AN OVERVIEW OF HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY (HRST) FROM RESEARCH DEVELOPMENT AND INNOVATION (RDI) SECTOR DURING 1993-2009 IN ROMANIA

Nicolov Mirela [1,2]
[1]*University of Oradea, Faculty of Economic Science*
[2]*Aurel Vlaicu University of Arad, Faculty of Engineering*

The present paper present a study done on the Human Resources in Science and Technology (HRST) in Research Development and Innovation (RDI) sector in Romania during 1993-2009. This paper started from the elements defined in Canberra Manual based on the qualification and occupation. Labor force in this study refers to university level and technician level as skill from education. These definitions from Canberra Manual for HRST were used in the present paper in reference to all the researchers in Romania for different areas of research as engineering and technology sciences domains, natural and exact sciences, medical sciences, agricultural science, social sciences and humanities. After a short presentation of the US origin of the Human Resources in Science and Technology Management and the situation from Europe, the present paper are dealing with the area of the Human Resources in Science and Technology system from Romania, the sector of Research Development and Innovation. This study is focused on the employees by categories of the activities in research, development and innovation sector. We took into account the employees with different categories of graduation diploma which are working in the fields of research and development activities too. Samples data were took from Tempo online database from National Institute of Statistics from Romania, updated database in 21 of October in 2010. Data were took for simulations in December 2010. We try to do a simulation on the evolution of Human Resources in Science and Technology (HRST) in Research Development and Innovation (RDI) sector in Romania during this period (1993-2009) and we observed that real data fitting on a regression curve of sixth degree whose coefficients were defined during this study. This type of simulation can be good for future forecasting for Human Resources in Science and Technology in Research Development and Innovation (RDI) sector in Romania.
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1. Introduction

From Canberra Manual, the fifth Frascati Manual, the demand for Human Resources for Science and Technology (HRST) as definition is based on two dimensions, qualification and occupation. The qualification axis tell us about supply of HRST the number of people who are currently or potentially available to work at certain level. (OECD, Canberra Manual, 1995)
The demand for HRST, the number of people who are actually required in S&T activities at a certain level, is related to the occupation dimension.
HRST are people who fulfill one or other of the following conditions: successfully completed education at the third level in an Science &Technology field of study; and not formally qualified

as above, but employed in a Science &Technology occupation where the above qualifications are normally required.
HRST can be split into two major categories. (OECD, Canberra Manual, 1995): University- level HRST and Technician-level HRST.
The split between those two is related to skill levels and thus mainly to education. In general, education at the third level begins at the age of 17 or 18 and lasts three or more years. Successful completion of either a first or a postgraduate university degree (or equivalent) is the main criterion for university level HRST, whereas an award lower than a first university degree is the criterion for technician-level HRST.
The International Standard Classification of Education (ISCED) is the classification both of levels of education and field of study.
ISCED levels of education. (OECD, Canberra Manual, 1995)
0 Education preceding the first level; **1** Education at the first level; **2** Education at the second level, first stage; **3** Education at the second level, second stage; **4** (Not attributed), **5** Education at the third level, first stage, of the type that leads to an award not equivalent to a first university degree; **6** Education at the third level, first stage, of the type that leads to a first university degree or equivalent; **7** Education at the third level, second stage, of the type that leads to a postgraduate university degree or equivalent; **8** (Not attributed); **9** Education not definable by level.

2. Literature review

The theories of Human Resources Management has the origin in United States of America (Brewster, 2004; Brewster, 1994). The management of Human Resources in particular has been heavily influenced by thinking in USA.
The impact of the globalization was influenced on the way that people are managed, particularly in Europe Union (Brewster, 2004; Brewster, 1994). In human resources management (HRM) in particular is the US model of HRM one that will inevitably be followed in Europe? Our understanding of management in general and human resources management in particular has been heavily influenced by thinking in the United States of America. This is perhaps not surprising from a country that has been for decades the largest economy in the world. HRM like many other aspects of management was originally conceptualized and developed in the United States of America. The study of personal management which was "partly a file clerk's job, partly a housekeeping job , partly a social worker's job and partly a fire-fighting to head of union trouble" (Drucker, 1989). The American's theories about HRM would work anywhere in the world. "Relationships between the structural characteristics of work organizations and variables or organization context will be stable across societies" (Hickson et. all, 1974). Their main findings from cases in the USA, Canada and then UK were that companies are subject to the same relationships in terms of size, dependence on parent group and technology irrespective of country. Hickson et. all offered a culture free context of organization structure (Hickson et. all, 1974). Kidger appreciated that grew in isolation from the world economy are having their approaches supersede by universally applicable techniques (Kidger, 1991).
Other models of Human Resources Management (HRM) are continually being developed. And the rhetoric at least of HRM has been spread to many other countries both in the theoretical discourse and within employing organizations. From the early days, there have been calls for comparative HRM, studying similarities and differences in management systems and the way people are managed in different countries (Brewster, 2004; Brewster, 1994; Redding, 1994).
The concept of Human Resources Management (HRM) has the origin in Europe (Brewster, 2004).
Whether the US derived visions of Human Resource Management (HRM) apply everywhere in the world is an important question for both theory and practice since following US prescription

