

THE PLACE OF ENGINEERING SCIENCE HUMAN RESOURCES IN THE RESEARCH & DEVELOPMENT ACTIVITIES IN ROMANIA

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Abstract: Between 2000 and 2006, Romania run through the transition imposed by “a knowledge-based society”, and the research & development activity played a primordial role.

The nationally established objectives regarding the creation and exploitation of knowledge concern the European research and innovation area, the education and training within this domain, as well as the matters related to the commencement and development of innovative business.

Competitiveness increase in a globalization world also comprises research and development domains, which by their activities must harmonize knowledge to human, financial and material resources.

In this context, human resource represents the basis of research and development activity, and the work results display the essence of the Romanian scientific community performance.

The place of human resources within the Romanian engineering science is reflected by means of an analysis concerning the evolution and structure of researchers, as the main human component involved in the research and development activity.

As compared to the other research and development domains, the engineering and technologic scientific research is the best represented one as regarding the number of employees developing such activities. This fact is highlighted by the structural modifications established between the years 2000 and 2006. Romanian scientific community must be oriented towards the education of the human resources in the field of engineering and technologic sciences.

In this respect, certain documents have been elaborated in order to explicitly present the contribution of the professional and technical education to the accomplishment of the 2007-2013 National Development Plan objectives.

It is also necessary to intensify the activity of the national managers towards offering a wide range of career opportunities in order for the modern engineers to be very good from the professional point of view and have better chances.

The current orientations represent fundamental landmarks used in order to increase the capacity of human resources to interactively respond to labor market.

By complying with the strategies formulated in order to establish the place and role of human resources within competitive market, the human capital in the field of research shall be construed as being the decisive factor for progress, assuming that the investment in this human research fund is the most profitable of all.

1. THEORETICAL ASPECTS CONCERNING RESEARCH & DEVELOPMENT ACTIVITY

Research and development are reflected from the point of view of both scientific research activities and technological development, taken as a whole.

Scientific research activities and technological development are marked out by those systematic activities oriented toward creating, developing and applying scientific and technological knowledge in the fields of science and technology.

The scientific research is represented by the main divisions including fundamental research activity and applied research, and it has scientific investigation, scientific technology, scientific product and scientific service as its main components.

The activity oriented towards attaining new scientific knowledge and towards formulating and checking new theories outlines *the fundamental research*.

The applied research is the activity concerning widening the knowledge base and using new knowledge in order to create or improve new processes, products and services.

The technological development presupposes the activity of transforming the scientific research results into plans, schemes and documentations, materializing the latter into new processes, products and services, as well as perfecting the existing ones in order to directly respond to the market demand, and it includes engineering and technological design activities and activities of manufacturing experimental models, by developing, transferring and applying the research results to economy and society.

The state policy regarding research & development, innovation and technological transfer (herein referred to as – domain of science and innovation) is a component of the state policy concerning socio-economic, educative and cultural fields, which is oriented toward development, coordination and stimulation of the activity performed within the domain of science and innovation and accomplished by generating new ideas and by implementing technical and scientific achievements.

It has been ascertained that the fundamental scientific research is the essential element of the entire scientific research and technological development, due to its high-risk universal character. This includes: main, formative, multidisciplinary and special research activities.

The main research activities, which are recognized by international scientific community as being of major importance, have two essential components: human force and important material means, with tradition, results and major objectives.

2. THE TENDENCIES OF ENGINEERING SCIENCE HUMAN RESOURCES KNOWLEDGE, EDUCATION AND TRAINING IN REGARD TO THE RESEARCH & DEVELOPMENT ACTIVITY IN ROMANIA

In a knowledge-based society, human resource represents a major component aiming not only at the main research activities, but also at the entire research and development activity.

One of the main European objectives is represented by the creation of a society based on *human resource knowledge, education and training* as a priority task. The purpose of the respective objective includes the provision of an adequate education system, according to the current requirements. The training of the human resource is supposed to be performed based on three target groups:

- young population;
- adults unemployed;
- employees working in trades considered as being a redundant source.

