ENGINEERING EDUCATION FOR A STRONG KNOWLEDGE SOCIETY IN ROMANIA

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Abstract. This paper aims to X-ray the engineering education from Romania, as the technical tertiary education is seen as a promoter of a smart and strong economic growth that is necessary to exit the present economic crisis. This goal is achieved by portraying the current engineering education developed in Romania and by placing it in an international context. The engineering education proves to be one of the pillars of a strong knowledge society as it offers the key competencies and skills to produce quality outcomes in terms of research and innovation.

1. INTRODUCTION

The knowledge-based society is an economy that properly uses the scientific knowledge as a competitive economic advantage and is based on creativity and innovation. These two key-terms encompass very well the engineering education, which is assumed to provide creative and innovative graduates, with the capacity to develop new sustainable solutions that are both technically and economically viable, within given constraints (social, ethical, political, environmental, commercial). The importance awarded to learning constitutes the cornerstone of the knowledge-society, especially education in the domain of science & technology. Engineering education is assumed to provide graduates endowed with a creative, flexible and systematic thinking that enables them to tackle various areas of activity, being also proficient in operation at an international level.

The current economic crisis represents a new driver of change that highlighted the importance of higher education as an investment for the future of individuals, by insuring better employability and reducing unemployment and poverty. The most recent strategy launched by the European Union (EU) seeks to counterattack the crisis by recommending the promotion of higher education and especially the sufficient supply of graduates in science & technology, engineering and mathematics (STEM) [1]. Similar to other European countries, Romania depends on technically skilled workforce that is required for economic recovery and sustainable growth, which will also pave the pathway to a strong knowledge-based society.

2. CRITICAL ANALYSIS OF THE ENGINEERING EDUCATION IN ROMANIA

The number of students in tertiary education rose during the last decade worldwide and in the EU and this demand is likely to increase in the next years, as the people with higher qualification tend to be more “employable” than others with lower education [2]. 19 million students were enrolled in tertiary education in EU-27 at the end of 2007, showing an increase of 19% compared with 2000. At the same time, a larger interest in engineering education was recorded over the world, for instance in 2007 more than 4 million first university degrees were earned in science & engineering worldwide, EU-27 accounting for a 19% of them (760,000), China for 21% and USA for 11% [3]. In EU-27, in 2007, the percentage of tertiary education graduates in the domain of science & technology per 1000 inhabitants was 13%, while engineering graduates accounted for about 12% of all graduates, showing an increase of 2% since 2002 [4].

The student population in tertiary education rose spectacularly during the last 20 years in Romania, after the falling of the Communist party at the end of 1989. The total number of the enrolled students increased from 192,810 in the academic year 1990/1991 to 907,353 in the academic year 2007/2008 [5], showing a total vigorous increase of 370%, registering a mean growth rate of 21.8%/year. However, the data after 2005 also contain students studying under Bologna auspices, thus there might be students taking second degrees.
The engineering education in Romania has an old and prestigious tradition and was started in 1818 by Gheorghe Lazar who founded the first technical higher education school with Romanian as a teaching language in Bucharest. Today, the number of institutions with official accreditation or provisional functioning authorization offering at least one Bachelor's degree program in engineering is quite large, scoring a number of 42, recording a percentage of 38.5% of all universities (see figure 1).

