ORIGINAL PAPER

IMPROVING ORGANIZATION PERFORMANCE THROUGH HUMAN CAPITAL DEVELOPMENT, USING A REGRESSION FUNCTION AND MATLAB

NICOLETA VALENTINA FLOREA[1], DOINA CONSTANTA MIHAI[2]

Manuscript received: 12.06.2015; Accepted paper: 22.08.2015;

Published online: 30.09.2015.

Abstract. *Due to continuous changing environment, individuals and organizations increasingly want to develop and build resources in order to achieve competitive advantage. To cope with these changes, the organization is trying to achieve new skills, competencies, and individuals and organizational knowledge, which can influence performance achievement. In this article we show that continuous development helps employees and organizations to reach their goals and achieve performance. Also, we demonstrate that applying a model of simulation organization could perceive a not too distant future, could compute performance, perceive risks and may determine the role of human capital in obtaining competitive advantage. Using simulation (a regression function) and a computer program (MATLAB) organizations can improve its processes, not necessarily by increasing the number of employees, but through their development (seen not as an expense but as an investment on long term).*

Keywords: *human capital, development, simulation, prediction, performance.*

1. INTRODUCTION

To achieve its goals, the organization should develop and use various analytical tools that can be used to model, analyze, simulate and design a business process [11] in order to reduce personnel costs, material and financial resources consumed and achieve efficiency. Thus, through modeling and simulation the manager can improve decisional problems and can improve their chances of getting a positive result. Organizations no longer allow intuitive actions to develop so, computer simulation has become more important than ever [14].

2. INVESTING IN EMPLOYEES' DEVELOPMENT IN ORDER TO OBTAIN LONG TERM PERFORMANCE

One of the most important factors requiring attention are the people working in the organization [18], therefore we must develop them in order to obtain results. The progress of a nation has always been dependent on its human resources and their efficient management [12]. The competition for talented employees intensifies [10], therefore, their development should be viewed as a long term investment and not as a cost, and recruiting talented

[1] Valahia University of Targoviste, Faculty of Economic Science, 130024 Targoviste, Romania.
E-mail: floreanicol@yahoo.com.
[2] Valahia University of Targoviste, Faculty of Sciences and Arts, 130024 Targoviste, Romania.
E-mail: mihaidoina2004@hotmail.com.

candidates as an activity that will bring performance for organization [7], and these things can happen only if the organization's culture is flexible, efficient and innovative, that the managers of these organizations believe that human resource development will bring performance [9]. It is not a cheap process, but in a turbulent environment is a necessary investment [3]. Human resource is perceived as the most valuable asset of the organization [8]. Training is a systematic process and leads to maximize interactions between people, progress, development opportunities of choice, combining practice with theory, provide feedback, develops attention, creativity, innovation, loyalty, teamwork, originality, communication, imagination and learning, solve problems, continually improving operations and reducing resistance to change [13]; It helps employees and organizations to gain new skills, knowledge and skills necessary to achieve performance [16]. Going into the future is done with the right people, so human capital development should be a strategic priority for any organization.

3. THE ROLE OF SIMULATION AND MODELLING IN ORGANIZATIONS

Many organizations have realized that simulation has become an important tool in solving and understanding the many and varied problems by collecting data and experience in order to find solutions safely, validating models, involving humans experience, using statistical analysis, using PCs to predict specific outcomes, testing and evaluating new systems [19].

Simulation is the imitation of a system/process physical or conceptual in order to improve its functioning and performance optimization [4]; explores real world problems without compromising real system [17] and is used to reduce the risk associated with creating new systems or implementing change [14]. Simulation is used because it gives organizations the best approach for analyzing real system [1]; offers the possibility of using experiments feasible, the ability to choose correctly, testing, every aspect of a proposed changes without the use of additional resources [19]; leads to understanding of simulation using scenarios, and can develop new policies, operating procedures, decision rules, information flows and organizational procedures without interruption real system [15].

There are also some disadvantages of using simulation: high costs due to the acquisition of expensive software, cost of training specialists in conducting simulation workflows, and may show only a facet of the process analyzed.