The European Research and Innovation Space includes the elimination of certain obstacles comprising both research mobility, and the European parliamentary structure specific to the R&D policies of the Member States.

The presentation of the Romanian engineering science human resource position can be reflected only in the context of an analysis of the evolution and structure of the

researchers, as the main human component involved in the research & development activity.

By taking over the statistical data regarding the number of researchers out of every 1000 occupied civil persons, an increment tendency has been established throughout the entire analysis period, i.e. 2000-2006. Given the average registered number of approximately 31 researchers out of every 1000 occupied civil persons per year, it has been established that this increment is of 1 researcher out of every 1000 occupied civil persons per year, which is reflected by an average increment of 4, 78% per year.

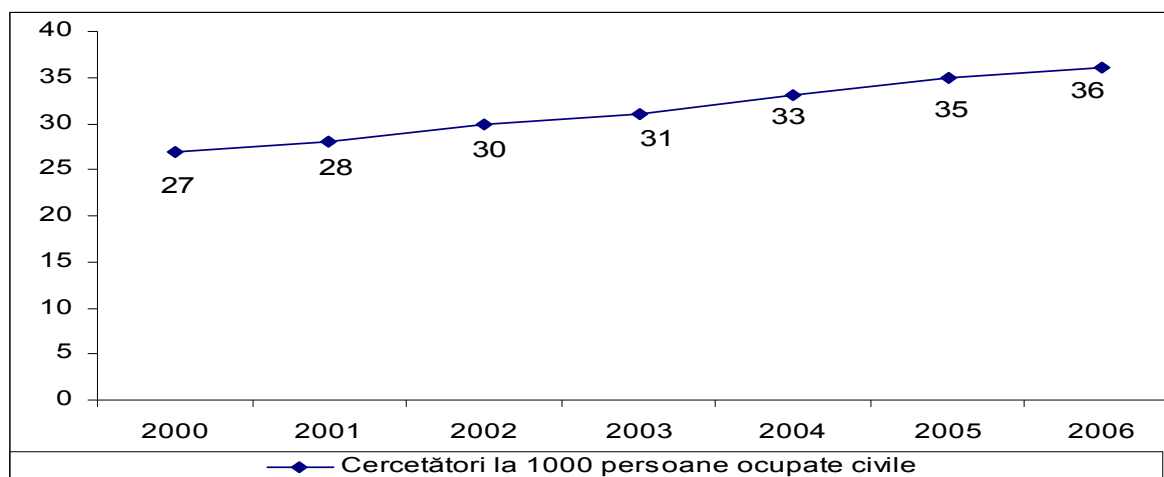


Diagram 1. The evolution of the number of Romanian researchers out of every 1000 occupied civil persons

The evolution of the number of Romanian researchers out of every 1000 occupied civil persons may be considered satisfactory, due to the fact that this indicator has increased throughout the entire analysis period.

This increment is low in proportion to the international requirements, and this fact is justified by the 15th place currently occupied by Romania in the top 28 countries of the world regarding the research & development activity personnel, with 22 958 researchers.

The classification of the researchers based on their occupation has allowed the quantification of the employees, as it is presented by table 1 below:

Table 1 – The research & development employee structure based on their occupation, between the years 2000 and 2006

Types of researchers based on their occupation	The research & development employee structure						
	2000	2001	2002	2003	2004	2005	2006
Certified researchers	60,42	60,44	61,85	63,38	63,72	69,11	66,57
Technicians and assimilated	19,13	18,24	19,63	16,43	16,56	15,04	14,60
Other employee categories	20,45	21,32	18,52	20,19	19,72	15,85	18,83

The structural fluctuations established for the period 2000-2006 are reflected by the structural modifications in both directions, increasing and decreasing, which have been registered every year regarding technicians-assimilated and other categories of employees, in favor of the researchers, whose number has permanently increased every year.

