Department of Mathematics and Computer Science
Faculty of Sciences
North Center University of Baia Mare
Technical University of Cluj Napoca, Romania

PROCEEDING

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Mathematical Modelling with Application in Economics

2nd Mini Symposium

ICAM 10

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Faculty of Sciences
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International Conference of Applied Mathematics

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Mathematical Modelling with Application in Economics

1-7 June 2014

Organized by:

Department of Mathematics and Computer Sciences

TUC-N, North University of Baia Mare

Department of Economics and Physics,

North Center University of Baia Mare

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2nd Mini Symposium

Mathematical **M**odelling with **A**pplication in **E**conomics

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Scientific Program

First day 02. 06.2014

SECTION ***APPLIED MATHEMATIC IN ECONOMICS***

9.00 -9.10	**Opening ceremony**
9.10 - 9.30	Vladimir Muka *Basis with different cardinals in a R- module*
9.30- 9.50	Corina Rădulescu, Rita Toader, Cezar Toader *Model for performance evaluation of clusters*
9.50- 10.10	Gratiela Boca, Rita, Toader ,Cristian Anghel , Diana Toader *The distribution of manufactured products*
10.10- 10.30	Corina Rădulescu , Ioan Abrudan, Rita Toader, Gratiela Boca, Florina Hahn *New trends in competitiveness through concentration and specialization of industrial sectors, Case: North West Region of Romania*
10.30- 10.45	**Coffee break**
10.45-11.05	Dinu Darabă *Optimizing Waste Costs in Production Management*
11.05-11.25	Gheorghe M.T. Rădulescu, Adrian T.G.M. Rădulescu, Mihai V.G.M. Rădulescu, Sanda Naş *Surveying in dynamic condition and its integration in structural health monitoring*
11,25-11.45	Gratiela Dana Boca *A Cross Matrix for Modeling Open Innovation in Production Management*
15.00	**Lunch break**

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2nd Mini Symposium on **M**athematical **M**odelling with **A**pplication in **E**conomics

1. Scientific Program

Second day 04.06.2014

SECTION ***APPLIED MATHEMATIC IN ECONOMICS***

9.00 -9.10	**Opening ceremony**
9.10 - 9.30	Gheorghe M.T. Rădulescu, Mihai V.G.M. Rădulescu, Adrian T.G.M. Rădulescu, Sanda Naş *The role of structural health monitoring for the design of the life cycle of constructions*
9.30- 9.50	Simona Sabou, Liliana Adela Zima, Rada Florina Hahn *Maximizing the efficiency of your marketing costs*
9.50- 10.10	Duka Erjon *Nurse Scheduling Problem*
10.10- 10.30	Rita Toader**,** Diana Cozma-Ighian , Cezar Toader, Izabela Pop *Factorial econometric model for the analysis of production capacity*
10.30- 10.45	**Coffee break**
10.45-11.05	Cezar Toader, Cristian Anghel, Cristian Vele *Problem with the consumer's optimal*
11.05-11.25	Liliana Zima, Simona Sabou, Rita Toader, Cristian Anghel *Model of behavior of the consumer*
11.25-11.45	Sabin Siserman *Statistic study on the possibility of implementing corporate governance in public enterprises with Local Administrative Units (LAU) as the majority shareholders*
	Closing ceremony

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BASIS WITH DIFFERENT CARDINALS IN A R-MODULE

Vladimir MUKA

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Durrës, Albania

Abstract: *The study of modules "walks" in parallel with the study of vector spaces. Both of them are constructed on abelian groups. Many definitions and conclusions on vectorial spaces are equally valid for modules too. The only distinction between them is affiliation of scalars. In vector space the external multiplication is done by scalar taken from a field, while in modules the external multiplication is done by scalar taken from a ring. This seemingly small change brings substantial changes in the content of these algebraic structures. An important difference lies in the isomorphism of bases. Basis of a vector space are isomorphs between them, while in modules bases are not always isomorphs among them. In this article we will present an example that shows that there is at least a R-module containing bases with different cardinals. Our main objective in this article is to construct a special R-module that will contain subsets that are for it, the basis with different cardinals from each other. Furthermore, we will prove that R-module constructed for each natural number n has n bases with different cardinals. This example formulated as an exercise is in the book "Modules and the structure of the Rings", author Janothan S. Golan, Tom Head.*

Keywords: *module, vector space, cardinal's R module*

1. Introduction.

Definition of module-Let R be a ring with identity.

The nonempty M set together with two operations: the first one that is called addition and is marked by + bounds each $(u, v)\in$MxM pair with a $u + v\in$M element; and the second operation, the left

scalars multiplication, denoted by juxtaposition, bounds each $(r, u)\in$RxM pair with an $ru\in$M element, is defined **the left R-modul** if the following properties are held:

1) M is an abelian group under addition.
2) For each $r, s \in R$ *and* $u, v \in M$ we have

$r(u + v) = ru + rv$

$(r + s)u = ru + su$

$(rs)u = r(su)$

$1u = u$

The R ring is called the basic ring of M, whose elements are called scalars.

Linear independence

A S subset of M module is linearly independent if for each $v_1, v_2, \ldots, v_n\in$S and $r_1, .r_2, \ldots, r_n\in$R, we have:

$r_1v_1 + r_2v_2 + \ldots + r_nv_n = 0 \Rightarrow r_i = 0$ for each $i = 1, 2, \ldots, n$.

Spanning (Generated) set.

A S subset of M module spans (or generates) M if for each $u\in$M, we have:

$u = r_1v_1 + r_2v_2 + \ldots + r_nv_n$

for some $r_i\in$R and $v_i\in$S, $i = 1, 2, \ldots, n$.

Basis of module.

A *B* subset of M is the basis if B is linearly independent and spans (generates) M.

Constructing of non commutative ring (R, +, -)

Let A be a random ring with identity. By means of its elements we construct $[a_{ij}]$ matrices with an infinite number of rows and columns. Thus, the indeces $i, j \in$ □ where □ is the set of natural numbers.

Le $m \in \square$ a random natural number.

Now let's take into consideration finite-rows matrices such that: for $1 \leq i \leq m$ the rows of $[a_{ij}]$ matrix have any element of A ring as their components and for $i > m$ the rows of $[a_{ij}]$, matrix have the zero element of A ring as their components.

These matrices make up the R set.

In the R set we define the operation of adding and multiplication of finite-rows matrices the same way as we define the adding and multiplication operation of finite matrices .

Thus:

$[a_{ij}] + [b_{ij}] = [t_{ij}]$ *ku* $t_{ij} = r_{ij} + s_{ij}$ for each $i, j \in \square$;

$[a_{ij}] \cdot [b_{ij}] = [u_{ij}]$ ku: $u_{ij} = \sum_{k \in N} a_{ik} b_{kj}$ for each $i, j \in \square$.

These two operations are well-defined. Indeed:

For the adding operation:

If the a_{ij} and b_{ij} elements stand in the rows with indices $i \leq m$ of the matrix, then they are random elements of the A ring, and as a result even their sum t_{ij} is a random element of the A ring.

If the a_{ij} and b_{ij} elements stand in the rows of $i > m$ indeces then they are equal to the 0 element of the A ring, as a result even their sum t_{ij} equals zero.

Thus the matrix $[t_{ij}]$ is a finite-row matrix and contains random element of the A ring, in the rows with indices i, for $1 \leq i \leq m$, and the zero element of the A ring in the rows with indices i, for $i > m$. So, the matrix $[t_{ij}] \in$R.

For the multiplication operation:

For $i \leq m$ and $k \leq m$ the elements a_{ik} and b_{kj} are random elements of the A ring. As a result even $s_{ij} = \sum_{k \in N} a_{ik} b_{kj}$ are random elements of the A ring.

For $i > m$ and any k the elements a_{ik} are all equal to the 0 element of the A ring. As a result even $s_{ij} = \sum_{k \in N} a_{ik} b_{kj}$ are all equal to the 0 element of the A ring.

Thus the matrix $[s_{ij}]$ is finite-row matrix and contains random elements of the A ring in the rows with indices i, for $1 \leq i \leq m$, and zero element of the A ring in rows with indices i, for $i > m$.

So, the matrix $[s_{ij}] \in R$.

Now let's show that the R set together with the two operations previously defined make up a ring.

The sum of two finite-rows matrices is reduced to the adding operation of the elements of the A ring That's why (R, +) is abelian group.

The multiplication operation of the finite-rows matrices is the same as the common multiplication operation of matrices, so that we can conclude that (R, +, ·) is a ring.

Constructing of bases with different cardinals for R-module R.

Let examine the ring (R, +, ·) as R-module R and let's show that this module has basis of different cardinals.

Let $c^{(1)}$ be the matrix $[a_{ij}]$ for which $a_{ij} = 1$ when $j = 2(i - 1) + 1$ and $a_{ij} = 0$ otherwise. So, $a_{11} = a_{23} = a_{35} = \ldots = a_{i,2i-1} = 1$ whereas the other components are equal to 0.

Let $c^{(2)}$ be the matrix $[a_{ij}]$ for which $a_{ij} = 1$ when $j = 2(i - 1) + 1$ and $a_{ij} = 0$ or else. Thus $a_{12} = a_{24} = a_{36} = \ldots = a_{i,2i} = 1$ whereas the other components are equal to 0.

Thus:

$$c^{(1)} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & ... \\ 0 & 0 & 1 & 0 & 0 & 0 & ... \\ 0 & 0 & 0 & 0 & 1 & 0 & ... \\ ... & .. & .. & .. & .. & .. & .. \end{bmatrix} \text{ and } c^{(2)} = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & ... \\ 0 & 0 & 0 & 1 & 0 & 0 & ... \\ 0 & 0 & 0 & 0 & 0 & 1 & ... \\ ... & .. & .. & .. & .. & .. & .. \end{bmatrix}$$

The set $\{c^{(1)}, c^{(2)}\}$ is basis for the R-module R.

To show that this set serves as a basis we at first must show that this set generates R and that it is linearly independent.

Let this random matrix $\left[a_{ij}\right]=\begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} & .. \\ a_{12} & a_{22} & a_{23} & a_{24} & a_{25} & .. \\ a_{13} & a_{32} & a_{33} & a_{34} & a_{35} & .. \\ a_{14} & a_{42} & a_{43} & a_{44} & a_{45} & .. \\ .. & .. & .. & .. & .. & \ddots \end{bmatrix}$ be part of set R.

Referring to the $[a_{ij}]$ matrix, let's mark by $a^{(1)}$ the matrix formed by columns with indices $2(i-1)+1$ and let's mark by $a^{(2)}$ the matrix formed by columns with indices $2(i-1)+2$. Thus,

$$a^{(1)}=\begin{bmatrix} a_{11} & a_{13} & a_{15} & ... \\ a_{21} & a_{23} & a_{25} & ... \\ a_{31} & a_{33} & a_{35} & ... \\ .. & .. & .. & \ddots \end{bmatrix} \text{ and } a^{(2)}=\begin{bmatrix} a_{12} & a_{14} & a_{16} & ... \\ a_{22} & a_{24} & a_{26} & ... \\ a_{32} & a_{34} & a_{36} & ... \\ .. & .. & .. & \ddots \end{bmatrix}$$

It is true the equation:

$$a^{(1)}c^{(1)} + a^{(2)}c^{(2)} = [a_{ij}]$$

This equation shows that the set $\{c^{(1)}, c^{(2)}\}$ spans (generates) R.

Now let's show that the set $\{c^{(1)}, c^{(2)}\}$ is linearly independent.

Let's have the linear combination $r^{(1)}c^{(1)} + r^{(2)}c^{(2)} = [0]$, with the scalars $r^{(1)}, r^{(2)} \in$ R.

Let's suppose that $r^{(1)} \neq [0]$. This means that in this matrix there is at least one component different to zero. Suppose that this component is $x_{kt} \neq 0$.

Examine the linear combination of the row with index k of the matrix $r^{(1)}$ and the linear combination of the column with index $2(t-1)+1$ of the matrix $c^{(1)}$.

In the matrix $c^{(1)}$, in its $2(t-1)+1$ indexed column all the components are equal to 0 except of $c_{t,2(t-1)+1}$ component which is equal to the element 1 of A ring.

Thus, in the matrix $r^{(1)}c^{(1)}$ for the $u_{k,2(t-1)+1}$ component it is true the equation:

$$u_{k,2(t-1)+1} = x_{kt} \cdot c_{t,2(t-1)+1} = x_{kt} \cdot 1 = x_{kt} \neq 0$$

In the $r^{(2)}c^{(2)}$ matrix, the component with index $v_{k,2(t-1)+1}$ is equal to 0. Indeed:

In the $c^{(2)}$ matrix, the columns that have components different to 0 are the only one with indices $2(t-1)+2$, whereas all components of the columns with 2(t - 1) + 1 indeces are equal to 0.

Therefore :

$$v_{k,2(t-1)+1} = \sum_{k\in N} r_{kt} \cdot c_{t,2(t-1)+1} = \sum_{k\in N} r_{kt} \cdot 0 = 0$$

Finally in the matrix $r^{(1)}c^{(1)} + r^{(2)}c^{(2)}$, for the $a_{k,2(t-1)+1}$ component we have:

$$a_{k,2(t-1)+1} = u_{k,2(t-1)+1} + v_{k,2(t-1)+1} = x_{kt} \neq 0$$

This conclusion contradicts the fact that $r^{(1)}c^{(1)} + r^{(2)}c^{(2)} = [0]$.

That's why it is alluded that $r^{(1)} \neq [0]$ and what remains is that $r^{(1)} = [0]$.

The same way of reasoning is followed to show that $r^{(2)} = [0]$.

So, the set $\{c^{(1)}, c^{(2)}\}$ is linearly independent.

Finally the set $\{c^{(1)}, c^{(2)}\}$ is the basis of R and the cardinal of this basis is 2.

Let's take $n = 3$. Let's mark by:

$c^{(1)} = [a_{ij}]$ for which $a_{ij} = 1$ when j = 3(i –1) + 1 and $a_{ij} = 0$ in other cases;

$c^{(2)} = [a_{ij}]$ for which $a_{ij} = 1$ when j = 3(i –1) + 2 and he $a_{ij} = 0$ in other cases;

$c^{(3)} = [a_{ij}]$ for which $a_{ij} = 1$ when j = 3(i –1) + 3 and $a_{ij} = 0$ in other cases.

Reasoning the same way, it is concluded that the set $\{c^{(1)}, c^{(2)}, c^{(3)}\}$ is the basis of the R-module R and the cardinal of this basis is 3.

In general, if n is a random natural number then as a basis for the R-module R serves the set $\{c^{(1)}, c^{(2)}, \ldots, c^{(n)}\}$where $c^{(k)} = [a_{ij}]$ for which $a_{ij} = 1$ when $j = n(i-1) + k$ and $a_{ij} = 0$ in other cases for k that accomplishes the condition $1 \leq k \leq n$.

Conclusions

There is at least one R-module finite with scalar received from an non commutative ring that for each natural number n has n bases with different cardinals from one another. This example, in the role of counterexample, confirms that assertion is not true, "the basics of an R-module are isomorphism between them".

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MODEL FOR PERFORMANCE EVALUATION CLUSTERS

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ABSTRACT :*In this paper we presented a model of evaluating the performance of a cluster based on turnover, the volume of exported products and the performance of human resources. We felt that these variables are relevant in evaluating the performance of a cluster. At the end of the paper determined the performance of an IT cluster based on the model developed variables. The mathematical model developed shows the application in managerial practice can be successfully used in evaluating the performance of clusters in various fields. In the model developed can be used as a variable and the degree of connectivity of the cluster and the number of newly created products.*

Key words: *performance, clusters, human resources, model, innovation, variables.*

JEL: *C80, L11, M31*

1. Introduction

Clusters consist of a group of related industries and other important entities from a competitiveness point of view.

Clusters often expand downstream towards various distribution channels and clients and sideways towards complementary product manufacturers and towards industries that are related to them by mutual qualifications, technologies or inputs.

Finally, some clusters include governmental institutions and other types of institutions, such as universities, standardization agencies, think tanks, professional training suppliers and employers' associations, which ensure specialized training, education, information, research and technical support". (Porter M. , 1998).

The "Competitiveness pole" is an association of companies, research-development and training organizations, which act in partnership in order to implement a joint development strategy. This strategy is built around innovative projects, its final goal consisting in approaching one or more markets. (Lundvall, 1992)

Also, innovation is today a sine qua non condition for economic success and for maintaining companies on the market. For a long time, and unfortunately, still, innovation has been regarded as a linear process: invention – prototype – testing – mass production – market. This model that draws through its simplicity, nowadays proves itself to be obsolete. Innovation is a complex process, based on the interaction of the actors involved in innovative systems. (Guth, 2007).

Essential contributions to the systemic approach of innovation were made by Lundvall, Nelson and more recently Guth.

All these considerations have lead to the unanimously accepted "triple helix" model, which joins together, within a cluster, representatives of:

- companies – representing the economic part of the cluster;
- universities and research institutes – representing the suppliers of innovative solutions, applicable to the real needs of the companies that are part of the cluster;
- local and regional public authorities, etc

However, in Romania, experience has proved that the three natural partners of the "Triple helix" model not only do not cooperate, but they also do not know each other and do not get to discuss with one another. There is a need for adapting the model and for turning it into a "Four clover" model, the fourth actor being the catalyst organizations – consulting firms, specialized in the technological transfer and innovation field, technological transfer centers, etc.

The main benefits of cluster organization are: innovation, market access, infrastructure, human resources, financial resources, proximity, reducing transaction costs and improving the image.

The main lines that define the performance of clusters, namely: access to human resources, access to specialized knowledge, entrepreneurship based on the opportunities, collaboration between organizations and culture specific organization (Tantalum, China, 2011)

2. Model for performance evaluation clusters

We developed a mathematical model P, which represents cluster performance according to three variables P (X1, X2, X3).

Variable X1 represents turnover of cluster variable X2 value of exported goods, variable X3 human resource performance, expressed in basis points resulting feedback on individual performance evaluations on a scale from 1 ... 5.

$P(x_1,x_2,x_3)\epsilon(0\ldots.5)$ $P_1 = 4{,}8$ $P_5 = 3{,}4$

$x_1\epsilon(1{,}5;3{,}5)$ $P_2 = 4{,}3$ $P_6 = 3{,}1$

$x_2\epsilon(2{,}7;4{,}7)$ $P_3 = 3{,}9$ $P_7 = 2{,}8$

$x_3\epsilon(2{,}5;4{,}5)$ $P_4 = 3{,}7$ $P_8 = 2{,}6$

I.

$$P(x_1,x_2,x_3) = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{12}x_1x_2 + b_{23}x_2x_3 + b_{13}x_1x_3 + b_{123}x_1x_2x_3$$

II.

$$\Delta x_1 = \frac{x_1max - x_1min}{2} = 1$$

$$\Delta x_2 = \frac{x_2max - x_2min}{2} = 1$$

$$\Delta x_3 = \frac{x_3max - x_3min}{2} = 1$$

$$x_1b = x_1max - \Delta x_1 = 3{,}5 - 1 = 2{,}5$$

$$x_2b = x_2max - \Delta x_2 = 4{,}7 - 1 = 3{,}7$$

$$x_3b = x_1min + \Delta x_3 = 2{,}5 + 1 = 3{,}5$$

Decoded values of the mathematical model

$$x_1 = \frac{x_1' - x_1b}{\Delta x_1} = \frac{x_1' - 2{,}5}{1} = x_1' - 2{,}5$$

$$x_2 = \frac{x_2^{'} - x_2 b}{\Delta x_2} = \frac{x_2^{'} - 3{,}7}{1} = x_2^{'} - 3{,}7$$

$$x_3 = \frac{x_3^{'} - x_3 b}{\Delta x_3} = \frac{x_3^{'} - 3{,}5}{1} = x_3^{'} - 3{,}5$$

The calculation of the mathematical model coefficients: $b_0, b_1, b_2, b_3, b_{12}, b_{23}, b_{13}, b_{123}$

$$b_0 = \frac{\sum_{i=1}^{n} x_0 i * Pi}{n} = \frac{x_{01}P_1 + x_{02}P_2 + x_{03}P_3 + x_{04}P_4 + x_{05}P_5 + x_{06}P_6 + x_{07}P_7 + x_{08}P_8}{8} = 3{,}57$$

$$b_1 = \frac{\sum_{i=1}^{n} x_1 i * Pi}{n} = \frac{x_{11}P_1 + x_{12}P_2 + x_{13}P_3 + x_{14}P_4 + x_{15}P_5 + x_{16}P_6 + x_{17}P_7 + x_{18}P_8}{8} = 0{,}47$$

$$b_2 = \frac{\sum_{i=1}^{n} x_2 i * Pi}{n} = \frac{x_{21}P_1 + x_{22}P_2 + x_{23}P_3 + x_{24}P_4 + x_{25}P_5 + x_{26}P_6 + x_{27}P_7 + x_{28}P_8}{8} = 0{,}45$$

$$b_3 = \frac{\sum_{i=1}^{n} x_3 i * Pi}{n} = \frac{x_{31}P_1 + x_{32}P_2 + x_{33}P_3 + x_{34}P_4 + x_{35}P_5 + x_{36}P_6 + x_{37}P_7 + x_{38}P_8}{8} = 0{,}22$$

$$b_{12} = \frac{\sum_{i=1}^{n} x_1 x_2 i * Pi}{n}$$
$$= \frac{x_1x_21P_1 + x_1x_22P_2 + x_1x_23P_3 + x_1x_24P_4 + x_1x_25P_5 + x_1x_26P_6 + x_1x_27P_7 + x_1x_28P_8}{8} = 0{,}05$$

$$b_{23} = \frac{\sum_{i=1}^{n} x_2 x_3 i * Pi}{n}$$
$$= \frac{x_2x_31P_1 + x_2x_32P_2 + x_2x_33P_3 + x_2x_34P_4 + x_2x_35P_5 + x_2x_36P_6 + x_2x_37P_7 + x_2x_38P_8}{8} = 0{,}1$$

$$b_{13} = \frac{\sum_{i=1}^{n} x_1 x_3 i * Pi}{n}$$
$$= \frac{x_1x_31P_1 + x_1x_32P_2 + x_1x_33P_3 + x_1x_34P_4 + x_1x_35P_5 + x_1x_36P_6 + x_1x_37P_7 + x_1x_38P_8}{8}$$
$$- 0{,}025$$

$$b_{123} = \frac{\sum_{i=1}^{n} x_1 x_2 x_3 i * Pi}{n}$$
$$= \frac{x_1x_2x_31P_1 + x_1x_2x_32P_2 + x_1x_2x_33P_3 + x_1x_2x_34P_4 + x_1x_2x_35P_5 + x_1x_2x_36P_6 + x_1x_2x_37P_7 + x_1x_2x_38P_8}{8}$$
$$= -0{,}05$$

$$P(x_1, x_2, x_3) = 3{,}57 + 0{,}47x_1^{'} - 1{,}17 + 0{,}45x_2^{'} - 1{,}66 + 0{,}22x_3^{'} - 0{,}77 + 0{,}1x_2x_3 - 0{,}35x_2^{'}$$
$$- 0{,}37x_3^{'} + 1{,}29 = 1{,}26 + 0{,}47x_1^{'} + 0{,}1x_2^{'} - 0{,}15x_3^{'} + 0{,}1x_2x_3$$

Performance calculation for an IT cluster has the following variables

$x_1^{'} = 3{,}5$ mil. RON

$x_2^{'} = 4{,}5$ mil. RON

$x_3^{'} = 3$

$$P(3{,}5; 4{,}5; 3) = 1{,}26 + 0{,}47 * 3{,}5 + 0{,}1 * 4{,}5 - 0{,}15 * 3 + 0{,}1 * 4{,}5 * 3$$

$$= 1{,}26 + 1{,}64 + 0{,}45 - 0{,}45 + 1{,}35 = 4{,}25$$

On a rating scale with numerical values from 1..5, P = 4.25 performance IT cluster is at a higher level of performance..

Conclusions . The model developed allows the determination of a cluster performance based on three variables considered the export value of products sold and the quality of human resources. The mathematical model developed shows the application in managerial practice can be successfully used in evaluating the performance of clusters in various fields.In the model developed can be used as a variable and the degree of connectivity of the cluster and the number of newly created products.

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DISTRIBUTION MODEL OF MANUFACTURED PRODUCTS

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ABSTRACT *In this paper we presented a model for distribution of products manufactured so that the total cost of transport is minimized. The model can be applied to a number of F units that carry goods from distribution centers Cj. The plan allows for the development of transport depending on the parameter Cj.*

Key words: *cost , products, distribution, transport, parameter, minim.*

JEL: *C80, L11, M31*

1. Distribution model manufactured products

Florescu (1987) recommended to realized some strategies for firms for a continuing improvement of economical activity. For that reason we take in consideration the following situation. In the model we considered two economic units Fi (i = 1,2) supplying three distribution centers Cj (j = 1,2,3). The F1 is performed 40% of all products and 60% are manufactured in accordance with the F2 centers C1 applications absorb 20%, 30% and 50% of the manufactured production (Jula, 2006). Using Duval (2006) information and Cipleu and Pap (2007) research work the logical prevision

van take in consideration that for xij amount of product transported from economic Fi units Cj centers

$$\begin{cases} x_{11}+x_{12}+x_{13}=40 \\ x_{21}+x_{22}+x_{23}=60 \\ x_{11}+x_{21}=20 \\ x_{12}+x_{22}=30 \\ x_{13}+x_{23}=20 \end{cases}$$

$$x_{ij} \geq 0 (i=1,2;\ j=1,2,3).$$

Efficiency function representing the total cost of transport is:

$$F(x) = 200\,x_{11} + 250\,x_{12} + 300\,x_{13} + 400\,x_{21} + 200\,x_{22} + 100\,x_{23}$$

$$x_{21} = 20 - x_{11}\ ,\quad x_{22} = 30 - x_{12},\quad x_{13} = 40 - x_{11} - x_{12}$$

$$F(x) = 200\,x_{11} + 250\,x_{12} + 300(40 - x_{11} - 400\,x_{12}) + 400(20 - x_{11}) + 200(30 - x_{12}) + 100(10 + x_{12} + x_{11})$$

$$F(x) = -400\,x_{11} + 150\,x_{12} + 27000$$

$$\begin{cases} x = x_{11} \\ y = x_{12} \end{cases}$$

$$\begin{cases} 20 - x \geq 0 \\ 30 - y \geq 0 \\ 40 - x + y \geq 0 \\ 10 + y + x \geq 0 \end{cases}$$

$$\begin{cases} x \leq 20 \\ y \leq 30 \\ x + y + 40 \leq 0 \\ y + x + 10 \geq 0 \end{cases}$$

It was a linear programming problem with two unknowns.