4. CASE STUDY - IMPLEMENTING A MODEL OF SIMULATION IN ORGANIZATIONS USING REGRESSION FUNCTION AND MATLAB

Human resources development, combined with the practical application of simulation is today recognized as a potential source for obtaining competitive advantage. By transferring knowledge, organizations can obtain performance [22]. Competitive advantage belongs to those organizations who know how to attract, select, retain and develop talents [2].

4.1. RESEARCH METHODOLOGY

Sample size: The reasearch was made using data and information from disscusions with HR specialists and using data from oficial site regarding OtelInox Targoviste financial situations.

4.2. RESEARCH OBJECTIVES

The article itôs analysing the impact that HR (number of employees and hours of training and development) could have on organizational performance (sold production), using simulation (regression function) and a computer program (MATLAB).

4.3. DATA PRESENTATION AND ANALYSIS

The analysed problem- We are using the prediction method on long term, using a model of multifactorial regression in order to observe the influence certain independent variables (number of training hours and total number of employees) could have on a dependent variable (sold production).

Starting from the multifactorial regression equation:

Y= b0+b1X1+b2X2,

where [6, 21]:

Y- dependent variable is considered the sold production,

b0, b1- regression coefficients,

X1, X2- independent variable as number of training hours and total number of employees.

Assume two variables x and y, with an expected linear relationship between them.

The estimation procedure is called linear regression (prediction), regressing x onto y, y being the dependent variable and x1 si x2 being the regressors [21].

As we may see in Table 1 we try to establish a relationship between total number of hours of training (being the first independent variable- X1) and total number of employees (being the second independent variable- X2) and sold production (the dependent variable- Y).

The analyzed organization has a total number of employees at the end of 2012 of 861 employees (Table 1) from them 77% are men and 23% are female (Fig. 1).

Table 1. Data regarding the number of employees on gender in 2012

Year	Nb. of total employees	From them (%):	
		male	female
2012	861	77%	23%

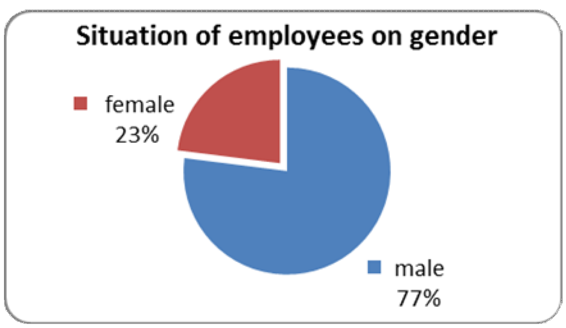

Figure 1. Reprezentation of employees on gender.

Table 2. Data regarding the structure of employees on age in 2012

Total nb. of employees	Groups of age (years)							
	18-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
861	36	50	68	132	190	215	127	43