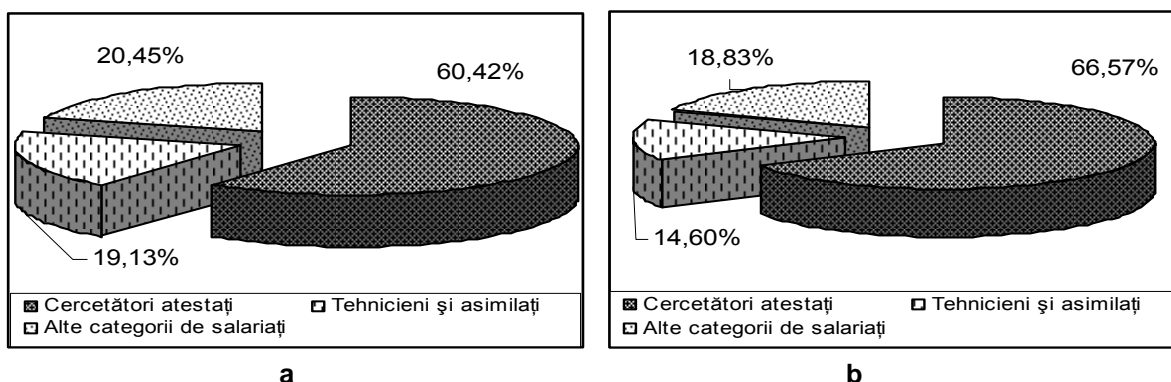


Fig. 1. Research & development employee structure based on their occupation, in 2000 (a) and 2006 (b)

The structural changes registered in favor of the researchers, by the diagrams presenting the research and development employee structure in 2006 as compared to 2000 are the best reflected ones. The 6, 15% difference is significant for showing the great stress laid in the last years on orienting the employees in this domain towards the researcher statute.

A suggestive image of the assignation of the research and development employees according to the execution sectors is highlighted by the determination of their structure, which is displayed in diagram 2:

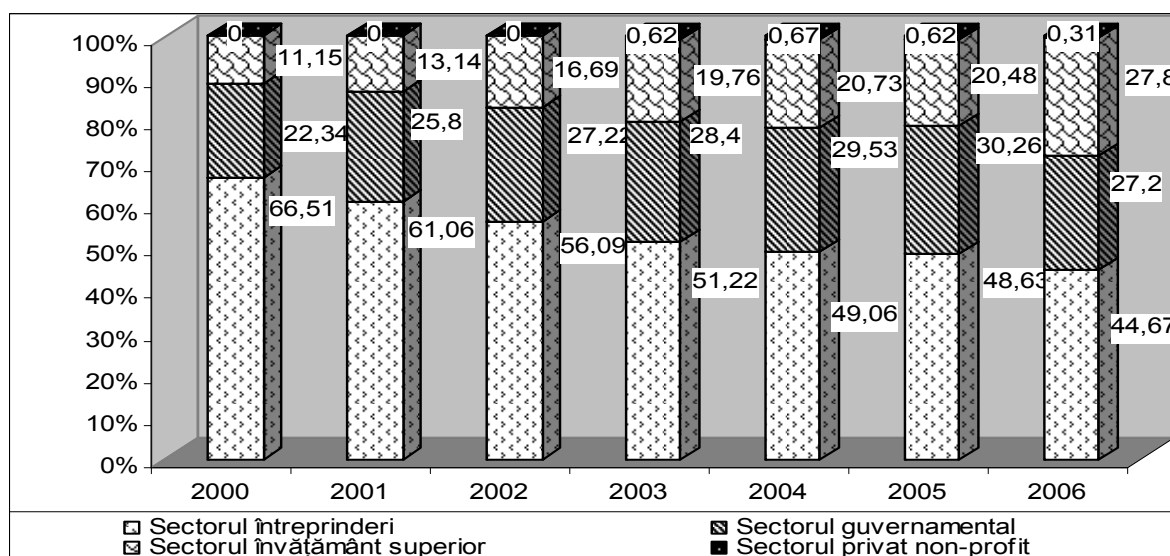


Diagram 2. Research & development employee structure based on execution sectors, for the period 2000-2006

This diagram displays the year-to-year structural changes registered by each sector. The 1st place is occupied by the company sector, in which most of the researchers' work, only that the decrease in annual percent changes indicates their reorientation towards the other execution sectors.

