MODELLING AND SIMULATING RISKS IN THE TRAINING OF THE HUMAN RESOURCES BY APPLYING THE CHAOS THEORY

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Abstract:

The article approaches the modelling and simulation of risks in the training of the human resources, as well as the forecast of the degree of human resources training impacted by risks by applying the mathematical tools offered by the Chaos Theory and mathematical statistics. We will highlight that the level of knowledge, skills and abilities of the human resources from an organization are autocorrelated in time and they depend on the level of a previous moment of the training, as well as on the impact of the risk factors that can materialize in the process of the continuous training of human resources. The process of self-correlation and continuous training ensures the sustainable and qualitative development of the human resource in order to preserve its character of strategic resource of a modern organization.

Keywords: Chaos Theory, modelling, simulating, risks, continuous formation of the human resources

JEL Classification: J_{24}, O_{15}

1. Introduction

The Chaos Theory describes the behaviour of the non-linear dynamic systems, which are, apparently, disordered; in reality **chaos represents a state of reorganization** of a system (Bula, P., Fudalinscki, J., 2010, pp. 35-40).

Nowadays, as a result of the computer improvement and of their calculating power increase, the Chaos Theory is successfully applied in many fields (Codreanu, S., 2007, pp. 10-20).

The continuous training of the human resources is made according to the always growing needs of them and the organization, to the development of the professional career in a permanently changing environment in order to ensure the growth and sustainability of the present and future abilities of the human resources in the fulfilment of the objectives set by the organization's management.

The system of training of the human resources is a non-linear dynamic system and, therefore, we appreciate that the mathematical tools offered by the Chaos Theory can also be applied in this field in order to identify the interior order and equilibrium of the human resources training in their evolution.

The training of the human resources, seen as a non-linear dynamic system, is changing at a variable time and rate, in accordance to the elements from the context of internal/external organizational environment, usually dynamic and disruptive, results of the presence of some risk factors that can materialize and affect the objectives of the human resources training (Mărăcine, V., Scarlat, E., 2002, pp. 110-115).

The activity of continuous human resources training, considered a dynamic system, the strategies set for their projecting and implementation, the preparing operations, the organization, the taking place of a training program, has in its own structure „sensitivities" towards the initial conditions, which means very little differences in the initial state of the training that can determine big differences in the evolution of the continuous training of the human resources. Other circumstances, events and possible situations will be associated to these sensitivities, which can disorganize the politics and training activities initially set, which creates an apparent state of chaos.

2. Modelling and simulation of the risks in the human resources training as a non-linear dynamic system

In the basis of a created problem, we will approach the modelling and simulation of the degree of human resources training in the conditions of materialization of some afferent risks in progress of training and forecast the degree of training in a given time period (Ionescu, Gh. Gh., Cazan, E., Negruşa, A.L.,1999, pp. 75-86; Rotărescu, E., 2011, pp. 35-38).

a) Case study

The commercial society „Telemobil" intents to purchase new types of mobile phones: Vodaphone, HTC, Samsung, Nokia C7, Apple, Iphone, for which the human resources do not have the knowledge and skills necessary in their selling and service offering. This new situation generates the apparition of some risks regarding not knowing the characteristics of the new mobile phones, their functions and service, which will affect the fulfilment of the selling and profit objectives set by the society.

The society is obliged to instruct the human resources through a training course, so that these can acquire new knowledge and skills regarding the characteristics, functions and services of the new types of mobile phones, including abilities to successfully promote the new products.

To be remarked, are the risks regarding:

r_1 → lack of knowledge about the characteristics of the new mobile phones;

r_2 → not knowing the principles of functioning of the new mobile phones;

r_3 → lack of abilities to realize the service for the new mobile phones.

Aim.

By applying the mathematical tools offered by the Chaos Theory and the SPSS 16 software in the risk management of the human resources training, we will highlight the fact that, generally, the trend of knowledge, skills and competences acquirement, at some point depends on the trends from the previous moments and on the management of the afferent risks components.