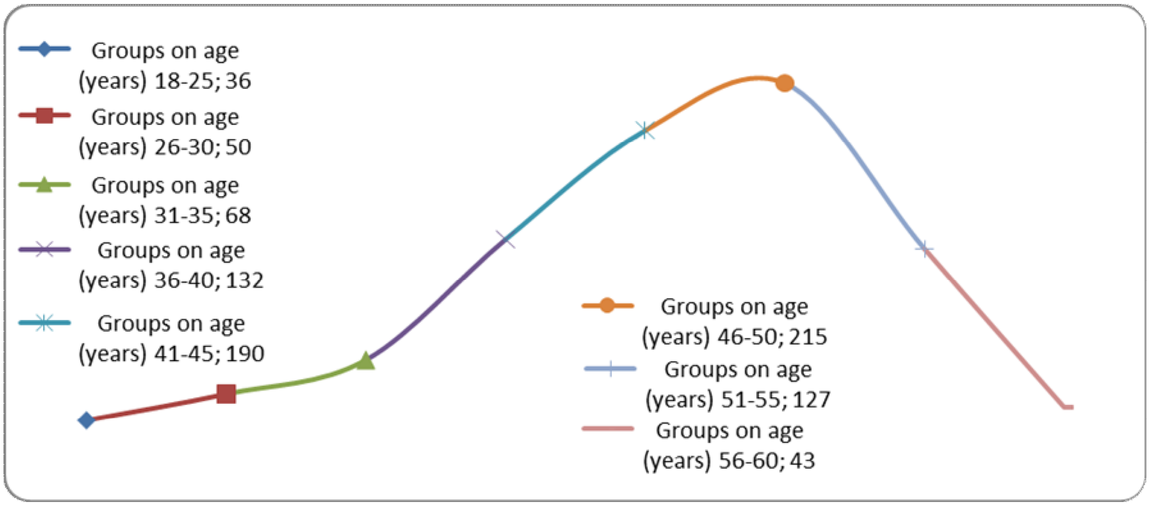

Figure 2. Structure of employees on age in 2012.

Table 3. Structure of employees on seniority

Groups of seniority	Nb. pf employees
1-5 ani	23
5-10 ani	36
10-15 ani	127
15-20 ani	198
20-25 ani	250
peste 25 ani	227
total angajati 2012	861

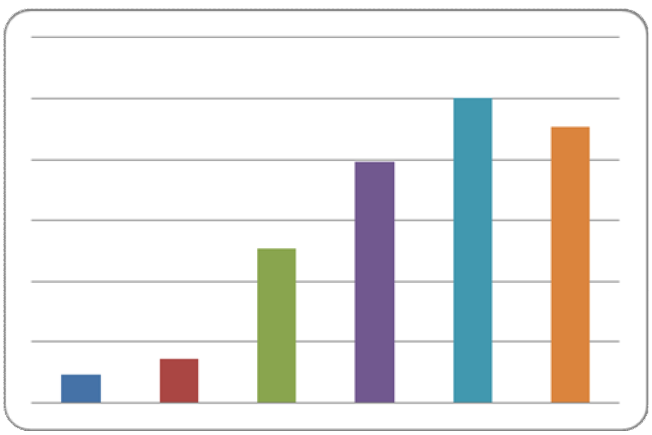

Figure 3. Structure of employees on seniority.

Table 4. Data regarding the nb. of training hours between 2011-2013

Year	Nb. of hours of internal training	Nb. of hours of external training	Nb. of total hours of training
2011	15 287	7172	22458
2012	8672	29798	38470
2013	16 124	4155	20279

Figure 4. Evolution on years of total hours of training.

4.4. STEPS OF IMPLEMENTATION OF REGRESSION FUNCTION ON THE PRESENTED MODEL

The function of multiple regression is a method of studying the evolution of a dynamic system starting from the successive observations of some scharacteristics of the system.
We denote as: $X_1, X_2, \ldots X_n$, the characteristics of the system which influence its evolution and with Y the variable which is dependent on $X_1, X_2, \ldots X_n$, cosidered independent variables.
This dependency is modeled through a linear equation, as:
$Y = b_0 + b_1X_1 + b_2X_2 + \cdots + b_nX_n$,
named the multiple regression function.

The coefficients are determined by using the least squares method, thus:
We note with $\varepsilon^2 = (Y - b_0 - b_1X_1 - b_2X_2 - \cdots - b_nX_n)^2$ the square of aproximation error of the system evolution. The independent variables $X_1, X_2, \ldots X_n$, and Y are considered vectorial variables and are representing the measures made on the system ina certain period of time, in m different moments:

$$X_1 = \begin{pmatrix} x_{11} \\ x_{21} \\ \cdot \\ \cdot \\ \cdot \\ x_{m1} \end{pmatrix}, X_2 = \begin{pmatrix} x_{12} \\ x_{22} \\ \cdot \\ \cdot \\ \cdot \\ x_{m2} \end{pmatrix}, \text{ é } , X_n = \begin{pmatrix} x_{1n} \\ x_{2n} \\ \cdot \\ \cdot \\ \cdot \\ x_{mn} \end{pmatrix}, Y = \begin{pmatrix} y_1 \\ y_2 \\ \cdot \\ \cdot \\ \cdot \\ y_m \end{pmatrix}.$$