(D1) x+y-40=0

$$\frac{x}{40}+\frac{y}{40}-1=0$$

(D2) x+y+10=0 , $\frac{x}{-10}+\frac{y}{-10}-1=10$

(D3) x=20 , (D4) x=30

$$D_1=\begin{cases}x=0 & x=40\\ y=40 & y=0\end{cases}$$

$$D_2=\begin{cases}x=0 & y=-10\\ y=-10 & x=0\end{cases}$$

The graphical representation of the lines results (see figure 1.).:

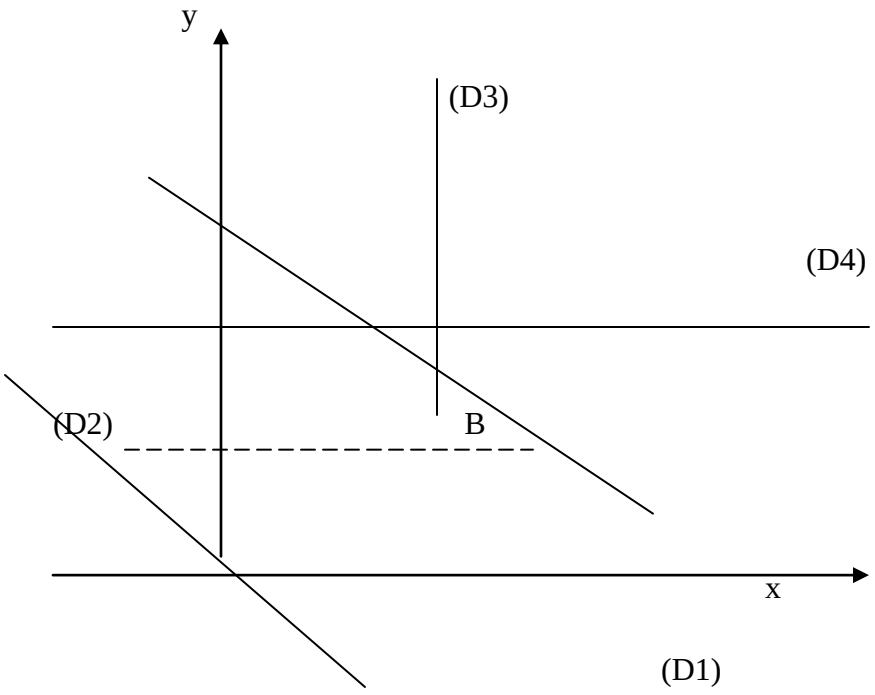

Figure 1. Graphical distribution

The maximum function will be:

$$F(x) = 400 \times 20 - 150 \times 20 + 27000 = 16000t$$

Conclusions

The model can be applied to a number of F units that carry goods from distribution centers Cj. The plan allows for the development of transport depending on the parameter Cj. The distribution model presented is very useful as it has huge implications both on sales and costs over a long period. The model shows the interrelationship between distribution and production, consumption respectively, analyzed by parametric functions that it performs in the economic circuit.

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NEW TRENDS IN COMPETITIVNESS THROUGH CONCENTRATION AND SPECIALIZATION OF INDUSTRIAL SECTORS CASE: NORTH WEST REGION OF ROMANIA

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Abstract: *The key factor in determining economic growth, for the entry in a market full of strong competitive forces, is economic competitiveness. In addition, the development of competitive economic advantages must be a constant process, which takes into account European trends, and the process of globalization as a whole. The paper provides an analysis of competitiveness through concentration and specialization patterns in NW Region of Romania, and by data processing reveals the most important industrial sectors in this region .Conclusions point out that the increase in competitiveness should not be seen as a process of exploiting short-term advantages but as a process of building an economic structure based on capital investment and research - development-innovation processes. In other words, a medium and long term perspective should consider a knowledge-based development of economy. Sustainable economic growth and improving living standards of the population are determined by the development of economic competitiveness in the context of global challenges (globalization of the economy, opening of international markets, rapid technological change), challenges that must be turned into opportunities for the Romanian economy*
Keywords: *competitiveness, industry, concentration ,Gini index, smart specialization*
JEL: *C80, L11, M31*

1.Critical analysis of competitiveness in Romania

Although it had a substantial progress in recent years, Romania has serious gaps in terms of competitiveness with the states of Western and Central Europe. The reasons for this are found in all the determinants of competitive ability. They all translate, ultimately, into low productivity, which defines the competitiveness issue in Romania. GDP in PPC101 is only 50% of the average of the new EU Member States. After analyzing the current situation, there is a disadvantage to many factors influencing competitiveness.

The use of energy-intensive technologies and equipment with expired life-span drastically reduces productivity in most industries.
The SME sector is probably the most affected, with a structure that shows a relatively low orientation towards productive activities, as can be seen from the analysis of the current situation. Despite a positive trend, SME share in GDP is still insufficient, requiring both a quantitative and qualitative growth of the SME sector.
The access of SME to capital, technology and infrastructure is low, well below the level that would allow the exercise of the vital role of SMEs in strengthening economic competitiveness, by introducing innovative processes and showing adaptability to market requirements. Scientific research suffers because of a declining level of investment in the field from the public and private sector, a reduced number of highly qualified specialists and an extremely low number of centers of excellence. Regarding aspects of corporate strategy, low skills in management are a disadvantage that manifests itself in all levels. Most local companies still base their competitive strategies on low cost and not on improving productivity.
Innovative companies are three to four times lower as a percentage of the total firms, compared to the European Union. Intellectual property protection has progressed at regulatory level, but less at implementation level. The infrastructure to support innovative start-ups is only in its early stages.
Regarding related industries and support services, the Romanian economy are seriously deficiencies. Many economic sectors have developed either due to the natural advantage (wood processing, construction materials, tourism) or as a result of massive state intervention toward forced industrialization (machinery, metallurgy, chemistry and petro-chemistry).
Both judgments have determined a low degree of aggregation and cooperation within the same sectors, with serious gaps in ensuring an adequate production chain, able to create added value.
Business infrastructure is very and support services are still at an early stage of development. The SME sector, which employs almost half of the employed population, has limited access to specialized consultancy services. In the OECD countries it was found that information and communication technology contributes significantly to economic growth, both through the related industry and by using information technology industries. Although in recent years Romania has decreased the gap on the implementation of the information society by developing the ICT industry, infrastructure (hardware, software, communication means) and specific applications and services, information and communication technology penetration is quite low, both because of a deficient request, partly due to a low purchasing power of the population, poor ICT education and the limited availability of infrastructure in terms of access and cost of use. Increasing economic competitiveness depends on economic activities and their location in terms of territory (Radulescu et.al, 2008), the distribution and spatial relations in which they stand when it comes to resources, workforce, facilities and relevant services and markets(Hahn,2007).

2. The relevance of the industrial sector for growth and development

The industrial revolution led to a sharp increase in the use of knowledge in practical work, laying the foundation for structural and qualitative changes in world economies and boosting competition between countries and changing competitive advantages. Globalization and implementation of the knowledge society led to increasing the role of human capital in economic development of countries and regions, the growth of export and competitiveness. Competitiveness is determined by

a country's ability to add value to products, services and processes in the global economy at a low cost. (Nabi and Luthria, 2002).The key factors of competitiveness in a globalized and interdependent economy become the knowledge and qualifications of the workforce. Kim, S. (1995) Human capital makes the difference between businesses.

2.1. Industrial competitiveness

The industrial competitiveness contains two main influence factors : government and market-related It It is expressed by offer characteristics, grouped into two categories:
1.cost, determined, in turn, by:
• productivity;
• factor prices;
• other variables of the offer (investment, organization, management);
2.quality (given by the level of profit for the same costs) having its three dimensions:
• innovative (capacity of products/services to incorporate new technical and technological elements);
• technical (feature of products/services to be consistent with technological documentation and reliable);
• marketing (advertising, ability to adapt quickly to changes in demand, trademark).Almost all of the analyses conducted on regional competitiveness reveal at least one of these factors in a dynamic evolution. The economic and social metrics of the factors are relevant for policy and decision makers within a state or region.

2.2. Critical analysis of the current state of development in the Nord West Region of Romania

The economic overview of the NV region of Romania captures the strengths with growth potential, generating added value and need financial support in the future, but also those who show negative trends, by whose support is trying to eliminate disparities and non-balanced development in Northwest region. The data provided by North West Development Agency (NWDA)(http://www.nord-vest.ro/planul-de-dezvoltare-regionala-2014-2020--eID1724.html)**,**shoes that relevant
macroeconomic indicators are places the Northwest region on third place by national ranking, in terms of contribution to GDP and Gross Value Added, but, below the national average values for labor productivity and GDP - per capita community, at large distance compared to the EU average. According to NWDA between 2005-2011, in nominal terms, the GDP in Northwest Region increased by 78%, with an average annual increase of 16.3% by 2008 ,and a slower annually pace since 2009 2.6%, following the general dynamics of national GDP, fluctuations due to economic crisis and growth of the inflation rate. In real terms, between2005 and 2008, GDP grew in Region NV with annual average of 5.5%, with a peak ecart- 10% in 2007, 2009 was marked by a decrease of about 6%, under the effect of the economic crisis. Representing 14.3% of the country and 12.92% of the total population, Northwestern region contributed 11.32% to the national GDP, occupying the entire period analyzed the 3rd position nationally, with a of 61,060,300,000 lei in 2011, an increase of 3% compared to 2010 (GDP Northwest Region in 2010 was 59,292.5 million,

respectively 14.079 million Euros).

2.3. Manufacture performances

There is increase in turnover in manufacturing units in spite of the number of employees which decreased significantly especially since the outbreak of the economic crisis that has left its mark through mass layoffs. Labor productivity grew on its bases. Manufacturing of North West is labor intensive, but considering the indicators evolution (growth of turnover and fewer employees) we conclude that the undertakings in this sector is emphasized the need to increase the degree of automation. Manufacturing was and is, one of the pillars of regional economic structure, in turn, is composed of traditional sectors, labor intensive and low value added. The following section will be addressed to the manufacturing industries in order to be identified regional specificities.

Table 1: Main indicators of NV region: Industrial Sector

Crt. No.	Industry	No. of active local units	No of SME'es	No of employees from SMS-es	Turnover milion lei	Productivity in SME thousands lei/ employee
0	1	2	3	4	5	6
1.	Diary industry	1.184	1.178	16.260	2.333	143,48
2.	Textile industry	943	926	2.720	330	121,77
3.	Footwear and leather industry	402	386	11.286	617	54,66
4.	Wood industry	979	976	7.429	893	120,2
5.	Celulosis and paper industry	120	119	1.819	393	216,05
6.	Furniture industry	700	684	10.082	874	86,68
7.	poligrafic industry	292	292	2.527	318	125,84
8.	Chemical industry	108	107	986	269	272,81
9.	Pharmacy industry	18	17	454	76	167,4
10.	Rubber and plastics industry	453	449	6.145	1.132	184,2
11.	Mineral product industry nemetalice (materiale de construcţii)	500	494	5599	995	177,7
12.	steel constructions and metal products industry	1.002	1.000	11282	1547	129,14
13.	electric eqhipment industry	98	91	1737	495	284,9
14.	means of transportation industry	285	207	3458	505	146,03

Sourse: NWDA,2015,Processed by authors

3. Analysis of competitiveness through concentration and specialization patterns; Functional regional specialization

Regional specialization on employment is defined as the weight distribution of employment in a particular branch of industry *i* in the employed population in manufacturing in a given region *j* compared to the norm. A region *j* is specialized in a particular branch of industry *i* if this branch has a large share in total employment in manufacturing in region *j*. Manufacturing of a region *j* is "highly specialized" if a small number of industries have a large share in total manufacturing.
Geographical concentration is defined as the share of different regions (counties) within a particular sector of economic activity (industry) *i*. A particular branch of industry *i* is "concentrated" if a large part of production is made by a small number of regions (counties) (Aiginger K., 2004).
In order to use these indices presented in econometric models to be presented below, they were calculated as (Aiginger, K., et al., 1999):

Note with:

- $E-$ employment;
- $s-$ share;
- $i-$ industry (sector,branch); $i=1,\ldots,n$;
- $j-$ region; $j=1,\ldots,m$;
- $s_{ij}^{s}-$ share of employment in industry i in region j in total employment/ in manufacturing in the region j;
- $s_{ij}^{C}-$ Share of employment in industry i in region j in total employment in the industry i; s_i- - The share of total population employed in the industry i in total employment in manufacturing ;
- s_j- The share of total population employed in industry j in toatal employment in manufacturing

$$s_{ij}^{s}=\frac{E_{ij}}{E_j}=\frac{E_{ij}}{\sum_i E_{ij}},\quad s_{ij}^{C}=\frac{E_{ij}}{E_i}=\frac{E_{ij}}{\sum_j E_{ij}},\quad s_i=\frac{E_i}{E}=\frac{\sum_j E_{ij}}{\sum_i\sum_j E_{ij}},\quad s_j=\frac{E_i}{E}=\frac{\sum_i E_{ij}}{\sum_i\sum_j E_{ij}}$$

(1)

Gini Index correspondent to regional specialization has been calculated based on the following următoarelor formulas:

$$\mathrm{GINI}_J^{s}=\frac{2}{n^2\bar{R}}\left[\sum_{i=1}^{n}\lambda_i(R_i-\bar{R})\right],\%$$, Where: $n-$ number of industries; $R_i=\frac{s_{ij}^{s}}{s_i}$ - (For each industry j in region); $\bar{R}-$ Average of R in industry λ_i- Pozition of industry i in yhe hierarhy of R_i.

Gini Index correspondent to geographical concentration has been calculated based on the following formulas:

$$\mathrm{GINI}_i^{C}=\frac{2}{m^2\bar{C}}\left[\sum_{j=1}^{m}\lambda_i(C_j-\bar{C}\right]$$, Where: number of regions; average of on regions; pozition of region j in hierarhy of ;

Regional specialization and geographic concentration of industry can be characterized by absolute and relative indicators. (Constantin, D. 2004), (Capello, R. 2006).In the literature there are several indicators, each with advantages and disadvantages. As an absolute measure of regional specialization and geographical concentration of the industry we use the Herfindahl index, and as a

relative measure the dissimilarity index proposed by Krugman and the Gini index transformed.The Herfindahl index (also known as Herfindahl–Hirschman Index, or HHI) is a measure of the size of firms in relation to the industry and an indicator of the amount of competition among them (Acar, W., and Sankaran, K. 1999)

- an H below 0.01 (or 100) indicates a highly competitive index;
- an H below 0.15 (or 1,500) indicates an unconcentrated index;
- an H between 0.15 to 0.25 (or 1,500 to 2,500) indicates moderate concentration;
- an H above 0.25 (above 2,500) indicates high concentration.

A small index indicates a competitive industry with no dominant players. If all firms have an equal share the reciprocal of the index shows the number of firms in the industry. There is also a normalised Herfindahl index. Whereas the Herfindahl index ranges from 1/*p* to one, the normalized Herfindahl index ranges from 0 to 1. It is computed as: using the normed Herfindahl index, information about the total number of players (*p*) is lost

Herfindahl Index correspondent to regional specialization
$H_j^s = \sum_i (s_{ij}^s)^2$.
Herfindahl Index correspondent to geographical concentration
$H_i^C = \sum_j (s_{ij}^C)^2$.

4. Appraisal of the concentration of industrial sector of NV region of Romania based on spatial concentration

There are several statistical methods (Săvoiu, Crăciuneanu and Ţaicu, 2010) used to identify inequalities and concentrations in spatial distribution of a phenomenon that has been applied to a number of economic problems. Some examples used in this regard are: coefficient of location, Herfindahl index used to measure industrial concentration, Gini coefficient which describes the spatial concentration, the index for measuring the degree of agglomeration.

The most used instrument is the coefficient of location (it has been defined by / shows the degree of specialization of a region in a particular industry . In this paper we use the Gini index for determining the total space concentration of industries and the coefficient of location to measure the level of concentration within the region (county). By application of the formulas described above one can determine the cumulative percentage of employees in the industry I and the cumulative percentage of employees in the total industry.

Cumulative weights can be represented by the so-called Lorenz curve. Gini's coefficient value locality is the surface coefficient of the straight line and the Lorenz curve 45 angular degree .

The Gini coefficient was used to measure the concentration of economic activity. It compares the Lorenz curve / element to see if it has the same contribution to the total sum of values of a variable.

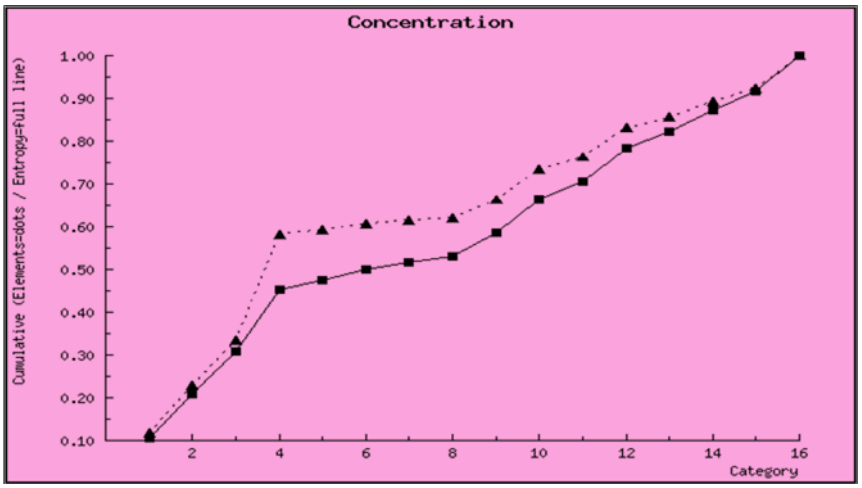
The Gini coefficient ranges from 0 where there is a concentration (perfect equality), to 1, where there is a total concentration (perfect inequality). Program Wessa was used for processing data. (Wessa , P. 2015)

Concentration - Ungrouped Data	
Entropy	2.381737
Maximum Entropy	2.772589
Normalized Entropy	0.859030
Exponential Index	0.092390
Herfindahl	0.120110
Normalized Herfindahl	0.061450
Gini Coefficient	0.479214
Concentration Coefficient	0.511161
Categories	16

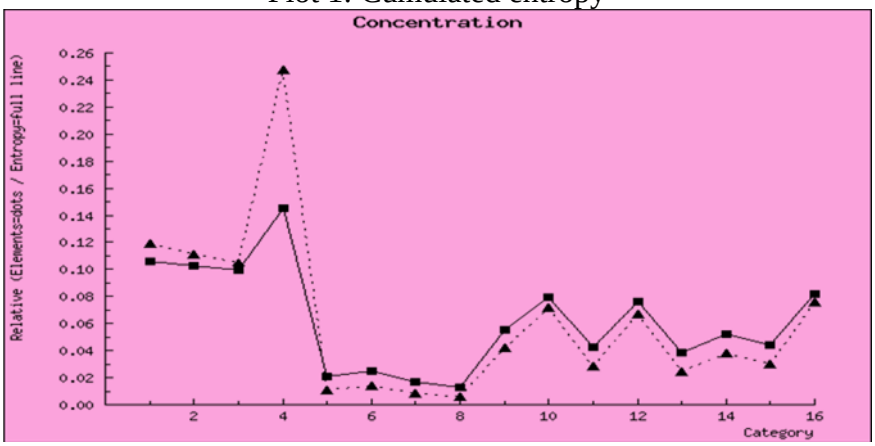
Concentration 2 - Ungrouped Data				
Category	Elements (Absolute)	Elements (Relative)	Entropy (Absolute)	Entropy (Relative)
1	12.650000	0.118846	0.253134	0.106281
2	11.850000	0.111330	0.244398	0.102613
3	11.190000	0.105130	0.236811	0.099428
4	26.330000	0.247369	0.345544	0.145080
5	1.190000	0.011180	0.050239	0.021093
6	1.470000	0.013811	0.059141	0.024831
7	0.900000	0.008455	0.040357	0.016945
8	0.640000	0.006013	0.030749	0.012910
9	4.450000	0.041808	0.132726	0.055726
10	7.630000	0.071684	0.188922	0.079321
11	3.010000	0.028279	0.100832	0.042336
12	7.150000	0.067174	0.181401	0.076163
13	2.640000	0.024803	0.091691	0.038497
14	4.040000	0.037956	0.124166	0.052132
15	3.230000	0.030346	0.106061	0.044531
16	8.070000	0.075817	0.195565	0.082110

Concentration 3 - Ungrouped Data				
Category	**Elements (Absolute Cumulated)**	**Elements (Relative Cumulated)**	**Entropy (Absolute Cumulated)**	**Entropy (Relative Cumulated)**
1	12.650000	0.118846	0.253134	0.106281
2	24.500000	0.230177	0.497532	0.208895
3	35.690000	0.335306	0.734343	0.308322
4	62.020000	0.582676	1.079886	0.453403
5	63.210000	0.593856	1.130125	0.474496
6	64.680000	0.607666	1.189267	0.499328
7	65.580000	0.616122	1.229624	0.516272
8	66.220000	0.622135	1.260373	0.529182
9	70.670000	0.663942	1.393098	0.584909
10	78.300000	0.735626	1.582020	0.664230
11	81.310000	0.763905	1.682852	0.706565
12	88.460000	0.831079	1.864253	0.782729
13	91.100000	0.855881	1.955944	0.821226
14	95.140000	0.893837	2.080110	0.873358
15	98.370000	0.924183	2.186171	0.917890
16	106.440000	1.000000	2.381737	1.000000

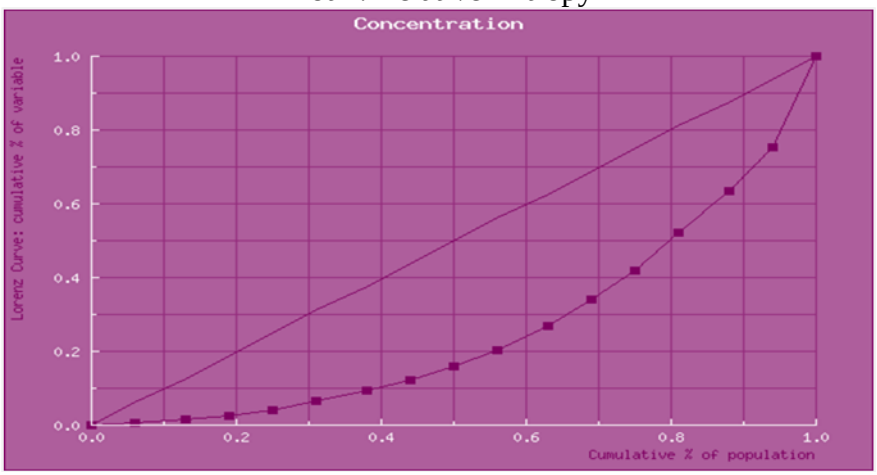
Concentration 4 - Lorenz Curve - Ungrouped Data		
Cumulative % of population	**Cumulative % of variable**	
	Expected	Observed
0%	0.000000	0.000010
6%	0.062500	0.006013
13%	0.125000	0.014468
19%	0.187500	0.025648
25%	0.250000	0.039459
31%	0.312500	0.064262
38%	0.375000	0.092540
44%	0.437500	0.122886
50%	0.500000	0.160842
56%	0.562500	0.202649
63%	0.625000	0.269823
69%	0.687500	0.341507
75%	0.750000	0.417324
81%	0.812500	0.522454
88%	0.875000	0.633784
94%	0.937500	0.752631
100%	1.000000	1.000000



Plot 1: Cumulated entropy



Plot 2: Relative Entropy



Plot 3: Lorentz Curve

The indicators of economic concentrations, like the Gini index and the coefficient of location, are designed to provide information about the degree to which each industry in a country, in our case

Romania, is concentrated in a number of areas, regardless of whether or not those areas are neighbors.
These indicators measure the variability in the distribution of employment in all observations of a certain region of the entire space, i.e. the concentration of economic activity (Arbia, 2001).
Thus, for the Northwestern Region, the synthesis of analyses performed in order to identify the regional specialization (industrial) sectors and areas of excellence is shown schematically in the tabel below:

Table 2 :The most important industrial sectors fron NW Region of Romania

Crt no	Industrial sector	% from Active units*	% from turnover*	% from employees*
1.	Diary industry	15,66	17,02	12,65
2.	Textile industry	12,20	4,46	11,85
3.	Footwear and leather industry	5,25	3,93	11,19
4.	Wood industry Furniture industry	22,47	19,02	26,33
5.	Celulosis and paper industry	1,45	1,60	1,19
6.	poligrafic industry	3,59	1,17	1,47
7.	Chemical industry	1,40	1,28	0,90
8.	Pharmacy industry	0,21	1,32	0,64
9.	Rubber and plastics industry	5,61	5,74	4,45
10.	Mineral product industry (unferrous)	6,55	4,99	7,63
11.	Metalurgic Industry	0,85	5,80	3,01
12.	Steel constructions and metal products industry	12,56	6,24	7,15
13.	Manufacture of computers and electronic and optical products	1,70	17,61	2,64
14.	Electric eqhipment industry	1,27	6,98	4,04
15.	Machinery and equipment industry	2,47	2,66	3,23
16.	Means of transportation industry	0,88	4,85	8,07

Source : Processed based on data provided by INS Tempo Online,2014

5. Conclusions

In terms of concentration of economic activity in the region in sectors, the analysis of the main economic indicators related to manufacturing sectors in the region may led to the identification of industrial clusters focusing significant financial and human resources.
There is a series of labor-intensive sectors in which most enterprises in the region operate; these sectors of regional significance need to be supported mainly due to the social risk they pose: **food industry, textile and clothing industry, leather and footwear industry, wood processing and furniture industry** and, on a smaller scale, the manufacture of metal and metal products and non-metallic mineral products industry (construction materials).
On the other hand, the following sectors produce high added value, with the potential to generate future smart specialization (http://s3platform.jrc.ec.europa.eu/home) (http://www.minind.ro/PROPUNERI_LEGISLATIVE/2014/SNC_2014_2020.pdf).
through sustained investment policies: manufacture of computers, electronics and optical products, manufacture of electrical equipment, manufacture of motor vehicles, metallurgical industry and, to a lesser extent, the pharmaceutical industry, rubber and paper
An important problem concerning the identification of economic and regional clusters is that there is no "baseline" for interpreting results.
The Gini index only shows the extent to which an industry deviates from a situation in which employment is distributed across regions in exactly the same way as the entire population.
Although the analyse of concentration shows a week proportion of intelligent specialized industries eg 8,13,14 the combination of R&D with economy can identify two domains with development potential, anchored on the one hand in the industrial economic reality of the region and on the other on development based on new technologies and further research in the field. Sustainable economic growth and improving living standards of the population are determined by the development of economic competitiveness in the context of global challenges (globalization of the economy, opening of international markets, rapid technological change), challenges that must be turned into opportunities for the Romanian economy**.**
In our opinion an intelligent approach to functional specialization involves focusing on public intervention (which will be multiplied by private investment) in these areas of specialization, according to the principle "limited resources directed to limited areas".