Problem to solve:

It is required to fulfil the selling and profit objectives set in the commercial society „Telemobil" by realizing the human resources training course and managing the afferent risks:

• the degree of training of the human resources in certainty conditions and, respectively, in the conditions of materializing of some risks provided in the case study;

• forecasting the degree of continuous formation on a time period of 12 months.

Solving.

b) Modelling and simulation of the human resources training in certainty conditions

Consequently, we will first proceed in finding the degree of values of the human resources training, recorded at the finish of a training course of the human resources in the field specific to the society „Telemobil" of commercializing the mobile phones, by using the SPSS 16 software.

Step 1.

We will consider that at the moment the course start, $t_0 = 1$, the existent level of knowledge, skills and abilities of human resources from the "Telemobil" Society is $X(T)$, and at the end of the training courses, that means at the moment $t_f = T$, it is $X(T)$. The level of human resources training at some moment of time t, we will mark it with $X(t)$. In the solving of the problem we will highlight the relation of autocorrelation between the different values $X(1), X(2), X(3), \ldots, X(T)$ by using the SPSS 16 software.

Step 2.

Using the SPSS 16 software, we created a file named *Serie-timp.sav*. with the time series $\{X(1), X(2), X(3), \ldots, X(T)\}$ that contains given values on a Likert scale from 1 to 5 of the degrees of human resources training.

Step 3.

We added the data {*X(1), X(2),X(3), ..., X(T)*} in the *Serie-timp.sav* file by the subjective appreciation of the numerical values representing the degree of training of the human resources at certain moments in time.

Therefore, we added 225 values between 1 and 5, which could represent the degrees of human resources training from the time series. The values 1-5 represent the degrees very low, low, medium, high, very high of the training of the human resources in a given time.

Step 4.

By applying the commands *Analzye→Time Series→Autocorrelations,* the program will analyze if the series is autocorrelated, showing the following results:

Table no. 1

Coefficients of autocorrelation

Lag	Autocorrelation	Std. Error[a]	Box-Ljung Statistic		
			Value	df	Sig.[b]
1	,491	,066	54,919	1	,000
2	-,097	,066	57,075	2	,000
3	-,493	,066	113,044	3	,000
4	-,252	,066	127,729	4	,000
5	,122	,066	131,160	5	,000
6	,298	,065	151,933	6	,000
7	,151	,065	157,293	7	,000
8	-,192	,065	165,995	8	,000
9	-,304	,065	187,867	9	,000
10	-,167	,065	194,492	10	,000
11	,130	,065	198,539	11	,000
12	,110	,065	201,434	12	,000
13	-,090	,064	203,386	13	,000
14	-,296	,064	224,590	14	,000
15	-,189	,064	233,245	15	,000
16	,023	,064	233,376	16	,000

According to specialists, the autocorrelation corresponding to any *lag k* is calculated with the formula:

$$r_k=\sum_n X_n(t)X_{n-k}(t) \tag{1}$$

The autocorrelation test is made in SPSS with the help of the Ljung&Box(1979), for ***lag*** autocorrelations greater or equal to 1.

Step 5.

After applying the commands *Analyze →Time Series →Sequence Charts*, the program displays the following chart, representing the periodicity of the evolution in time of the dynamic process of continuous human resources training, as seen in Figure no. 1.

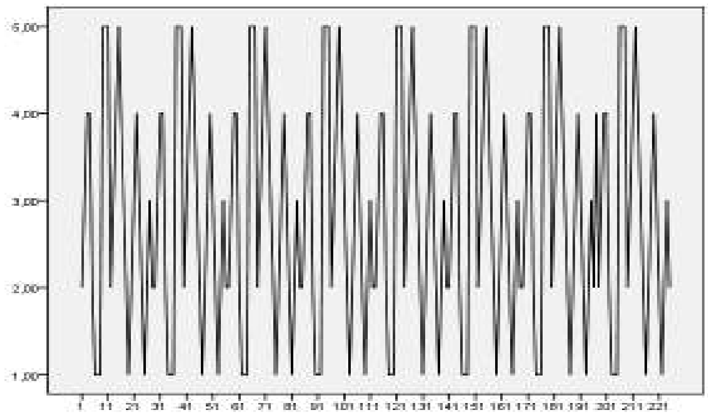

Figure no. 1. Graphic representation of a series of values of the degree of continuous human resources training