The least square method reside in determination the coefficients of regression function: $b_0, b_1, \ldots, b_n$ so that the square of aproximation error:
$\varepsilon^2 = (Y - b_0 - b_1X_1 - b_2X_2 - \cdots - b_nX_n)^2$ be minimum.
Solving this minimum issue suppose the next notations:
$B = (b_0 b_1 \ldots b_n)^t \in M_{(n+1)\times 1}$ the matrix of linear coefficients of regression function, matrix must be determined in the minimum point, with:

$$X = \begin{pmatrix} 1 & x_{11} & x_{1n} \\ \ldots & \ldots & \ldots \\ 1 & x_{m1} & x_{mn} \end{pmatrix} \in M_{m\times(n+1)}$$

are noted the observation matrix. With these notations the problem is transforming in determination of the next minimum:
$\min_B (Y - XB)^2 = \min_B (Y^2 - 2YBX + B^2X^2)$

which is reached for:

$$B_{min} = \frac{Y}{X^t} = \frac{X^t Y}{X^t X} = (X^t X)^{-1} X^t Y.$$

Based on the measurement made on the system are determined the coefficients of regression function and so we can anticipate its future evolution

$$\hat{Y} = XB_{min}, \hat{Y} = X[(X^t X)^{-1} X^t Y].$$

A particular case is when the Y variable depends on a single variable X_1, and in this case the matrix we defined above are as follows:

$$Y = \begin{pmatrix} y_1 \\ y_2 \\ \cdot \\ \cdot \\ \cdot \\ y_m \end{pmatrix}, \; X_1 = \begin{pmatrix} x_1 \\ \cdots \\ x_m \end{pmatrix} \; X = \begin{pmatrix} 1 & x_1 \\ \cdots & \cdots \\ 1 & x_m \end{pmatrix}, \quad B = \begin{pmatrix} b \\ a \end{pmatrix}, \quad Y = XB = b + aX,$$

well known in econometry as regression.
We calculate its coefficients, as:
$B = (X^t X)^{-1} X^t Y$ customed for a single independent variable.

$$X^t X = \begin{pmatrix} 1 & \cdots & 1 \\ x_1 & \cdots & x_m \end{pmatrix} \begin{pmatrix} 1 & x_1 \\ \cdots & \cdots \\ 1 & x_m \end{pmatrix} = \begin{pmatrix} m & \sum_{i=1}^{m} x_i \\ \sum_{i=1}^{m} x_i & \sum_{i=1}^{m} (x_i)^2 \end{pmatrix}$$

Now: $$(X^t X)^{-1} = \frac{1}{\left(m(\sum_{i=1}^{m}(x_i)^2) - (\sum_{i=1}^{m} x_i)^2\right)} \begin{pmatrix} \sum_{i=1}^{m}(x_i)^2 & -\sum_{i=1}^{m} x_i \\ -\sum_{i=1}^{m} x_i & m \end{pmatrix}$$

and:

$$B = (X^t X)^{-1} X^t Y$$

$$B = \frac{1}{(m(\sum_{i=1}^{m}(x_i)^2) - (\sum_{i=1}^{m} x_i)^2)} \begin{pmatrix} \sum_{i=1}^{m}(x_i)^2 & -\sum_{i=1}^{m} x_i \\ -\sum_{i=1}^{m} x_i & m \end{pmatrix} \begin{pmatrix} 1 & \cdots & 1 \\ x_1 & \cdots & x_m \end{pmatrix} \begin{pmatrix} y_1 \\ \cdots \\ y_m \end{pmatrix}$$

$$B = \frac{1}{(m(\sum_{i=1}^{m}(x_i)^2) - (\sum_{i=1}^{m} x_i)^2)} \begin{pmatrix} \sum_{i=1}^{m}(x_i)^2 & -\sum_{i=1}^{m} x_i \\ -\sum_{i=1}^{m} x_i & m \end{pmatrix} \begin{pmatrix} \sum_{i=1}^{m} y_i \\ \sum_{i=1}^{m} x_i y_i \end{pmatrix}$$