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OPTIMIZING WASTE COSTS IN PRODUCTION MANAGEMENT

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***Abstract**: In case of the investment process, the optimization is based on a mathematical model or a range of mathematical models which describe the process. The Choice of the most appropriate mathematical model is the guarantee to obtain useful information for investors. This paper presents a classic analytical method of decreasing the investment cost in the batch production systems that are specific to the engineering industry.*

***Keywords:** linear modeling, classical analytical method, optimization, efficiency, optimal variant.*

***JEL:** 90C46, 90C59, 49J35, 90B70, 65K10.*

1. Introduction

For the efficient use of the investment resources, the investment process in the field of technical systems requires the use of the mathematical optimization methods based on static linear programming (geometric methods, analytical methods and sequential methods) and dynamic linear programming, when taking into account the influence of the time factor.

Depending on the potential of the mathematical model, the concept of optimum could have a double meaning: a permanent or relative one.

Using the mathematical models we can establish a data base and improve the quality of manufacturing process, an ever ending spiral of quality products (Boca, G.D., 2014).

The closest to the optimum variant, resulting from the application of mathematical methods, provides the investors with useful information to adopt the solution with the lowest investment risk, in order to achieve the closest economic efficiency to the proposed one.

Modeling and solving the optimization problems involve the following sequential steps (Loorkar and and Robinson, 1970):

- Choice of the aimed function - usually it is the criterion of economic efficiency to be achieved and which is to meet some specific, immediate and prospective needs. A benchmark to be maximized or minimized will be selected accordingly.
- The main and secondary restrictions are determined – the minimum level for some economic effects to be achieved, the minimum level of the production costs, the minimum amount of the resources.
- The objective function is created, starting from its dependence on the variables of the solutions underlying the formulated alternatives.
- Solving the algorithm formed by the system of equations and inequalities as well as the aimed function.
- Verifying the stability of the optimal solution identified in relation to the adopted hypotheses and considering whether there are other alternative variants that would provide suitable results with fewer risks under those hypotheses.
- Recommendation for investors on the variant that would be adopted, presenting its advantages over other alternatives.
- Recommendation for investors on the variant that would be adopted, presenting its advantages over other alternatives.

2. Case study

Considering that a batch of products is manufactured by a production system comprised of some technological equipment operating in discontinuous mode and others in semi-continuous mode. Mathematically, it is assumed that the production system made up of a string of $\boldsymbol{X}$ technological equipment in batch operation mode and $\boldsymbol{Y}$ equipment in semi-continuous operation mode, to form the $\boldsymbol{G}$ group of equipment.

The total manufacturing time of a batch of parts will be [1]:

$$D = \sum_{i=1}^{X} t_i + \sum_{j=1}^{Y} d_j \qquad (2.1)$$

where: t_i and d_j are durations of the manufacturing processes.

Noting with ***Q*** the production task of a batch of parts, the manufacturing system productivity could be expressed as[1]:

$$W = \frac{Q}{D} \qquad (2.2)$$

The imposed restrictions also refer to the cost of the technological equipment.

To determine the cost of the technological equipment, their number is considered, corresponding to various technological operations ***i*** with discontinuous operation mode, which are necessary to meet the production task *Q*, are different but proportional to ***Q***; expressions to determine the cost of their purchase can be expressed in the form[1]:

$$C_i = u_i \cdot X_i^{\alpha_i} = u_i \cdot (K_i \cdot Q)^{\alpha_i} = a_i \cdot Q^{\alpha_i}, \qquad i = 1, \dots, X \qquad (2.3)$$

where : a_i and α_i – are specific constants of the batch mode operating equipment;

u_i – unit cost of the equipment;

K_i - constant of proportionality.

Using the same rationale for the batch mode operating equipment we could assume[1]:

$$C_k = b_k \cdot \left(\frac{Q}{\theta_k}\right)^{\beta_k}, \qquad k = 1, \dots, Y. \qquad (2.4)$$

where: b_k and β_k– are the specific constants of the semi-continuous mode operating equipment;

θ_k – the operation time that is necessary to manufacture a batch of products.

The total investment cost, which also represents the aimed function, will be:

$$C_T = \sum_{i=1}^{X} a_i \cdot Q^{\alpha_i} + \sum_{i=1}^{Y} b_k \cdot \left(\frac{Q}{\theta_k}\right)^{\beta_k} \quad (2.5)$$

Minimizing this expression with respect to the variables $t_i$and d_j should be done by respecting the restrictions relative to the respective production, expressed by the relation:

$$W = \frac{Q}{D} = Q/\left(\sum_{i=1}^{X} t_i + \sum_{j=1}^{G} d_j\right). \quad (2.6)$$

Using the substitution of the *Q* (2.6), production task into the aimed function (2.5), an equivalent equation without restrictions is obtained:

$$C_T = \sum_{i=1}^{X} a_i \cdot W^{\alpha_i} \cdot D^{\alpha_i} + \sum_{k=1}^{Y} b_k \cdot W^{\alpha_i} \left(\frac{D}{\theta_k}\right)^{\beta_k} \quad (2.7)$$

Combining this relation, results the final form of the system, whose solution will offer the solution that is close to the optimal one:

$$\sum_{k=1}^{Y} g_k \cdot D^{\beta_k} \cdot \beta_k \cdot \tau_j^{-\beta_k - 1} \frac{\partial \theta_k}{\partial d_j} = \frac{\sum_{i=1}^{X} e_i \cdot \alpha_i \cdot D^{\alpha_i}}{\sum_{i=1}^{X} d_i} \quad (2.8)$$

The system can be solved by means of the following algorithm (Stancu et. all, 1995):

Step 1. Give values to the unknowns $\tau_1, \tau_2, \ldots, \tau_R$ and calculate D, using the relation (2.1).

Step 2. Determine E, with the relation (2.16).

Step 3. The equation (2.17) becomes:

It will be solved using a numerical method.

Step 4. Compare the new value obtained for E with the supposed value, and in the event of discrepancy replace $E_{supposed}$ with $E_{calculating}$, and resume the calculations from the step 2.

$$\text{When } \left|E_{supposed} - E_{calculating}\right| \leq \delta, \tag{2.9}$$

where δ is an accepted limit.

The final solution allows the investor to choose the equipment whose features are necessary for an efficient productive activity.

The above presented calculation algorithm can become very efficient and easily used by those concerned, especially if it would result in a computer software.

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SURVEYING IN DYNAMIC CONDITION AND ITS INTEGRATION IN STRUCTURAL HEALTH MONITORING

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Abstract: *Tracking behavior over time of land and buildings, with a history of over 150 years, which merges with the advent of optical-mechanical instruments for measuring angles and level differences, theodolites, level, has dealt with quasi-static structural monitoring. In fact, between the observation cycles, at an interval of several months to several years, based on the evolution of the phenomenon of subsidence and landslides, there were deviations of a few millimeters or fractions of a millimeter. In this context monitoring was considered static. Surveying in dynamic conditions, appeared and was formed as a need to monitor the behavior of structures in dynamic regime. Buildings with very bold and innovative design features required in situ study of the objectives, both during execution. Basically, this process checks if the actual behavior falls under the project specifications. The opportunity of this new branch of Surveying appeared in the 1970s, but has developed at an accelerated pace in the last 20 years, primarily due to projects involving the construction of bridges and very tall buildings, where it contributed significantly in the execution by developing new tools and technologies.*

Keywords: *Tracking the behavior over time of land and constructions, Surveying in dynamic conditions, Structural Health Monitoring, sensors, bridge, tall constructions.*

1. INTRODUCTION

Tracking the behavior over time of land and constructions has always been a distinct branch of Engineering Surveying and although work in this field, finding movements of resistance elements

tracked in a regime close to the static, a few millimeters per year, has been integrated into Structural Health Monitoring, it is clear that any construction in the category of bridges (with exceptional design parameters) or very tall buildings should be monitored both in static regime, as a result of subsidence, landslides and the rheology of construction materials, and in dynamic regime, the effect of wind, sunshine or bridge traffic. To have a unified monitoring concept "tracking the behavior of land and buildings" had to be included in "Structural Health Monitoring", the surveying activity specific to the field, gaining the attribute "dynamic". Structural Health Monitoring(SHM), however, is a much more comprehensive field because it includes the health of a building considered as a whole, not only in terms of geometry and motion parameters produced by exciting forces(2, 3, 4)). Thus, by analyzing companies dealing with manufacturing monitoring techniques and SHM activity itself, it can be seen that around 10% deal with corrosion analysis, a similar percentage with the analysis of the rheology of component materials in a resistance structure. These components cannot be integrated into Surveying in dynamic conditions, but all the other, regarding motion and movement, can.

In the work Dynamic topography, plate driving forces and the African superswell (1) the authors joined the two terms to define the terrain tracking technique for crustal deformations. The defined concept, "Dynamic topography", refers to the technique that would record the link between the processes observed to occur on the Earth's surface and its internal dynamics.

The Chinese researcher Xuebing (10) uses the term DS when mapping using a total station with a telescope having a radius of 500 m.

Some specialized companies in the US and Australia have taken the term DS either is the company name, for example Dynamic Land Surveying, in Bonne Terre, USA or Surveying in dynamic conditions in Mandurah, Australia.

In his work entitled Surveying, Volume 1, S. K. Duggal (5) gives another meaning to the term DS, that he joins with GPS measurements. He notices that some experts replace the term dynamic with kinematic, although there are differences between the two terms, previously presented by the author, classifying surveying measurements in general, according to a pattern presented by the author in his doctoral thesis (2003): Pseudo Static Surveying, Rapid Static Surveying, Kinematic Surveying.

Briefly, at the launch of the Surveying in dynamic conditions concept, we presented some aspects that make it different from the current activity of topography, operating in a static environment. We continue by presenting these issues in order to better understand ours effort to keep this concern in the sphere of terrestrial measurements, in the field of Surveying.

2. INTRODUCTION TO THE SUBJECT OF TRACKING THE BEHAVIOR OVER TIME OF CONSTRUCTIONS

Under the forces of gravity of the building, due to the change of soil moisture and temperature of the foundation, as well as other causes, the soil particles move. As a result, the buildings' foundation soil subsides (soil compaction without changing the structure), swells, settles (soil descends into the voinds created by rocks) and moves in a horizontal direction (sliding). Thus, displacements of foundations and land elements of buildings occur. These movements of buildings can take place in plan and in elevation(9). Construction movements (displacements) in elevation are called subsidence, and in plan - slides. If the displacements of various points of constructions are the same in size and direction, they are called uniform, otherwise - non-uniform. Non-uniform displacements of points alter the shape and size of the building, and therefore lead to deformation. Experience has shown that all buildings and constructions are subject to displacements and deformations. There are no absolutely stationary and non-deformable constructions. Deformations are also caused by variable loads acting on the construction(6, 7, 8). For example, loads caused by wind, solar radiation, vibrations from machines during operation, seismic stress and others. According to their nature, building deformations are divided into elastic and residual. If after the termination of stress the construction takes its original shape, then the deformations are elastic. Elastic deformations occur until the load does not exceed a specified limit value. If the action of loads exceeds this limit, the size and shape of the building are not restored. In this case, the durability of the construction is unbalanced, and its elements show cracks and ruptures; accidents or destruction can also occur.

In order to prevent accidents and study the causes of poor quality of construction more carefully, systematic observations of deformations and displacements of buildings are carried out. To achieve this goal special appliances and equipment is placed in building structures to record strains and mutual displacements of construction points. In making these observations geodetic methods are the most useful, as they enable an overall characterization of the displacement of points and structures in space.

Displacement means a change in the position of a point of a building under loads, and deformation means a change in the relative distance between the points of a building under loads

The measurement of displacements and deformations of constructions may be of a relative or an absolute nature.

- The relative nature of the measurements corresponds to the situation when we measure the distance or closeness of two or more points of the building subject to observation.
- The absolute nature of the measurements corresponds to the situation when the displacements of the points are measured against a set of fixed landmarks, located outside the area of influence of the deformations and of the foundation soil, forming the so-called general reference system.

A building subject to a stress regime determined by its functional conditions may suffer both displacements and deformations:

a. linear,
b. angular, and
c specific.

a. Linear displacements and deformations

- Subsidence – downward vertical displacements of the foundation and foundation soil of the building.
- Terrain settlements – these deformations are collapses, and are caused by the radical change in the structure of the terrain.
- Bulging or lifting - representing vertical upward displacements of foundations or of the pit dug for the foundation of a building, due to changes in the equilibrium of pressures in the structure of the foundation soil;
- Arrows - building elements such as: beams, pillars, slabs, subject to vertical or horizontal loads causing bending thereof; the center line moves away from its initial position with a maximum value called arrow;
- Tilts - are due to non-uniform subsidence without violating the integrity of the buildings and their geometric elements. In practice we distinguish between a building tilt and a foundation tilt.
- Construction dislevelment - measured by the maximum differences of uneven subsidence of two neighboring bearing elements relative to the distance between them;
- Cracks and fissures - breaks in individual parts or planes of the construction, as a result of non-uniform subsidence and additional strain;
- Horizontal displacements – otherwise known as slippage of elements of the building or its entirety, due mostly to horizontal forces (pushing by the earth or water) or changes in the balance of the foundation soil.

b. Angular displacements and deformations

They are rotations of the foundation elements of building (slabs, foundation blocks, etc.) due to the action of loads and changes in the balance of the foundation soil. These rotations can occur horizontally (twisting of the building) or vertically (tilting of the building).

Determining the size of these rotations is done with instruments, apparatus and appliances having an accuracy corresponding to the likely amplitude thereof, and can result in two sets of data:

- Linear sizes whose ratio determines the tangent of the rotation angle;
- Angular sizes expressing the rotation angle of the building element being observed.

c. Specific deformations

Specific deformations are the lengthening or shortenings of a construction element (piece of reinforced concrete, reinforcement from a piece of reinforced concrete, metal bar, etc.) under strain or compression; using the relationship between the strain acting on the part and the resulting deformation, expressed in a state of maximum effort by Heek's law (elasticity of materials), we can estimate the strain state existing in the construction element.

Current tracking is a construction monitoring activity that consists of observing and recording aspects, phenomena and parameters that can indicate changes in the building's ability to meet the strength, stability and durability requirements established by the project. The current tracking of constructions applies to all buildings of any category or class of importance and form of property except residential buildings with ground floor and ground floor plus one floor. The current tracking of constructions' behavior is carried out by direct visual examination and using permanent or temporary means of measuring. The current tracking of constructions' behavior is performed in accordance with the instructions provided in the execution projects. The instructions for current tracking will include, necessarily, the following:

a. phenomenon observed by simple visual observation or using measurement devices;
b. areas of observation and measurement points;
c. adjustments for measuring devices or observations (niches, stairways, handrails, platforms, etc.);
d. measurement, processing, interpretation program, including cases in which observations or measurements are done outside the established periodicity;
e. way of recording and storing data (e.g. records, computer disks, etc.);
f. primary processing mode;
g. ways of transmitting data for interpretation and decision-making;

Special tracking is an activity of tracking the behavior of constructions consisting in measuring, recording, processing and interpreting parameter values that define the extent to which buildings retain their strength, stability and durability requirements established by the project. Special tracking is set for:

- new constructions of exceptional importance established through the project;
- constructions being used that have a dangerous evolution, as recommended by the results of an expert report or an extensive inspection;
- the request of the owner, State Construction Inspection, Public Works, Urban Planning or bodies recognized for specialized fields.

When establishing the special tracking of behavior this will also incorporate current tracking. Special tracking of construction behavior is performed using complex and specialized observation and measurement means, tailored to specific objectives in each case, taking into account existing technical regulations, standards, norms, technical instructions, technical guides).

The foundation soil, under any construction, starts to compact with loading, phenomenon known as subsidence.

This process begins and should be tracked immediately upon completion of foundations and will continue after the commissioning of the buildings until these displacements are completely removed.

The known method is the middle precision geometric leveling regularly comparing, through measuring cycles, the position of mobile markings, mounted on the structure, to benchmarks considered fixed, mounted in areas considered stable over time.

At the same time, there is a danger - for any reason - of movements in plane of the building or structural parts thereof, phenomenon known as sliding. The tracking method used was, for a long time, angular intersection. Since the appearance of state-of-the-art total stations it can be combined with planimetric raying.

By measuring cycles one can see the same variation of the relative positions, but this time in the horizontal plane.

The figure 1 shows the two movements of tracked constructions, like so: a. the occurrence of subsidence phenomenon, b. tracking subsidence by middle geometric leveling, c. the occurrence of slippage phenomenon, d. tracking slipping through angular intersection.

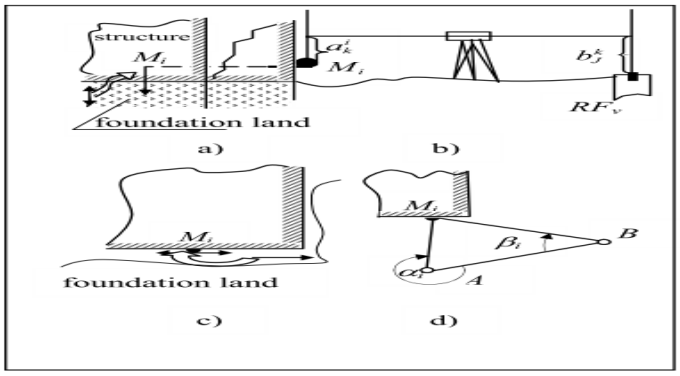

Figure 1. Tracking behavior over time in static regime. Causes and methods

(Source: Authors)

3. THE CAUSES THAT MAKE "STRUCTURAL MONITORING" NECESSARY AND MODERN METHODS USED. THE OPPORTUNITY OF TRANSFORMING THE ACTIVITY OF TRACKING CONSTRUCTION BEHAVIOR INTO A CONCEPT, I.E. STRUCTURAL MONITORING

In 1889 George A. Fuller (1851-1900) created, in Chicago, the Tacoma Building, the first structure ever built whose exterior walls were not load-bearing, columns and beams assuming the

role of structural elements, thus being the first frame structure. It was obvious that the svelte structure required monitoring not only for static actions, such as land settlement under the foundation, but also for dynamic actions such as the action of wind. But there were no means of recording the excitation (the variable pressure of wind) - response (oscillating movement of structural elements) ratio; they appeared much later with the release of sensory techniques for structural monitoring (figure 2).

An effect of those anterior presented was reconsideration of calculus methods, of standards, of concepts regarding mathematical modeling in the projecting process of constructions, but it must be pointed a very important fact: no design method can be validated unless after an analysis regarding the behavior through execution and in time of the construction under the action of disturbing factor's action, wind, earthquake, unequal sunny, at this chapter the geodesic measurements being the ones that give possible answers.

In short, these were the factors that led to the shift from "Tracking behavior over time" to "Structural Monitoring", later incorporated in the comprehensive "Structural Health Monitoring".

Modern continuous methods, appealing to modern techniques (usually sensory), do not exclude but complement methods considered classic, so that the monitoring of the health of constructions now comprises all these methods, from middle precision geometric leveling for static analysis of settlements to the use of fiber optic sensors and to monitoring the oscillations of structures in kinematic regime.

Two types of constructions have led to the concept of Structural Monitoring, later extended to Structural Health Monitoring: bridges and very tall constructions.

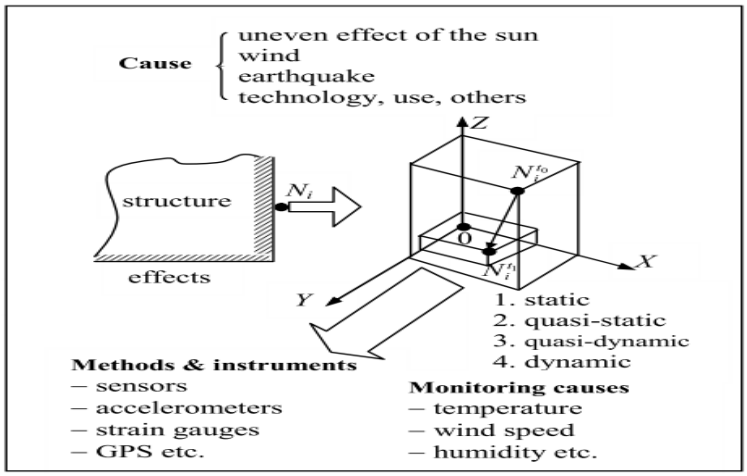

Figure 2. Tracking behavior over time in dynamic regime. Causes and methods.

(Source: Authors)

Since the difference between SM and SHM is derived from non-topographical causes, like the evolution of the state of construction materials (rheology), the analysis by the designer of the risk of an object, we will keep the wording SM in the paper to define the new concept of tracking behavior of buildings under different effects of static or kinematic stress factors.

The concept was later extended to all categories of SM constructions, incorporating "Tracking behavior over time", meaning that long-term effects are detected by conventional means and those taking place now are detected by the new SM methods.

Our common causes of the opportunity of introducing continuous monitoring under kinematic regime in these structures: uneven exposure to sunlight, wind, earthquakes, usage or stand-by mode of the structure.

4. CONCLUSIONS

Surveying in dynamic conditions,, expensive as far as activities go, was relatively recently introduced and due to its costs it is applied only to exceptional constructions, especially bridges with outstanding design features, very tall structures, nuclear constructions, dams, etc. Generally, the activities A, 1 and B, 2 overlap, in that the records made in dynamic regime are carried out continuously. Note that the entries in categories 2 and B, though interpolation, as stated above, can provide data in category 1 and A. It is thus a reverse process to the one performed in the methodology of tracking the behavior over time of constructions, when sequential data made up a whole. Surveying in dynamic conditions, is used to determine the natural frequencies of the structure, mode shape and how the damping systems mounted on the structur have an effect. Dynamic monitoring, where input excitation is not caused by test engineers, is called testing the action of vibrations made by the environment, i.e. excitation from wind, waves, human activity, traffic, etc.. With continuous dynamic monitoring, a lot of data is created. In order to limit the amount of such data, only records of phenomena of interest are saved, the remaining data being ignored because it can block the system due to the volume, without any major contribution.

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A CROSS MATRIX FOR MODELING OPEN INNOVATION IN PRODUCTION MANAGEMENT

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Abstract: *Innovation has become the industrial religion of the late 20th century. Business sees it as the key to increasing profits and market share. Governments automatically reach for it when trying to fix the economy. Around the world, the rhetoric of innovation has replaced the post-war language of welfare economics. Innovation: nothing new? Recent years have seen much focus on how innovation can lead to improvements in productivity assisting in economic development The article present the big difference between making culture in a particular field and practicing it. Innovation is the instrument of entrepreneurship. It invests resources with a new capacity to produce prosperity.*

Keywords*: open innovation, quality, product life cycle. quality, cross culture, management change*

JEL: *90C46, 90C59, 49J35, 90B70, 65K10.*

1. Introduction

Management like any other field of knowledge, must have its sources of innovation, change development in a world evolution (Abrudan, 2012). When we are talking about innovation we can be agreed that innovation is being democratized, that's mean in Eric von Hippel (2012) opinion that users of products and services both firms individual consumers are increasingly able to innovate for themselves. Global management can succeed through effective leadership, cross cultural communication and mutual respect, without them, it is destined to fail. To achieve organization goals and avoid potential risks manager organization should be culturally sensitive and promote creativity and motivation through flexible leadership. The entrepreneur's role, as Schumpeter saw it, was to act as a powerful element in this process of creative destruction, allowing the economy to renew itself and bound onwards and upwards again (McDaniel, 2005).

Today, companies in a wide range of industries are executing nearly every step in the production process, from discovery to distribution, through some form of external collaboration.

These various types of collaborative alliances take on many forms, ranging from R&D partnerships to equity joint ventures to collaborative manufacturing to complex co-marketing arrangements.

The study identify once again and sustain, Chesbrough (2006) opinion who define two types of innovation

- c**losed innovation** which requires control;
- **open innovation** – when companies use external as well internal ideas and both external and internal ways to market. The internal ideas can be taken to the market through external channels to generate additional value.

Also it is possible to create a model for innovation evolution using the Schumpeter's wave model and taking in consideration also the three waves of global evolution under Alvin Toffler (1995) with the new challenge (Figure 1.) .

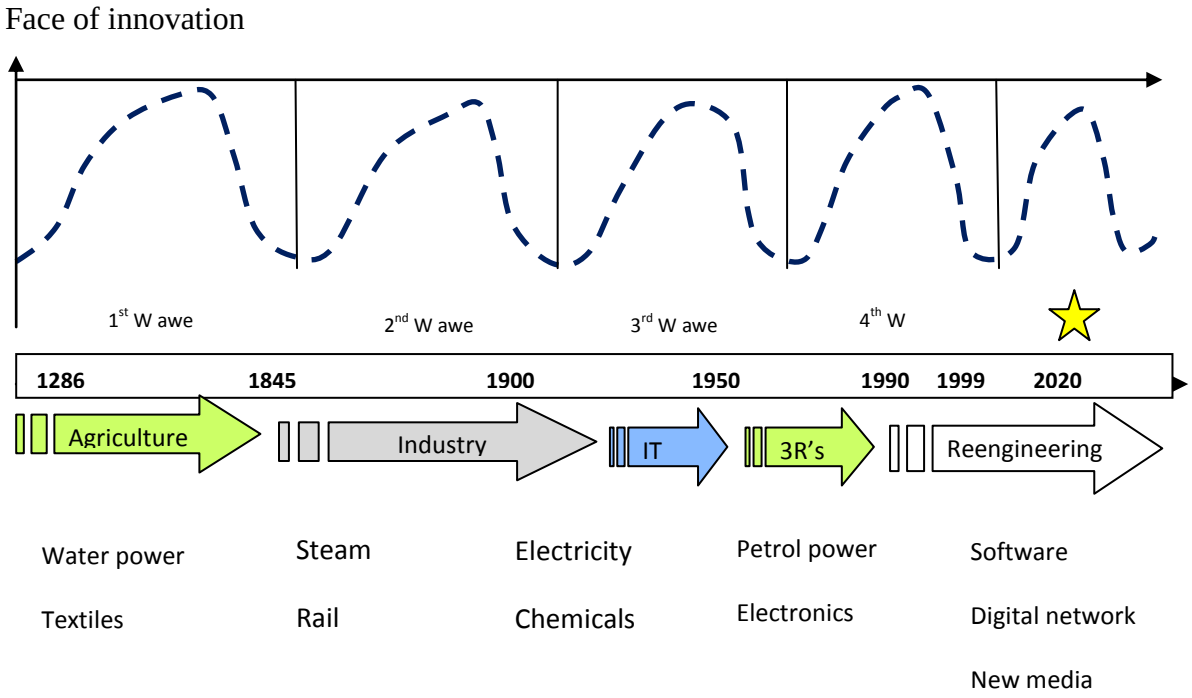


Figure 1: Schumpeter's wave.