in either area may be detrimental if theories are not transferable, for example, the need for a contingent approach encompass cultural, sectorial and regional differences . Similarly, other theorists have also argued for the need to c over both national differences and organizational contingencies, although they have used different terminologies: macro economy, micro economy (Gronghaug,1992) exogenous, endogenous (Brewster, 2004; Brewster, 1994), external and internal variable (Morley, 2004). How the theory applies particularly to the European setting remains a conceptual and empirical challenge. One problem is that the complications noted above make research difficult and there is a scarcity of empirical data (Brewster, 2004; Brewster, 1994). Despite these theories and the complexities of understanding different national contexts geographical differences are apparent, and the effort to understand them is important. There are a number of critical differences between the North American context and the European (Brewster, 1994).Such a comparison involves substantial generalization. We must remain aware of the substantial differences of the substantial differences within North America, even within individual states in the USA and the differences between European countries.

3. Research methodology

Research methodology in this paper is based on the simulation of the data from 1993 to 2009 for employees in research and development activities by occupation and sex and for employees working in the fields of RDI activities. Data were taken from the Romanian National Institute of Statistic updated database Tempo online at 21.10.2010. Data used in this study, for this simulation was taken in December 2010. This research is based on the real data of Human Resources from RDI area, as a case study for Romania.

[Sources:https://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=26: CDP102B]

The central objective was to see what was happened in the period indicated (1993 -2009) with human resources, if the real data respect a regression curve at a specific order which have to be determined. Another objective is to determine the coefficient for the regression curve obtained for HR data.

4. Descriptive statistics and results

Employees in research and development activities by occupation and sex

Number of employees in research and development activity is the total number of employees at one point, which participate directly or indirectly, to solve problems that are the objects of the unit, being paid for services performed.

Data for the period 1990 - 1992 are not available because the methodology was based on the recommendations of UNESCO (in research and development and design was included) that were different from those used by OECD and Eurostat, according to the Frascati Manual. Since 1993, UNESCO gave the methodology.

Human Resource in Science and Technology (HRST) maximum value was recorded in 1993 when there were 75,618 employees and the minimum value was registered in 2000 and had the value of 37,241. If in 1993 were registered the maximum number of employees 75,618 in Research & Development & Innovation area, 37,878 were women - that was 50.07% and 37,770 were men - that is 49.92%. In 2000 they were registered with the minimum number of employees 37,241 in R&D&I, 17,114 were women - that is 45.95% and 20,127 were men - that is 54.04%. The total human resource engaged in R & D & I area in 1993, researchers 5 and 6 level of education according to ISCED, employees with higher education - level 5 and those with higher education and doctoral - level 6) is 52.32%, technicians (who have only secondary education level) is 23.97% of the total employees engaged in human resource that RDI and the rest up to 100% are other categories of employees. In 2000 the human resource engaged in research

decrease the number of researchers with doctorates and higher education is 62.24% of the total number of employees in RDI, the number of technicians is 18.13% of other categories of employees total RDI sector is 19.62%. In 2009, the human resource of RDI increases compared to 2000 when there was minimum, with 5179 employees, ie by 13.9% compared to 2000, when he was at a minimum. In 2009 the total human resource is lower compared to the maximum value of 1993 to 43.92% ie 33,228 employees, and higher minimum of employees in 2000 to 5179, representing a 13.9% share - more employees than in 2000. You could say that 54.33% of the human resource engaged in RDI sector in 2009 were men and 45.66% were women.