The evolution in time of the dynamic process of continuous human resources training required the update, at different periods of time, of the human resource's knowledge and competences according to the selling needs of the new mobile phones acquired in order to fulfil the selling and profit objectives of the society.

If the values from the graphic contained in Figure no. 1 represent the degree of knowledge, skills and competences in commercializing the mobile phones, further on, we will approach the way in which these degrees will be affected by the risks mentioned in the case study.

c) Modelling the risks in human resources formation as a non-linear dynamic system

Theoretically, this activity can be mathematically modelled, if we combine the interaction between the probability of occurrence of the risks and the level of variable values of human resources formation (knowledge, skills, abilities etc.) at a certain time.

In this way, we will define the „f" function, which has values the levels of human resources formation, from the formula:

$$f(p_i) = X(i) \quad \text{for} \quad i \in \{1,2,3,\dots,T\} \tag{2}$$

where:

$f(p_i)$ –represents the value of the "f" function at the moment of time t_i, in the presence of risks of probability p_i;

$X(i)$ –represents the level of variable formation at the i moment.

We will also define the function that has as values the probabilities of occurrence of risks in the process of human resources formation, therefore:

$$g(t_i) = p_i \qquad \text{for} \quad i \in \{1,2,3,\dots,T\} \tag{3}$$

where:

$g(t_i)$ –represents the value of the "*g*" function at the moment of time t_i;

p_i–represents the probability of occurrence if risks at the *i* moment;

(if at the moment if time t_i occur the risks $r_{1,\dots,}r_{m,}$ with the probabilities $p_{i1},\dots,p_{im}$, then $p_i = p_{i1} + \dots + p_{im}$).

By composing the two functions we will obtain a new function „*h"* whose numerical values will constitute the levels of human resources formation affected by the risks that occur in the formation process, stated in the following mathematical model:

$$h(t_i) = (f \circ g)(t_i) = f(g(t_i)) \qquad \text{for} \quad i \in \{1,2,3,\dots,T\} \tag{4}$$

In the case of positive risks the value of the *"h"* function at the moment *"i"* can be obtained as a **report** of the level of formation $f(t_i)$ and the probability of occurrence of positive risks $g(t_i)$ which lead to **the increase of the level** of knowledge, skills, abilities etc. according to the formula below:

$$h(t_i)=f(t_i)/g(t_i) \tag{5}$$

In the case of negative risks the value of the *"h"* at the "i" moment can be obtained as **report** of the level of formation and the probability of occurrence of the positive risks $g(t_i)$ which leads to the **decrease of the level** of knowledge, skills, abilities etc., according to the formula below:

$$h(t_i)=f(t_i)\times g(t_i) \tag{6}$$

If the probability of risk occurrence multiplies itself more times in the analytic expression of the *"g"* function, the value of this function decreases.

$$g(t_i)=p_i^k \;\; \text{for} \;\; i \in \{1,2,3,\dots,T\} \text{ and } \; k \in \mathbf{N}^* \tag{7}$$

If the probability of risk occurrence divides itself many times in the analytic expression of the *"g"* function, then the value of this function increases.

$$g(t_i) = p_i^{-k} \text{ for } i \in \{1,2,3,\dots,T\} \text{ and } k \in \mathbf{N}^* \tag{8}$$

By these changes in the mathematical model from the formulas (7), (8) will be highlighted a bigger influence on the increase and a smaller one on the decrease of the level of formation, and thus, the trainer will be able to decide in consent and will choose the option of optimizing the level of human resources formation by managing adequately both the positive and negative risks.