Source Adapted by author from ''The Economist, 1999''

Now when the new 21st Century knock on economy door, new innovations are the provocation, a new concept as social innovation- reengineering, 3R's, rebranding of products, new design, green product, new technologies and architectural innovation- cooperation between the actors from global market- creates new professions, business model innovation.

Researching a new vision for open innovation we can be agree with Clement (2014) which consider innovation a power engine for economical development.

The innovation speed along time evolution, was increasing from a difference of 40 years between 1950 -1990 to a new born wave between 1990-1999 after 9 years. Time as a variable together with the evolution and diversification of economical activity contribute to a new model for innovation cycle evolution.

The economy management was adapted and implemented new changes and develop new fields in function of market and customers' needs.

Each wave present the new face of innovation with impact on the entire life cycle of products and manufacturing activity.

The fifth wave on face of innovation bring a new orientation in production management, the new trend for organization is the reengineering, a management change which will be able to close the quality circle with the 3R's, an never ending cycle (Daraba, 2014).

Along the innovation road we can observed that we are on a new wave of reengineering and of the digital and software influence in economical market a new provocation for production management, as a conclusion innovation make the difference (Donofrio,2008).

Creating and understanding the management knowledge even for small enterprises facing wicked problems, innovation push and encourage the firms for performances (Goh, 2005).

2. Case study. A Model for Open Innovation in Production Management

A healthy economy it isn't in equilibrium, but she is constantly being disrupted by technological innovation. Knowledge creation, new measures for new economy. In their research work Leadheater (1999) and Jorna (2006) identify the necessity of new measure for the new economy and sustain the importance of innovation for sustainable innovation.

Taking in consideration the economical environment it is possible to create a model for open innovation and the important role of actors (customers and producers) position involved in market equation. The equation which can illustrate the specific elements involved to show new results from internal and external resources C is

$$\mathbf{A+E=C} \quad (1)$$

Where: **C** - represents the goal, customer need, leading to growth for the organization,
A - represents the firm's current asset base as well as assets the firm can create internally within a commercially feasible time frame,
E- represented by C in the original equation) represents externally available resources.

A strategic plan for technological process focus on A, will limit the value of C by forcing the outcome to be determined by the firm's in-place resources.In this scenario, the organization cannot pursue a more valuable C because it is constrained by internal skill sets, technologies, and physical assets. The variable E unlocks the equation, freeing the organization from the constraints of its own existing capabilities. Explicitly including external skill sets, technologies, and other assets as inputs in the planning process enables a far more valuable C. The planning process should include identification of external assets that complement the firm's internal asset portfolio.

Encourage planners to include B as a core part of strategic planning as a way to think their way to a more valuable C.If we are looking to organization like a n open economic system we can identify the two variables input and out put variables that's mean the connection between the target to achieve customer satisfaction and the final result the product. All of the inputs impact the manufacturing process. The inputs of the process create an output, "Y". The goal is to have "Y" linked to the needs and expectations of the customer (see figure 2).

Figure 2. The Voice of customer Process

The causes are the X_n, these inputs create a process output which the project strives to improve toward a target and reduce variation.

These improvements must be directly linked to the critical needs of the customer.

The quality equation has often been defined as:

$$\textbf{Quality = Outcomes/Costs} \quad \textbf{(2)}$$

but that leaves out an extremely important factor, some are saying: service.

Under the outcomes and costs which are major factors, a new definition of quality is being discussed:

$$\textbf{Quality = Outcomes x Services / Costs} \quad \textbf{(3)}$$

Service, of course, representing the customers experience in this equation, a provider can better control the result of its "quality."

The chart present the elementary needs and more levels involved in figure 3.

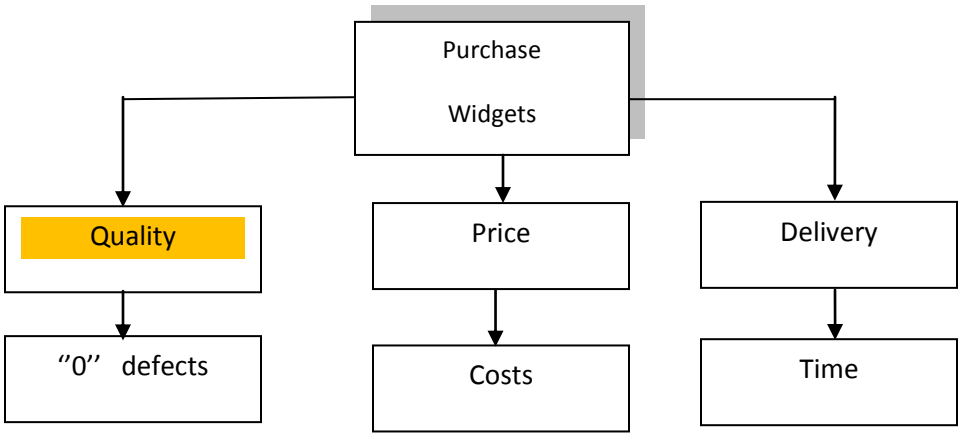
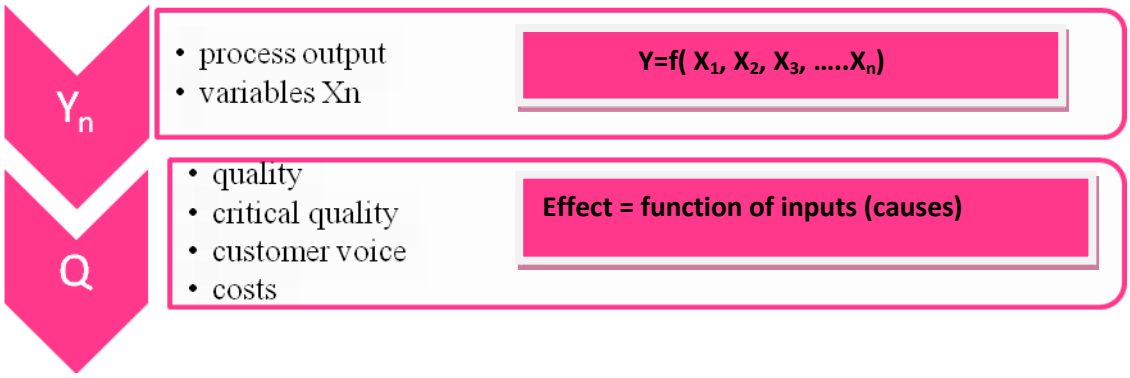


Figure 3. Levels involved in customer needs

Customers that unfortunately don't get their desired outcome will still be evaluated for the quality of care they received. The customer in our case it is also the organization including here the needs to a critical quality from customer perception.

The customer needs means spending resources and money to achieve customer needs and specification. Customer needs are in the areas of : cost, delivery quality, service, and more.

The Process is described by the output variables and input variables, Y_n is a function of all the inputs.



Effect should be a positive gap closure to satisfy the needs of the customer. A function of inputs taking in consideration the causes.

The effect should be a positive feedback to satisfying the needs of the customer. Also if me make a translation of quality with the accounting vision, we can observed the balance between the costs/ effect and the results/ outcomes

$$\textbf{EFFORT} = f(e_1, e_2, \ldots, e_n) = \textbf{EFFECT} \qquad (4)$$

Redefining C, as an objective enabled by the combination of A and E, fosters productive wants behavior. Nelson (1986) take in consideration some variables e_i and suggest the importance of technical advance in industry, later Porter (2000), complete the never ending quality circle with the necessity of local clusters in a global economy, the importance of competition and local development.

The most common rationales offered for this upsurge in collaboration, involve some combination of other variables as risk sharing, obtaining access to new markets and technologies, speeding products to market, and pooling complementary skills. For that reason, Khuntia and Agarwal (2009), present the importance of information technology and the necessity of information in harmonization with the customers' expectations. It is important to take in consideration also another aspect including here the organization like a system with inputs and outputs elements on production management process. Questions that encourage external thinking in the planning

process include: the internal resources A, customers resources C and external resources E, the manager ability to create and realized combination of elements (see Table 1).

Table 1. Question to encourage the external thinking in innovation

INPUT current	**A**	**What** internal resources does the firm have to meet these needs?
RESOURCES	**C**	**What** are the unmet customer needs that lead to a more valuable C?
		What additional resources does the firm need?
customer goals		**How** might the firm acquire the additional resources?
OUTPUT	**E**	Can be developed a partnership with an external source?
		Does the firm have the skills to create and manage collaborative relationships with external sources?
external		**What** external sources can be adequate quantity and quality of the needed resources?

Following the Pressman (2002) model, it is possible to establish the known and unknown impact on economy using transfer of information and involve different partners from market.

Alliances fail when managers forget that every strategic alliance is really when alliances are in one: $O_{1,2}$ organization A and B. O_3 is the combination between the organization A and organization B (see figure 4).

$$0_3 = 0_1 + 0_2 \quad (5)$$

The internal alliances within each firm will shape the external partnership, for better or worse (see figure 4) in function of the each organization and how they will transfer technology and the innovation

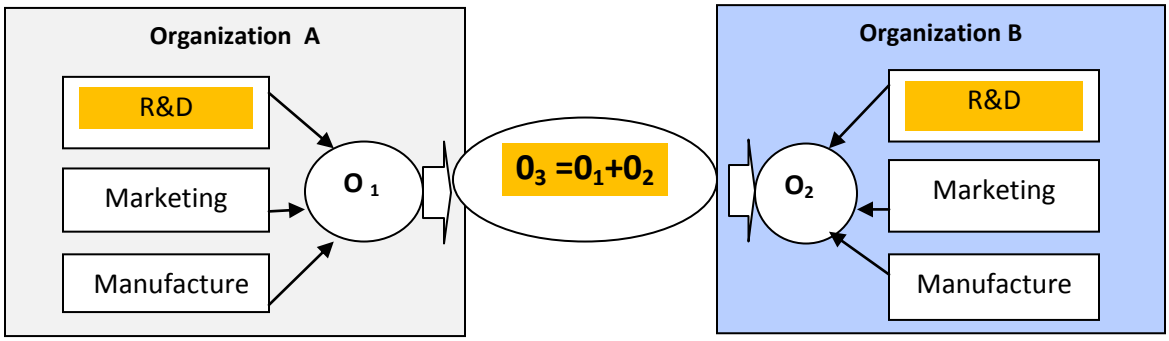


Figure.4. Strategic alliance between organizations for future innovation

3.Results

Using the model for open innovation it is possible to identify and analyze a cross matrix for production management from different organization using the transfer of innovation and programs in manufacturing and production management.

The method applied to different stages from the technical characteristics of the manufacturing process permit to create a data base of information's, methods and tools used in strategic alliance between organizations.

Applying QFD (Quality Function Development) method organizations can determine the characteristics of raw materials and some elements which can be improved from technological point of view and bring fresh air of innovation in each stage of production management process taking in consideration the customer and organization demands (see figure 5).

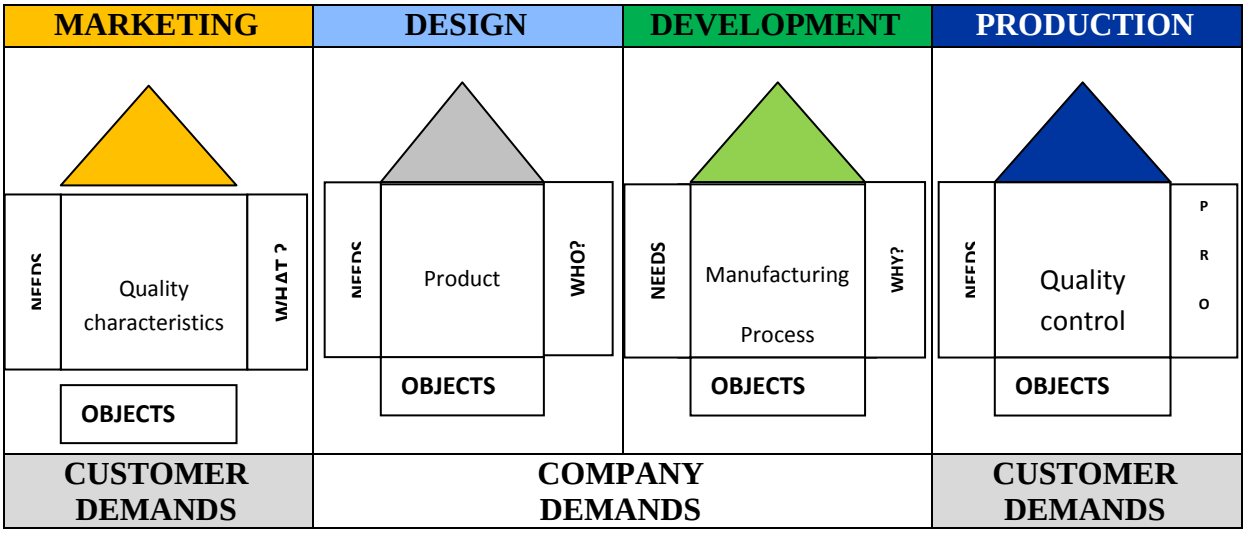


Figure. 5. Quality Function Development in an organization

One problem is the manager knowledge's regarding the relative costs of quality. The problem is more complex because effects it has to be quality.

The quality management means that analyzing activity of quality management from economical point of view, economic issues such as the cost of quality and quality effects must to be in a quality balance (effort =effect).

Today, quality management has become a modern management for enterprises which implemented and developed a quality management system under the standards, a system like a house of quality, a matrix which permit to discover and adapt the best solution for organizations.

4.Conclusion

If we examine the cross matrix for innovation validity, the model it's a multidimensional model of organization commitment (Figure 6.).

Building upon the people component as described above the culture of successful regional clusters supports "serial entrepreneurs and innovators", retaining their talents and supporting the transfer of their skills to and development in to in others (Pressman, 2002), (Porter, 2000):

1. Cutting production time;
2. Customer's voice into production process reduce the unnecessary costs;
3. Innovative design changes that are gaining acceptance in market.

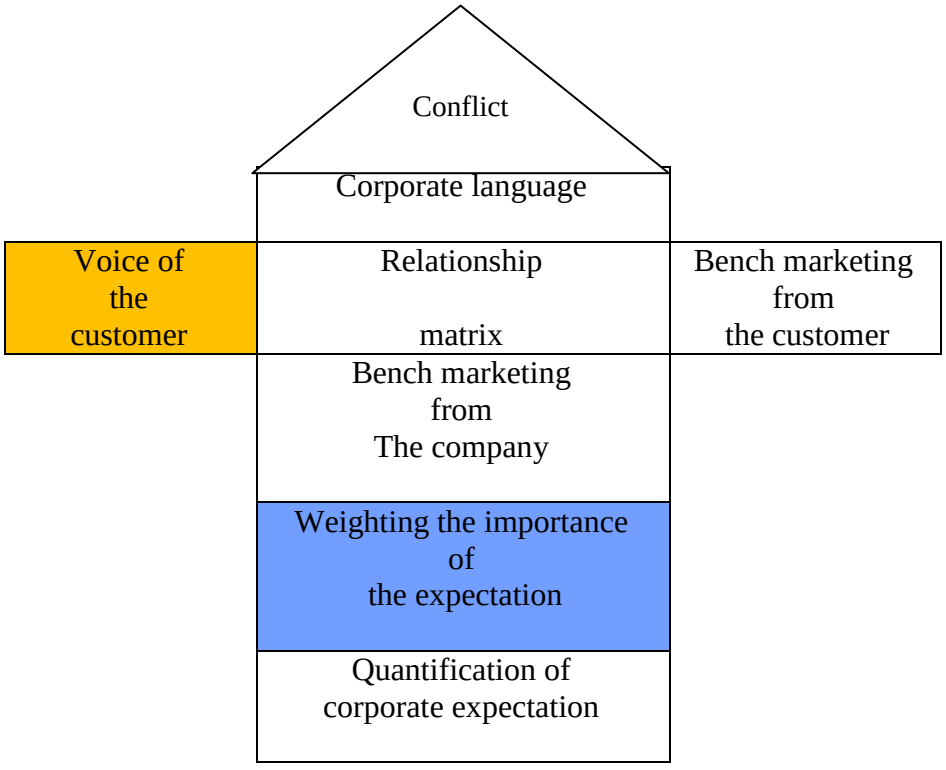


Figure. 6. A model of open innovation place

As a conclusion for organization, should be better to invest and encourage innovation because innovation it is the economy engine.

A differentiated regional innovation policy (Tornatzky, 2000), the strategies between organizations, the regional clusters, a open innovation with new measures in a new economy will be the

foundation for production in a healthy economy which will bring the harmonization with the customer needs in a global market.

The transition from closed to open innovation paradigms is a prime example of the need for cultural management change within organizations and amongst individuals, in order to harness the opportunities of collaborative, open and multidisciplinary working.

Activities between organizations from different countries, aim to support development of such a cross management culture within and between academic and industrial sectors (Varga, 2000), (Tornatzky, 2000).

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THE ROLE OF STRUCTURAL HEALTH MONITORING FOR THE DESIGN OF THE LIFE CYCLE OF CONSTRUCTIONS

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Abstract: *Structural health monitoring(SHM) is a non-destructive in-situ structural sensing and evaluation method that uses a variety of sensors attached to, or embedded in, a structure to monitor the structural response, analyze the structural characteristics for the purpose of estimating the severity of damage/deterioration and evaluating the consequences thereof on the structure in terms of response, capacity, and service-life. Various sensors and other technologies and devices obtain data that will be centralized, transmitted, processed and interpreted to continuously determine the health of the construction. SHM includes such tools, methodologies and techniques traditionally called Non-Destructive Testing (NDT) and Non-Destructive Evaluation (NDE). However, there are differences between the three concepts, on the one hand NDT, NDE and SHM on the other hand, so: NDT/NDE normally refers to a one-time assessment of the condition of materials at a single point and the effect or extent of the deterioration in the structure using equipment external to the structure. SHM normally refers to activities focused on assessing the condition of the structure or its key components based on response to various types of loads. It generally involves on-going or repeated assessment of this response.*

Keywords: *Structural Health Monitoring, Non-Destructive Testing, Non-Destructive Evaluation, sensors,*

1. INTRODUCTION

Structural Monitoring (SM) is an indirect way of detecting the level of damage that has been done to a structure via natural or human induced disturbances. Structural Monitoring (Radulescu

A.T.G., 2011) was done using wired systems that collected and monitored data from these structures. This was an expensive and inflexible approach because the system could not be easily redeployed if better data collection points were discovered on the structure. Wireless Sensor Networks became a good way to solve this problem, and thereby meet a major requirement for a viable SM system. Autonomous motes could now be deployed over a field of interest while data was collected at a base station (Ajiboye ,O, 2010) . The decision to use WSNs came with a significant tradeoff; bandwidth had to be sacrificed for flexibility and price.. Realtime data monitoring involves continuous data capture with a very small time margin between data sample blocks (Anumba,C., 2010). The marginal time is represented as a percentage of total execution time, and the acceptable threshold will be set by the system designer. This idea forms the basis for this thesis work where a single hop network will be observed and characterized for continuous data sampling and onchip computation.

The most safe and durable structures are usually structures that are well managed. Measurement and monitoring often have essential roles in management activities. Many structures are in much better conditions than expected. In these cases, monitoring allows to increase the safety margins without any intervention on the structure. Taking advantage of better material properties, over-design and synergetic effects, it is possible to extend the lifetime or load-bearing capacity of structures. A small investment at the beginning of a project can lead to considerable savings by eliminating or reducing overdesigned structural elements.

Malfunctioning of civil structures often has serious consequences. Concrete is the most used material in civil engineering.

The schedule and pace of monitoring depends on how fast the monitored parameter changes in time. For some applications, periodical monitoring gives satisfactory results, but information not registered between two inspections is lost forever. Only continuous monitoring during the whole lifespan of the structure can register its history, help to understand its real behavior and fully exploit monitoring. The investment in the maintenance of the structure, using periodical inspections as a mean of control, can exceed the cost of a new structure.

2. AN OVERVIEW OF STRUCTURAL MONITORING AND THE CONSTRUCTIONS LIFE-CYCLE

Security of the civil engineering works requires regular monitoring of the structures. The current methods are often difficult applications, the resulting complexity, dependency from the condition of the atmosphere, and also the costs, limiting the applicability of these measurements. Special attention is therefore focussed on maintaining them in a serviceable condition. The problem is quite complicate as it is function of their age, variety of structural types, different processes of deterioration and increasing volume and composition of traffic. From this viewpoint, surveillance and monitoring have already become a widely used standard. The aim of these activities is first of all to detect the deterioration process already in its initiation phase and to investigate and identify the causes of deterioration. Secondly, by monitoring the progress of deterioration on the different parts of the structure it is possible to give an input for actions aiming at keeping the safety and functionality of the structure within acceptable limits by performing adequate repair actions. Instrumental monitoring is gaining more and more attention as a convenient tool to follow, on a long-term scale, the global performance or the local variations of relevant properties of structures. Mostly developed in the last 10-15 years, this type of approach even not common practice, has been and is used on both new and existing structures to keep under control structures of strategic importance or very deteriorated structures whose critical conditions may require continuous attention(Radulescu, 2014).

For the quality of the construction, a very important function is hold by the geodetic measuring and tracing technologies. These must satisfy the necessary precision on construction's execution phases starting with the design-imposed precisions, then tracing, practically the lead of the phase construction process, carrying forward with the time behavior study both on execution process and during the exploitation.

In this context, the monitoring techniques and instruments, which nowadays are considered to be classical, have been partially replaced by new observation methods and sensors and more recently by fully operational monitoring and early-warning systems [Anderson et al. 1998, Van Gosliga et al. 2006]. n fact, the need for structural monitoring has been attracted the interest and

various ideas exposed by a great number of researchers – for instance, see [Gikas et al. 2008, Gikas 2010, 2012]. Also, at an early stage [1990-2010] a distinction between low and highly dynamic phenomena was made. The introduction of GPS for deformation monitoring in the nineties [Celebi 2000], the use of accelerometers [VCE 2009-2015], Fiber Optic Sensors [Culshaw et al. 1984, Glišiæ et al. 2002, Inaudi 1998, Smartec 2011], terrestrial laser scanners [Gikas 2012] and other systems have now changed the landscape in geodetic structural monitoring.

h. STRUCTURAL HEALTH MONITORING CLASSIFICATION

SHM classification can be done on four levels (Sikorsky, 1999; Bisby, 2006; Dong, 2010):

Level I: At this level, SHM system is capable of detecting damage in a structure, but cannot provide any information on the nature, location, or severity of the damage. It cannot assess the safety of the structure. In fact is: Detect presence of damage

Level II: Slightly more sophisticated than Level I. Level II systems can detect the presence of damage and can also provide information on its location. In fact is: Detect presence and location of damage

Level III: A Level III SHM system can detect and pinpoint damage, and quantify the damage to indicate the extent of its severity. In fact is: Detect presence, location and severity of damage

Level IV: This is the most sophisticated SHM systems. At this level, the system is capable of providing detailed information on the presence, location, and severity of damage. It is able to use this information to evaluate the safety of the structural system. In fact is: Detect presence, location, severity and consequences of damage

The classification of SHM methods can be made from the point of view of nature and the complexity of the instruments used adapted to the objectives in view, but also depending on the nature and level of information provided (Sikorsky, 1999; Bisby, 2006; Dong, 2010). In the first case, Bisby classified SHM into four classes: static field testing, dynamic field testing, periodic monitoring and continuous monitoring (Figure 1).

With activities that generally are in dynamic continuous regime, the current SHM components can be classified into the following categories:

1. Data acquisition systems
    a. Internal, sensors or other devices mounted on the structure
    b. External, topographic total stations, laser scanners, video systems
2. Systems of local data collection and storage in specialized devices (Data Acquisition Board)
    c. Cable
    d. Wireless
6. Data transmission and communication systems
7. Intelligent data processing systems
8. Data storage, classification and interpretation systems
9. Press releases, statistics upon request.

Then, the construction designer must take the following two steps:

10. Comparing data received with forecasts of the execution project, and
11. Decision making - the functioning of the construction is stopped, or it continues, there are dangers, hazards during operation, etc.

These latter activities are generally completed with automatic warning systems for when behavioral deviations that exceed the provisions of the execution project are detected. Based on typical flow of components we can build a relationship diagram of the eight components, like so: (Figure 2) The advantages of monitoring the health of constructions (SHM) can be summarized as follows:

1. Observing the law, as all states require this activity through mandatory laws and regulations;
2. A better understanding of structural behavior in situ;
3. Early detection of degradation of the monitored building;
4. Ensuring that the structure can withstand loads, even in the most unfavorable combination thereof;
5. Reducing the so-called "down time", i.e. the time in which the functionality of the structure is disturbed by remedial or modernization activities;
6. Adopting improved strategies of maintenance and general management for the operation of

the monitored structure for better resource allocation.

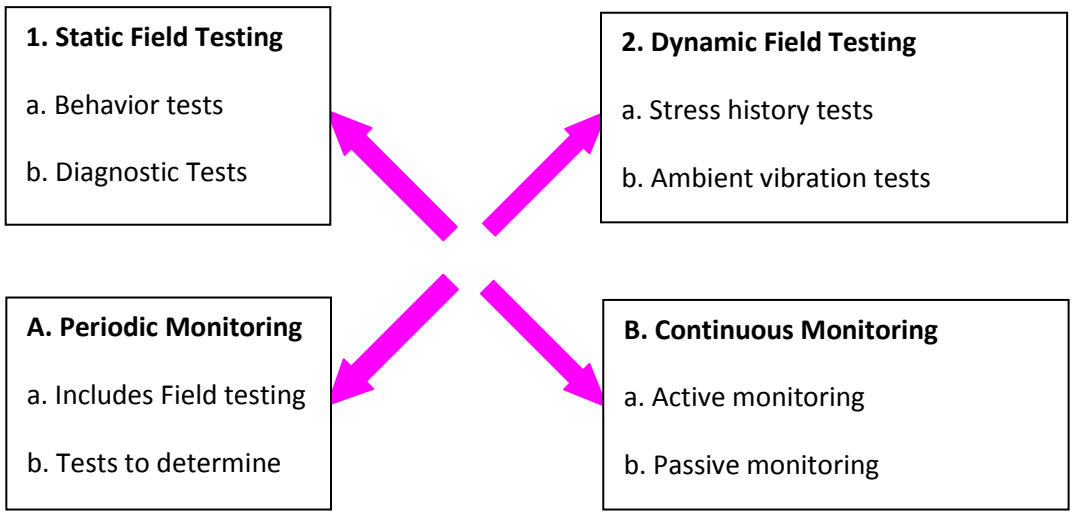

Figure 1. Categories and sub-categories of SHM systems

Source: Bisby 2006

An ideal SHM system should be able to provide information on request about the status of a structure and warnings on any significant damage detected. Some clarifications on the selection of appropriate technology is needed.

1. Data acquisition systems

a. Internal, sensors or other devices mounted on the structure

The first step in identifying the SHM strategy after establishing a structure to be monitored is the knowledge of parameters that the designer of the structure requires, the monitoring system, the monitoring points, basically the specifications for the future activity, which must contain all of this data.