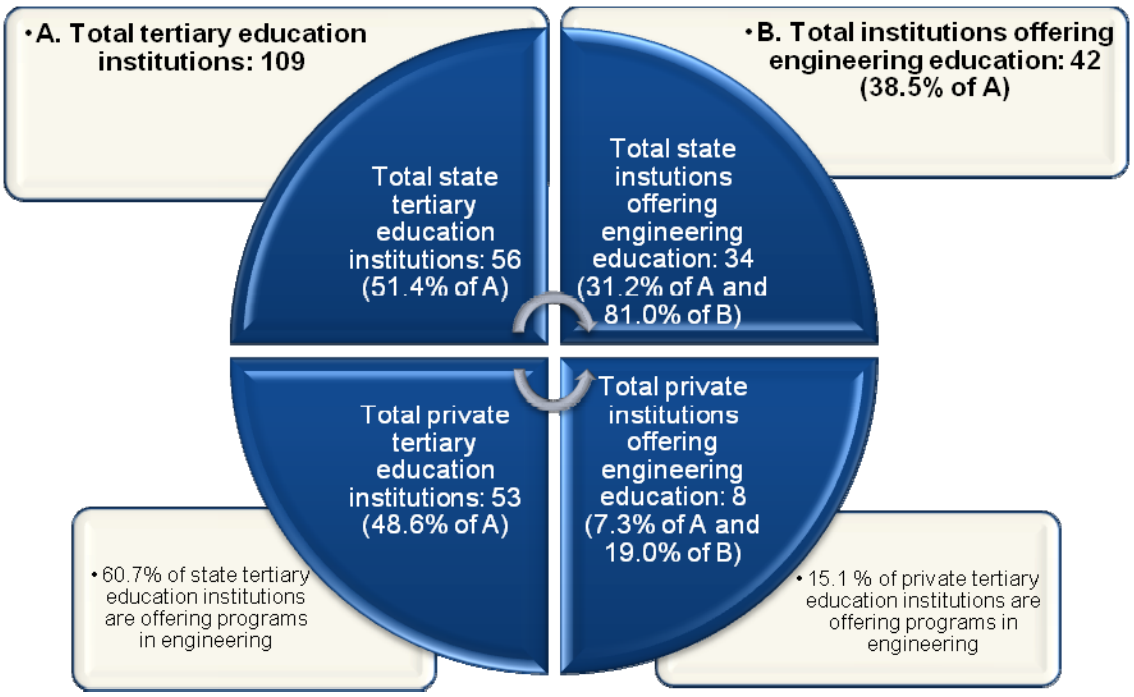

Figure.1. Tertiary education institutions offering engineering education in Romania.
Source: computed from Official Journal of Romania – Monitorul Oficial (MO), MO 465/06-07-2009, Part I-B.

The appealing for technical tertiary education rose too, but at a much smaller rate of a mean 2.82%/year, showing a steadily small increase over the 1990-2008 period, from 120,541 students in 1990/1991 to 178,258 students in 2007/2008, illustrating a total 47% growth. The engineering students accounted for 63% of all student enrollments in 1990/1991, while at the end of 2008 the figure dropped to about 20%. Taking into consideration the huge growth of student population, one may assert that this is a significant change and the students were much more interested in other specialties, like, for instance, economics that registered more than 10 times increase over the mentioned period. The reasons of this choice are varied and embrace a whole range of motivations. From the obvious initial ones arisen after a long period with a totalitarian regime and a decrease in industrial activity, to the introduction of private tertiary education institutions with laxer educational requirements, and the more recently launched "4 years +2 years" for a Master degree in engineering that underpins the Bologna process, all have left a mark on the students choice.

The total demand for tertiary technical education, after a dramatic decrease in 1995/1996, recovered ground mostly due to the contributions of constructions and electrical engineering. Unfortunately, some engineering specialties, like chemical technology/chemical engineering, faced a dramatic decline of student enrollments, registering a halving of its students since 1990 (from 8,262 in 1990/1991 to 4,008 in 2007/2008). The first dramatic change appeared in the year of the debut of private tertiary education in Romania (academic year 1995/1996), when more places were available to youngsters, very few in engineering. The second event that deepen the decline in the number of students in chemical technology might be attributable to the introducing of the Bologna process, which requires 3-years degrees for other specialties aside engineering (4-years program for Bachelor's degree in engineering), this pushing further away students to more "rapid" achievable degrees, like economics (see figure 2).