The risks quantifying in the human resources formation by simulating in the informatical product SPSS 16 will be made for the values of the *„h"* function, respectively, the levels of formation and the probabilities of risk occurrence associated to these.

In this way, the following steps will be made:

Step 1.

We will consider that at the moment the course start, $t_0 = 1$, the existent level of knowledge, skills and abilities of human resources from the "Telemobil" Society is *h(1)*, and at the end of the training courses, that means at the moment $t_f = T$, it is *h(T)*. The level of human resources training at some moment of time *t*, we will mark it with *h(t)*. In the solving of the problem we will highlight the relation of autocorrelation between the different values *h(1), h(2), h(3), ..., h(T)* by using the SPSS 16 software.

Step 2.

Using the SPSS 16 software, we created a file named *Serie-timp.sav*. of a time series {*h(1), h(2), h(3), ..., h(T)*} that contains given values on a Likert scale from 1 to 5 of the degrees of human resources training.

Step 3.

The data {*h(1), h(2),h(3), ..., h(T)*} from the formula (5), representing numerical values representing the degree of training of the human resources at certain moments in time were subjectively set, on a scale from 1 to 5 and added into the file *Serie-timp.sav.*

Step 4.

By applying the commands *Analzye→Time Series→Autocorrelations,* the program will analyze if the series is autocorrelated:

Table no. 2

Coefficients of autocorrelation

Lag	Autocorrelation	Std. Error[a]	Box-Ljung Statistic Value	df	Sig.[b]
1	,239	,066	13,061	1	,000
2	,353	,066	41,567	2	,000
3	,121	,066	44,910	3	,000
4	,135	,066	49,109	4	,000
5	,059	,066	49,914	5	,000
6	-,244	,065	63,748	6	,000
7	-,075	,065	65,074	7	,000
8	-,172	,065	72,071	8	,000
9	-,087	,065	73,855	9	,000
10	-,180	,065	81,567	10	,000
11	-,032	,065	81,805	11	,000
12	-,180	,065	89,538	12	,000
13	,108	,064	92,362	13	,000
14	,071	,064	93,589	14	,000
15	,124	,064	97,343	15	,000
16	,250	,064	112,628	16	,000

Step 5.

After applying the commands *Analyze →Time Series →Sequence Charts*, the program displays the following chart, representing the periodicity of the evolution in time of the dynamic process of continuous human resources training, as seen in Figure no. 2.

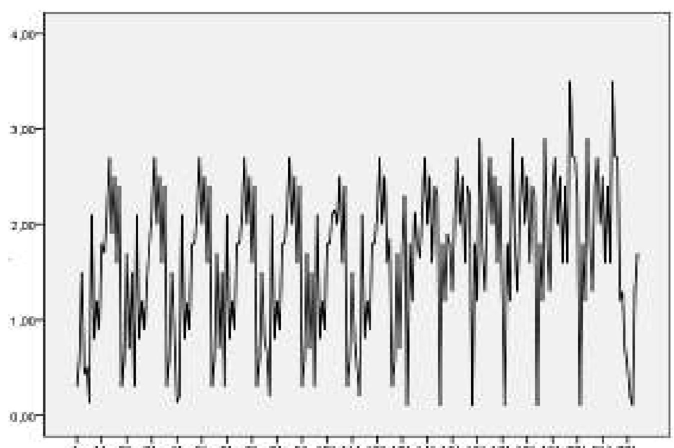

Figure no. 2. Graphic representation of a series of values of the degrees of continuous human resources training impacted by risks

The series above was analyzed for 225 values in order to be able to graphically exemplify their trend. We can observe that the degree of human resource's knowledge, skills and competences from the Telemobil Society impacted by the risks mentioned in the case study are under the degrees of the variables obtained and recorded in the graphic from Fig.1, realized in the hypothesis of the lack of risks. This information, obtained in the last situation, obliges the organization's management to take into consideration the presence of risks that can affect the fulfilment of the objectives set bt the organization and, consequently, to prepare, organize and realize the training course of the participant for acquiring the knowledge, skills and competences required for knowing the new characteristics of the new purchased mobile phones, as well as their selling in conditions of profit and efficiency.

d) Using WinQSB in forecasting the degree of continuous human resources training impacted by risks

Problem.

