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MULTIPLE REGRESSIONS ANALYSIS OF FACTORS THAT INFLUENCE THE EFFICIENCY OF HUMAN RESOURCES

Nicolina-Irina HĂDĂREAN-ŞOMLEA, Liviu Onoriu MARIAN

Abstract: *The factors for efficiency of human resources were analyzed with multiple regression analysis, in the case of a company. This analysis generally belongs to the multivariate methods, and it is also an explanatory method of analysis. Regression analysis describes the relationship between a dependent variable and several independent variables. The dependent variable is the productivity value and the independent variables are the following:training factor, wage levels factor, career advancement factor and job safety factor.*
Key words: *analysis of variance; Student test; coefficient of determinations – R^2; multivariate analysis of dependencies.*

1. INTRODUCTION

Progress of any society depends on the efficiency of how the human resources, the natural resources and financial resources are used. Quality of human resources must be one of the central concerns of businesses both in terms of achieving but also in terms of its use because appropriate employees, well trained, motivated and correctly rewarded secure success for the company, according to the paper: **„**Human Resources Quality as a Long Term Objective", by E. Băcanu.

2. INFORMATION

Human resources appear as an important variable, determining the success or failure of the business.

2.1 Methodology

The research methodology is based on statistical analysis, which in this paper includes the multiple regression analysis. This type of analysis is used for modeling and analyzing several variables. The multiple regression analysis extends regression analysis [E. Titan et al.], by describing the relationship between a dependent variable and several independent variables [C. Constantin, 2006]. It studies the simultaneous emotions that some independent variables have over one dependent variable [C. Lefter, 2004], and it can be used for predicting and forecasting. The multiple regression model can be much more realistic than the uni-factorial regression model [Z. Goschin, M. Vatui, 2002].

In our study the dependent variable consists in productivity and the independent variables are the following: training factor, payroll factor, career advancement factor and job safety factor.

All of these variables were monitored throughout six years.

First we presented the necessary data for the analysis, after which we obtained the regression equation. We calculated the coefficient of determination R^2, which had the aim of indicating the percent of how much of the total variance is explained by the independent variables. Than we turned to F test and to Student test, respectively t with n-(k+1) degrees of freedom, in order to see which hypothesis can be accepted.

2.2 Multiple regression analysis

To perform a factor analysis we identified the main factors that influence the human resources efficiency.
Were identified a total of 14 important factors and this are: working conditions, training level,

job satisfaction, job security, work responsibility, career advancement, wage levels, communication, increase product quality, work organization, fulfillment of labor standards, level of adaptability, access to information, productivity.

We started with the following assumptions:

H1-The most important factor affecting the efficiency of human resources in a company is level training;

H2-Second factor influencing human resource efficiency is the wage level;

H3- The third factor affecting the efficiency of human resources is job security;

H4-The fourth factor is the career advancement.

To identify the most important factor was requested the opinion of specialists in human resources. A questionnaire has been made which was sent to 20 companies asking the human resources managers to prioritize these factors due to importance. Research continued by analyzing the first five most important factors. We evaluated the four assumptions and we found out that H1, H2 and H3 do not confirm, only H4 confirms.

We wanted to achieve a mathematical analysis to establish based on data collected and transformed into indicators validation or invalidation of assumptions from which we started in research. The multiple regression model can be more realistic than one-factorial regression model [GOS02]. In our study, the dependent variable is the productivity while the independent variables are: training factor, wage levels factor, career advancement and job safety factor.

First we present the necessary data for analysis then we obtain the regression equation. We calculated the coefficient of determination R^2 which aimed to show the percentage of total variance is explained by the independent variables. Than we turned to F test and to Student test, respectively t with n-(k+1) degrees of freedom, in order to see which hypothesis can be accepted.

The main purpose of this analysis is to know how is the productivity influenced by the independent variables and what are those measures that should be taken based on the results obtained with using SPSS - Statistical Package for Social Sciences [C. Constantin, 2006]. Null hypothesis argues that none of these factors can affect the value of labor productivity factor.Using the SPSS program kit in the case of multiple regression we have come to the following results:

Table 1

Regression coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1441,081	3160,250		,456	,539
training factor	12,409	,657	1,788	18,876	,008
wage level factor	150,317	10,083	,174	14,908	,001
career advancement factor	,063	,067	,244	,941	,219
job security factor	-4,895	,962	-,500	-5,089	,253

Based on the nonstandard coefficients we obtain the regression equation:

$\hat{y}$ =1441,081+12,409x_1+150,317x_2+0.063x_3-0,895x_4 where: x_1= training factor; x_2 = wage level factor *;* x_3 = career advancement factor; x_4 = job security factor.

Table 2

Estimation of standard deviation - Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,768[a]	,737	,747	3,71261

The coefficient of determination R^2 indicating the percent of how much of the total variance is explained by the independent variable is 73.7%. The analysis of variance for multiple regression will be made starting from the following results:

Table 3

Variation analysis - ANOVA[b]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	483,324	3	161,108	14,938	,017[a]
Residual	21,570	2	10,785		
Total	504,894	5			

a. Predictors: (Constant) training factor, wage level factor, career advancement factor, job security factor b. Dependent Variable: productivity factor

The result is that most part of the total variance is generated by the regression equation.

In order to test the validity of multiple regression model a global test must be used, which researches whether all the independent variables have regression coefficients equal with zero, or in other words if the explained variance is not due to a random. The regression coefficients of the sample have as correspondents the following regression coefficients: β_1, β_2, β_3, β_4, β_5, [Kulcsar, E., 2009]. The alternative and null hypotheses are formulated as follows:

$H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$

H_1 = not all β coefficients are equal to 0.

