able to understand that there will be things that can be enhanced overtime. (Meganck et al., 2020)

Table 13 presents the result of ANOVA on skills and competencies of each program and the employment years of the graduates. The skills and competencies were clustered into three (3) which include critical thinking, decision making, and technical skills. Critical thinking and decision making were found to be significantly contributing with the employment tenure which resulted to p-values of 0.002 and 0.001, respectively. This means that the longer the graduates have been employed, the more they were able to develop their analytical skills. However, technical skill showed a p-value of 0.995 which suggests that there is no significant relationship between the years of employment and the graduates' technical skills. Technical skills are usually acquired during matriculation in the program and are enhanced through experience. The results signify that the graduates of the program were assigned higher level of jobs which greatly require more of their critical thinking and decision-making abilities rather than the technical abilities.

Table 12. Correlation of Skills and Competencies with Positions

Skills and Competencies	r
Communication	0.117
Human Relation	0.71
Research	0.967
Entrepreneurial	0.765
Information Technology	0.533
Problem-solving	0.854
Critical Thinking	0.225
Creative Thinking	0.165
Leadership Skills	0.799
Ability to work independently	0.239
Decision Making	0.459
Ability to work under pressure	0.754
Time Management	0.579
Initiative/Risk Taking	0.416

Table 13. Summary of ANOVA on Skills and Competencies by Program

Skills and Competencies	P value	Remarks
Critical Thinking	0.002	Significant
Decision Making	0.001	Significant
Technical Skill	0.995	Not Significant

3.5.2.2 Work-Related Attributes

The study also included the program's contribution in developing the graduates' work-related values. These include love of god, self-reliance, honesty, and love for truth, punctuality, obedience to superior, perseverance, and hard work, creativity and innovativeness, courage, professional integrity, love for co-workers and others, unity, fairness and justice, leadership, tolerance, efficiency, supportiveness, perseverance, self-discipline, nationalism, and open-mindedness. The same evaluation scale was utilized to rate the work-related attributes. Table 14 presents the summary of ratings by program.

Table 14. Mean Rating of Work-Related Values by Program

Attributes	IE	EMG	SEM
Love of God	2.17	2.45	2.40
Self-reliance	3.22	3.26	3.31
Honesty and love for truth	2.61	2.98	2.86
Punctuality	2.78	2.92	2.77
Obedience to superior	3.00	3.01	3.06
Perseverance and hard work	3.30	3.31	3.32
Creativity and innovativeness	3.22	3.39	3.54
Courage	3.12	3.29	3.35
Professional integrity	3.30	3.41	3.51
Love for co-workers and others	2.74	2.93	2.94
Unity	2.85	3.08	3.09
Fairness and justice	2.71	2.97	2.92
Leadership	2.95	3.20	3.19

Tolerance	3.03	3.20	3.06
Efficiency	3.41	3.45	3.50
Supportiveness	2.92	3.15	3.08
Perseverance	3.38	3.42	3.51
Self-discipline	3.22	3.50	3.44
Nationalism	2.10	2.44	2.34
Open-mindedness	3.12	3.32	3.22

Most of the IE graduates viewed efficiency as the most developed work-related values during their stay at the HEI with the highest mean of 3.41. EMG graduates, on the other hand, identified self-discipline with a mean of 3.50 while SEM achieved advancement in creativity and innovativeness. For the least developed, graduates of the three (3) programs recognized nationalism since it posted the lowest mean of 2.10, 2.44, and 2.34, respectively.

3.6 Program Educational Objectives (PEO) Achievement

The study also included the program educational objectives (PEO) achievement of the graduates of the three (3) programs. PEOs are “what graduates are expected to attain within a few years of graduation” from the program (ABET, 2015). The PEOs are created in compliance to ABET accreditation requirements which provides students, employers, and the society the assurance that the program meets the quality standards for applied and natural science, computing, engineering, and engineering technology programs and assures that the graduates are prepared to enter a global workforce (ABET, 2020). The PEOs of the IE program are: 1) undertaken, singly or in teams, projects that show ability to solve complex engineering problems in the areas of productivity, quality control, methods and process improvement, systems analysis, logistics and supply chain, ergonomics, facilities planning, strategic management, and other related industrial engineering fields; 2) had substantial involvement in projects that help in nation building and advancement by successfully demonstrating professional and technical competencies; 3) demonstrated professional success via promotions and/or positions of increasing responsibility; 4) demonstrated professional advancement towards completion of developmental/continuing education in advanced IE and related degrees; and 5) exhibited professional attitude and ethical behavior in industrial engineering practice (MU, 2020). For the EMG and SEM programs, the PEOS are: 1) undertaken, singly or in teams, projects that show ability to solve complex engineering problems in the areas of service quality, operations management, systems analysis, logistics and supply chain, facilities planning, strategic management, and other related engineering management fields; 2) had substantial involvement in projects that help in nation building and advancement by successfully demonstrating professional and technical competencies; 3) demonstrated professional success via promotions and/or positions of increasing responsibility; 4) demonstrated professional advancement towards completion of developmental/continuing education in advanced engineering management and related degrees; and 5) exhibited professional attitude and ethical behavior in engineering management practice (MU, 2020).