The current European requirements have emphasized the orientation of the higher and governmental education towards the intensification of the research activity. This reorientation of the respective sectors is highlighted by the increased number of researchers, which is reflected by year-to-year percentage increase, so that both sectors have achieved nearly the same percentage (around 27%) for 2006.

In this context, the research & development employee structure based on the professional level has been established both for 2000 and 2006, in order to show the structural changes undergone by the latter:

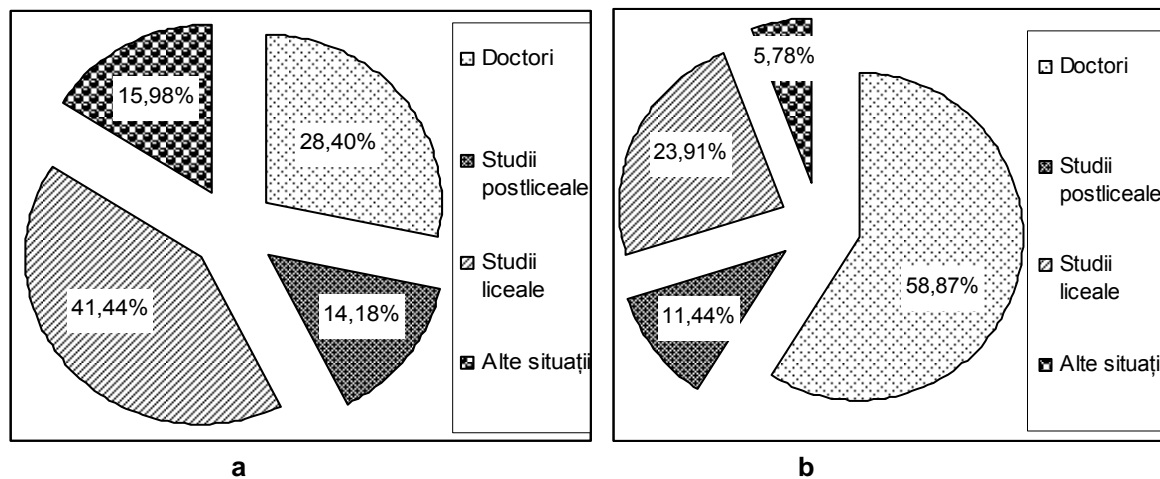


Fig. 2. Research & development employee structure based on the professional level, in 2000 (a) and 2006 (b)

The most important fluctuation has been established for the research and development employees with high school diplomas, whose number nearly halved, whilst the number of research and development employees with doctor's degrees doubled. Thus, while the major part of the employees performing research and development activities in 2000 had high school diplomas (41, 44%), the ones with higher education degrees predominated in 2006 (58, 87%), due to the fact that the current requirements on increased competitiveness take into consideration the high-quality standard of research, which presupposes the use of adequate labor resource to serve the current orientation of labor market.

The difference established for the other situations of the research and development employees' category is significant, decreasing from 15, 98% to 5, 78%, while the employees with high school diplomas category has registered a low percentage difference in 2006 as compared to 2000. The established difference constitutes only 2, 74%, which means that the number of researchers with post high school degrees is quite constant as compared to the other categories. Thus, this type of employees is not especially regarded, nor it is considered useless, being trained and perfected in this scope of activity.

The importance of the Romanian research human resources may be established by reflecting and highlighting the research & development employee structure in proportion to the prior scientific domains: natural and exact, medical, social, engineering and technological, agricultural and humanistic sciences.

If we analyze the research and development employee structure based on scientific domains, we can notice that the engineering research domain is the best represented one in proportion to the others domains, achieving the highest ratios from 2000 (62, 47%), to 2006 (43, 33%).

