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School Licensure Exam Performance and Engineer Shortage in the Philippines[1]

Geoffrey Ducanes and Clarissa C. David

Abstract

This policy brief examines the licensure exam performance of HEIs in the four most popular engineering fields: civil; electrical; electronics; and mechanical engineering. Although there are observed differences across programs (e.g., much higher passing rate in mechanical compared to electronics engineering), two consistent findings from the analyses are that small schools tend to perform much worse than larger schools, and the student-to-faculty ratio is inversely related to performance. These results suggest that the school's financial capacity and, therefore, their ability to invest in well-equipped laboratories and to hire an adequate number of well-trained faculty may be especially crucial in engineering. Policy responses are necessary to improve the availability of quality engineering programs. Interventions will be necessary to increase the number of future engineers to support the government's planned heavy investment in infrastructure and development outside Metro Manila.

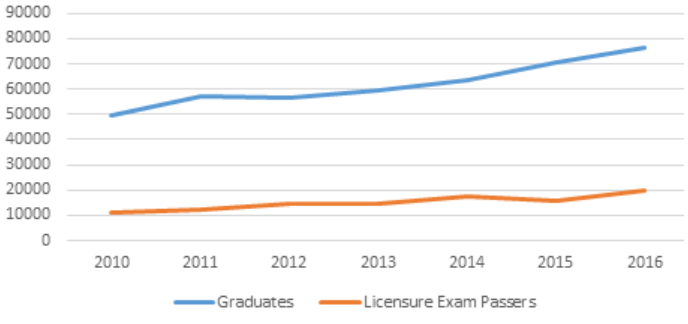
A shortage of qualified engineers

Engineering has been a popular field of study for tertiary students historically and up to the present. It is common for children to aspire toward becoming a doctor, a lawyer, a teacher, or an engineer[2]. In school-year 2016-17, according to data from the Commission on Higher Education (CHED), Engineering and Technology was the third most popular discipline in terms of number of enrollees (around 449,000) in higher education, following only Business Administration and Related Disciplines (921,000) and Education and Teacher Training (741,000).

Engineering carries with it a measure of stature[3] and typically pays better. According to data from the Philippine Statistical Administration (PSA), only architects, lawyers, and doctors earn more, on average, than engineers[4]. In the 7 years from 2010 to 2016, over 434,000 students in the country graduated with Engineering degrees. In the same period, 106 thousand Engineering graduates passed the various licensure exams in Engineering.[5] There is an increasing trend in both the number of Engineering graduates and the number of licensure exam passers (Figure 1).

Despite the relatively large number of Engineering graduates and licensure exam passers in recent years, there is still a perceived shortage in the number of Engineers (and scientists) in the country. According to the World Economic Forum's Global Competitiveness Index, the Philippines ranked only 67th out of 140 countries in terms of availability of scientists and engineers in 2015-2016, placing it behind Malaysia (5th), Singapore (11th), Indonesia (34th), and Thailand (47th), although still ahead of Vietnam (75th), Myanmar (122nd), Cambodia (127th), and Lao PDR (129th) among ASEAN countries.[6]

Figure 1. Number of graduates and licensure exam passers in engineering



The current government's flagship Build, Build, Build program aims to modernize physical infrastructure in the country by rolling out 75 infrastructure projects and raising infrastructure spending to at least 7% of GDP by 2022.

[1] *The opinions expressed in this publication are those of the author/s. They do not reflect nor represent the opinions or views of the University of the Philippines, the UP Center for Integrative and Development Studies, the sources of data, or its affiliates. The presentation and interpretation of information in this publication do not imply the expression of any opinion on the part of UP or CIDS.*

[2] *See, for example: Ambisyon 2040 Public Consultations: Discussions with the Filipino Youth. http://2040.neda.gov.ph/wp-content/uploads/Vision2040_final.pdf*

[3] *Engineer is used as a title similar to how Atty. is used for a lawyer or Dr. is for a medical doctor.*

[4] *Labor Force Survey October 2016.*

[5] *These are in Aeronautical Engineering, Agricultural Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Electronics Engineering, Geodetic Engineering, Marine Engineering, Mechanical Engineering, Metallurgical Engineering, Mining Engineering, Naval Architecture and Marine Engineering, and Sanitary Engineering. Not all Engineering fields are subject to a licensure exam, most notable Industrial Engineering.*

[6] *http://reports.weforum.org/global-competitiveness-report-2015-2016/*

It is expected to further increase local demand for qualified engineers. Abroad, land and sea-based Filipino Engineers are among the highest paid overseas workers[7], with strong demand from the Middle East, Asia Pacific, and the US.