The PEOs were rated by the graduates with 1 being the lowest (signifying very poor achievement) and 5 as the highest (excellent achievement). Table 15 presents the summary of achievement using the mean rating of the PEOs for each program while Table 16 shows the verbal interpretation of the mean ratings.

Table 15. Summary of PEO Achievement by Program (Mean Ratings)

PEO	IE	EMG	SEM
1	3.91	4.04	3.81
2	4.17	4.23	4.23
3	3.85	3.98	3.80
4	3.66	3.86	3.77
5	4.20	4.28	4.23

Table 16. Likert Scale (Skills and Competencies, and Work-related Values)

Scale	Scale Range	Degree of Achievement	Verbal Interpretation
5	4.01-5	Excellent	Excellent achievement of the outcome
4	3.01-4	Good	Good achievement of the outcome
3	2.01-3	Average	Average achievement of the outcome
2	1.01-2	Poor	Poor achievement of the outcome
1	0-1	Very poor	Very poor achievement of the outcome

Graduates of the IE program have expressed a good achievement of PEOs 1, 3, and 4 with mean ratings of 3.91, 3.85, and 3.66, respectively while the achievement levels for PEOs 2 and 5 were excellent, denoted by a high mean rating of 4.17 and 4.20, respectively. For the EMG program, graduates felt that they have excellent achievement of PEOs 1, 2, and 5 with mean ratings of 4.04, 4.23, and 4.28, respectively while the achievement level was good for PEOs 3 and 4 with mean ratings of 3.98 and 3.86, respectively. Finally, graduates of the SEM program believed they have excellently achieved PEOs 2 and 5 with a mean rating of 4.23 while satisfactory achievement was evident in PEOs 1, 3, and 4 with mean ratings of 3.81, 3.80, and 3.77, respectively. The high level of achievement of the PEOs denote that the programs have successfully developed the graduates' technical skills and competencies and has helped them become accomplished professionals in the industry.

4. Conclusion

A graduate tracer study is an important tool in determining the success level and competencies of graduates in a program. This also aid in identifying the set of skills and technical abilities that students have acquired during their matriculation. This study considered the graduates of IE, EMG, and SEM programs of the subject HEI in the Philippines. The personal and employment profiles of the graduates were identified and revealed that most of the graduates have high level job positions and have been employed a few months after their graduation, signifying that the graduates are highly employable. However, the bachelor's degree attained by the graduates and job title of the graduates have no correlation with one another as the Pearson correlation value obtained was less than 0.3. This suggests the possibility that a graduate may choose a different career path for personal growth and career development. There is also not enough evidence to suggest that a certain correlation between the respondents' job title and year graduated does exist within the population. The relevant attributes of the HEI that helped in the graduates' employability were also identified in the study. These include the range of courses offered (curriculum), number of optional courses concerning the program, number of compulsory (core) course, student workload, teaching quality, inter-disciplinary learning, facilities, research capacity, labor market relevance, industry linkage, and cost (of education). In terms of the skills and competencies, the graduates of the three (3) programs believed that they have excellent decision-making ability. Similarly, IE graduates felt that they have developed their problem-solving, critical thinking, creative thinking, ability to work independently, ability to work under pressure, time management, and initiative/risk upon completion of the program while for EMG and SEM, the graduates have identified many similarities with the IEs including leadership skills and human relation. In terms of work-related attributes, efficiency was viewed by IEs as their dominant character while the EMGs and SEMs recognized self-discipline and creativity and innovativeness. The levels of achievement of the PEOs were also satisfactory for all programs since the mean ratings of achievement were classified under very good and excellent. It is essential for schools and universities to conduct the graduate tracer study after several years to determine how relevant is the education they provide to the needs of the industry. It will also aid in improving the quality of education and services to make it at par with other education institutions.

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Biographies

Josephine D. German is an Associate Professor of the School of Industrial Engineering and Engineering Management at Mapua University in Manila, Philippines. She has earned her BS in Industrial Engineering and Masters in Engineering (major in IE) from the same University. She is a Professional Industrial Engineer (PIE) with over 15 years of experience and has taught several courses in IE. She has done several research projects in the field of logistics and supply chain management, systems modelling, entrepreneurship, risk management, vulnerability assessments, and ergonomics and has an extensive experience in academic audits and accreditations. She is also a member of the Philippine Institute of Industrial Engineers (PIIE).

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