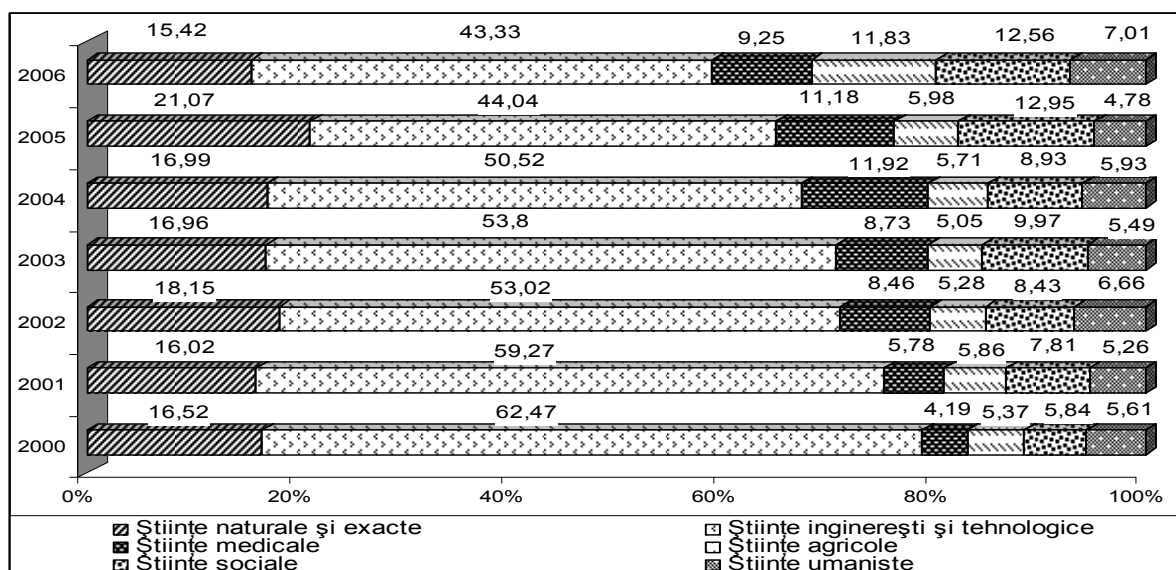


Diagram 3 Research and development employee structure based on scientific domains, for the period 2000-2006

In 2000, the medical sciences were represented by the lowest number of researchers, achieving only a ratio of 4, 19%. Year by year, the intense concern for increasing the quality level of this domain has been observed, by the sustained increases in the number of employees involved in the research activity, so that in 2006, it has achieved the ratio of 9, 25%, outrunning the humanistic sciences, which have maintained a relatively constant level of the number of employees involved in the research and development activity, achieving only 7, 01%.

Researchers, as the essential element in developing the engineering and technological science, constitute the most representative component of the human resources afferent to this domain. The engineering and technological science is considered as being a domain necessary for human existence. The changes it experiences demand variations and developments in scientific staff training and perfecting.

Although the number of researchers involved in the engineering and technological sciences is far higher than the one of the other scientific domains, this indicator has slightly decreased by an average of 1, 72% per year for the period 2000-2006, representing an average decrease in the number of employees of 239 researchers per year.

