Engineering Education in Brazil by the Numbers

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Abstract

This work discusses the Education Engineering in Brazil, and compares it with higher education in other knowledge areas. Regional differences, course distribution between public and private institutions are discussed issues in this work. The decreasing interest in engineering baccalaureate courses (in Brazil graduation courses) by secondary education students is other aspect related to Engineering Education that are discussed in this work. Engineering courses in Brazil have high rates of abandonment. These rates are discussed in this work. The analysis was based on official data, mostly from INEP (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira) a federal organization associated to the Education Ministry.

1. Introduction

The growing demand on technological qualified labor force shows how technology development plays a key role in national competitiveness in a global age of information. Therefore, a qualified formation of human resources is vital for the nation development. Recent research revealed a shortage of technology workers in Brazil, mostly a shortage of engineers. Educational system, including Engineering Education, has not been in tune with the new technological demands, quantitatively or qualitatively, yet. The World Economic Forum together with INSEAD (Institut Européen d'Administration des Affaires), publishes the Global Information Technology Report, which makes use of the Networked Readiness Index (NRI). The NRI measures the extent to which 133 economies from both the developed and developing world's leverage ICT (Information and Communication Technologies) advances for increased growth and development through a methodological framework, using indicators that reflect the economic performance and environment for the competitive development of nations.

The Brazil's rank has not been improving. Brazil obtained the 59th rank in 2007 and 61st in 2010. Among the best ranks of all indicators are: Financial market sophistication and Level of competition index. However, two indicators that are strongly related with the quality of Engineering Education - Quality of math and science education, and Quality of the educational system , were123 and 107(among 133 countries).These two aspects can be a bottleneck of an Engineering Educational System.

The higher education in Brazil is offered by universities, university centers, schools, higher education institutes and technological education centers. The students have the option of three undergraduate program's types: Bachelor's degree, teaching licensure and technological education. The post-graduation programs are divided into lato sensu (specializations and MBAs) and stricto sensu (Master's and PhD degrees). This work focuses on bachelor degree and stricto sensu post-graduation, Master and Doctorate, degrees. A Bachelor degree requires a course that takes four (usually in Social Sciences and Humanities) to six (Medical Schools) years for completion. Master degrees take two years and Doctorate degrees take three to four years.

Although Engineering Courses in Brazil share many aspects of the Higher Education System with other courses, they have specific issues, like the extreme dependency on math and science education. The engineering education system is designed to train engineers for the

engineering profession and most of engineers in Brazil have bachelor degree. This system has specific issues relative to regional differences, course distribution between public and private institutions, compared to other knowledge areas. Section 2 presents characteristics of Engineering Graduation Courses, bachelor courses mostly, and of Higher Education in general.

2. Characteristics of Higher Education Institutions in Brazil: Graduation Courses

Engineering courses have requirements of minimum of hours. The total of hours can vary from 1600 hours (some short courses) to 6435 hours, with an average of about 3400 hours. Such diversity is spread over all characteristics of courses.

Higher Education Institutions offer three academic degrees through graduation courses: bachelor degree, licentiate degree, and technological degree. Their courses can be distance education courses or on-site presence courses. Most of engineering courses are among the four categories listed in Table 1 (excluding four exceptions).

Table 1: Distribution of Engineering Courses.

Engineering Courses in 2009				
Distance Education Bachelor Degree	Technological on-site	Technological distance education	On-site Bachelor Degree	Total
51	641	583	2073	3348

Most of engineering courses are bachelor courses (62%). Besides, there are very few distance learning engineering courses that permit bachelor degrees. Only 2.4% of bachelor's engineering courses are distance learning courses. On the other hand, the group of Social Sciences, Business and Law courses (Law School, Sociology, Psychology, Management, and other courses) has 43% of distance learning courses in bachelor's courses. Another difference is the proportion of bachelor's courses – only 40% of the courses of Social Science, Business and Law School group are bachelor's courses.

Higher Education Institutions are classified by academic organization type – Universities, University Centers, Isolated Schools, and Federal Institutes of Science, Technology and Education, and by their administrative organization type – Federal Public, State Public, Municipal Public, Private in the strict sense, and non-profit Private Institutions (Confessional Private, and Community Private).

The distribution of new students admitted in Higher Education System by area indicates how appealing is these areas. Figure 1 illustrates these choices in 2009. There are seven areas considered:

1. Social Sciences, Business and Law Schools,
2. Education,
3. Health and Social Welfare,
4. Engineering,
5. Sciences, Math and Computation,
6. Arts and Humanities, and
7. Agriculture and Veterinary.