$$B = \frac{1}{(m(\sum_{i=1}^{m}(x_i)^2) - (\sum_{i=1}^{m} x_i)^2)} \begin{pmatrix} \left(\sum_{i=1}^{m}(x_i)^2\right)\left(\sum_{i=1}^{m} y_i\right) - \left(\sum_{i=1}^{m} x_i\right)\left(\sum_{i=1}^{m} x_i y_i\right) \\ -\left(\sum_{i=1}^{m} x_i\right)\left(\sum_{i=1}^{m} y_i\right) + m\left(\sum_{i=1}^{m} x_i y_i\right) \end{pmatrix}$$

Thus, we obtain the formulas for the coefficients of regressions function $y = ax + b$:

$$a = \frac{m(\sum_{i=1}^{m} x_i y_i) - (\sum_{i=1}^{m} x_i)(\sum_{i=1}^{m} y_i)}{m(\sum_{i=1}^{m}(x_i)^2) - (\sum_{i=1}^{m} x_i)^2},$$

$$b = \frac{(\sum_{i=1}^{m}(x_i)^2)(\sum_{i=1}^{m} y_i) - (\sum_{i=1}^{m} x_i)(\sum_{i=1}^{m} x_i y_i)}{m(\sum_{i=1}^{m}(x_i)^2) - (\sum_{i=1}^{m} x_i)^2}$$

Table 5. Data registred in organization between 2011-2013

Year	Sold production (mil. lei) (Y)	Total nb. of hours of training/year (thousands of hours) (X_1)	Total nb. of employees (X_2)
2011	127,88	22,458	865
2012	151,34	38,470	861
2013	155,51	20,279	855

Source: www.otelinox.ro/situatii financiare [23]

We introduce in MATLAB the independent variables for X_1 and X_2, obtaining:

X=[1 22.458 865; 1 38.470 861; 1 20.279 855];
Xtr=X'
Z=Xtr*X
Z_{inv}=inv(Z)
Y=[127.88;151.34;155.51]
B=Zinv*Xtr*Y

$$X_{tr} = \begin{bmatrix} 1.000 & 1.000 & 1.0000 \\ 22.4580 & 38.4700 & 20.2790 \\ 865.000 & 861.000 & 855.000 \end{bmatrix}$$

$$Z = 1.0e+06 * \begin{bmatrix} 0.0000 & 0.0001 & 0.0026 \\ 0.0001 & 0.0024 & 0.0699 \\ 0.0026 & 0.0699 & 2.2206 \end{bmatrix}$$

$$Zinv = 1.0e+04 * \begin{bmatrix} 1.5268 & 0.0002 & -0.0018 \\ 0.0002 & 0.0000 & -0.0000 \\ -0.0018 & -0.0000 & 0.0000 \end{bmatrix}$$

$$Y = \begin{bmatrix} 127.8800 \\ 151.3400 \\ 155.5100 \end{bmatrix}$$

Thus, are determined the values for b_0, b_1 si b_2 of regression function:

$$B = 1.0e+03 * \begin{bmatrix} 2.6399 \\ 0.0007 \\ -0.0029 \end{bmatrix}$$

Y= 2639,9 + 0,7 X_1 - 2,9X_2

From the found formula by the simulation model result that, total hours of training and total number of employees are important factors in the evolution of sold production. In order to increase with a monetary unit of training hours will be obtained an increase with 0,7 monetary units of sold production and an increasing with a monetary unit of number of employees it will be obtained an decrease with 2,9 monetary units of sold production.

It is noted that the value of the free term of 2639,9 is not at all high, which allows us to conclude that the factors which were not taken into account in the model construction has a low influence on the evolution of sold production. The positive value of the free term reveals that the variables that were not included in the econometric model have little effect on the development of positive sold production.