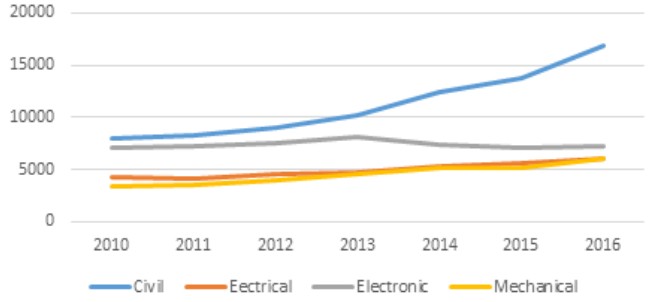
The K-12 program of the Department of Education, which cluster students into different tracks or strands (such as STEM) starting in grade 11 – is in part intended to increase the future supply of engineers and scientists. It would provide better preparatory training in mathematics and science for high school students intending to study science or engineering in college. It is still too early to tell whether the K-12 program will be successful in this regard.

The current quality of engineering programs is highly uneven, with many consistently poor performing schools, especially small higher education institutions (HEIs). Raising the quality of Engineering programs should be pursued in tandem with improving the quality of incoming Engineering college students.

Most popular engineering fields

The four most popular Engineering fields by the number of licensure examees are (in descending order) Civil Engineering, Electronic Engineering, Electrical Engineering, and Mechanical Engineering (Figure 2). The growth in number of exam takers has been the fastest in Civil Engineering – more than doubling from 2010 to 2016. A steady growth in the number of exam takers in Electrical and Mechanical Engineering has occurred as well, but in the case of Electronic Engineering the number of exam takers in 2016 differs little from that in 2010 and is noticeably down from its peak in 2013.

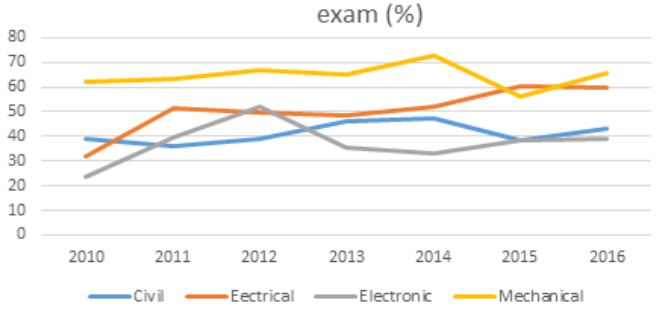
Figure 2. Number of licensure exam takers in 4 largest engineering fields



In 2016, there were 248 schools offering programs in Civil Engineering, 193 in Electrical Engineering, 215 in Electronics Engineering, and 158 in Mechanical Engineering. In all cases, majority of the schools are private schools. An even larger majority of licensure exam takers are from private schools.

The changes over time in overall passing rate in the four Engineering disciplines have been erratic and show no clear trend (Figure 3). Overall passing rate is usually the highest in Mechanical Engineering, followed by Electrical Engineering, with Civil Engineering and Electronic Engineering trading places as having the lowest passing rate. In 2016, 65 out every 100 exam takers in Mechanical Engineering passed, as opposed to only 39 out of every 100 in Electronic Engineering.

Figure 3. Overall passing rate in PRC licensure exam (%)