Choosing the sensors depends on a variety of considerations, where costs are crucial but the most important thing is of course their ability to meet the requirements of the specifications mentioned. Specialized literature provides sufficient information in this regard. Two papers (Dong, 2010) provide data about 100 manufacturers of monitoring techniques, with all the necessary details, cost, performance, etc..

b. External, topographic total stations, laser scanners, video systems

Using external monitoring instruments is generally limited to certain timeframes, but there are situations when robotic total stations can be installed in special protective boxes, providing data acquisition with a frequency of a few minutes for each point indicated by 360 degrees prisms (see the monitoring of the Beska bridge in Serbia).

2. Systems of local data collection and storage in specialized devices (Data Acquisition Board)

a. Cable

b. Wireless

From sensors to Data Acquisition Board data transmission has traditionally been made via cable, but the emergence of wireless systems has facilitated this process. However, there are still problems with the loss of information on route, but perhaps in time this deficiency will be remedied and the system will be comparable in terms of quality of data with the original.

3. Data transmission and communication systems, We use both phone lines and the internet, by setting up specialized sites with password protected multi-access.

4. Intelligent data processing systems,

Data from monitoring systems become very large (quantitative) in a short time and data combinations become virtually endless, so there must be a clear logic behind choosing and processing data (Ni,2010). In setup the data sampling rate, a general rule is that the amount of data should not be so scanty as to jeopardize its usefulness, nor should it be so voluminous as to overwhelm interpretation (Mufti 2001). Decisions regarding appropriate sampling rates should thus be based on experience. For example, the data collected during continuous monitoring activities may be substantially compressed by recording only changes in readings or only data exceeding a specified threshold value. Another option is to only keep peak values of readings for each event, such as a heavy truck passing over a bridge(Dong 2010).

5. Data storage, classification and interpretation systems, We use conventional data storage systems, high-capacity external hard drives or CDs.

6. Press releases, statistics upon request,

Two ways of communicating data coming from the monitoring activity can be used, either online or through a specialized site (study the communication version of the Austrian company VCE), or other means via internet.

7. **Decision making - the functioning of the construction is stopped, or it continues, there are dangers, hazards during operation, etc,**

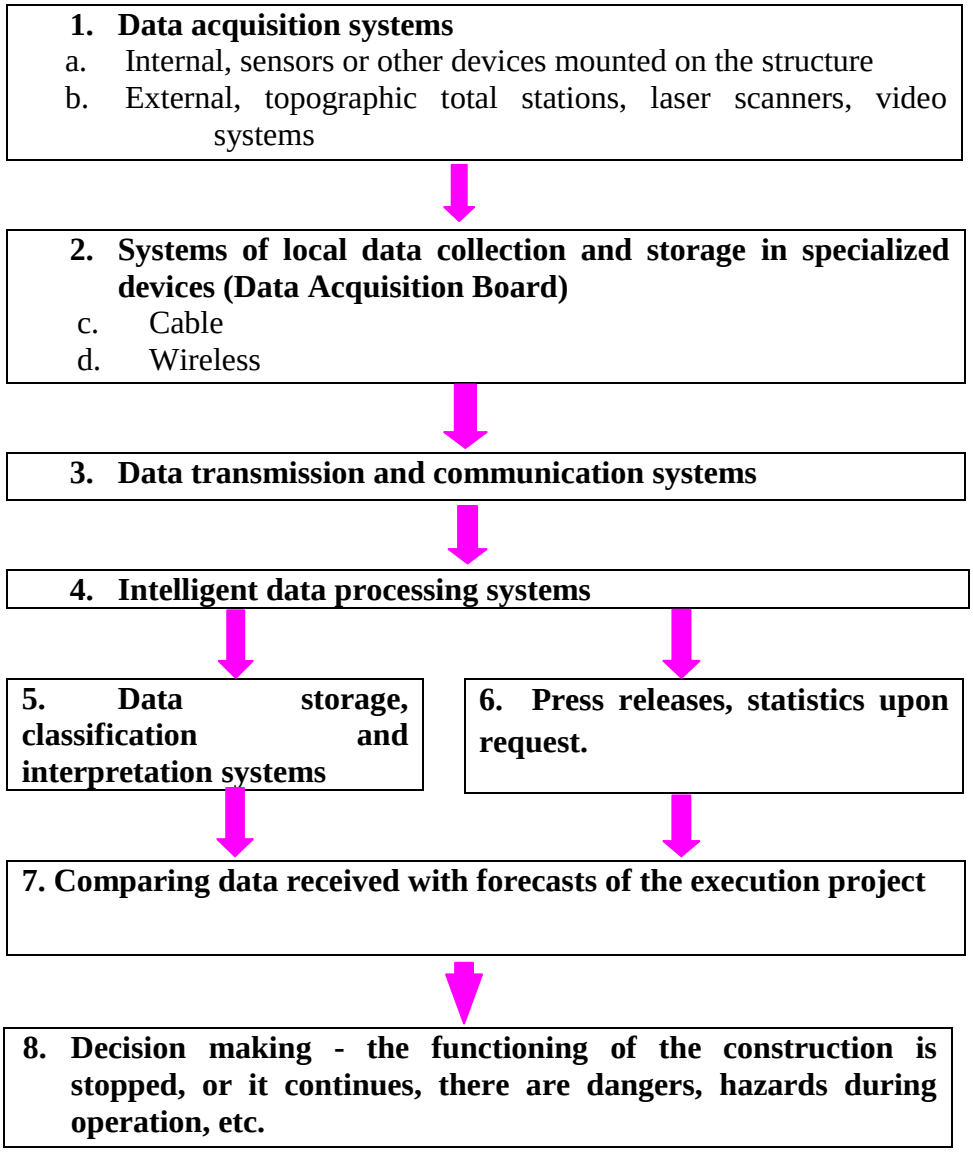

Figure 2. Components of a typical SHM system (Source: Author)

These are the most important activities in SHM, but also the most difficult. These steps require deep knowledge of the predicted behavior of the monitored structures and are usually covered by experts in building structures, typically the architects of the tracked constructions. I will not deal with the development of this topic as it goes beyond the concerns of both the author and the paper.

Structural Monitoring, more precisely Structural Health Monitoring (SHM), provides for the registration of structural and environmental parameters, and other factors that stress it. The main parameters of the structure that must be tracked are presented in Table 1.

Table 1. The most usually monitored parameters in SHM of civil engineering (Source: Authors)

Nr.	***Category of parameter***	***Material parameter***	***Structural parameter***
0	**1**	**2**	**3**
a	**Physical**	1.Porosity, 2.Temperature, 3. Humidity	1.Temperature, 2.Humidity
b	**Mechanical**	1.Elastic module, 2.Thermal expansion coefficient, 3.Poisson ratio, 4.Strength (compressive, tensional or shear), 5.Cracking	1.Stress, 2.Strain, 3.Deformation, 4.Displacement, 5.Load, 6.Mechanical degradation
c	**Chemical**	1.Chemical composition, 2.Chemical Degradation (chloride concentration and carbonatation penetration in concrete, oxidation of steel, oxidation of rebars, decaying of timber)	1.Chemical degradation

The main parameters of the natural environment that should be tracked are presented in Table 2.

Table 2.The main parameters of the natural environment that should be tracked

No.	*Atmospheric parameters*	*Characteristics of atmospheric parameters that are monitored, data acquisition points*
0	**1**	**2**
a	**Temperature**	1.Atmosphere, 2. Soil, 3.Distribution of patchy sunshine on the surface of the structure
b	**Wind**	1.Soil, 2. Distribution on the structure
c	**Atmospheric pressure**	1.Soil,
d	**Humidity**	1.Soil,

Source: Authors

Table 3. .The main parameters of the artificial environment that should be tracked

No.	*Monitored structure*	*Characteristics of monitored parameters, data acquisition points*
0	**1**	**2**
a	**Bridges**	1.Traffic, 2.Traffic accidents, 3.Structure accidents, 4.Water level, 5.Structure degradation
b	**Tall constructions**	
	b.1. Residential	1.Effect of oscillations on people living inside, 2. Structure degradation
	b.2. TV towers, Relays	1.Effect of incline and oscillations on transmission, 2. Structure degradation
	b.3. Utility, others	1.Operation/non-operation, 2.Accidents during operation, 3. Structure degradation
	b.4. Smoke chimneys	
c	**Nuclear facilities**	
d	**Current civil buildings**	
e	**Current industrial buildings**	
f	**Special constructions, other**	
g	**Dams**	1. Traffic , 2.Water lever up-stream and down-stream, 3. Structure degradation

Source: Authors

Generally, SHM activity during execution differs from that in the service period, but some of the sensors can stay, thus cutting the cost of the overall process.

4. THE ADVANTAGES OF STRUCTURAL HEALTH MONITORING

SHM must be designed so that with minimal cost we can obtain information that on the one hand can satisfy the needs for information used to protect the integrity of the structure, and on the other hand provide sufficient data about the in situ behavior of a structure so that the architect can validate the solution chosen. Some of the benefits/advantages of a properly designed SHM are (Merit, 2006):

- Real time monitoring with alarms increase the safety for the end-uses,
- Down time reduction,
- To verify, control, assess, understand the actual behaviour of the structure,
- Calibration of FEM and calculations,
- Decreased maintenance costs.

Some disadvantages of the monitoring are mentioned as follows:

- Costly,
- Might disturb and delay the construction work.

Operational evaluation of SHM will try to adapt the best monitoring techniques to detect those defects that may affect the structure.

i) What are the life-safety and/or economic justification for performing the SHM?

ii) How is damage defined for the system being investigated and, for multiple damage possibilities, which cases are of the most concern?

iii) What are the conditions, both operational and environmental, under which the system to be monitored functions?

iv) What are the limitations on acquiring data in the operational environment?

5. CONCLUSIONS

The theoretical studies, but also practical reality, reveal that the application of topo-geodesical methods in tracking the phenomenon regarding the SHM areas is made using a mixture of terrain measurement fields, and also using their connection to other engineering sciences.

- The constructions are made out of multiple parts and elements which are under pressure and interact with one another when exposed to extreme conditions.
- The buildings vary greatly in size, geometry, structural system, construction materials and foundation characteristics. These attributes influence the way in which a building behaves when it is under pressure, either by normal exploitation circumstances or by natural events.
- The systems for monitoring structural health allow the fast evaluation of a building's state and such a deviation must be made known as an adequate means of increasing safety and of optimizing operational and maintenance activities for complex buildings.
- Tha data resulted from the monitoring system are used in order to improve the functionality, maintenance, repair and structural replacement based on reliable and objective data. Detecting damages which are currently occurring can be used for the performance deviations in the design activity.
- The monitoring data can be integrated into the structural administration systems and can increase the quality of the decisions by providing reliable and impartial information.

The static, quasi-static and dynamic monitoring activity of constructions and terrains, in any category or made in any location conditions, is a specifically topographic activity and must be kept like this, and the paper represents only a modest argument.

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MAXIMIZING THE EFFICIENCY OF YOUR MARKETING COSTS

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Abstract: *Costs represent the expenses made for the production and sale of a particular good or service. In marketing, the analysis of the costs is made especially from the point of view of their sensitivity as regards changing the number of units produced and sold. But, in this paper, we have considered that the most important costs, along with the production costs, are the distribution and promotion costs, and that the decision made in accordance with the company's desire to carry out a profit is made through prior examination of the foreseen situations, on the basis of the estimate marketing budget. The case study presented in this paper approaches the problematic of decision making at the level of the marketing department of a company, where this would have as potential priority objectives maximizing the profit, increasing the market share or improving the company's image, in the sense of creating an image of superior quality products.*

Key words: Efficiency, marketing costs, optimal decision, budget, profit.

JEL: C80, L11, M31

1.INTRODUCTION

In this paper we want to study and explore the concept of marketing cost efficiency, mainly of the distribution and promotion costs. These aspects have a particular importance for the efficiency of a company's activities.

Through carrying out and assignation of the budgets towards the promotion activities, the company pursues to obtain a higher price from the buyers, especially for the exported goods.

At the same time, the distribution costs sometimes make the decision making more difficult as regards the relation between price and the sold quantities.

The case study presented in the present paper approaches the problematic of decision making at the level of the marketing department of a company, if the company would have as potential priority objectives maximizing the profit, increasing the market share or improving the company's image, in the sense of creating an image of superior quality products.

2. THEORETICAL ASPECTS

According to the marketing concept, in the company's activity, where efficiency principles are applied, the assignation of the budget for the activities must be used as a verification key.

The indicators used are those of the type sales versus budget assigned to it, additional sales made versus budget, actual consumers.

Obviously that, in the end, the total budget is accumulated, in order to verify if the estimated incomes and the other costs of the company will produce the expected profit.

Within the foreseen marketing budget of a company, the relevant elements are the distribution and promotion costs, which will be thus established in order to lead to the achievement of a high level of product sale.

Through carrying out and assignation of the budgets towards the promotion activities, the company pursues to obtain a higher price from the buyers, especially for the exported goods.

The optimal level assigned to the promotion activities will be established through the increase of the costs in this respect until the point where the modification rate of the sales value or of the income becomes equal to the variation rate of the promotion costs.

At the same time, the distribution costs sometimes make the decision making more difficult as regards the relation between price and the sold quantities.

If the buyers are located at various distances and thus appear various distribution costs, the company can approach different solutions, respectively may establish the same price for all buyers supporting the distribution costs, may pass this charge on to the buyers or may apply an intermediary position between these variants.

3. CASE STUDY:

Within this case study we have approached the problematic of decision making at the level of the marketing department of a company, if the company would have as potential priority objectives maximizing the profit, increasing the market share or improving the company's image, in the sense of creating an image of superior quality products.

The situations proposed on the marketing mix are the following:

- *as regards the product policy:*

Situation 1**:** keeping the present range of products, without additional variable production costs;

Situation 2**:** extending the product range, which would imply additional variable production costs of 30 lei/product.

- *as regards the price policy:*

Situation 1: establishing the price at 400 lei/product;

Situation 2: establishing the price of 500 lei/product.

- *as regards the distribution policy:*

Situation 1: choosing a short distribution channel, which implies distribution costs of 50 lei/product;

Situation 2: choosing a long distribution channel, which implies distribution costs of 60 lei/product.

- *as regards the promotion policy:*

Situation 1: using a reduced promotional budget of 1 000 lei;

Situation 2: using a high promotional budget of 8 000 lei.

The present variable production costs are of 100 lei/product, and the fixed production costs (FC) are of 46 000 lei.

Taking into consideration the demand's elasticity as regards the price, the influence of the promotional policy and the distribution links on the basis of a complex model, the quantities estimated to be sold in each situation of the marketing mix were calculated (presented in the last column of Table 1).

For each situation of the mix, we have calculated the turnover (T), the total costs (TC) and the profit (P) using the following formulas:

$T = UP \times Q$

$TC = FC + PB + (VC+DC) \times Q$

P = T-TC

Table 1. Marketing mix cost breakdown

Mix	Variable costs VC-lei/piece.-	Unit price UP -lei/ piece.-	Distribution costs DC-lei/ piece.-	Promotional budget PB -lei-	Estimated sales Q -piece-
1.	100	400	50	1 000	350
2.	100	400	50	8 000	800
3.	100	400	60	1 000	400
4.	100	400	60	8 000	880
5.	100	500	50	1 000	230
6.	100	500	50	8 000	480
7.	100	500	60	1 000	270
8.	100	500	60	8 000	520
9.	130	400	50	1 000	360
10.	130	400	50	8 000	820
11.	130	400	60	1 000	415
12.	130	400	60	8 000	905
13.	130	500	50	1 000	235
14.	130	500	50	8 000	500
15.	130	500	60	1 000	280
16.	130	500	60	8 000	540

Table 2. Financial results in each situation

Mix	Turnover –lei-	Total costs -lei-	Profit –lei-
1.	140 000	99 500	40 500
2.	320 000	174 000	146 000
3.	160 000	111 000	49 000
4.	352 000	194 800	157 200
5.	115 000	81 500	33 500
6.	240 000	126 000	114 000
7.	135 000	90 200	44 800
8.	260 000	137 200	122 800
9.	144 000	111 800	32 200
10.	328 000	201 600	126 400
11.	166 000	125 850	40 150
12.	362 000	225 950	136 050
13.	117 500	89 300	28 200
14.	250 000	144 000	106 000
15.	140 000	100 200	39 800
16.	270 000	156 600	113 400

4. CONCLUSION

The mix situation that assures the maximization of the profit is situation 4 (the profit is of 157 200 lei).

Independently of the evolution of the transactions from the reference market, the mix situation that must be chosen in order to increase the market share is the one where the company's

turnover and the quantities produced and marketed are maximum, in our case situation number 12 assures a turnover of 362 000 lei and a sale volume of 905 pieces.

In order to improve the image of a product produced by the company, we must take into consideration its marketing at a high price, which also implies a high quality, respectively 500 lei/product, and also the assignation of a high promotional budget to put it into the spotlight, meaning the 8 000 lei budget.

The length of the distribution channel is less important because within the distribution policy, is important the image the final resellers have before the product consumers, respectively the stores through which the product is marketed.

Considering all these aspects, is better to choose a long distribution channel, meaning the situation with the distribution costs of 60 lei/product.

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NURSE SCHEDULING PROBLEM

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***Abstract**: In this paper, what i have been discussed, is analyzing penalties and cost shifts based on several elements for nurse scheduling problem (NSP). NSP's issue is to assign nurses to different tasks based on constraints. The problem is known to be NP-hard, in other words it does not have a solution or needs years to be solved. In this work we try to solve the problem by satisfying the constraints set, and we also include the nurse's preference and try to balance the difficulty level of all the involved nurses. We also analyze the complexity of the problem as a function of parameters such as number of nurses, number of shifts, optimality of the function. According to the importance in practice, many scientists have developed NSP problems in a satisfactory time limit.*

***Keywords**: NSP(Nurse Scheduling Problem), IP(Integer Programming), LIP (Linear Integer Programming), NIP(Non Linear Integer Programming), SIP(Scheduling in Integer Programming), MIP (Mixed Integer Programming), MILP(Mixed Integer Linear Programming), G-IP (Goal Programming), Constraint Programming (CP), CPLEX, Limbo ext = Integer Programming applications and Software, NP-hard(Nurse Scheduling in Integer Programming)*
***JEL:** C80, L11, M31*

1.1 **Introduction**

Scheduling is always defined in the following way: Scheduling concerns in allocation of limiteted resources to tasks over time. It is a decision making process with the goal of optimizing one or more objectives e.g: competition time or resource utilization. Most of works focuses in scheduling the time domain. The importance of good scheduling is strongly motivated by the present development of technology [1]. In most literature materials about scheduling problem are focused in two kinds of scheduling problems. One type is allocating resources to a program in order to optimize a given performance measure and the other type is scheduling the machine or other processors to produce a minimal time or cost. If there are tasks which can be performed by several devices, scheduling is needed in other case is not important (different devices performed exclusive

tasks). A scheduling problem may not be hard to formulate but solving it is entirely an other matter. Most scheduling problems are NP-hard. My problem, nurse scheduling is a NP-hard problem (Non-deterministic http://en.wikipedia.org/wiki/NP_(complexity)Polynomial-Time hard). NP-hard means that the result of the optimal time that we find can be verified in polynomial time. Combinatorial problems constitute an important set of problems in computer science and applied mathematics. Scheduling conserns the allocation of limited resources to tasks over time. A scheduling problem is defined by description of the processors, by description of the task and the measure of performance. Nurse Scheduling Problem is a typically Constraints Satisfaction Problem (CSP) since it consists in assigning a value from a finite domain to each variable of a finite set. In Constraints Programming the constraints are the same as Integer Linear Programming. The nurses attendance in work is to a certain degree more important than the presence of doctors as they have to be alert all the time. The doctors are needed for an intervention, but then nurses are needed all the time as long as the patients are in the hospital, they are like baby-sitters: they have to be there. At first i will propose my problem, then i will explain the constraints and the code. I will run several experiments with the code in order to see the performance and i will discuss the results.

1.2 **Introduction to Integer Programming**

Scheduling Problems is part of Integer Programming (IP). Integer programming models are used in a wide variety of applications, including scheduling, resource assignment, planning, supply chain design, auction design, and many others. The foundation of much of analytical decision making is linear programming. In a linear program, there are *variables, constraints,* and an *objective function.* The variables, or decisions, take on numerical values. Constraints are used to limit the values to a feasible region. These constraints must be linear in the decision variables. An integer program begins with a linear program, and adds the requirement that some or all of the variables take on integer values[3]. In our problem that we will work on, we will fill up a certain number of shifts and a certain number of nurses to cover for these shifts. A shift will be defined not only as a certain shift that means 8 hours. A shift is defined also as a task that is completely different from the rest. If during the day, there is a need for a anesthesiologist and a normal nurse, these two will be considered as two different shifts. Anesthesiology nurses work together with the anesthesiologists

during the surgery and during the recovery time. They can work together scheduled, ambulatory or emergency cases. In hospitals that include a emergency service, some nurses work around 12 hours per day. Nurses can be assigned to either day or night shifts, and each day to one activity.

This table is 6 shift table according to my special case.

Table1 : The Nurse Shifts

Day Shifts (D)	8.00-16.00
Emergency Day Shifts (ED)	8.00-20.00
Emergency Night Shifts (EN)	20.00-8.00
Supervision (S)	09-17.00
Auxiliary Shift	11.00-19.00

First the head nurse gathers nurses‘ preferences concerning the day they would like to be off and from this, tries to schedule that satisfaction of nurses. If during one week a nurse has done extra work then he/she can recover the over-time worked during the following week or later. The primary values and requirements of our problem

Activities	**Requirements**	**Problem**
Work or shifts.	Number of people required in hospital each period of the day or week.	Staff scheduling Resolved by Branch and Bound Algorithm and Mixed Integer Linear Programming

The requirements that we will have, will constitute our constraints which are listed below.

C1: Coverage constraints require a number of nurses for each shift (DS, EDS, ENS, S) and each day.

C2: Working hours must not exceed 12 hours per day

C3: Working hours must be close to 38 hours per week, and must not exceed 48 hours per week

C4: A nurse cannot work more than three night shifts during a week.

C5: If a nurse works an EDS (respectively ENS) on Saturday, then he/she also works an EDS on Sunday and than next Monday and Tuesday is free.

C6:This allows minimal rest time between 2(two) shifts. If a nurse works an Night Day Shift the following day is free. If a nurse works an EDS the following day is free.

The constraints C1 to C4 are considered hard constraints. Constraints C5 and C6 are considered soft constraints. They express the preferences of the nurses and we must have an optimal and an acceptable planning for not violate them. If a hard constraint fails then the entire schedule is invalid. As for a soft constraint, it is desirable that these constraints are met but not meeting them doesn't make the schedule invalid. Hard constraints typically include a specification of shifts e.g a nurse must work 12 hours per day, a nurse must nor work more than 48 hours per week, all patients should have their nurse, and a nurse must work nor more than 3 nights during the week. Differences in qualifications between nurses also create hard constraints. Soft constraints may include minimum and maximum numbers of shifts assigned to a given nurse in a given week. In our case, if a nurse works on Saturday and Sunday, on Monday she will be free.

1.3 The NSP objective

The objective is to find a good planning that maximizes the nurses' satisfaction. The search have been stopped after a reasonable time for different reasons:(i)Solvers, especially the ILP (Integer Linear Programming) Solver have found a very good solution almost reaching the asymptotic value after a short time, (ii)Even after 12 works of search the best value found was the one given after one hour. A good schedule could be acceptable even if it has not exactly the minimal difference between minimum penalty **(P_{min})** and maximum penalty **(P_{max}).**

The aim of this problem is to maximize the the fairness of the schedule, while respecting all the constraints. There is a probability of getting the minimal difference between P_{max} and Pm_{in} in the first minutes of executing the application. In some cases, after days of running the code, the

objective value that is the difference between $\mathbf{P_{max}}$ and $\mathbf{P_{min}}$ was 0.12. There are different ways to assign penalty scores to different shifts. Surveys of nurses employed in a certain hospital by asking them about the most difficult or the least liked shifts can be a method. Another way can be to have a combined score of the nurse surveys, the head nurse opinion and the administrators opinion. These assignments of the shift penalties may be conducted periodically as sometimes the situation may change; the workload may be affected by different situations during the course of a year. We have assigned the penalty of each shift associated to each type and day. The penalties are integer values and included in the interval [1, 2]. The idea of putting the numbers in shifts is that a nurse that works in a supervision shift her penalty is 1.6, nurse that works on a day shift her penalty is 1. A nurse that works in a week 2 , supervision shifts has more difficulties that e nurse that works 3 day shifts.

The shifts that has penalty 0 that the nurse has works during the week. Simple calculation: **1.6+1.6>1+1+1**

Table 2: Penalties of the shifts

Type of Shift	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
DS	1	1	1	1	1	0	0
EDS	1.2	1.2	1.2	1.2	1.2	1.4	1.4
ENS	1.2	1.2	1.2	1.2	1.2	1.4	1.4
Supervision	1.4	1.4	1.4	1.4	1.4	1.6	1.6
Shift 5	1.6	1.6	1.6	1.6	1.6	0	0
Aux *	1.2	1.2	1.2	1.3	1.1	0	0

The sixth shift (Auxiliary is a test shift to see the Objective Value). The best schedule would be the one that minimizes total penalties to each employee. We need to find a schedule with lower penalty for each nurse and the lower difference in comparison to the other nurses. The problem will be modeled and solved by using ILP (Integer Linear Programming) [4].

1.9 The variables of the Problem and constraints

For each day each shift will be as written as: $\mathbf{X_{ijk}}$ where $\mathbf{1 \le i \le N}$, indexes the nurses

$\mathbf{1 \le j \le H}$, indexes the day with the scheduling horizon and$\mathbf{1 \le k \le S,}$ possible shifts.

We have integer linear problem and we have to values **0** and **1** and $\mathbf{X_{ijk}}$ can take

$\mathbf{X_{ijk}}$ **=1** *nurse i works on shift k on day j*

$\mathbf{X_{ijk}}$ **=0** *otherwise*

The objective of the scheduling is to reach a load distribution between the nurses. The fairness objective is to solve the penalties $\mathbf{P_{jk}}$ for each day (j) and shifts (k). The penalties are given in the table2.The function will be:

Minimize $\mathbf{Z = P_{max} - P_{min}}$ **(1)**

Pmax is the upper bound of the total penalty of each nurse. $\mathbf{P_{min}}$ is the lower bound.