Engineering and Sciences, Math and Computation have almost the same number of new admissions, much lower than numbers relative to Social Sciences, Business and Law Schools. The low performance in Math and Science possibly contributes for this unbalanced distribution. Enrollments in each of the seven areas also have different distributions relative to the administrative organization type. While in Social Sciences there is a strong presence of Private (in strict sense) institutions, in Engineering there is a predominance of Public institutions. Figure 2 illustrates this. Next sub-section concentrates in Engineering numbers.

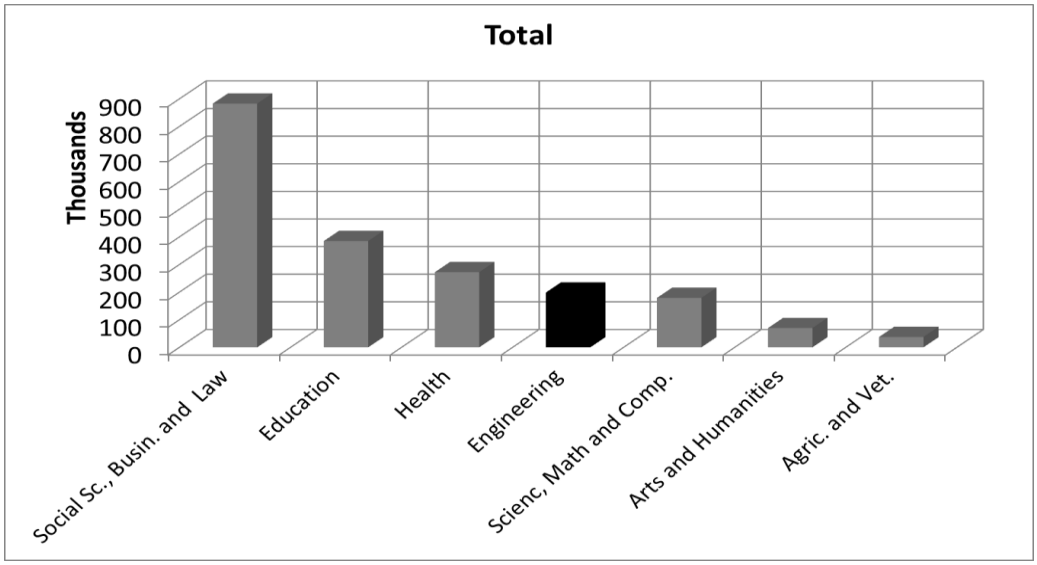

Figure 1 – Admissions in 2009 in each Area.

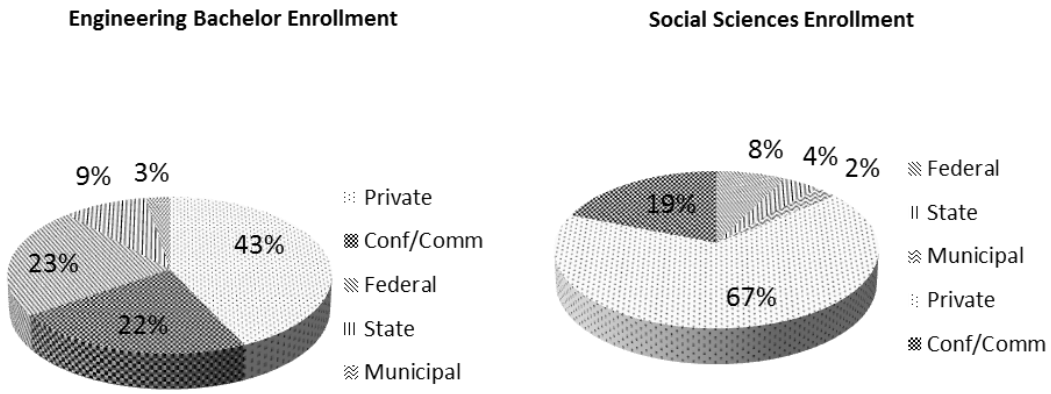

Figure 2 – Enrollment distribution by administrative organization type of Higher Education Institutions: Engineering Bachelor Courses (left) and Social Sciences, Business and Law Scholl Courses (right).

2.1 Engineering Courses

Technology development plays a key role in national competitiveness by giving a country a competitive edge in our age of information. Recently, Brazil has invested huge amount of money to improve infrastructure throughout the country and are facing a problem related to the lack of engineers not only in the needed number but also and - more importantly - well prepared regarding the use of new technologies and a strong scientific background. Large technological enterprises such as Brazilian Petroleum Company (Petrobras) and one of the largest mining companies in the world (Vale), have looked for engineers with this background and have failed to find the number and quality required.