We presume that the management of the "Telemobil" Society wants a forecast for one year of the degree of the human resources training in the conditions of new risks occurrence as the ones mentioned in the case study solved in this article. We consider the known values of the function on a time period of 12 months and use the WinQSB software to forecast its values on the following 12 months.

<u>**Solving:**</u>

The module Forecasting from WinQSB is opened, it is chosen the field of the problem to solve and, that means, the forecast on time series, the measurement unit for which is realized the forecast and the period of 12 months, according to Figure no. 3.

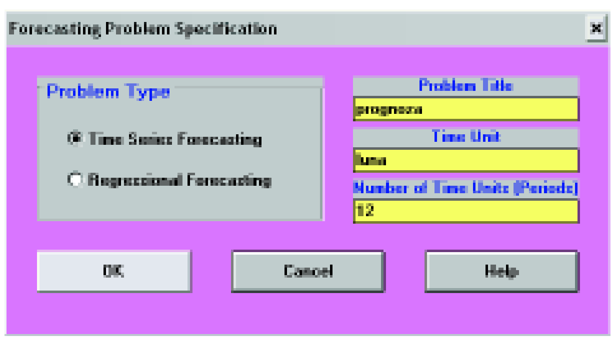

Figure no. 3. Defining the problem in the Forecasting module from WinQSB

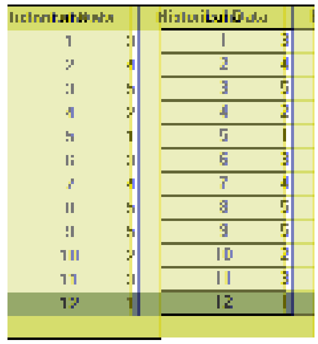

Figure no. 4. Adding the data

In order to forecast the degree of human resources training in a year we will consider to be known the values of training from the previous year, values contained in Figure no. 4.

Before starting the program WinQSB for the data analysis, in the field from Figure no. 5 is checked the method in which we want to make the forecast and that means the average method that follows a linear trend as well as the time period of a year.

The problem's solution is obtained by applying the commands *Solve and Analyze – Perform Forecasting* and is shown is Figure no. 6. The first column of the table contains the input values, that means the values of the „*h”* function recorded on a previous period, the second column, the values resulted after the wanted forecast and the difference between the recorded values and the ones forecasted is shown in the column named Forecast Error. The software forecasts that, in the following year, the value of the knowledge, skills and competences degree is contained in the interval *(1-m, 1+m)* , where „*m”* represents the arithmetical mean of the errors shown in the column Forecast Error, which means -2 in the case study. This means that the forecasted values of the degree of human resources training in the conditions of occurrence of the risks mentioned in the case study from point „a" will be represented by natural numbers 1,2 r 3, indicators that express a low level or environment of the human resources training for the following year.

This information is necessary to the trainer or to the organization's management in order to take into consideration the risks that can occur in the perspective of one year of professional training and, consequently, to be able to manage the risks in order to fulfil the objectives forecasted by the organization regarding the purchase of new types of mobile phones, their selling and obtaining the desired profit.