In order to test the null hypothesis we turn to F test that requires an analysis of the variance identified in the ANOVA table above. From the data in the previous table it can be ascertained that the value of the calculated F is 14,937 for the variance generated by the regression. The critical value of F, at the significance level of 0.05 with 5 degrees of freedom at numerator and 4 at denominator is 10,127. By comparing the values of F it results that it is compulsory to accept the alternative hypothesis, meaning that not all regression coefficients are equal to zero. This means that a significant influence of multiple regression occurs over the dependent variables. The issue that arises now is to know which regression coefficients may be zero and which may not. It is compulsory to make an assessment the realization of a statistical test for each under the conditions where the null hypothesis states that each coefficient β is equal to zero and the alternative hypothesis states that these are different from zero [Kulcsar, E., 2009]. The test used is the Student test, respectively t with n-(k+1) degrees of freedom [Kulcsar, E., 2009]. For each of the five variables, from the SPSS results, we get the calculated t values. These are:

18,876 for the training factor;

14,908 for the wage level factor;

0,941 for the career advancement factor;

-5,089 for the job security factor.

In order to define the decision rule concerning the null hypothesis, the calculated t values will be compared with the critical value of t at a significance level of 0.05 in the case of a two-tailed test, with 10 – (5+1), meaning with 4 degrees of freedom. This value is: ± 12,706.

- In the case of the training factor calculated t is 12,876 and is than higher critical t. Therefore the null hypothesis is rejected and it is accepted that β_1 is different from zero.
- For the wage level factor calculated t is 14,908 and is than higher critical t. Therefore the null hypothesis is rejected and it is accepted that β_1 is different from zero.
- In the case of the career advancement factor calculated t is 0,941. We can see that the calculated t is lower than the critical t. This means that the null hypothesis is accepted and that β_4 is equal to zero.
- For the job security factor the calculated t is -5, 089 and is lower than the critical t. This means that the null hypothesis is accepted and that β_4 is equal to zero.

Therefore it is considered that two of the variables the career advancement factor and the job security factor are not significant predictors for the dependent variable: productivity. In this case the regression model will no longer contain these variables.

If we make the determinations for the new regression model, the results will be:

Table 4

Estimation of standard error deviation – Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,696[a]	,484	-,032	11,53953

a. Predictors: (Constant), wage level, training factor

In this case the coefficient of determination R^2 is 48.40%.

Table 5

Regression coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
	,909	28,333		,032	,380
wage level	-624,518	52,204	-,542	-11,963	,002
training factor	4,399	,462	1,455	9,509	,001

A new regression equation results from the above presented: $\hat{y} = 0{,}909 - 624{,}5168x_1 + 4{,}399\ x_2$ where: x_1 is the wage level factor and $x_{2\ is}$ the training factor.

Table 6

Analysis of variance - ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	479,453	2	239,726	24,378	,001[a]

	Residual	19,668	2	9,834		
	Total	499,121	4			

a. Predictors: (Constant), wage level, training factor

b. b. Dependent Variable: productivity factor

We can see that the value of the calculated F is 24,378 for the variance generated by the regression.

The critical value of F, at the significance level of 0.05 with 2 degrees of freedom at numerator and 2 at denominator is 19,00. If we compare the results we can see that it is obligatory to accept the alternative hypothesis. This means that a significant influence of multiple regression occurs over the dependent variables. Again we need to know which regression coefficients may be zero and which not. For this reason we achieved an individual evaluation of the regression coefficients.

We could see that in the first regression model two of the independent variables weren't significant predictors for the productivity factor. For this reason we elaborated a new regression model. By performing the above mentioned tests and we found that using the Student test, respectively t with n-(k+1) degrees of freedom, for each of the two variables we get the calculated t values.

We compared the calculated t values with the critical value of t at a significance level of 0.05 in the case of a two-tailed test, with 6 - (2 +1), meaning with 3 degrees of freedom. This value is: ±3,1824.

- In the case of the training factor, calculated t is 9,509, is higher than critical t 3,1824, therefore the null hypothesis is rejected and it is accepted that β_1 is different from zero.
- For the case of the wage level factor, calculated t is -11,963, is higher than critical t 3,1824, therefore the null hypothesis is rejected and it is accepted that β_1 is different from zero.

3. CONCLUSIONS

From the data presented above we can draw the conclusion that two of the efficiency factors of human resources are significant predictors for the dependent variable, namely the productivity in the analyzed period 2006-2011. With the method of multivariate analysis of dependencies we could find significant and powerful correlations between the independent variables.

4. REFERENCES

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Analiza de regresie multiplă a factorilor care influențează eficiența resurselor umane în întreprinderi industriale

Rezumat: Factorii de eficiență ai resurselor umane au fost analizați utliyând modelul de regresie multiplă, în cazul unei societăți. Această analiză, în general, face parte din metodele multivariate şi este, de asemenea, o metodă de analiză explicativă. Analiza de regresie descrie relația dintre o variabilă dependent şi o serie de variabile independente. Variabila dependentă este repreyentată de valoarea productivității iar variabilele independente sunt următoarele: factorul de pregătire profesioanlă, factorul de salariyare, factorul de avansare în carieră şi factorul de siguranță a locului de muncă.

Nicolina-Irina HĂDĂREAN-ŞOMLEA, Drd. Ing., Technical University Cluj-Napoca, e-mail: h_irinuca@yahoo.com.

Liviu Onoriu MARIAN, Prof. Dr. Engineer, Dean at the Faculty of Economic and Judicial Studies, Petru Maior University of Targu Mures, email: liviu.marian@yahoo.com.