This work does not intend to analyze the lack of quality engineers, but the lack of engineers in numbers. Although there are many indicators that are related with this issue, this work concentrates in analyze the access and the completion rates in Engineering Schools.

In order to enter Higher Education Institutions in Brazil, candidates must undergo a public open examination called "Vestibular", which usually lasts 1–2 days and takes place once a year. Some institutions may run Vestibular twice a year, for two yearly intakes instead of only one. This option is popular with private institutions, while public institutions usually run Vestibular only one time every year. Higher Education Institutions offer a limited number of places, and the best qualified candidates will be selected for entrance.

Recently some universities in Brazil started accepting students according to performance during school and a new entrance examination was designed by the Education Ministry and adopted by most public universities, ENEM (which stands for Exame Nacional do Ensino Médio). Both ENEM and "Vestibular" will co-exist in the future.

Table 2 shows the number of places and the rate candidate/place by administrative organization type of institutions. It can be seen that public institutions have the toughest entrance process.

Table 2: Rate candidate/seat by administrative organization type of institutions.

Administrative organization	*Authorized Admissions in 2009*	*Inscriptions Entrance Process/ Admissions*
Public	52,689	3.01
Private Strict Sense	221,775	1.27
Confessional/ Community	47,817	1.73

Although the numbers in the Table 2 suggest that there are excluded candidates from the Engineer Courses - in many institutions all seats are not be filled. This could show the decreasing appeal on engineering careers. Figure 3 illustrates how this issue affects institutions by administrative organization. Private institutions have 52% of offered places unfilled. On the other hand, public institutions fulfill all places in Engineering Courses.

Another important indicator is the completion rate of Engineering Courses. This indicator shows current tertiary completion rates in education systems, i.e. the percentage of students who follow and graduate from tertiary programs.

In this work completion rate correspond to the division of graduation by entry rates. Completion rates are defined as the proportion of new entrants into any level of education who graduate. Dropouts are defined as students who leave the Engineering course. Data on graduates and new entrants are based on the INEP (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira - a federal organization associated to the Education Ministry) annual data collection.

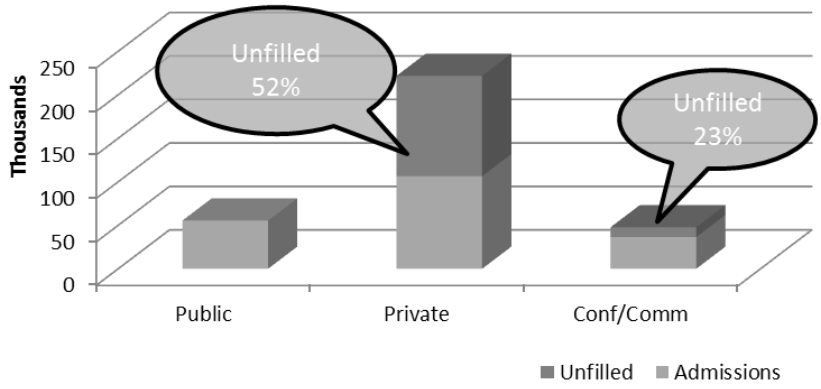

Figure 3 – Places unfilled in engineering courses by administrative organization.

The completion rate is affected by geographical localization of the courses. Regional differences in completion rates can be illustrated by the Table 3. Rates were calculated for each geographical region. This table shows the proportion of students that graduate by students that finished secondary education.

REGION	PERCENTAGE
South	3,11 %
Southeast	2,63 %
Midlle-West	1,47 %
North	0,87 %
Northeast	0,80 %

Table 3: Graduates/ Students that finished secondary education.

High dropout rates may indicate that the education system is not meeting students' needs. For countries with low completion rates (there may be many reasons why students do not complete a degree), policy makers have much room to maneuver to raise the number of graduates and meet labor force needs. Similarly, in countries with low access to tertiary programs, high completion rates compared to the average can counterbalance the first.

Engineering courses have high rates of dropout. Although they are different for public and private institutions, they are high in all cases. Table 4 shows these rates, in percentage, by administrative organization.

Table 4: Abandonment in Engineering courses.

Administrative Category	*Dropout*
Public	*59%*
Comun/ Confes	*75%*
Private	*75%*

In these calculations all courses were considered, from bachelor degree courses to short courses.

3. Conclusions

The low interest in engineering courses by secondary education students, allied with high rates of abandonment, in Brazil could affect national competitiveness. Inspiration for improving our Engineering Education can be found locally. We should investigate what is adequate and what is not. Studying the differences in Higher Education may contribute to improve Brazilian Engineering Education.

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