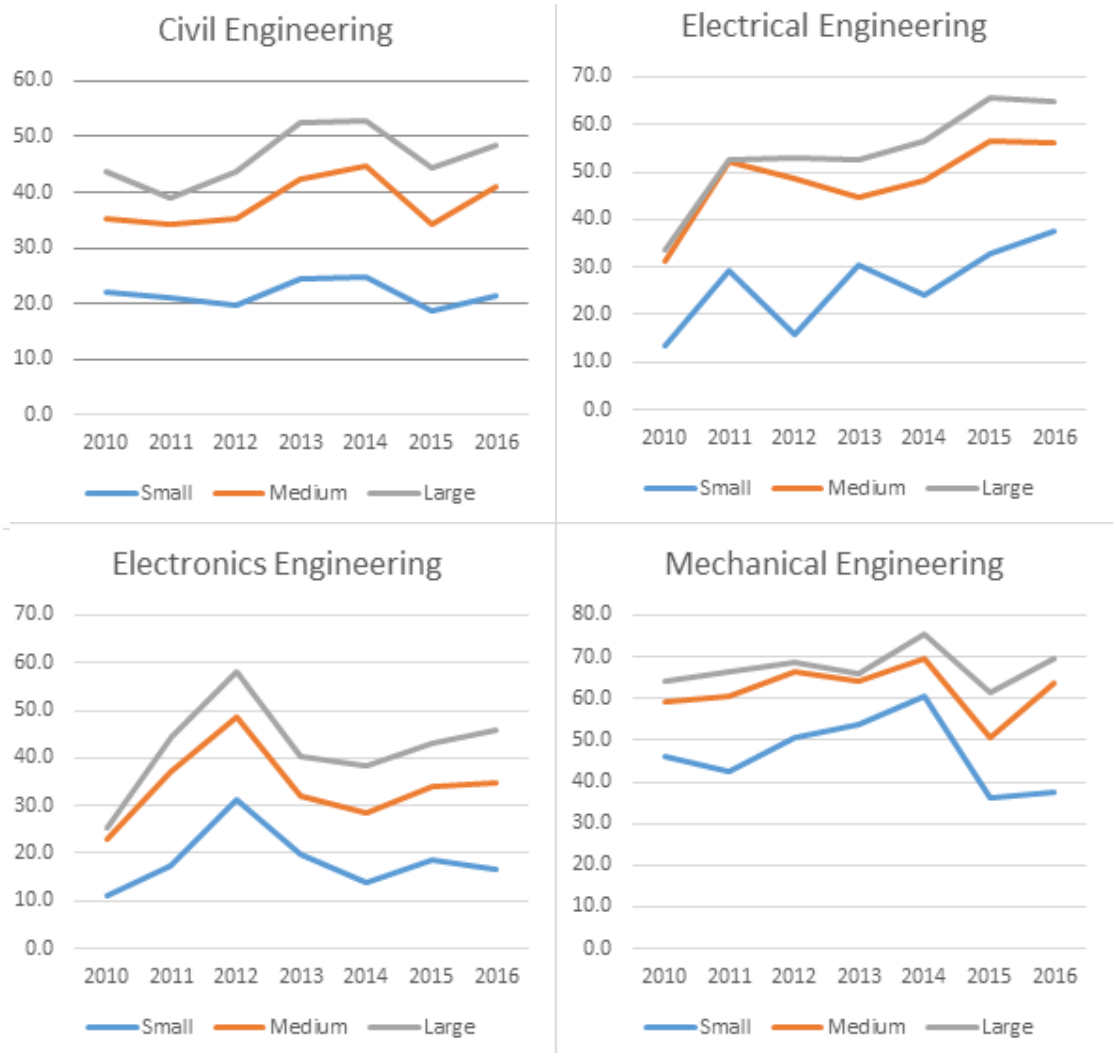
Which programs do better?

Engineering programs in small schools tend to have much lower passing rates. Regardless of Engineering discipline, a very clear pattern that emerges is that performance in the licensure exams is directly related to the size of the school (Figure 4). In Civil Engineering, the gap in the passing rate between large and small schools in 2016 is 27.4 percentage points, 27.3 percentage points in Electrical Engineering, 29.3 percentage points in Electronics Engineering, and 32.2 percentage points in Mechanical Engineering. School size is likely strongly correlated with the school's ability to invest in costly software, equipment, and physical infrastructure, which are especially necessary in the study of Engineering, and which may explain the observed patterns.

Public schools tend to do better than private schools. In all Engineering disciplines under study, public schools tend to do better than private schools. In Civil and Electrical Engineering, Local Universities and Colleges (LUCs) performed best, followed by State Universities and Colleges (SUCs), and then private schools, although in both cases there were just a few LUCs who offered the courses. In particular the Pamantasan ng Lungsod ng Maynila, an LUC is the top high-performing school. In Electronics and Mechanical Engineering, SUCs consistently performed better than private schools, whereas the performance of the LUCs has been more erratic (in large part because of the very small number of exam takers). UP Diliman and Mindanao State University-Marawi City are both SUCs and the only high-performing programs in Electronics Engineering. In Mechanical Engineering, some of the top performers include Polytechnic University in Taguig, Technological University of the Philippines, and University of the East in Manila. Outside of Manila some of the top performing programs include Holy Angel University in Region 3, St. Louis University in CAR, and University of Batangas, a private university.

[7] https://www.workabroad.ph/article/156/WorkAbroad-ph--Sea-based-engineers--healthcare-professionals-are-highly-paid-overseas

Figure 4. Passing rates in different engineering licensure exam by size of school



No consistent pattern in performance by island group. In Civil Engineering, NCR had the highest passing rate while Mindanao had the lowest.[8] In Electrical Engineering, Mindanao typically had the highest passing rate (excluding 2016 when it experienced a sharp drop-off) while Visayas had the lowest. In Electronics Engineering, NCR has done best since 2014, and other Luzon has performed worst over the entire period. In Mechanical Engineering, there is no clear pattern, although in both 2015 and 2016, NCR did noticeably better than the other groups.