4.5. SIMULATION OF A FUTURE SITUATION FOR OBTAINING THE ORGANIZATION PERFORMANCE

We propose a possible simulation of situations by maintaining the number of employees (with the calculated value negative) and increasing the number of training hours because it had a positive influence. We suppose that the company wishes that in the coming period to achieve a higher sold production. This can happen only on account of the increasing number of training hours and maintaining nearly constant the number of employees in the previous period because the dependent variable- sold production- reflects the firm's revenues, the profits. If we have a larger number of employees, this would automatically lead to increased salary expenses, and this would lead to lower profits. Therefore, we intend to grow than the number of training hours that are still perceived as extra charges, but can be perceived as a long term investment in employee development, which will lead to motivating employees and keeping them as long-term, improving performance, reducing the number of errors and scrap and thus increase profits.

Tabel 6. Data simulated for the future period.

Year	Sold production (mil. lei) (Ynew)	Total hours of training hours/year (thousand of hours) ($X_{1\hat{c}}$)	Total nb. of employees ($X_{2\hat{c}}$)
2013	155,51	20,279	855
2014	?	23,320 855 (increasing with 15% to 2013)	855
2015	?	25,6529 854 (increasing with 10% to 2014)	854
2016	?	28,2118 853 (increasing with 10% to 2015)	853

In the example above we changed the values of the variable X1, representing the number of training hours for the year 2013 as follows: 15% of the value increase for the year 2013 to 2014, the new value increased by 10% from 2014 to 2015 value and new value simulated corresponding 2014 increased again by 10% to determine the value for 2016. The number of employees in the mentioned considerations, we maintained almost constant, decreasing the average employee (possible entry of new employees and the possible outputs through resignations and retirement) (Tabel 6).

We redefined the variables to not create interpretation errors.
The matrix B is replaced with Xtr.

```
X=[1 22.458 865;1 38.470 861;1 20.279 855];
Xtr=X'
Z=Xtr*X
Zinv=inv(Z)
Y=[127.88; 151.34; 155.51]
B=Zinv*Xtr*Y
Xnew=[1 23.320 855;1 25.6529 854;1 28.2118 853];
Ynew=Xnew*B
```

$$X_{tr} = \begin{bmatrix} 1.0000 & 1.0000 & 1.0000 \\ 22.4580 & 38.4700 & 20.2790 \\ 865.0000 & 861.000 & 855.0000 \end{bmatrix}$$

$$Z = 1.0e+06 * \begin{bmatrix} 0.0000 & 0.0001 & 0.0026 \\ 0.0001 & 0.0024 & 0.0699 \\ 0.0026 & 0.0699 & 2.2206 \end{bmatrix}$$

$$Zinv = 1.0e+04 * \begin{bmatrix} 0.0002 & 0.0000 & -0.0000 \\ 0.0018 & -0.0000 & 0.0000 \\ 1.5268 & 0.0002 & -0.0018 \end{bmatrix}$$

$$Y = \begin{bmatrix} 127.8800 \\ 151.3400 \\ 155.5100 \end{bmatrix}$$

$$B = 1.0e+03 * \begin{bmatrix} 2.6399 \\ 0.0007 \\ -0.0029 \end{bmatrix}$$

$$Y_{new} = \begin{bmatrix} 162.3825 \\ 167.1862 \\ 157.7449 \end{bmatrix}$$

Y_{new} become:
$Y_{new2014} = 157,7449$
$Y_{new2015} = 162,3825$
$Y_{new2016} = 167,1862$.

Thus, maintaining almost constant the wage charges and increasing the number of hours of training offered by organization for its employees, this can increase its sold production in 2013 from 155,51 (mil. lei) to 157,7449 (mil. lei) in 2014, to 162,3825 (mil. lei) in 2015 and to 167,1862 (mil. lei) in 2016.

5. PROPOSALS AND CONCLUSIONS

As we can observe, if organizations apply a simulation and modelling process, by using a simple and reliable mathematical and informatic model (in our case the regression function and MATLAB), it will obtain the following benefits:

- Reduce costs (being lower than the actual system products, eg. Costs simulation training activity is lower than for training at work),
- Improved networking and collaboration between employees involved in research projects and teamwork,
- Develop experience, gain new knowledge, experiences, exchange ideas, improves the communication and innovation, increase the motivation of employees,
- Associated with computer simulation, the organization can view a software system can help increase response capabilities makers by charging broader opportunities and by clarifying and assessing the effects of any action,
- Could be a way of solving problems for which analytical and algorithmic solutions are not possible.