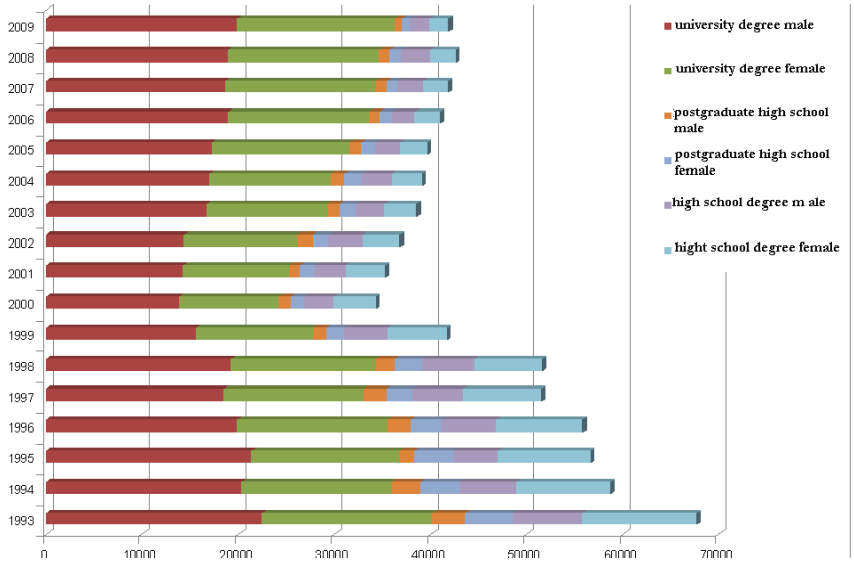

Figure 1: Human resources with different categories of graduation diploma.: University degree (male and female), high school graduation diploma (male and female) and postgraduation high school diploma (male and female).
(Source: author's calculus)

Employees working in the fields of RDI activities
The results used in this study were taken from the site of Romanian National Institute for Statistics data base Tempo online, the updated database on 21.10.2010, Data were taken for simulations in December 2010.
(Source:https://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=26: CDP102D, and Romanian Statistical Yearbook, 2008) :Number of employees in research and development activity is the total number of employees at a time, that participate directly or indirectly, to solve problems that are the objects of the unit, being paid for services performed.
Depending on training, a diploma of graduation, the researchers are employed on such scientific fields: natural and exact sciences, engineering and technological sciences, medical sciences, agricultural sciences, social sciences and humanities. For the period 1990-1994 data are not available due to data collection, it was not carried out of the research and scientific domains.
To study the number of researchers in scientific fields we used the data available between 1995 and 2009. It seems that the total number of researchers fell in 2000, with the lowest value: 23,179 for Romanian researchers in the whole system, and the highest value was recorded in 1995: the return of 35094.Are placed the number of researchers in 2008 (at 3084 value) and then drop again in 2009 with almost 200 employees in Romania.

In Figure 2 is shown the graphically the variation in time from 1995 to 2009 the number of researchers in total and for the natural and exact sciences, engineering and technological sciences, medical sciences, agricultural sciences, social sciences, humanities.
It may be noted that the highest number of researchers is recorded in engineering and technological sciences and the natural and exact sciences. Were represented graphically for example, the total number of researchers, the number of researchers in the natural and exact sciences and the number of researchers in engineering and technological sciences and found that it corresponds to the order of 6 to regression curves for all 6 areas.