These bounds are defined as follows :

$$\mathbf{Pmin} - \left(\sum_{j=1}^{H} \sum_{k=1}^{S} \mathbf{1/Ri * Xijk * Pjk}\right) \leq \mathbf{0 i = 1....,N}$$

$$\mathbf{Pmax} - \left(\sum_{j=1}^{H} \sum_{k=1}^{S} \mathbf{1/Ri * Xijk * Pjk}\right) \geq \mathbf{0 i = 1...., N} \quad \mathbf{(2)}$$

Ri design the work rate of each nurse

Ri=1 full time work

Ri<1 part time work

The constraints:

We will introduce 6 (six) possible shifts :

Table 3 : All shifts

Shifts	Names
DS Day	k=1
EDS Emergency Day Shifs Day A	k=2
EDS' Emergency Day Shifs Day B	k=3
ENS Emergency Night Shifs	k=4
S Supervision	k=5
A Auxiliary Shift	k=6

1.4. Explanation of the Constraints

We will explain the constraints :

- **C1 :**Coverage Constraints require a number of nurses for each shift and each day . This is expressed in one equation :$\mathbf{Rjk} = \sum_{i=1}^{N} \mathbf{Xijk}$ **i= 1....,N j= 1...,H (3)**
- **C2**: Day working hours will not be more than 12 hours .

$\sum_{i=1}^{N} \mathbf{Xijk} \leq \mathbf{1}$ **i= 1....,N j= 1...,H (4)**

- **C3:** The working hours must be close to 38 hours per week and must not exceed 48 hours .The number of hours during worked during shit k :

$\sum_{j=1}^{H} \sum_{k=1}^{S} \mathbf{Xijk} * \mathbf{Nk} \leq \boldsymbol{H/7} * \mathbf{48} * \boldsymbol{Ri}$ **i= 1....,N (5)**

- **C4**: A nurse can not work more than 3(three) night shifts during a week

We need to add a new index h that corresponds to the week :

$1 \leq h \leq H/7$

The equations for the constraint:

$\sum_{j=7h-6}^{7h} \mathbf{Xij} \leq \mathbf{3}$ **i= 1....,N h=1...., H/7 (6)**

- **C5 :**If a nurse works on Saturday , then she will be free Next Monday.

  These constraints implies several equations .the same shifs is assigned during both days of the weekend :

- **X**i,(7h-i),k – **X**i,7h,k =0

  i= 1....,N h=1...., H/7 k=3 and k=4

  After a weekend working on the 2(two following) days are off :

Xi,7h,k + $\sum_{k'=1}^{4} \mathbf{Xi, 7h + d, k'} \leq \mathbf{1}$ **(7)**

i= 1....,N ; h=1...., H/7-1 ; d=1 ; d=2; k=3; k=4

- **C6**

This allows minimal rest time between 2 (two) shifts:

If a nurse works an Night Day Shift the following day is free. If a nurse works on Emergency Day Shift , the following day must me an Emergency Night Shift or could be free. Each EDS and ENS must be followed by a rest:

$$\sum_{k'=1}^{4} \mathbf{Xi, 7h - 6 + j, k'} \leq \mathbf{1}$$

Xi,7h-7,j,k + **k=2; k=3; k=4**

i= 1....,N ; j=1; j=2; j=3; j=4; j=5 h=1...., H/7

Each EDS must be followed by an ENS : **X**i,7h-7+j,3 - **X**i,7h-7+j+1,4 = 0

1.5 Creating The Code

i= 1....,N ; j=1; j=2; j=3; j=4 ;h=1...., H/7

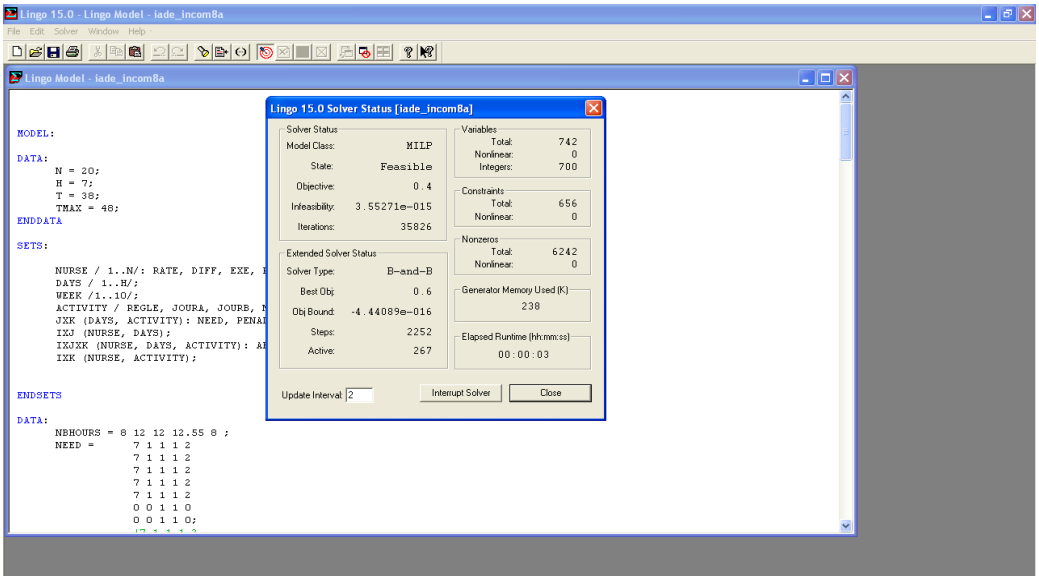

Figure 1 : MILP Mixed Integer Linear Program

My code is structured by sets in Lingo 15 Application Software that is part of Lindo Systems. Sets are the foundation of Lingo Modelating Language and simple groups of related objects. A set must be a list of products, employees ect. Each member in the sets must have one or more characteristics associated with it. We call these characteristics attributes. My sets are:

DATA:

N = 20;

H = 7;

T = 38;

TMAX = 48;

ENDDATA

SETS:

NURSE / 1..N/: RATE, DIFF, EXE, P;

DAYS / 1..H/;

WEEK /1..10/;

ACTIVITY / REGULAR, DAY-A, DAY-B, NIGHT, SSPI/: NBHOURS;

JXK (DAYS, ACTIVITY): NEED, PENALITY;

IXJ (NURSE, DAYS);

IXJXK (NURSE, DAYS, ACTIVITY): AFFECT;

IXK (NURSE, ACTIVITY);

ENDSETS

In the sets we have nurses days and weeks. In the activity path we have the shifts that are regular DAY-A (first day shift), DAY-B(second day shift) we need to shifts in the first preside that means double nurses more than night shifts), NIGHT(Night shift) and SSPI (Supervisor Shift). The number of Rows is the 20 as the number of nurses. The number of columns is the number of shifts (5Shifts per day). We have 7 groups of columns (7 days). In a row we must not have more that seven 1-s . For example the first nurse in the first day is not working. In the second day on Tuesday is working on the first shift, on Wednesday is not working too. We have 20 Nurses(N) but before running the code we can change the number of nurses in **N = 20;** The interval of adding/deleting must be [15;25]. The software will not run less than 15 nurses and more that 25 nurses in the period of 10 weeks. When we add a nurse in these rows we must add the binary numbers 1 and 0 in the code in the row of RATE and 0 in the row of EXE. The numbers after the exclamation mark are considered as comments.

RATE = 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 ; !.8 .8 .8 .8 .8 .8 .8 .8 .8 .8 .8 .7 .7 .5 .5 .5 .5 .3;

EXE = 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0; !0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0;

Ps : we must have 20 binary 1-s and 0-s. RATE and EXE rows. We have 7 Days (N) in a week and 5 shifts (k). When we see these attributes IXJ (i=nurse, j=day, k=shift). Affect must be 0 and 1 that means it works or not. A nurse must be an activity per day.Here are shown the shifts for 20 nurses:

Department of Mathematics and Computer Science
Faculty of Sciences
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Technical University of Cluj Napoca, Romania

TEST		Mon1	Tue1	Wed1	Thur1	Fri1	Sat1	Sun1	Mon2	Tue2	Wed2	Thur2	Fri 2	Sat2	Sun2
Nurse 1	TP	0	R	0	R	S	0	0	0	0	0	0	0	0	0
Nurse 2	TP	0	0	R	D	N	0	0	0	0	0	0	0	0	0
Nurse 3	TP	0	R	0	0	0	D	D	0	0	0	0	0	0	0
Nurse 4	TP	D	0	S	0	R	0	0	0	0	0	0	0	0	0
Nurse 5	TP	0	D	N	0	R	0	0	0	0	0	0	0	0	0
Nurse 6	TP	R	0	R	0	S	0	0	0	0	0	0	0	0	0
Nurse 7	TP	R	0	S	D	0	0	0	0	0	0	0	0	0	0
Nurse 8	TP	D	N	0	R	0	0	0	0	0	0	0	0	0	0
Nurse 9	0.8	S	R	D	0	0	0	0	0	0	0	0	0	0	0
Nurse 10	0.8	R	D	0	R	R	0	0	0	0	0	0	0	0	0
Nurse 11	0.8	0	R	R	R	R	0	0	0	0	0	0	0	0	0
Nurse 12	0.8	R	R	0	S	0	0	0	0	0	0	0	0	0	0
Nurse 13	0.8	R	0	R	R	D	0	0	0	0	0	0	0	0	0
Nurse 14	0.8	S	0	0	R	D	0	0	0	0	0	0	0	0	0
Nurse 15	0.8	R	R	R	R	0	0	0	0	0	0	0	0	0	0
Nurse 16	0.8	0	R	0	S	R	0	0	0	0	0	0	0	0	0
Nurse 17	0.8	0	S	R	0	R	0	0	0	0	0	0	0	0	0
Nurse 18	0.8	R	S	R	0	0	0	0	0	0	0	0	0	0	0
Nurse 19	0.8	0	0	0	0	R	N	N	0	0	0	0	0	0	0
Nurse 20	0.7	N	0	D	N	0	0	0	0	0	0	0	0	0	0
Nurse 21	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nurse 22	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nurse 23	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nurse 24	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nurse 25	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nurse 26	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FT	R	N	D	S

Regular= R N= Night D=Day S= Special Shifs FT= Full Time

We have other activities Affect (Nurse, Day, Shift). The values of the output are either 0 or 1, which means that a nurse does not work in a certain shift if the result is '0', and works if the result is '1' . Now we have the table for the Affect. Shifts for 20 Nurses

Table 4 : Shifts for 20 nurses

2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0
0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5 : The output represented by '0' and '1'

P is Penalty the value of Penalty. Diff is the difference between how many hours works per week and time minimum. *For example a nurse is working =8*3+1*12=36.*

*The number of variables is:7 days*5shifts/day*20nurse=700 (integer variables). From the definition of X_{ijk}, where X can have values of '0' and '1'.*

i=1:20 (20 nurses), j=1:7 (7 days of the week), k=1:5 (5 shifts),

In the code there is a variable called Diff that calculates the difference between the working hours and the minimum time a nurse can work. The minimum time a nurse can work is 38 hours. For example: a nurse that works three 'regular' shift (8 hour/shift) and one 'Day_B' shift (12 hour/shift) then the total working hours are 8*3+1*12=36. Since the minimum working hours are 38, the DIFF-value for this nurse is 38-36=2.We can generate different type of constraints. If we want to arrange the schedule so that the 7^{th} nurse never meets the 11^{th} nurse, we can set a constraints of the type as below:

$$\mathbf{X_{7jk}+X_{11jk}<2}$$

Based on our output of the code, and based on the hours that each nurse works we can always minimize the number of nurses in order to reduce the costs of the hospital. In one run of the cod with 5 shifts, 20 nurses that was executed for 1 minute we notice that some of the nurses work 14 hours less than the minimum working hours which is 38 hours/week.

$$\mathbf{Diff = T_{min}-T_{working}=38-36=2}$$

Table 6 Diff and Penalties (N=20, 5 shifts, 10 weeks)

14	***3.6***
5.45	***3.6***
6	***3.8***
10	***3.8***
5.45	***3.6***
14	***3.6***
10	***3.8***
5.45	***3.6***
10	***3.8***
2	***4.2***
6	***4***

14	***3.6***
2	***4.2***
10	***3.8***
6	***4***
14	***3.6***
14	***3.6***
14	***3.6***
4.9	***4.2***
0.9	***4***
0	***0***
0	***0***
0	***0***
0	***0***
0	***0***
0	***0***

Total Diff and Penalties :

8.79375	**3.675**
14	**4.2**
5.45	**3.6**

NSP Model Statistics:

Vars= 742 (all are linear)

Integer vars= 700 Binary vars= 700

Nonzeros= 6711 Const nonz= 6240(3400 are +- 1) Density= 0.014

Smallest and largest elements in abs value= 1.00000 48.0000

No. < : 440 No. =:195 No. > : 20 No. posd : 0, Obj= MIN, GUBs <

Single cols= 40

700 integer variables = 20 nurses * 7 days * 5 shifts. Binary Variables that means the value is zero or one. Non zeros variables means that we have no result equal to zero.

Smallest and largest elements in absolute value are 1 and 48.

We have also **NBHOURS = 8 12 12 12.55 8 8**. How many hours works a nurse in a shift.

Table 7 : NBHOURS

Shifts	Hours
Regular	8
Day A	12
Day B	12
Night	12.55
SSPI	8
Auxiliary Shift	8

An attribute that is in the code is NEED that mean how many hours a nurse must need to work. T_{max} is an other attribute that is calculated $\mathbf{T_{max}=Affect* NB_{hours}}$.

For a nurse the Diff is the multiplication of penalty and NB hours for a nurse

The excel file is updated it we change the number of nurses the tables will always change. If we have 18 nurses the table will have 2 rows less. In a hospital the different assigned tasks require the introduction of a new "shift" at the same time. So in this work an extra shift may define a completely different task at the same time at the same section of the hospital. An anasteolog may be needed, a nurse that is specialized in bones may be need etc. When we solve these problems, as the number of shifts increases the complexity of the problem is increased. A question until now, is that the weekly total penalty is 38. But in the outputs we get 76. And on average we get a penalty (difficulty score) of 3.8 (76/20=3.8). The total 'penalty' that is needed per week is 76. Because we have a need of 7 nurses for the 'regular' shift (7 nurses*5days*1),

$$7 \times 1 \times 5 + 1 \times 1.2 \times 5 + 1 \times 1.4 \times 5 + 1 \times 1.4 \times 2 + 1 \times 1.4 \times 5 + 1 \times 1.6 \times 2 + 2 \times 1.6 \times 5 = 76$$

We executed the code for 4 seconds at least 3 times and we did not see any difference in the assigned jobs, the penalty values and the difference between the hours worked and the t_min (t_min=38 hours per week.)

The only difference was in the 'solver steps' and the 'solver iterations'. We observe a penalty of 3.8+/-0.3. When we executed the code for a longer time (60 seconds) we observed a smaller penalty value (P_{max}-P_{min}=0.6). The penalty is 3.8+/-0.2. We have a smaller standard deviation of the penalty value distribution. We also noticed that there are 54 different job assignments, i.e. a different of 7.7% in the job distribution. 2 subsequent executions of 1 minute (58.37) showed no difference at all for the assigned tasks.

The Diff and penalties are exactly the same. We executed the code for 3 min and we noticed no change from the the 1 minute executed case. Everything was the same, the P_{max}-P_{min} (still 0.6), Diff, and the individual penalties. We can comment on the 'Diff' and the penalty for each nurse. For all the runs/execution of 4 sec and 60 seconds the values of Diff are the same (Diff_ave=8.4075). The difference is in the distribution of these less-working hours.

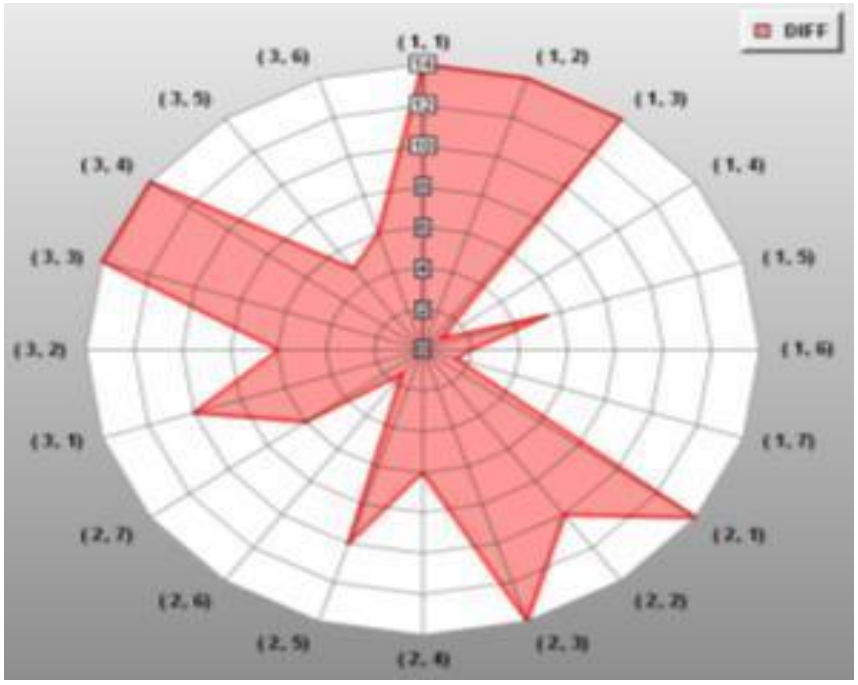

Figure 2. The Diff for 5-shifts, 20 nurses, executed for 60 seconds

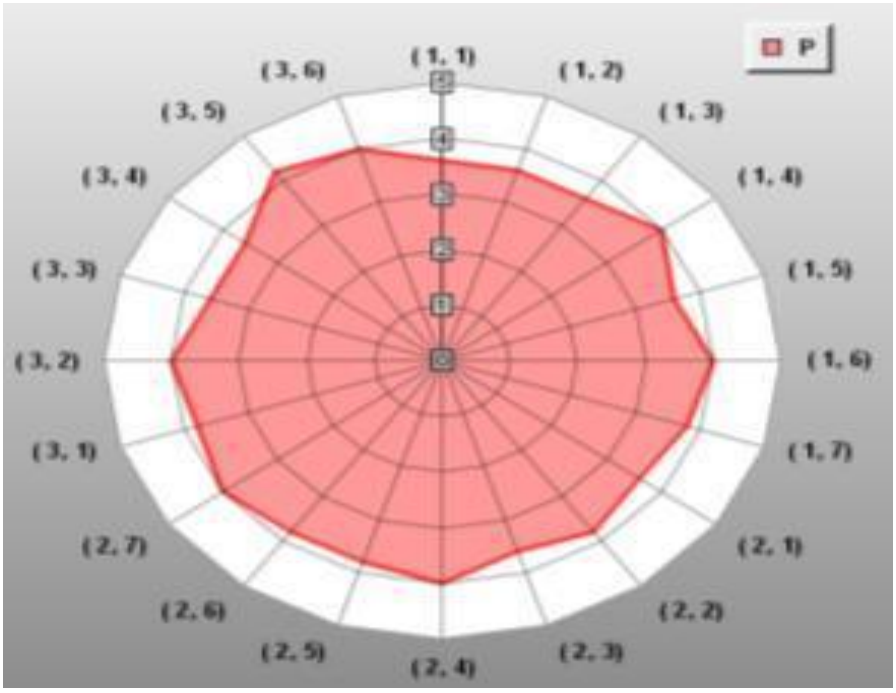

Figure3. The penalty for the 20 nurses.

The ideal case would be when we see a 'perfect' circle

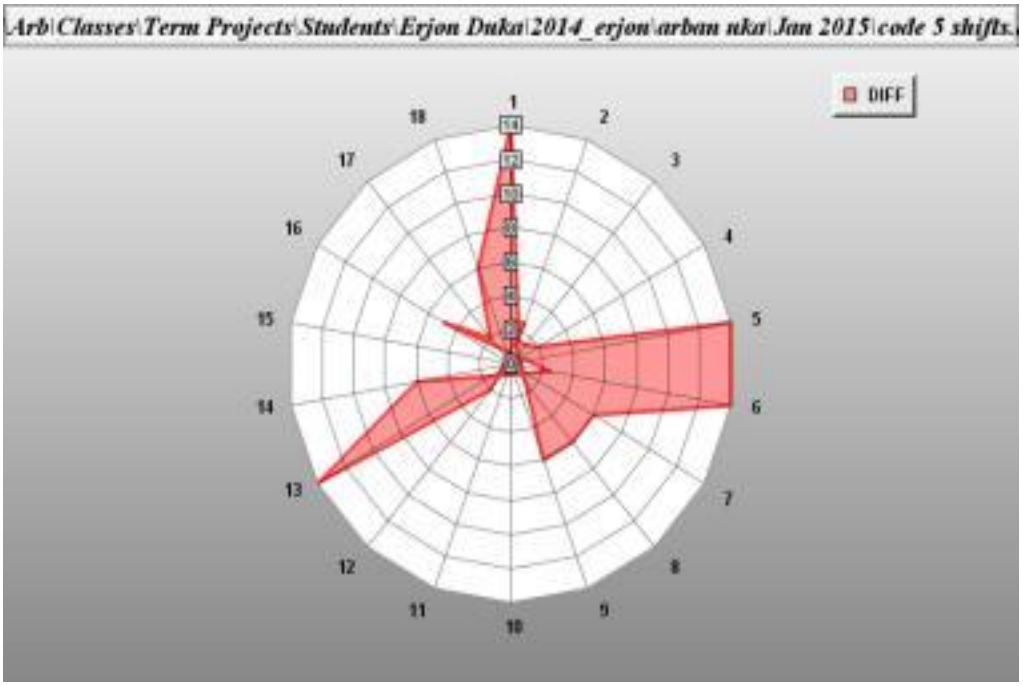

Figure4. 18 nurses, 5 shifts 57.85 seconds run

1.6 Review the Constraints

We can add different constraints for example Nurse 7 and Nurse 11 must nor work a day together

X7jk + X11jk >=1

In the code we have added other constraints. To create and implement the code in Lingo 15 Application we must remember the constraints :

C1: Coverage constraints require a number of nurses for each shift (DS, EDS, ENS, S) and each day.

C2: Working hours must not exceed 12 hours per day

C3: Working hours must be close to 38 hours per week, and must not exceed 48 hours per week

C4: A nurse cannot work more than three night shifts during a week.

C5: If a nurse works an EDS (respectively ENS) on Saturday, then he/she also works an EDS on Sunday and than next Monday and Tuesday is free.

C6: This allows minimal rest time between 2(two) shifts. If a nurse works an Night Day Shift the following day is free. If a nurse works an EDS the following day is free.

Here we see constraint C3:

Calculating the difference between the actual working time of the period and regular timework(**here** 38hper week)**;**

```
@FOR (NURSE( i): [différence]
        T* RATE ( i)* (H/7)
        - EXE ( i)
        - @SUM( JXK ( j, k):
                AFFECT ( i, j, k) * NBHOURS ( k))
        = DIFF ( i)
);
@FOR (NURSE( i): [diffrationnel]
        @FREE (DIFF ( i))
);
```

Time constraint for the maximum working period can be improved by placing the stress one each week;

```
@FOR (NURSE( i): [tempsmax]
        @SUM( JXK ( j, k):
                AFFECT ( i, j, k) * NBHOURS ( k))
        <= (H/7)* TMAX * RATE ( i)
);
```

A nurse cannot be assigned to more than three nights a week**;**

```
@FOR( NURSE( i) :
        @FOR( WEEK( h)| h #LE# WE : [troisnuits]
                @SUM (DAYS (j)| (j #LE# ((h-1)* 7+ 7)) #AND# (j #GE# (h-1)*7) :
                AFFECT ( i, j, 4))
        <= 3
));
```

An other interesting constraints is that If Saturday is worked(day and night emergency) then Sunday too;

```
@FOR (IXK (i, k) | (k #GE# 3) #AND# (k #LE# 4) :
    @FOR (WEEK (h)| h #LE# WE:
        @FOR (DAYS( j)|  (j #EQ# (h-1)*7+ 6)  :[weekend]
            AFFECT ( i, j, k)
            - AFFECT ( i, j+1, k)
            = 0
)));
```

It is called weekend constraints. If a nurse works on Saturday and Sunday on Monday is off. After a weekend worked on Monday is not working.

```
@FOR (NURSE (i)  :
    @FOR (WEEK (h)| h #LE# WE-1:
        @FOR (DAYS( j)|  (j #EQ# h*7) : [apresweekend_1jour]
            @SUM (ACTIVITY (k):
                AFFECT ( i, j+1, k))
            + AFFECT (i, j, 3)
            <= 1
)));
@FOR (NURSE (i)  :
    @FOR (WEEK (h)| h #LE# WE-1:
        @FOR (DAYS( j)|  (j #EQ# h*7) : [apresweekend_1nuit]
            @SUM (ACTIVITY (k):
                AFFECT ( i, j+1, k))
            + AFFECT (i, j, 4)
            <= 1
)));
```

! After a weekend worked on Tuesday is not working;;

```
@FOR (NURSE (i ) :
    @FOR (WEEK (h)| h #LE# WE-1:
```

```
            @FOR (DAYS( j)|  (j #EQ# h*7) : [apresweekend_2day]
                  @SUM (ACTIVITY (k):
                        AFFECT ( i, j+2, k))
                  + AFFECT (i, j, 3)
                  <= 1
));
@FOR (NURSE (i ) :
      @FOR (WEEK (h)| h #LE# WE-1:
            @FOR (DAYS( j)|  (j #EQ# h*7) : [apresweekend_2night]
                  @SUM (ACTIVITY (k):
                        AFFECT ( i, j+2, k))
                  + AFFECT (i, j, 4)
                  <= 1
));
```

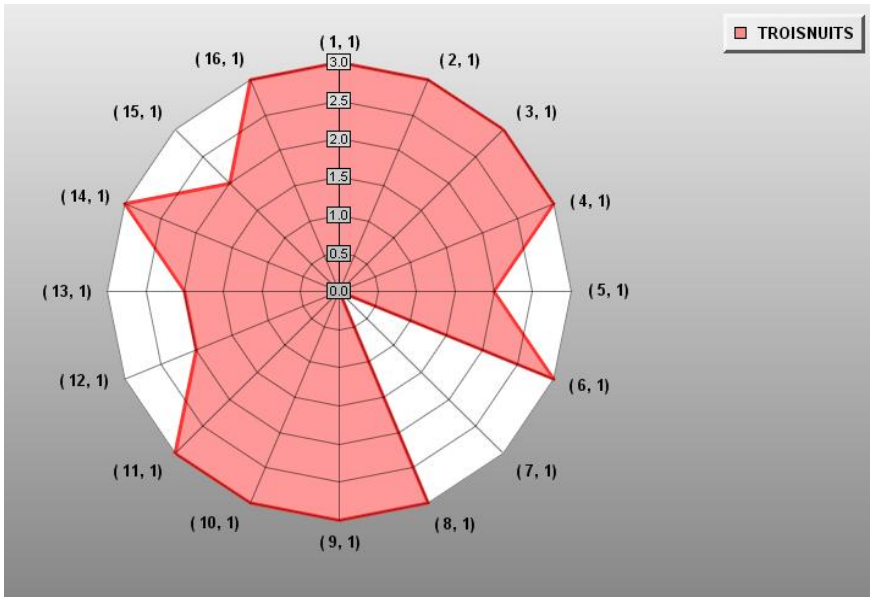

Figure 5 :Nurse 5 works 1st night and 2nd night but not the 3rd one

In the graph is shown that nurse 5 works first night and second night but nut the third night.