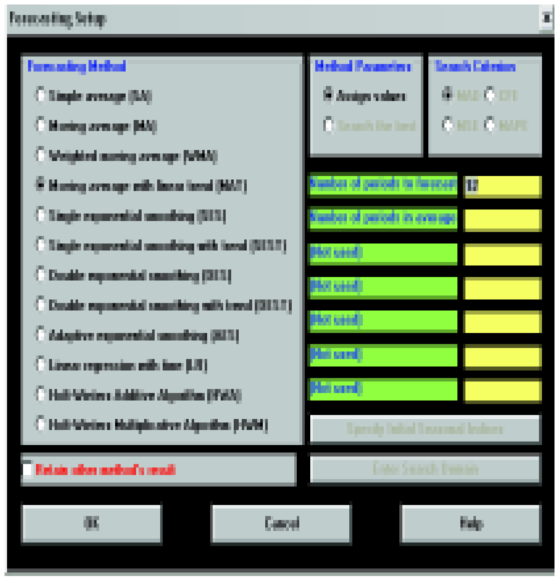

Figure no. 5. Selecting the method of making the forecast

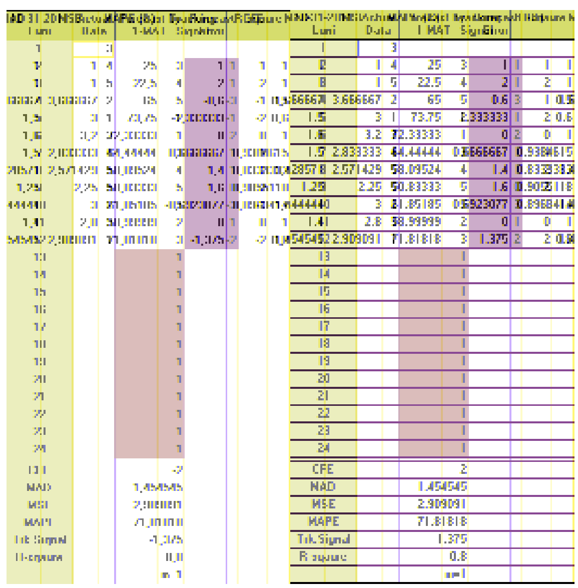

Figure no. 6. Showing the values forecasted by the module ***Forecasting*** **from WinQSB**

3. Conclusions

The Chaos Theory, the mathematical tools offered by it and the mathematical statistics have revolutionized the scientific knowledge that permitted us their use in the field of training of the human resources, considered a non-linear dynamic system. Through the two used applications we highlighted the fact that there is an autocorrelated relationship in time and periodically of the degree of human resources training, that it depends on the degree of a previous moment, determined by the interval of repetition of the training moments represented by the segments shown in the graphics from Figure no.1 and 2.

In the process of human resources training, the degree of knowledge, skills and competences towards the initial state develops, according to the case, it diminishes in the presence of risks from the inside of outside the process. In fact, the knowledge previous to the debut of the human resources training process were correlated and autocorrelated in the training process, including through the management of risks specific to the case study, where it has been operated with opportunities and negative risks that could affect positively or negatively the fulfilment of the training objectives and the organizational ones, such as selling and profit, set by the management of the „Telemobil" Society.

Therefore, the evolution of the continuous human resource training is not random, the state of knowledge, skills and competences represents an autocorrelated series, which depends on the states recorded at the previous moments and on the management of the afferent risks.

References

1. Bula, P., Fudalinscki, J., (2010), *The Chaos Theory in Managing an International Company; Example of PKN ORLEN,* in: "Review of General Management", vol. 12, no. 2, pp. 35-40
2. Codreanu, S., (2007), *Introduction to the Theory of Deterministic Chaos*, House of Science Book, Cluj-Napoca
3. Ionescu, Gh. Gh., Cazan, E., Negruşa, A.L., (1999), *Modelarea şi optimizarea deciziilor manageriale*, Editura Dacia, Cluj-Napoca
4. Mărăcine, V., Scarlat, E., (2002), *Applications of the Chaos Theory in economics*, in: "Informatics Magazine", vol. 21, no. 1, pp.110-115

5. Rotărescu E., (2011), *Application of the Chaos Theory in Studying the Process of Continual Formation of the Human Resources,* in: "Management of Sustainable Development", vol. 3, no. 1, Sibiu, pp.35-38