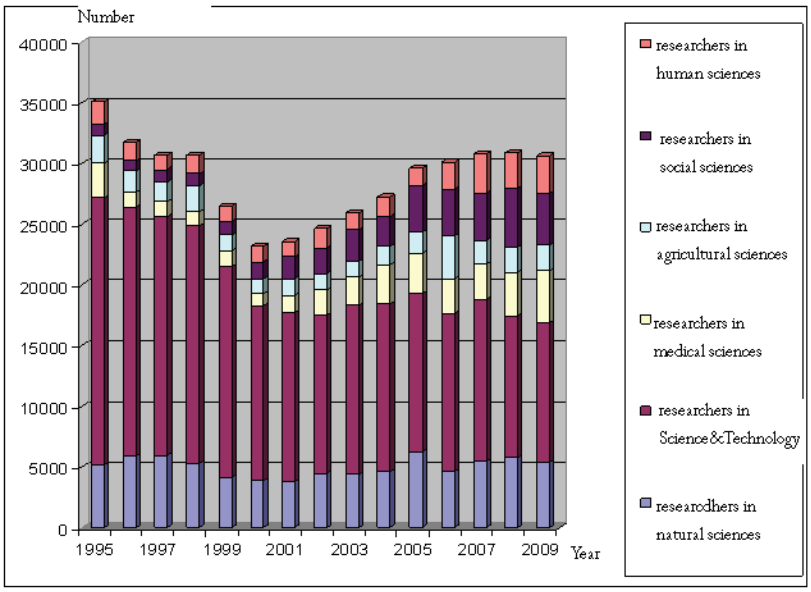

Figure 2: Researchers on different areas of research as human sciences, social sciences, agricultural sciences , medical sciences , Science& Technology and natural sciences. Source: graphics are from auhours results based on the data took from https://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=26:

Table 1: The coefficients C_0,…, C_6 , R^2 and order of regression equation for different activities domain

	order of regression eq.	R^2	C0	C1	C2	C3	C4	C5	C6
Total number of researchers	6	0.947	39998	-8105	3819	-1055	138.6	- 8.254	0.181
Engineering and technological sciences	6	0.977	25033	-5128	2624	-725.1	92.26	-5.364	0.116
Natural and exact sciences	6	0.758	1123	6075	-2493	423	-34.64	1.367	-0.020
Agricultural sciences	6	0.591	5188	-4695	2355	-547.8	62.50	3.392	0.07
Medical sciences	6	0.947	5642	-4325	1668	-341.1	38.61	-2.202	0.048
Social sciences	6	0.975	443.7	807.3	-480.2	124.4	14.79	0.847	-0.018
The humanities	6	0.913	2566	-840.2	144.5	11.15	-5.318	0.489	-0.014

Source: author calculus

The characteristic equation of the regression for the data in the present study is:

$$y=C_6x^6+C_5x^5+C_4x^4+C_3x^3+C_2x^2+C_1x+C_0$$

Coefficients $C_0,\ldots, C_6$ are listed in table 1 for each case.
For **the total number of HRST in RDI**, in 1995 was 35,094 the maximum number recorded, in 2000, the minimum number of 23,179 was registered. For **engineering and technological sciences,** in 1995 was recorded the maximum number of 22,024 researchers and 11,538 is the minimum number of registered 2009.We can observe that HRST engaged in technological sciences and engineering decreased from 62.75% in 1993 to 37.65% in 2009. For **natural and exact sciences,** maximum number of researchers in 2005 is 6238 and 3781 is the minimum in 2001. HRST recorded in RDI in natural and exact sciences and the exact ranges vary from 14.76% of the total number of researchers in 1993 to 17.54% in 2009.For **agricultural sciences** the maximum number of researchers in 2006 was recorded as 3567 and 1244 was the minimum recorded in 2000. The percentage of agricultural science research ranging from 6.6% in 1995 to 5.4% in 1997 then has been an increase from 7% in 1998 and then was an decrease to the minimum value of 5.04% recorded in 2000 and then in 2006 reach to maximum of 11.84%. For **medical sciences** the maximum number of HRST was recorded in 2009 as 4289 and in 2000 was recorded the minimum number of researchers, 972. As percentage, engaged in the RDI as HRST in the field of medical science, increasing from 7.89% in 1995 to 13.99% in 2009. For **social sciences** there was the maximum value recorded for HRST in RDI in 2008, 4862 and the minimum of 834 registered in 1996. As percentage we can say that HRST in social sciences vary from 2.57% in 1995 to 15.75% in 2008. For **the humanities** the maximum value registered for HRST in RDI since 2007 is 3149 and the minimum value recorded is the value of 1153 in 1997. At the humanities sciences, researchers percentage is increasing from 3.76% in 1997 to 10.24% in 2007, then decrease slightly.
This type of study was done in order to make a first type of simulations of HRST in RDI sector in Romania. We deal in this paper with the HRST (used form the updated database at 21.10.2010 of www.insse.ro) having different activities as engineering and natural sciences to humanities and with different graduation degrees. The conclusions are that the smallest amount of HR was recorded in 2000 and the highest was in 1995. We succeed to do a simulation on the evolution of Human Resource during this period (1993-2009) in Romania and we observed that real data fitting on an regression curve of sixth degree whose coefficients were defined during this study. This type of simulation can be good for future forecasting of HRST in RDI sector in Romania.

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