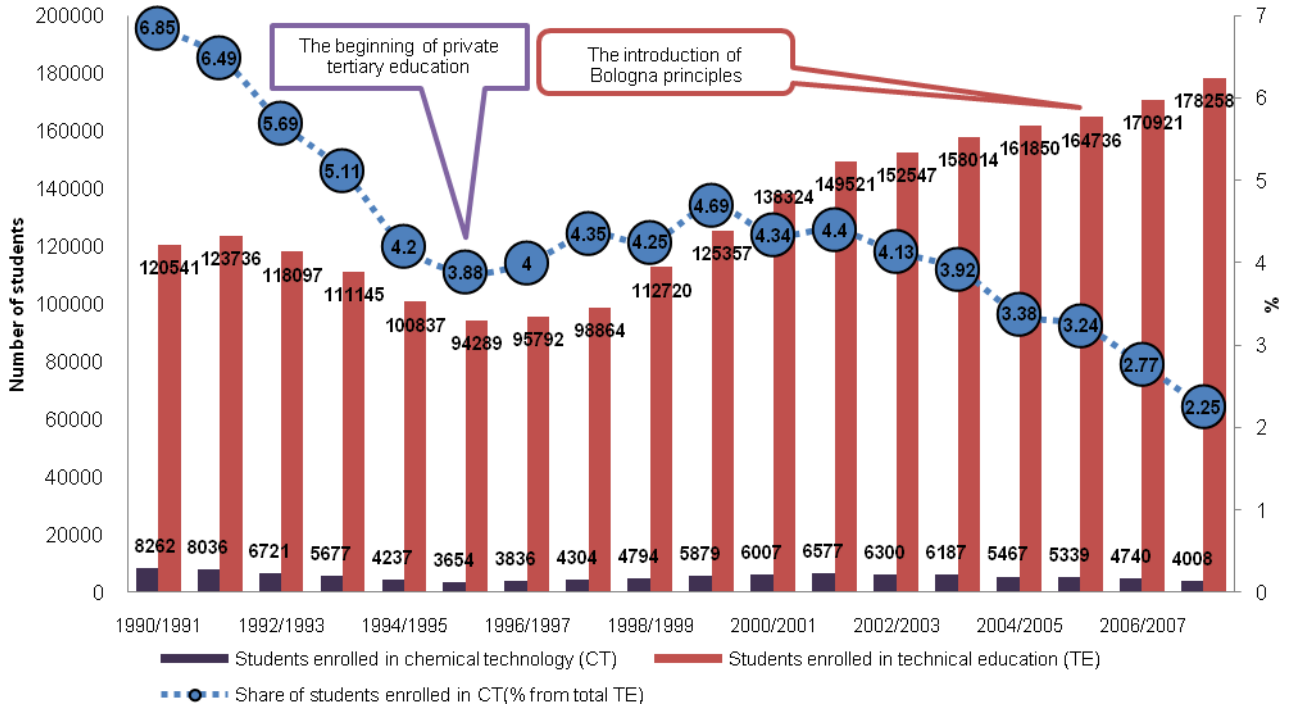

Figure 2. The evolution of the student enrollments in tertiary technical education in Romania during 1990-2008.
Source: computed from The National Statistics Institute (NIS), Romanian Statistical Yearbook, 2009.

The number of tertiary graduates in EU-27 has risen with a pace of 4.3%/year since 2000, reaching a total 35% increase in 2007. One reason of this strong increase resides in the introduction of Bologna process that took place in during 2002-2006 in most of the European countries. In Romania, the number of tertiary graduates increased massively, recording a 384% increase in 2007, compared with the value of 1990 (the year 2007 does not contain Bologna graduates). The graduates in technical education increased over time, but their share in the total graduates decreased progressively over the studied time interval, from a value of 70% in 1990, to 19% in 2007. Unfortunately, in terms of the number of engineering graduates in chemical technology, the same negative trend was registered and the numbers declined from 1,379 in 1990/1991 to only 876 at the end of 2007, scoring a total 36.47% decrease over the mentioned period.
The importance of higher education, especially technical, was recognized by the EU since the launching of the Lisbon strategy for jobs, growth and competitiveness [6]. The benchmarks set by the Council of EU involve several indicators to be achieved by 2010

and 2020. The ones referring to tertiary education involve an increase of at least 15% in the number of tertiary graduates in STEM, a 40% share of adult population (30-34 year olds) with tertiary educational attainment and a 2% investment of Gross Domestic Product (GDP) in higher education. Romania has registered a progress only in complying with the first benchmark, but despite the general positive high numbers, the current trend is negative, as portrayed above. Regarding the second benchmark, Romania has a long road to meet the 40% benchmark from the present 16%, being among the countries with the lowest attainment rates for adult population. The last benchmark is even harder to achieve considering the economic downturn and the Government unwillingness to invest in higher education. The spending per student in tertiary education registered only 0.90 of GDP in 2006, very far from the Lisbon benchmarking of 2%.

3. ISSUES TO BE ADDRESSED IN ROMANIAN ENGINEERING EDUCATION

Unfortunately, a future increase in student enrollments in some engineering specialties, like chemical engineering, will be difficult, considering also the demographic changes and the declining interest of the youngsters in those studies. Therefore, major efforts should be directed to promote and support engineering education by all the stakeholders involved (Government, universities, students and graduates in engineering, public and private enterprises).

The first approach is to communicate the valences of engineering to interested stakeholders, which should be made aware of what the engineering carrier entails. Chemical engineering provides the graduates with a superior technical versatility that makes them able to work in a diversity of fields, not only in chemical industries, but also in the modern matters of sustainable development and climate change, renewable energy, biomaterials and nanotechnology. Therefore, engineering should be perceived as it really stands for, a way to personal achievement and success in modern times.