Predictors of engineering program performance

Individually for each of the 4 Engineering disciplines in 2016, we used multiple regression analysis to estimate the relationship of passing rate with student-to-faculty ratio, island group, type of school, size of school, and age of school (Table 1). This allows for a more precise assessment of the relationship between each factor and passing rates, controlling for all variables in the model.

In Civil Engineering, a one-unit increase in the student-to-faculty ratio is associated with a 0.2 percentage point decline in passing rate, after controlling for the other variables. Schools in NCR, on average, have a passing rate higher by 10 percentage points. Small schools had passing rate lower by 29.5 percentage points and medium schools had passing rate lower by 8.1 percentage points compared to large schools.

In Electrical Engineering, a one-unit increase in the student-to-faculty ratio is associated with a 0.6 percentage point decline in passing rate. Schools in Mindanao, on average, have a passing rate higher by 11.3 percentage points. Private schools had a passing rate lower by 8.4 percentage points compared to SUCs. Small schools had passing rates lower by 41.2 percentage points and medium schools had passing rates lower by 13.6 percentage points compared to large schools.

In Mechanical Engineering, a one-unit increase in the student-to-faculty ratio is associated with a 0.4 percentage point decline in passing rate, after controlling for the other variables. Small schools had passing rates lower by 46.7 percentage points and medium schools had passing rates lower by 14 percentage points compared to large schools. Schools established in the 1990s, on average, have passing rates higher by 19.3

[8] *In 2016, however, ARMM had the highest passing among all regions in Civil Engineering. This is entirely due to MSU- Marawi, which is one of only two schools in ARMM (and the only public school) represented in the 2016 Civil Engineering licensure exam, and which did very well in the exam.*

percentage-points, and schools established in the 2000s have passing rates lower by 47.8 percentage-points compared to schools established before 1970.

Across all models, the total percentage variation in passing rates explained by the factors is between 28% and 31%. The moderate level of explanatory power of these models suggest that other factors, as yet unavailable in existing data, should be considered in assessing predictors of program performance in engineering.

Low-performing programs

We attempted to identify and count schools that consistently do poorly and those that consistently do well in the Engineering licensure exams. We define a low-performing school as one where in at least 4 of the 5 years from 2012 to 2016, its passing rate was at most 25%. Using this definition, 40 of 213 schools that had exam results in Civil Engineering in the past 5 years were identified as low-performing, 15 of 173 schools in Electrical Engineering, 53 of 194 schools in Electronics Engineering, and 6 of 132 schools in Mechanical Engineering. Mindanao had a disproportionately large share of the low-performing schools in Civil Engineering, NCR and other Luzon in Electrical Engineering, other Luzon in Electronic Engineering, and NCR again in Mechanical Engineering (Table 2). In all Engineering fields, the low-performing schools were predominantly small private schools (Tables 3 and 4).

Recommendations

As CHED itself recognizes, "(t)he advancement of the different engineering professions is highly dependent on the strength and quality of the engineering degree programs."[9] In this regard, there is still much to be done to advance the engineering professions. As shown above, the performance of schools in the different licensure exams is highly uneven, with a

Table 1. Multiple regression analysis of engineering passing rates in top Engineering courses, 2012-2016 (All school types)

Dependent variable: Engineering passing rate	Civil		Electrical		Electronics		Mechanical	
Student to faculty ratio	-0.2	**	-0.6	***	-0.2	*	-0.4	**
Island group (Base=Visayas)								
NCR	10.0	**	7.8		10.7	*	0.9	
Oth. Luzon	-0.2		8.5		-0.2		-6.5	
Mindanao	-1.8		11.3	*	4.5		-0.7	
Type of school (Base=SUC)								
LUC	6.1		14.6		-7.3		21.1	
Private	-4.4		-8.4	**	-2.8		-5.8	
Size of school (Base=Large)								
Medium	-8.1	**	-13.6	***	-9.0	**	-14.0	***
Small	-29.5	***	-41.2	***	-28.8	**	-46.7	***
Year school was established (Base=Before 1970)								
1970s	-6.1		5.9		-9.2		2.4	
1980s	-7.3		-1.0		10.7		-4.9	
1990s	3.3		1.5		-4.5		19.3	**
2000s	3.7		3.6		9.9		47.8	**
Constant	56.0		82.6		47.0		89.1	
No. of obs.	184		126		137		109	
F-stat	6.21		4.16		3.93		3.24	
R^2	0.304***		0.307***		0.276***		0.288***	

Notes: Only schools with at least 10 takers were included; ***-significant at 1% level, **-significant at 5% level, *-significant at 10% level.