People are the active resources of the organization, because their potential, experience and passion, and their development initiatives can actively contribute to increasing organizational efficiency and effectiveness [20]. Human resources are a key resource vital to organizations in their competitive success. Increasingly more and more an organization's competitive advantage lies in its people. An organization is nothing without its people, possibly a lot of expensive equipment [5].

REFERENCES

[1] Anderson, P. H., Beveridge, D.A., Scott, T.W., *Threshold Entrepreneur. A New Business Simulation. Solo Version*. Prentice-Hall Inc., Upper Saddle River, New Jersey, 2000.

[2] Bohlander G., Snell S., *Managing human resources*, 15th edition, Cengage Learning, Canada, 2010.

[3] Cartwright, R., *Implementing a Training and Development Strategy*, John Wiley & Sons, 2003.

[4] Chang, M., *Monte Carlo Simulation for the Pharmaceutical industry. Concepts, algorithms and care studies*, CRC Press, USA, 2011.

[5] DeCenzo et al, *Personnel/Human resouce management*, Englewood Cliffs, Prentice-Hall, 1988.

[6] Dixon K.R., *Modelling and simulation in Ecotoxicology with applications in MATLAB and Simulink*, CRC Press, 2011.

[7] Florea N.V., Mihai D.C., *Journal of Science and Arts*, **4**(29), 299, 2014.

[8] Florea, N.V., *Auditul resurselor umane*, Editura C.H.Beck, Bucuresti, 2013.

[9] Florea, N.V. Goldbach R.I., Goldbach F., *Relationships between human resources management and organizational culture*, ECMLG - 2011, Nice, FranŞa, 487-496, 2011.

[10] Florea N.V., *Using branding to attract, recruit and retain talented staff*, Management &Marketing Univ. din Craiova, 283-297, 2011.

[11] Laguna M., Marklund J., *Business process modeling, simulation and design*, Pearson Edu India, 2011.

[12] Lakhdar S. et al, *Gestion de ressources humaines*, Universite de Boeck, Canada, 2001.

[13] Matthews J. et al., *Anatomy of Performance Training*, Bloomsbury Publishing, 2014.

[14] McHaney R., *Understanding computer simulation*, Ventus Pub., ApS., 2009.

[15] Pegden, C., Shannon, R. and Sadowski, R., *Introduction to simulation using SIMAN*. Second Edition. McGraw-Hill, Singapore, 1996.

[16] Rosenberg M.J., *Beyond E-Learning: Approaches and Technologies to Enhance Organizational Knowledge, Learning, and Performance*, John Wiley & Sons, 2005.

[17] Sa Silva P. et al., *Simulation, Games and challenges from schools to enterprises*, 63-74, from *Enterprise and organizational modelling and simulation*, 7th International Workshop, EOMAS 2011, Springer, London, UK, 2011.

[18] Sims, R.R., *Organizational success through effective human resources management*, Greenwood Pub. Inc.Group, USA, 2002,

[19] Sokolowski, J.A., Banks, C.M., *Principles of modeling and simulation. A multidisciplinary approach*, John Wiley & Sons, N.J., USA, 2011.

[20] StegŁroiu, I., Florea, N.V., *Instrumente și tehnici de recrutare și selecție,* Editura C.H.Beck, Colec"Ħ Afaceri, Bucure'Ħi, 2013.

[21] Walish, P. et al., *MATLAB for neuroscientists: an introduction to scientific computing* in MATLAB, Academic Press, 2014.

[22] Wilson, J.P., *Human Resource Development: Learning & Training for Individuals & Organizations*, Kogan Page Publishers, 2005.

[23] www.otelinox.ro/

[24] http://reliawiki.org/index.php/multiple_linear_regression_analysis