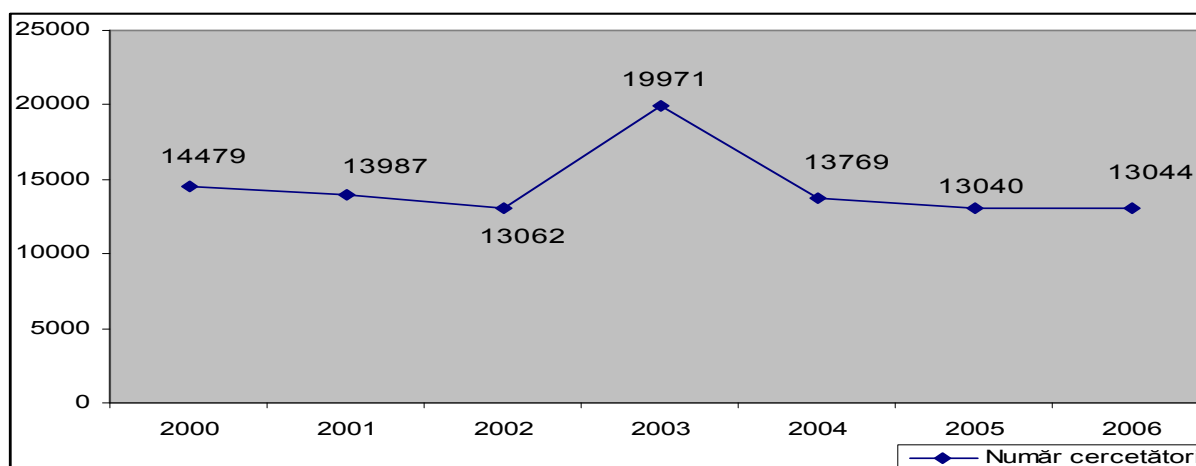


Diagram 4. Evolution of the engineering and technological science researchers, for the period 2000-2006

This diagram shows the tendency of the number of researchers involved in engineering and technological science, as an almost constant evolution oscillating around a value of 13500 researchers.

Nevertheless, there was an exception registered in the year 2003, when the number of researchers reached the maximum level of 19971 persons, which was justified by the attempt to encourage human resources to work in this domain, either by training programs especially organized for the researchers, or by programs for orienting the financing funds towards engineering and technological sciences.

This attempt to revigorate the engineering and technological science domain by attracting human resources in research failed because the financial offer didn't meet the expectations of the researchers, who looked for a financial appreciation in proportion to their effort either abroad, or in other domains.

According to the recommendations of the European Union on encouraging the exact and engineering sciences, Ministry of Education and Research has had the initiative and support of the Romanian Government to create the opportunity to increase the number of qualified persons, both by higher education and especially by high school education.

In this context, the professional and technical education system must bring a substantial contribution to the socio-economic development, by providing initial and continuous training programs for the labor force. The guidelines shall be established not only based on the demographic tendencies and social policies, but also according to the prognosis regarding the labor market evolution.

3. CONCLUSIONS

In the period 2000-2006, the engineering and technological scientific research domain, as a strategic sector established by most of the European countries, still runs through the transition stages. This transition demanded by a "knowledge-based society" is oriented towards stimulating knowledge creation, absorption, diffusion and exploitation.

Encouraging the development of certain innovative business must prevail in order to raise the quality standards of the research and development activities within engineering and technological sciences domain.

This direction is oriented toward the applicative research – technological transfer relation. This initiative includes the costs of certain structures specific for the initiation of certain business in the Member States of European Union and for introducing certain maps for the small companies. In this context, this innovative process continues the review of the financial instruments for directing the formation of a support in order for high-tech companies, small companies and other initiatives regarding risk capital to commence their business.

Romanian scientific community must be oriented toward the determination of certain assessment criteria regarding scientific engineering research, as a necessity of increasing competitiveness in a globalization world.

The presented orientations concerning the education of the human resources involved in engineering and technological sciences can be found within the strategic planning documents of the education offer elaborated nationally, regionally, locally and at the level of the education facility. These documents have been elaborated for the year 2013, in order to explicitly present the contribution of the professional and technical education to the accomplishment of the 2007-2013 National Development Plan objectives.

The current orientations represent fundamental landmarks used in order to increase the capacity of human resources to interactively respond to labor market.

The idea of concluding a National Education Pact between the main society components (organizations, associations, etc.) and the education components represents a present-day fundamental requirement, as an expression of a national priority in the European and international context.

It is also necessary to intensify the activity of the national managers towards offering a wide range of career opportunities in order for the modern engineers to be very good from the professional point of view and have better chances.

Practical realities have shown that human resources shall become a stronger advantage in the future, being considered as the decisive factor of progress. It is estimated that the investment in this human capital shall be the most profitable of all.

The Pact acceptance indicates an extremely favorable state of facts and mind for further promoting consensus and raising human and professional qualities of the Romanian researchers in order for them to reach the international competition level.

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