The second approach is to redesign the engineering curricula, as knowledge of basic engineering science is necessary, but not enough. The development of “soft skills”, like team work, ability to communicate, managerial thinking, are essential for engineers in today’s economy, as this is what the industry is seeking [7] and this will lead to the enhancement of graduates’ creativity and entrepreneurship. Therefore, more room has to be made for “soft disciplines” in the engineering curricula, but unfortunately it is already crowded with fundamental knowledge in mathematics, physics, chemistry, and so on. The effect of the introducing of Bologna process for engineers (4 years program accumulating 240 credits) was that the “liberal disciplines” were squeezed out - foreign languages, history, economics, management etc [8]. The solution is to act on the only variable left, as fundamentals cannot be sacrificed, namely time. Therefore, the second cycle conducting to a Master degree should become the recognized standard for professional purposes, implying a 6 years program, accumulating 240+90/120 credits. In such a way, the expanded program will give more room for the development of soft skills, the “liberal disciplines” being developed throughout the entire program. It might be argued that in such a way the already long educational cycle will become even longer, but not complying with today’s standards might have a dramatic effect on certain engineering programs.

The third approach refers to improving admittance standards. Unfortunately, there specialties that are not based on rigorous selection process, due to seemingly lack of competition, so less qualified students are attracted. Lowering the admittance standards determines a further decrease of the educational requirements, and the students will manage to pass their exams without really understanding what the disciplines are about. This is really counterproductive and will have as effects the undermining not only of the universities reputation, but also, more importantly, the country’s competitiveness.

The forth approach refers to the attraction of talented and enthusiastic persons towards engineering programs. Consequently, university-business partnerships must be fostered and made public and these will guarantee that more students will be aware of their opportunities. Additionally, these actions will lead to an easier integration of students on work placements and internships, providing them with reliable specialty knowledge. Moreover, a system of study and research grants should be available especially to engineering students and should be properly advertised. The relations with other universities from abroad must be strengthened and made public. More students should be involved in foreign scholarships and this opportunity must be aggressively advertised by the universities supporting exchange/research programs. Universities must understand that the international experience is of tremendous importance, as the students with study-abroad experience will have a competitive advantage on the labor market, being more prepared to communicate in foreign languages and more culturally sensitive. However, it might be argued that the effect will be a massive brain-drain from Romania, but this could be counterattacked by Romanian Government working closely with universities, involving better return migration policies, higher research & development public expenditure and more available academic positions for high-skilled persons. Moreover, by strongly involving into mobility programs, the number of foreign students attending engineering programs in Romania might be increased. The level of the foreign tertiary student participation in Romania represented 1.3% of all tertiary students enrolled in the country, while the share of all outgoing tertiary students scored 2.2% (data for 2007) [9]. Therefore, currently Romania is a net sender of students, but at very low levels compared with other European countries.

The fifth approach involves a proper funding of tertiary education by the Romanian Government. The percentage of public spending on education (% of GDP) in Romania grew from 2.86% in 2000 to 4.3% in 2006, while the EU-27 mean reached a value a little over 5% [9].The spending per student in tertiary education grew over the last years, from a value of about 20% of the public spending on education in 2001 (representing 0.70 of GDP) to about 22% in 2006 (representing 0.90 of GDP). These percentages bring Romania among lowest performers in EU-27, the mean average of the European region recording percentages of 1.08 and 1.12%, respectively [9]. The absolute amount in the public funding reached 5,000 RON/student/year (about 1,200 EUR) in 2008 [10]. Judging the figures in purchasing power parities, this sum brings Romania on the last place among EU-27 in terms of public spending per student [4]. Unfortunately, in Romania investments in education are not considered as priorities, given the present economic downturn. Considering the Romanian dramatic scoring in public education funding and the massive decrease of GDP in 2009, the Government should find better ways to invest in higher education as an essential part of the recovery plan, and not to further cut the public funding for tertiary education.

The engineering education provides the foundations for a strong knowledge-based society that relies on creativity and innovation, if properly addressed. In terms of innovation, currently Romania stands well-below the mean European performance, as portrayed by the European Innovation Scoreboard (the innovation index is a composite index, made up of 29 indicators, among which tertiary education students, graduates and PhD holders in science & engineering). The global innovation score of Romania in 2008 was of 0.277, a very low figure compared with the European mean of 0.475 (data for 2008) [11].

4. CONCLUSIONS

In the longer term, the Romania's economy is going to depend on the skills and preparation of the graduates produced by the current Romanian educational system. The

investments in higher education will assist the Romanian economy to re-launch in the short-term and will contribute to the long-term economic competitiveness. Engineering education is one of the keys towards a strong knowledge society, as it produces high skilled persons with fresh ideas that can be translated into research, innovation and competitiveness.

In order to build a strong-knowledge based economy, the Romanian education system should produce sufficient graduates in engineering, both in quantitative and qualitative terms. The labor market for engineers is characterized by major changes that imply significant challenges for the future professionals. Their role is changing and a new skill profile is requested, as engineering graduates should be provided with appropriate knowledge in such a way that they should be able to continuously self-evolve in order to cope with the permanently changing market requirements and societal needs.

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