The first thing that we do in the code is after declaring the sets, attributes and constraints is minimize the gap between nurses with the highest rate of strain and the nurse having the low estates.

MIN= PMAX - PMIN;

!MIN = PMAX;

P_{max} and P_{min} are the penalties.

! Variables are binary assignment;

@FOR(IXJXK(i, j, k): [binary]

@BIN(AFFECT(i, j, k))

The*@FOR* function is used to generate constraints across members of a set.

A binary integer variable also called a 0/1 variable is a special case of an integer variable that is required to be either zero or one.

It's often used as a switch to model Yes/No decisions. In our case @BIN is associated to the Affect that we have told before is 0 and 1.

As we said before a nurse can be assigned to only one activity per day.

@FOR (nurse(i):

@FOR (days (j): [unicity]

@SUM(ACTIVITY (k): AFFECT (i, j, k))

<= 1.

1.7 Testing for 5,6 and 7 shifts

After we have done a lot of test of NSP we create a table for the results. When we see carefully the table we detect that when we run the code several times without changing any data we see that objective value (our case to solve) change from 0.1 to 0.6 .

When we change nothing but also we add time the objective value becomes minimum from 0.8 to 0.6 and sometimes if we are lucky we can see it 0.1. The maximum time for running the code is 3 days from Friday to Monday in my work PC'lab in Fastip, University of Durres. The objective value was 0.12.

Our propose is to make it 0.1 or the ideal value that is zero. In this table we have write in the columns : number of nurses, number of weeks, ESS (Extended Solver Steps), TSI (Total Solver Iterations) ERS(Elapsed Runtime Seconds that is time in the table) , Total Variables, Integer Variables, Total Constraints, Non-linear Constraints, Total Non zeros Non linear Non zeros .

The search have been stopped after a reasonable time for different reasons:

- Solvers , especially the ILP Solver have found a very good solution almost reaching the asymptotic value after a short time
- Even after 12 works of search the best value found was the one given after one hour
- A good schedule could be acceptable even if it has not exactly the minimal difference between P_{min} and P_{max}.

One interesting issue that I would like to underline in this thesis is that when i minimize (15 nurses) the number of nurses the Generator Memory Used of Lingo Program reduced itself by 1KB. The minimum number of starting the program is 15 Nurses.

I can't solve my application using 10 nurses. The minimum number of weeks would be 5 weeks. In other words program will nor run in 10 nurses and 3 weeks.

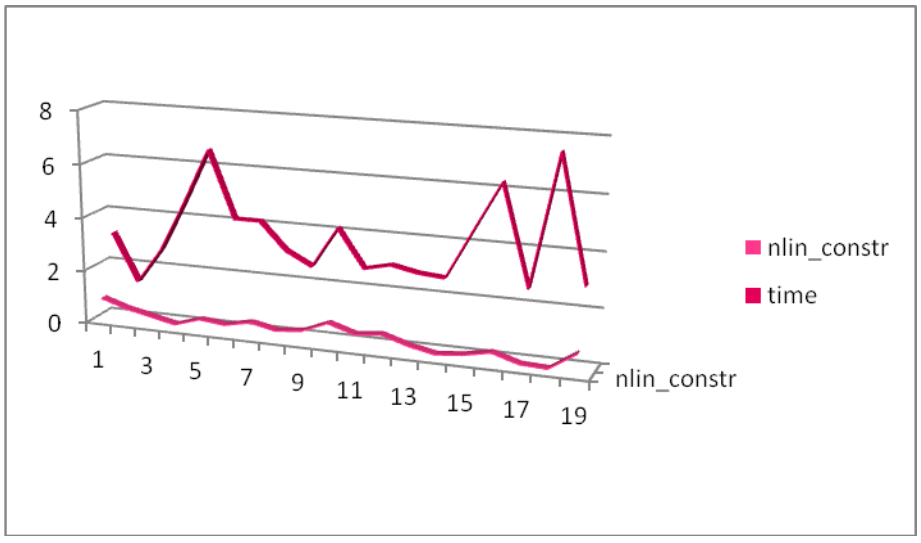

Figure 6 Non-Linear Constraints vs. Time

The Objective Value vs Time 20 Nurses 5 Shifts.

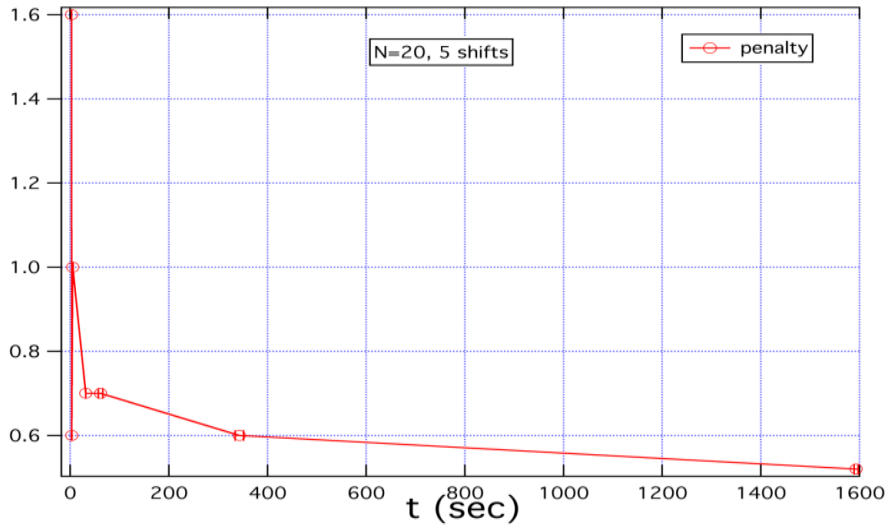

Figure 7 Penalty VS Time 20 Nurses 5 Shifts 10 weeks

In this graph we see that when the time executing is growing the objective value goes closed to Zero that is your scope.

The Problem is resolved. All summary' penalties of the shifts for each employer are equal.

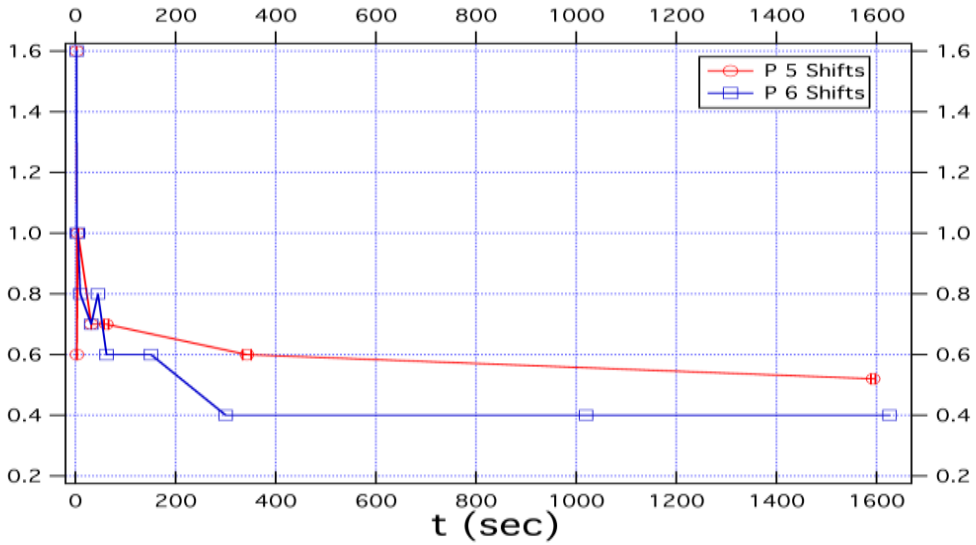

Figure 8. Objective value vs. Time: for 5 shifts and 6 shifts.

Interestingly, we notice a faster convergence (in computer time) for the case of 6 shifts. This seems counterintuitive, as with more shifts that have to be filled, there would be much more possibilities to check. We see that when we increase the number of shift the objective value is decreasing. It si fact that when we add a shift the software must do more iterations but the penalty is decreasing.

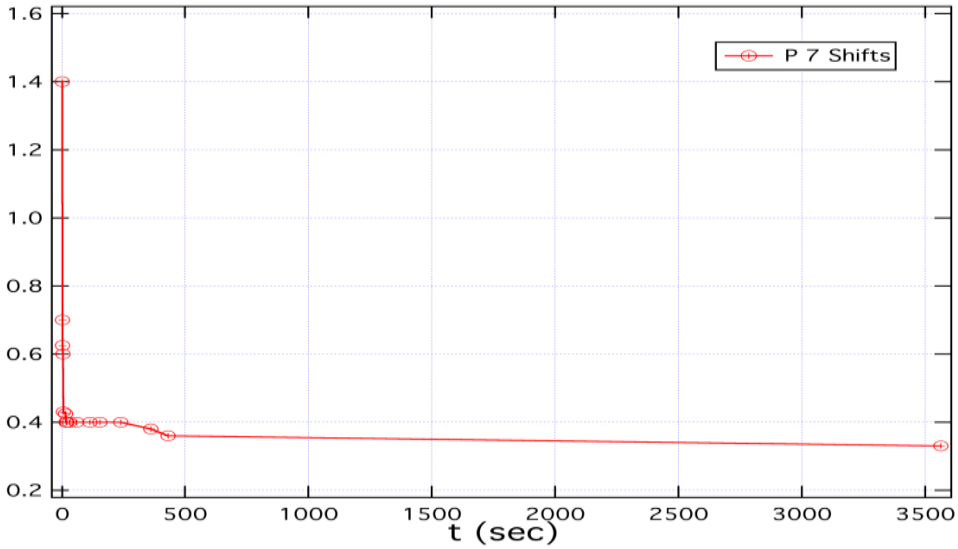

Figure 9. Objective value vs. time for 7 shifts.

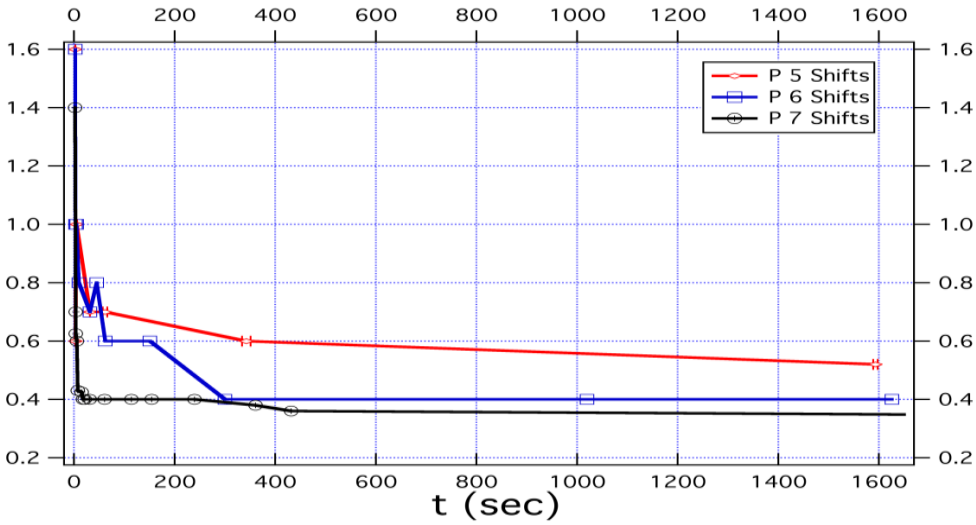

Figure 10. Objective value vs. time for 5, 6 and 7 shifts

In the last graph we notice that the case which has more combinations to check for an optimal solution, it takes less time. During the whole range of the values of time, the case with 7 shifts has always values that are lower than the cases for 5 and 6 shifts. At first look this seems very counterintuitive. One interpretation of these results may be that with more combinations to deal with, the easier it is to keep balance among all the nurses with respect of the penalty assigned to them. It is fact that when we add a shift the software must do more iterations but the penalty is decreasing. In the figure 11 we show the value of the optimal value of the penalty as a function of the total iterations for 6 and 7 shifts. Here we notice that when there are 7 shifts, for the same number of iterations, the objective value is smaller.

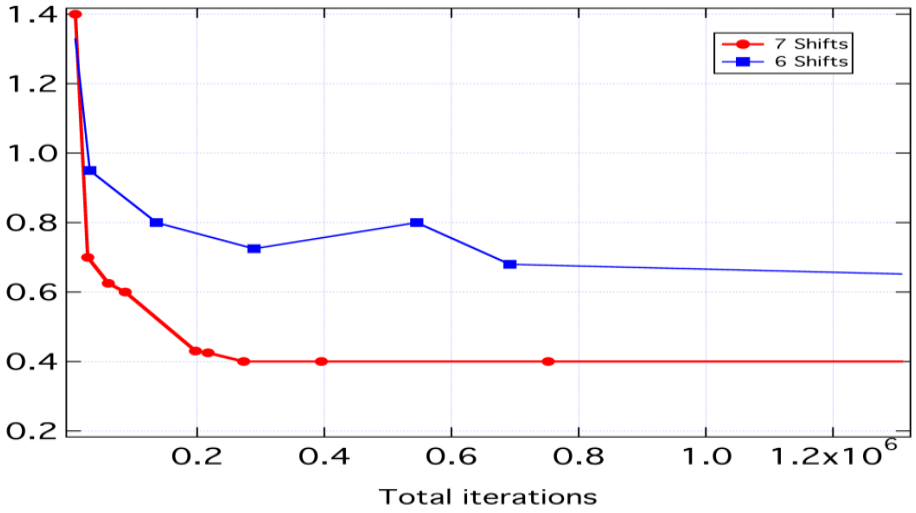

Figure11.The penalty as a function of the total iterations for 6 and 7 shift

Conclusion

This project aims to apply learning's of operations research and optimizing resources to practical cases. The aim of this problem is to maximize the fairness of the schedule, while respecting all the constraints. In regards with the results obtained after some tests ILP has found a very good solution to our problem. Better values of the penalties associated to the shifts could be defined in order to represent the reality more accurately especially by taking into account the length of the shifts.

The models can also be solved by means of optimization software. As shown in this paper, the current schedules can benefit from this work. My problem is NP-hard that it means unsolvable. My

objective is to do the objective values (diff =0.1). The ideal must be 0 but it is impossible. there is shown in the table in 5 shifts , 20 nurses 10 weeks. We see that when we increase the number of shift the objective value is decreasing. It's fact that when we add a shift the software must do more iterations but the penalty is decreasing. We see that with the same number of iterations the penalty is smaller when we add a shift.

Future Work

Nurses who received high penalty schedules in previous iterations of the schedule construction will be considered early in the current iteration, which reduces the chance of having trouble with generating their individual schedule later on in the process.

The approach is simple and efficient. It is also observed that the greedy local search carried out between the schedules constructions for each nurse greatly improved the roster constructed following a quality spiral to improve the medical activity [9].

This indicates that the approach can be easily adapted for hybridization with other techniques (i.e. exact methods and meta-heuristics).

It will be particularly interesting to perform a study using exact methods to obtain the best combinations for high quality schedules or rosters and modeling the management and managerial implication [10].

Operating on sequences, rather than on individual shifts by meta-heuristics, is also an interesting direction for future work.

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FACTORIAL ECONOMETRIC MODEL FOR THE ANALYSIS OF PRODUCTION CAPACITY

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Abstract: *In this paper we presented a model of production capacity that can be used in the practice of management: developing a production plan and investment plan, correct sizing of production units and the necessary equipment, adoption of optimal solutions concentration, specialization or combining production, comparing and assessing the results obtained in relation to similar companies, operating on this market.*

Key words:*model, econometric, production, optimal, capacity*

JEL: *C80, L11, M31*

1. Introduction

The methodology of determining CP = production capacity calculation involves the following steps (Barbulescu, 1995):

• Collection, processing and systematization of primary information for the calculation.

• CP calculation at the links below and then higher horsepower

• Develop balance, highlighting the key links, and places "narrow" and excess capacity; • Drafting of technical and organizational measures to eliminate narrow spaces and willingness to use links with excess capacity (Cotelnic, 1998).

To calculate the horsepower of an undertaking following advice:

1. CP is determined only basic productive units. Production units or ancillary service may influence on a case by case basis, the use of only the CP;

2. Determination of CP is made productive links, starting at a lower level calculations, work, continuing to calculate CP sectors, workshops, and afterwards polling company taken as a whole;

3. Establish higher horsepower each link is based on the component units of horsepower;

4. In determining the existence of CP is allowed normal human and material resources. Temporary absence of these resources can not influence the size of the CP, which has a constant value at a time, regardless of the extent of its use.

To calculate CP firm must start from CP calculation of the main groups of machines (Unguru, 1994):

CP calculation requires determination:

Td - time fund available;

Np -production technical standard

We estimate the regression model that the sum of squares of deviations from the actual values are minimum estimates. (Neagu, 1995)

We estimate the model parameter values based on M.C.M.M.P

$$\sum (y_i - \hat{y}_i)^2 = \min$$

Minimum requirement resulting from this feature:

$$\begin{cases} n \cdot a + \sum X \cdot a = \sum Y \\ \sum X \cdot a + \sum X^2 \cdot b = \sum X * Y \end{cases}$$

$$\hat{a} = \frac{\Delta a}{\Delta}; \qquad \hat{b} = \frac{\Delta b}{\Delta};$$

$$\hat{a} = \frac{\sum Y_i \cdot \sum X_i^2 - \sum X_i \cdot \sum X_i Y_i}{n \cdot \sum X_i^2 - (\sum X_i)^2}$$

$$\hat{b} = \frac{n \cdot \sum X_i Y_i - \sum X_i \cdot \sum Y_i}{n \cdot \sum X_i^2 - (\sum X_i)^2}$$

$$\begin{cases} 34a + 8409.77a = 10155.2 \rightarrow a = 1.20268 \\ 8409.77a + 9641077b = 12598939 \rightarrow b = 1.30574 \end{cases}$$

Using the above estimate equal system parameters as follows:

$$\hat{a} = \frac{10155.2 * 9641077 - 8409.77 * 12598939}{34 * 9641077 - (8409.77)^2} = -31.30291$$

$$\hat{b} = \frac{34 * 12598939 - 8409.77 * 10155.2}{34 \cdot 9641077 - 70724231.4529} = 1.33410$$

The estimated model is:

$$\hat{y}_i = -1{,}88669 + 0{,}066891 x_i$$

We checked the linearity assumption of the model, calculating linear correlation coefficient and correlation ratio. To calculate the coefficient of determination checking linearity assumption we calculated linear correlation coefficient ry / x and correlation ratio Ry / x:

$$\sigma_x = \sqrt{\frac{\sum \left(x_t - \bar{x} \right)^2}{n}} = \sqrt{\frac{7550852.331}{34}} = \sqrt{222073.89} = 471.25$$

$$\sigma_y = \sqrt{\frac{\sum \left(y_t - \bar{y} \right)}{n}} = \sqrt{\frac{33630.9}{34}} = \sqrt{989.14} = 31.45$$

$$r_{y/x} = \frac{\operatorname{cov}(y,x)}{\sigma_x \sigma_y} = \frac{\left(x_t - \bar{x}\right)\left(y_t - \bar{y}\right)}{n\sigma_x \sigma_y} = \frac{505759{,}61}{34 * 471.25 * 31.45} = \frac{505759{,}61}{512239.32} = 0.9873$$

$$R_{y/x} = \sqrt{1 - \frac{\sum_{t=1}^{34}\left(y_t - \hat{y}_t\right)^2}{\sum_{t=1}^{34}\left(y_t - \bar{y}\right)^2}} = \sqrt{1 - \frac{698{,}13}{33630{,}9}} = \sqrt{0.97535} = 0.9873$$

$$R^2 = (0.9876)^2 = 0.9754$$

b parameter estimates:

$$\hat{b} = \frac{\begin{vmatrix} n & \sum y_t \\ \sum x_t & \sum y_t x_t \end{vmatrix}}{\begin{vmatrix} n & \sum x_t \\ \sum x_t & \sum x_t^2 \end{vmatrix}} = \frac{n\sum x_t y_t - \sum x_t \sum y_t}{n\sum x_t^2 - \left(\sum x_t\right)^2} = \frac{4932792.304}{69903892.23} = 0.070565$$

a parameter estimates:

$$n * \hat{a} + \hat{b}\sum x_t = \sum y_t \Leftrightarrow \hat{a} = \frac{\sum y_t - \hat{b}\sum x_t}{n} \Leftrightarrow \hat{a} = \frac{257.24 - 0.070565 * 7401.08}{13} = -6{,}1980$$

$$S_{\hat{u}}^2 = \frac{\sum\left(y_t - \hat{y}_t\right)^2}{n-k-1} = \frac{259.2017}{11} = 16{,}0997 \Rightarrow S_u = \sqrt{S_u^2} = 4{,}0124$$

$$S_a = \sqrt{S_u^2 * \left[\frac{1}{n} + \frac{\left(\bar{x}\right)^2}{\sum\left(x_t - \bar{x}\right)^2}\right]} = \sqrt{16{,}0997 * \left[\frac{1}{13} + \frac{324118.26}{5377222.46}\right]} = \sqrt{2{,}20849} = 1{,}4861$$

The estimated model takes the form:

y=-6,195096+0,070564x

Conclusion

Equality between linear coefficient of correlation and correlation report confirms the hypothesis that the relationship between the two variables is linear and that the model is a strong correlation between them.

The model can be used in managerial practice in developing CP balance, which is calculated using the CP workload. With production capacity model can determine all changes in CP gave to determine the use of CP

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PROBLEM WITH THE CONSUMER'S OPTIMAL

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ABSTRACT|: *The paper presents optimum consumer issue, analyzed in two ways, when the consumer maximizes the usefulness and minimizes its costs that make them subject to the obtainment of a fixed utilities. The problem of optimal consumer is still very important in making the decision the consumer. Customer satisfaction was analyzed by a utility function.*

Keywords: *customer, optimum utility, costs, decision .*

JEL: *C80, L11, M31*

1. Introduction

The problem of optimal consumer is one subject that solves extreme by introducing a Lagrange multiplier and optimization tool.

$$L(q_1, q_2, \lambda) = U(q_1, q_2) - \lambda(p_1 q_1 + p_2 q_2 - V)$$

Where q_1, q_2 represent the consumed quantities of the two goods;

p_1, p_2 prices of two goods;

$$\max_{q_1,q_2,\lambda} L(q_1,q_2,\lambda)$$

$$\frac{\partial L}{\partial q_1}=0\Rightarrow\frac{\partial U}{\partial q_1}=\lambda p_1 \quad (1)$$

$$\frac{\partial L}{\partial q_2}=0\Rightarrow\frac{\partial U}{\partial q_2}=\lambda p_2 \quad (2)$$

$$\frac{\partial L}{\partial \lambda}=0\Rightarrow p_1q_1+p_2q_2=V \quad (3)$$

Optimal condition:

$$\frac{\partial U}{\partial q_1}:\frac{\partial U}{\partial q_2}=\frac{p_1}{p_2}\Rightarrow\frac{Umg_{q_1}}{p_1}=\frac{Umg_{q_2}}{p_2} \quad (4)$$

Umg_{q_1} marginal utility

We have considered utility function:

$$U(q_1,q_2)=\sqrt{q_1q_2}$$

The optimum condition based on the utility is :

$$\frac{\frac{\sqrt{q_2}}{2\sqrt{q_1}}}{p_1}=\frac{\frac{\sqrt{q_1}}{2\sqrt{q_2}}}{p_2}\Rightarrow q_2=\frac{p_1}{p_2}q_1$$

The optimum quantity consumed of good 1:

$$q_1^*=\frac{V}{2p_1}=f_1(p_1,p_2,V) \quad (6)$$

The optimum quantity consumed of good 2:

$$q_2^*=\frac{V}{2p_2}=f_2(p_1,p_2,V) \quad (7)$$

Maximum utility:

$$U(q_1^*, q_2^*) = \sqrt{q_1^* q_2^*} = \frac{V}{2\sqrt{p_1 p_2}} = Z(p_1, p_2, V)$$

Customer satisfaction is measured by the utility function $U(q_1, q_2)$.

$$H = \begin{pmatrix} \frac{\partial^2 U}{\partial q_1^2} & \frac{\partial^2 U}{\partial q_1 \partial q_2} \\ \frac{\partial^2 U}{\partial q_2 \partial q_1} & \frac{\partial^2 U}{\partial q_2^2} \end{pmatrix}$$

We considered utility function:

$$U(q_1, q_2) = \sqrt{q_1 q_2}$$

$$\bar{U} = \sqrt{q_1 q_2} \Rightarrow q_2 = \frac{\bar{U}^2}{q_1} \Rightarrow \begin{cases} q_1 \to 0 \Rightarrow q_2 \to \infty \\ q_1 \to \infty \Rightarrow q_2 \to 0 \end{cases}$$

2. The problem of optimal analytical

We have considered utility function:

$$U(x_1, x_2) = x_1(x_2 - a), x_1 \geq 0; x_2 \geq 0; a > 0$$

x_1, x_2 consumed quantities

The functions of the application

$$x_1 = \frac{V - ap_2}{2p_1}; x_2 = \frac{V + ap_2}{2p_2}$$

Initial situation X_1 =75. X_2=25

Final situation X_1=10, X_2=12,5.

Intermediate situation is characterized by:

$$\begin{cases} U(x_1, x_2) = U(15, 25) \\ RMS_{21} = \dfrac{p_1}{p_2} = \dfrac{1}{2} \end{cases}$$

$$x_1 = 15\sqrt{2}, x_2 = 10 + \frac{15}{\sqrt{2}}$$

The substitution effect corresponds to the passing of the initial situation intermediate situation:

$$\Delta x_1 = 15\sqrt{2} - 15 > 0; \Delta x_2 = 10 + \frac{15}{\sqrt{2}} - 25 < 0$$

Consumer income should increase by:

$$\Delta V = \left(20 + \frac{60}{\sqrt{2}} \right) \cdot 10^4 - 4 \cdot 10^4 \cong 22,85 \cdot 10^4$$

Conclusion

The utility is a function of maximum prices of goods consumed and consumer income. For optimum problem analyzed showed that utility will decrease when consumption increases p2. The substitution effect reduces the consumption of good 2 of which prices increased and increased consumption of good 1 that has become relatively cheaper. Increased consumption of this good p2 reduce the income effect. For two good, the income effect and the substitution effect is cumulative and consumption drops. For good one higher income effect is the substitution effect and also decreases consumption. P2's optimal choice if growth had been accompanied by an increase in income V.