Table 2. Number of low-performing schools by location of school by Engineering field

Island group	Civil Engineering	%	Electrical Engineering	%	Electronic Engineering	%	Mechanical Engineering	%
NCR	3	8	4	27	7	13	3	50
Other Luzon	18	45	7	47	32	60	1	17
Visayas	6	15	1	7	4	8	1	17
Mindanao	13	32	3	20	10	19	1	17
Total	40	100	15	100	53	100	6	100

*Includes only schools with examinees in at least 4 of the 5 years from 2012 to 2016

Classification: low-performing schools are those with at most 25% passing rate in at least 4 of the 5 years from 2012 to 2016; highlight means subgroup had a disproportionate share in number of low-performing schools relative to its share in total schools offering the program

Table 3. Number of low-performing schools by type of school by Engineering field

Type	Civil Engineering	%	Electrical Engineering	%	Electronic Engineering	%	Mechanical Engineering	%
SUC	6	15	2	13	4	8	0	0
LUC	0	0	0	0	0	0.0	0	0
Private	34	85	13	87	49	92	6	100
Total	40	100	15	100	53	100	6	100

*Includes only schools with examinees in at least 4 of the 5 years from 2012 to 2016

Classification: low-performing schools are those with at most 25% passing rate in at least 4 of the 5 years from 2012 to 2016; highlight means subgroup had a disproportionate share in number of low-performing schools relative to its share in total schools offering the program

[9] *CHED Memorandum Order No. 56, Series of 2016.*

Table 4. Number of low-performing schools by size of school by Engineering field

Size	Civil Engineering	%	Electrical Engineering	%	Electronic Engineering	%	Mechanical Engineering	%
Large	3	8	2	13	2	4	0	0.0
Medium	19	48	0	0	25	47	4	67
Small	18	45	13	87	26	49	2	33
Total	40	100	15	100	53	100	6	100

*Includes only schools with examinees in at least 4 of the 5 years from 2012 to 2016
Classification: low-performing schools are those with at most 25% passing rate in at least 4 of the 5 years from 2012 to 2016; highlight means subgroup had a disproportionate share in number of low-performing schools relative to its share in total schools offering the program

substantial number of low-performing schools that consistently fail in getting their graduates to pass the various licensure exams.

Two consistent findings that emerge in each of the four Engineering fields from the analyses above is that (1) small schools tend to perform much worse than larger schools and (2) the student-to-faculty ratio is inversely related to licensure exam performance. These two variables reflect the financial capacity of the school: large schools tend to have more financial resources, and schools with greater financial resources are able to afford a smaller student-to-faculty ratio.

Most Engineering programs are investment-heavy, requiring expensive laboratories and equipment to be able to provide proper training for their students. There are substantial economies of scale in the construction of such laboratories and the purchase of such equipment, putting small schools at a great disadvantage. In short, unless very heavily subsidized, small schools cannot afford the investments necessary for a proper Engineering program. This is likely the reason why low-performing schools are disproportionately small schools, and why there is almost no small school that performs consistently well in the Engineering licensure exams.

This suggests that CHED should be more strict when approving Engineering programs, especially in small schools, ensuring that schools who offer Engineering courses have well-equipped laboratories and a sufficient number of qualified teachers. One possibility is to encourage Engineering programs that are by themselves too small to invest in well-equipped laboratories to pool their resources together and either to share laboratories and equipment or make common program offerings.

There are very few high-performing Engineering programs in the country, especially in Civil Engineering and Electronics Engineering.[10] CHED can examine these few that have done well to try and identify the factors that allowed them to succeed, including in terms of faculty staffing, admissions procedures, investment in laboratory and equipment, and curricula. There are many regions in the country with no identified high-performing Engineering programs, making it difficult and costly for aspiring Engineers in these regions to get into one. CHED should invest and allocate resources to ensure that, at least at the regional level, there is a presence of a good program in the different Engineering fields. This would complement the government's program to invest heavily in infrastructure and expand development outside Metro Manila and into the countryside.

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[10] *Where high-performing is defined as having a passing rate of at least 75% in the licensure exam in at least 4 of the past 5 years. Only 7 in Civil Engineering, 20 in Electrical, 2 in Electronics, and 28 in Mechanical.*

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For further information, please contact:

Publications Unit
UP Center for Integrative and Development Studies
Lower Ground Floor, Bahay ng Alumni
Magsaysay Ave., UP Diliman
Quezon City 1101 Philippines
Tel. No. 981-8500 loc. 4266 and 4268
E-mail: cidspublications@up.edu.ph

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(Source: Executive Order 9, September 24, 1985).

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