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MODEL OF BEHAVIOR OF THE CONSUMER

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ABSTRACT : The paper presents analysis of factors that influence consumer behavior, pattern of behavior of the consumer using Lagrange multiplier, the function of utility to the consumer preferences and elasticity Analysis application on the basis of income and price.

Key words: consumer behavior, factors, analysis, model, Lagrange multiplier

JEL: *C80, L11, M31*

1.Analysis of the behavior of consumers

The increase in complexity of life economic, has shown the need to mechanism knowledge human economic behavior, which in turn requires a separate study of the two components: behavior of man as a producer of goods and services, and the consumer's behavior.

Increase of the purchasing power, at the same time as the improvement of the level of education and culture, give him the opportunity buyer to satisfy several needs, more sophisticated, higher levels of quality assurance, aspects of which it is absolutely essential to take into account the manufacturer, in order to meet the wishes of consumers. Special complexity of consumer behavior is explained by many factors affecting directly or indirectly as a last resort decision-making.

The analysis of the behavior of the consumers' purchase will take into account the following:

• reaction to the consumer marketing strategy of the firm, which has an impact on its success in the market place;

• by tossing the marketing of the company, which must satisfy consumers;• ability to predict how consumers will respond to company strategies;

• high cost of this research, the difficulty of achieving them and the risk of getting incorrect information.

Field research in consumer behavior highlights, that the way in which he is responsible consumer embarrass stimuli may be structure in four types of behavior (M. W. Pride, O. C. Ferell - "Marketing - concepts and Strategies" ed. -7 Houghton Miffin Company, Boston 1991):

• decision-making at the limit, when you buy a product on an occasional basis, for which takes time to search for the moderate information and deliberations;

• deciding extensively, when buying products unfamiliar expensive, and therefore involves a decision complex. Use a number of criteria for assessing possible alternatives, which requires a longer periods;

• behavior of the purchase impulsively, as determined by a stimulus strongly and consistently to buy something immediately. For some individuals is dominant behavior of purchase, although it causes often.

From the analysis presented it is found that buying a product does not determine the type of behavior for the decision. In some cases, the individuals are engaged in a decision to be taken extensively first time, when you buy a certain type of product, but a decision to limit is sufficient when you purchase the product for the second time. If, on the expiry of a routine purchase, brand, until then not preferred it may meet, it shall take a decision to limit or one extensive livestock farming, to proceed to a new brand.

Using consumer model correlations correlations can be established between the components behavioral mechanism, which will reveal relations between the causal link. Consumer model inputs are represented by factors such as theoretical and hexogen a faced by the consumer.

The factors that influence purchasing behavior is nothing more than information received by an individual from outside sources and may be: stimuli objective, represented by the attributes of real mix of marketing; stimuli by symbolic imposing revolutionaries, those linked to the person's subjective perception (real or imaginary) in the attributes of product, social stimuli, expressed by the information received from other consumers, family, social groups, manner in which consumers are approaching buying decisions knows a wide variety, whereas their reactions are determined to a large extent the problems environment in which they live their life.

Consumer behavior can only be explained by familiarity with the system of factors to act in close liaison and interconditionare.

Dubois and Jolibert grouped factors influencing consumer behavior in the :

• individual factors, which include: your personality, cognitive style, life style and risk perceived;

• environment factors, which relate to: social factors demographic factors (graph of family life, social classes), reference groups, family, economic environment.

In the analysis of the behavior of consumer Ph. Kotler starts at analysis of factors influencing it, grouped in:

•factors cultural - represented by : culture, subculture and social class;

• social factors, including : reference groups, family, roles and different statuses;

• factors by relate to: age and the stage of the life cycle, and the subsequent occupation, lifestyle, economic circumstances, his personality and his opinion.

Classification of I. Andreiu Catoiu takes into account two types of variables that influence purchasing behavior: directly observable and deducted by research type interferential.[1]

Factors influence consumer behavior are:

I. with direct influence exercise :

• factors demo-economic;

• specific factors not IFM marketing;

• situationali factors, such as;

• pressure of time;

• important cumparaturii;

• an opportunity to purchase is made.

II. influences deducted shall exercise :

• factors also psychological (theoretical) ;

• factors such as sociological (exogen) .

E. Hill and T. O'Sullivan(6) that the social environment of the consumer, individual circumstances and psychology to combine to influence decisions about what shopping should do it". They emphasize three categories of factors:

• social environment - reflected in : culture, groups not symmetrical and social class;

• personal characteristics - defined by : personality, lifestyle, motives, attitudes and beliefs, perception;

• individual circumstances - designated by : sex, age, the life cycle of the family, income, education.

Economic factors have essential role on consumer model, because at macro-economic level they characterized purchasing capacity available to the undertaking at a given moment, constituting prerequisite training consumer behavior.

Employers' associations consider consumer income is essential factor which by size, shape, dynamic, distribution in time, destination, etc. is indicative of material consumer behavior and main restriction which requires it.

It is to be noted that not all goods and services have the same sensitivity to the level of income. For example, when you shall be reduced income a person, the expenses for the products of durables and those for activities cultural and fun are the most affected. As a result, the most important criteria in decision-making are functionality and the price of the goods and services.

On the basis of traceability behavioral differences between men and women, producers may address in the manner specified segment of the market.
Knowledge of these variables has significance, as it pass and against possibility of consequences from the point of view of marketing, of some tendencies of demographic variables, which will change consumer behavior.

Psychological factors are endogenous variables that explain consumer behavior by their multiple effects on individual, which in good measure may not be directly observable and therefore are usually deducted. Of the many variables also psychological with major impact on consumer behavior moral: perception, motivation, learning and attitude.

Individual behavior will be different, since the sensitivity of the information depends on their goals, expectations and motivations subject.

3. The model of consumer behavior

The model consumer behavior consumer income lead to changes in optimal quantities of the two goods consumed and therefore the maximum utility obtained by the consumer. We denoted by x1 and x2 quantities of goods consumed and p1, p2 unit prices of these goods. Consumer preferences are represented by the utility function:

$$U(x_1, x_2) = \sqrt{x_1} + x_2, x_1 \geq 0, x_2 \geq 0$$

We have calculated price elasticity of demand on the basis of income and price in the case

$p_1 = 10^4$; $p_2 = 2*10^4$ şi $V = 3*10^6$.

Mathematically, the amendments shall be written as follows:

$$p_1 dq_1^* + p_2 dq_2^* = dV$$

$\frac{\partial U}{\partial q_1^*} dq_1^* + \frac{\partial U}{\partial q_2^*} dq_2^* = dU(q_1^*, q_2^*)$ (Total differential function maximum utility)

$$dU(q_1^*, q_2^*) = \lambda p_1 dq_1^* + \lambda p_2 dq_2^* = \lambda \left(p_1 dq_1^* + p_2 dq_2^* \right) = \lambda dV \Rightarrow$$

$$\Rightarrow \frac{dU}{dV} = \lambda$$

When the income is hereby amended with DV, maximum usefulness of consumer is hereby amended with the .

In conclusion, Lagrange multiplier shows us as far as it will change the function objective at optimal (usefulness in our case), where the variable restriction (in our case the income) is hereby amended by one unit.

The model of consumer behavior of this function requires maximizing $\sqrt{x_1} + x_2$

$p_1 x_1 + p_2 x_2 = V$.

Be λ Lagrange multiplier associated with it. Lagrangean is:

$$L(x_1, x_2, \lambda) = \sqrt{x_1} + x_2 + \lambda(V - p_1 x_1 - p_2 x_2)$$

And the conditions of optimal approximately I lead to the system:

$$\frac{1}{2}x_1^{-\frac{1}{2}} - \lambda \cdot p_1 = 0$$
$$1 - \lambda \cdot p_2 = 0$$
$$p_1 x_1 + p_2 x_2 = V$$

The solution this equation system in X1, X2 and λ is:

$$x_1 = \frac{p_2^2}{4p_1^2}, x_2 = \frac{V}{p_2} - \frac{p_2}{4p_1}$$

We have X2 >0 because .If this condition is not checked, we will have the solution

$X_1>0$, $X_2=0$.

Demand elasticity's of good k in relation to the revenue

$$\eta_k = \frac{\frac{\partial x_k}{\partial V}}{\frac{x_k}{V}}, k = 1,2$$

Demand elasticity's of good k in relation to the price of k

$$\xi_k = \frac{\frac{\partial x_k}{\partial p_k}}{\frac{x_k}{p_k}}, k = 1,2$$

Demand elasticity's of good k in relation to the price of h

$$\gamma_{kh} = \frac{\frac{\partial x_k}{\partial p_h}}{\frac{x_k}{p_h}}; k, h = 1,2$$

For $p_1=l0^4$; $p_2=2*10^4$ şi $V = 3*10^6$:

have $X_1=1$, $X_2=299/2$ and elasticity's:

Consumer object 1:

$$\eta_1 = \frac{\frac{\partial x_1}{\partial V}}{\frac{x_1}{V}} = 0$$

$$\xi_1 = \frac{\frac{\partial x_1}{\partial p_1}}{\frac{x_1}{p_1}} = 0,0002$$

$$\gamma_{12} = \frac{\frac{\partial x_1}{\partial p_2}}{\frac{x_1}{p_2}} = 2$$

Consumer object 2:

$$\eta_2 = \frac{\frac{\partial x_2}{\partial V}}{\frac{x_2}{V}} = 1,003$$

$$\xi_2 = \frac{\frac{\partial x_2}{\partial p_2}}{\frac{x_2}{p_2}} = -1,007$$

$$\gamma_{21} = \frac{\frac{\partial x_2}{\partial p_1}}{\frac{x_2}{p_1}} = 0,003$$

Conclusions

Using consumer model may be established correlations between behavioral mechanism components, what they will reveal relations between the causal link.

Behavior models have applicability in practice to the understanding and the possibility buyer's influence.

Economic factors have essential role on consumer model, because at macro-economic level they characterized purchasing capacity available to the undertaking at a given moment, constituting prerequisite training consumer behavior. They directly affects the size and evolution of consumption.

Elasticity function application in relation to the price lets us determine application to change sensitivity price change.

In accordance with mathematical model to a request reed seller revenue increase if prices decline and decline if prices are increased, and to a request inelastic, seller revenue increase if prices are increased and subtract if prices decline.

Lagrange multiplier shows us as far as it will change the function optimal lens to utility in our case, when variable in restriction, the level of income is hereby amended by one unit.

The model of consumer behavior, highlighted variables that characterize multiplicity behavior of purchase and then the consumption of individual, and which show the report cause-effect between variables and behavior.

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STATISTIC STUDY ON THE POSSIBILITY OF IMPLEMENTING CORPORATE GOVERNANCE

IN PUBLIC ENTERPRISES WITH LOCAL ADMINISTRATIVE UNITS (LAU) AS THE MAJORATY SHAREHOLDERS

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Abstract: *The option of governmental monitoring of the management of certain economic entities whose capital/patrimony is in totality or in majority, directly or indirectly, owned by central or local public authorities stemmed from the inappropriateness of the current laws regarding commercial entities when applied to majority state-owned public companies. This incompatibility creates some advantages for the public businesses in question, which refer to privileged positions on the market for certain (especially public) services to the detriment of those provided by private entities. The most harmful consequence of this state of affairs is the ineffective management of public money. To this, one may add disloyal competition towards private economic entities that are active in the same line of work: state-owned enterprises enjoy the favour of being granted execution, service provision or supply contracts by means of direct award, not as a result of public bids. The issuing of the Government Emergency Ordinance no. 109 of November 30, 2011, regarding the corporate governance of public companies, tried to "bring order" in the management of these entities. However, the actual application of the Ordinance was and is still faced with serious difficulties, which the present statistic study aims to highlight, by analysing public enterprises in which local administrative units (LAU) hold the majority of shares.*

Keywords: *corporate governance, public enterprises, local administrative unit, regionalisation, capitalisation.*

1. General remarks

The temporal and pragmatic determination of corporate governance in economic entities in which local administrative units are the majority shareholders is subsequent to the regionalisation measures that were adopted by Romania following pressure from international bodies even before

the country's accession to the European Union (see Law 315/2004, which resulted in the creation of eight regions without legal personality). In this context, "regionalisation carried out by means of local communities was designed in such a way that local authorities could have extended attributions and a wide range of actions, which would thus allow them to achieve the goals set" (Sabău, Hahn, Toader, 2013, orig. Romanian, my translation). Nevertheless, the creation of the regional organisational framework proved behind the times. Even the economic entities that were in the trust of local public authorities were unable (or did not understand how) to apply governance principles in their own "courtyard" and thereby overcome the improprieties noticed by the mission of the International Monetary Fund in 2011 (Siserman 2014a). The concept of governance was effective and successful in all the other states of the European Union. The present statistic and case study analyses the observations and recommendations of the mission of the International Monetary Fund, which underlay the issuing of the Government Emergency Ordinance 109/2011 regarding the corporate governance of public companies. These enterprises will be distinguished according to their legal form and number of employees.

2. The situation of companies with Local Administrative Units (LAU) as the majority shareholders, according to their legal form, location and number of employees

After a (subjectively or objectively) long silence, the Ministry of Finances revealed the names and identification data of public entities with territorial-administrative units as their majority shareholders. The "list" was officially published for the first time in the first trimester of the year 2013 and it was subsequently updated by the Ministry of Finance, almost every trimester, until May 2014. This case study is based on the last version of the aforementioned list, dated May 2014 (Siserman 2014b). The data referring to the entities in question were completed with further information about patrimony (fixed assets, current assets, claims, debts, subscribed and paid-in capital, and ownership equity respectively), object of activity and number of people that work in these public companies based on employment contracts. These facts were gathered from the websites of the Ministry of Public Finance. According to their legal form, majority state-owned economic entities may be autonomous administrations (AA), public limited companies (PLC) or private limited companies (Ltd.). By majority public controlling interest, one understands that the direct and indirect shares of the local or central authorities make up more than 50 per cent of the

subscribed and paid-in capital (and patrimonial assets respectively, in the case of autonomous administrations).In this category of majority state-owned economic entities 1,170 companies were identified, spread throughout the forty-one local administrative units (counties) and the municipality of Bucharest. The pie charts below illustrate the absolute and relative distributions of these economic entities in Romania, according to their legal form.

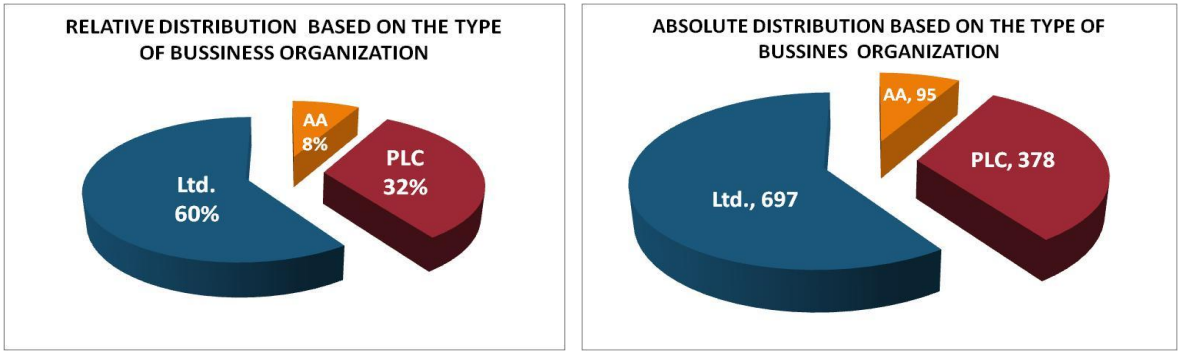

Fig. 1 Public entities grouped according to their legal form (May 31, 2014).

As regards the distribution of these entities according to the counties where they are located, the situation is as follows:

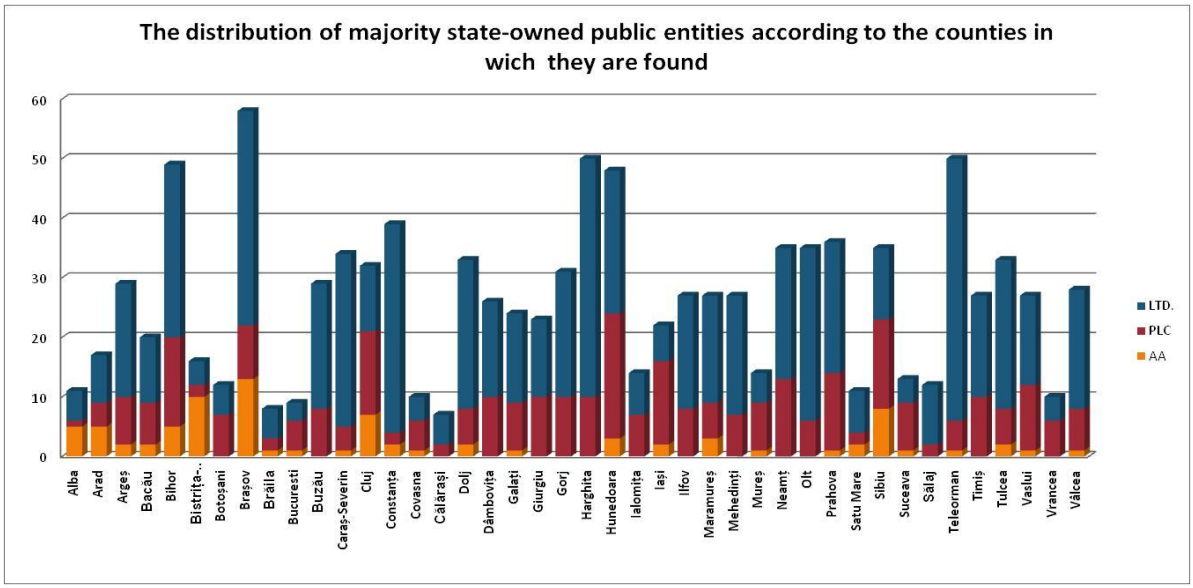

Fig. 2 Distribution of public entities according to legal form and county of location

On May 31, 2014, the situation of public companies with local administrative units as the majority shareholders was as follows:

AMENDMENTS RECORDED AT NTRO	**AA**	**PLC**	**Ltd.**	**TOTAL**
ACTIVE ENTITIES – WITHOUT AMENDMENTS RECORDED AT NTRO	92	281	596	969
BANKRUPT ENTITIES		41	10	51
INSOLVENT ENTITIES		25	15	40
ENTITIES UNDERGOING DISSOLUTION-LIQUIDATION (WITH DEREGISTRATION)	2	11	20	33
DORMANT ENTITIES		3	19	22
SHELF ENTITIES		1	15	16
ENTITIES UNDERGOING REORGANISATION	1	7	4	12
ENTITIES UNDERGOING DISSOLUTION		1	8	9
ENTITIES UNDERGOING LIQUIDATION		4	5	9
ENTITIES WHOSE PUBLIC CAPITAL DECREASED TO LESS THAN 50%		2	1	3
ENTITIES UNDERGOING DISSOLUTION-LIQUIDATION (WITHOUT DEREGISTRATION)			2	2
ENTITIES UNDERGOING DISSOLUTION WITHOUT LIQUIDATION (SUBJECTED TO MERGER)		2		2
ENTITIES WHOSE PREINCORPORATION, WHICH WAS ESTABLISHED THROUGH A DECISION OF THE LOCAL COUNCIL, IS ANNULLED BY THE AUTHORITY OF THE PREFECT			1	1
ENTITIES SUBJECTED TO REORGANISATION AS PUBLIC INSTITUTIONS			1	1
TOTAL	**95**	**378**	**697**	**1170**

Fig. 3 The situation of public entities on December 31, 2013

According to the sources quoted and the last balance report dated December 31, 2013 (published on June 31, 2014, on the website of the Ministry of Public Finance), there were in total 107,788 employees in commercial companies and autonomous administrations that were not going through (active) existential difficulties.

Given the fact that, for all these companies, local administrative units are the majority or unique shareholders and, therefore, given the existence of dismemberment of the right of ownership, it would be necessary to implement corporate governance, according to the Government Emergency Ordinance 109/2011. By analysing the number of employees according to the classes of personnel and upon grouping this number into significant spreads that represent the number of employees, one can notice the existence of several public companies without employees. This implicitly indicates a state of inactivity, which is yet to be recorded at the National Trade Register Office (NTRO). On May 31, 2014, the situation of majority LAU-owned public companies in relation to the number of employees was as follows:

a) The situation of majority LAU-owned autonomous administrations

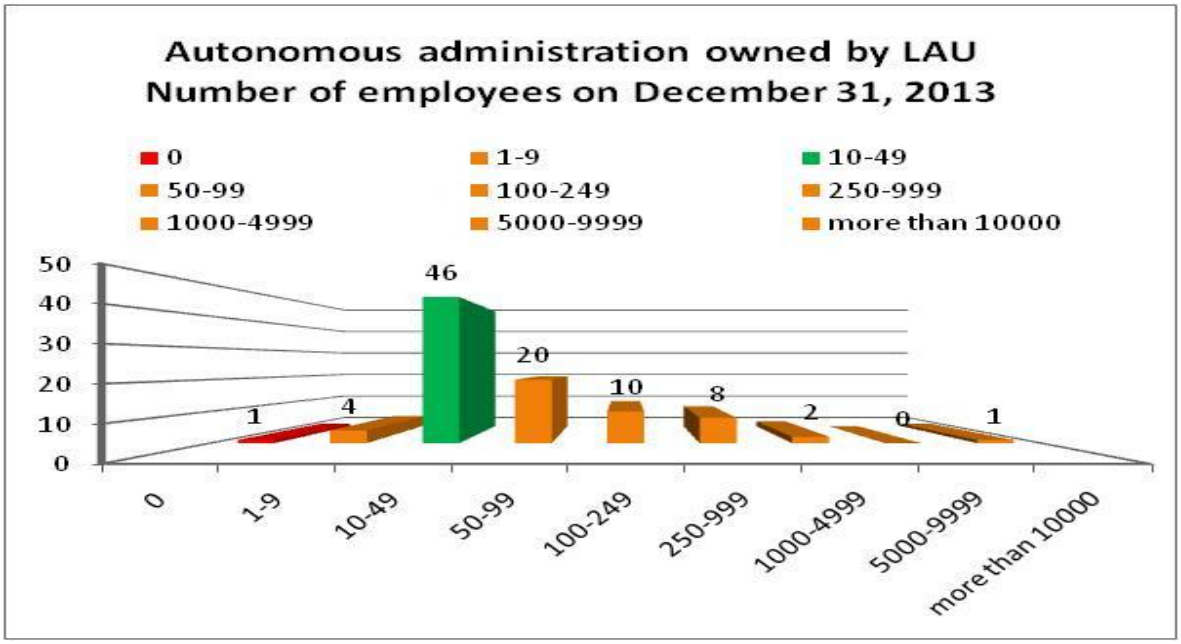

Fig. 5 Number of employees in autonomous administrations

The autonomous administration that had no employees on December 31, 2013, was under the guardianship authority of the Local Council of Margău commune, Cluj county. Most autonomous administrations have between 10 and 49 employees. These administrations are active in the fields of forestry and exploitation of real property. The autonomous administrations (AA) with more than 250 employees (nine such companies) display the following objects of activity:

- Construction works on roads and motorways 2 AA
- Supply of heating agents 1 AA
- Growth of ephemeral plants 1 AA
- Urban, suburban and metropolitan passenger transportation 5 AA

The largest autonomous administrations, which have more than 1,000 employees, are RATC Iaşi (1,355 employees), RADET Bucharest (3,637 employees) and RATB Bucharest (1,120 employees).

b) The situation of public limited companies

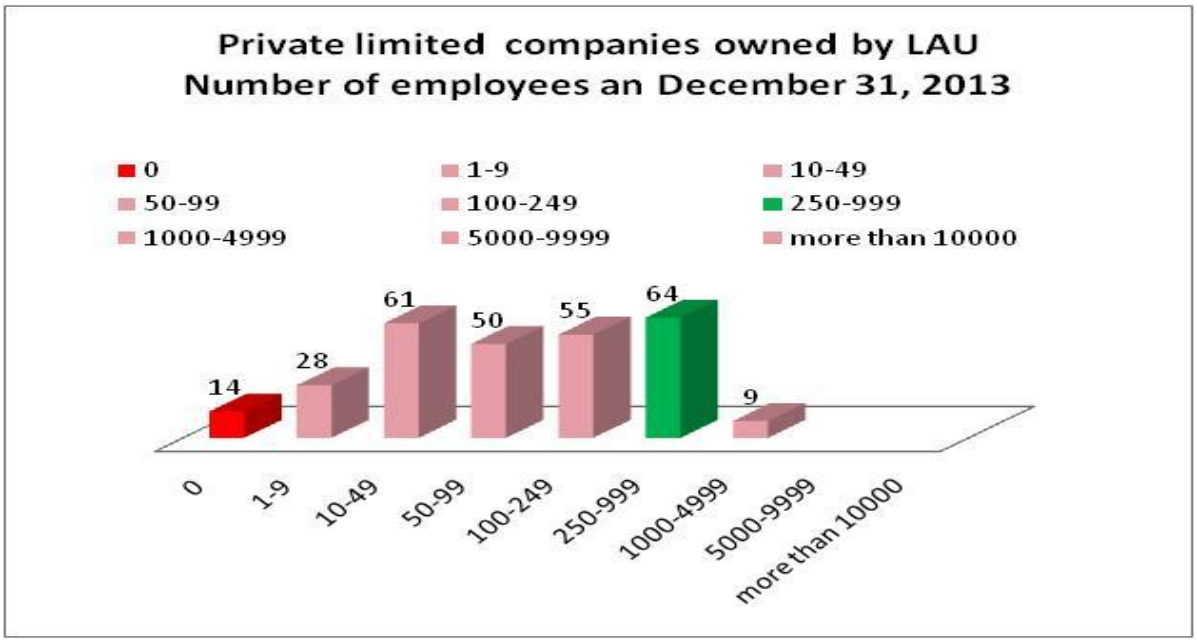

Fig. 6 Number of employees in public limited companies

The 14 public limited companies (PLC) without employees are active in the following fields:

- Sport activities and sport clubs	3 PLC
- Letting and sub-letting of real property	3 PLC
- Contract-based administration of real property	2 PLC
- Service activities associated with air transport	1 PLC
- Landscape maintenance	1 PLC
- Tourism booking and support	1 PLC
- Collection of non-hazardous waste	1 PLC
- Real estate development	1 PLC
- Collection and treatment of waste water	1 PLC

The 73 public limited companies with more than 250 employees have as main objects of activity

- Water abstraction, treatment and supply	40 PLC
- Steam and air conditioning (heating agent) supply	7 PLC
- Collection of non-hazardous waste	7 PLC
- Urban, suburban and metropolitan passenger transportation	6 PLC
- Construction works on roads and motorways	4 PLC
- Landscape maintenance activities	3 PLC
- Letting and sub-letting of owned or leased real property	2 PLC

- Electricity production 2 PLC

- Real property management activities 1 PLC

- Footwear making 1 PLC

c) The situation of private limited companies

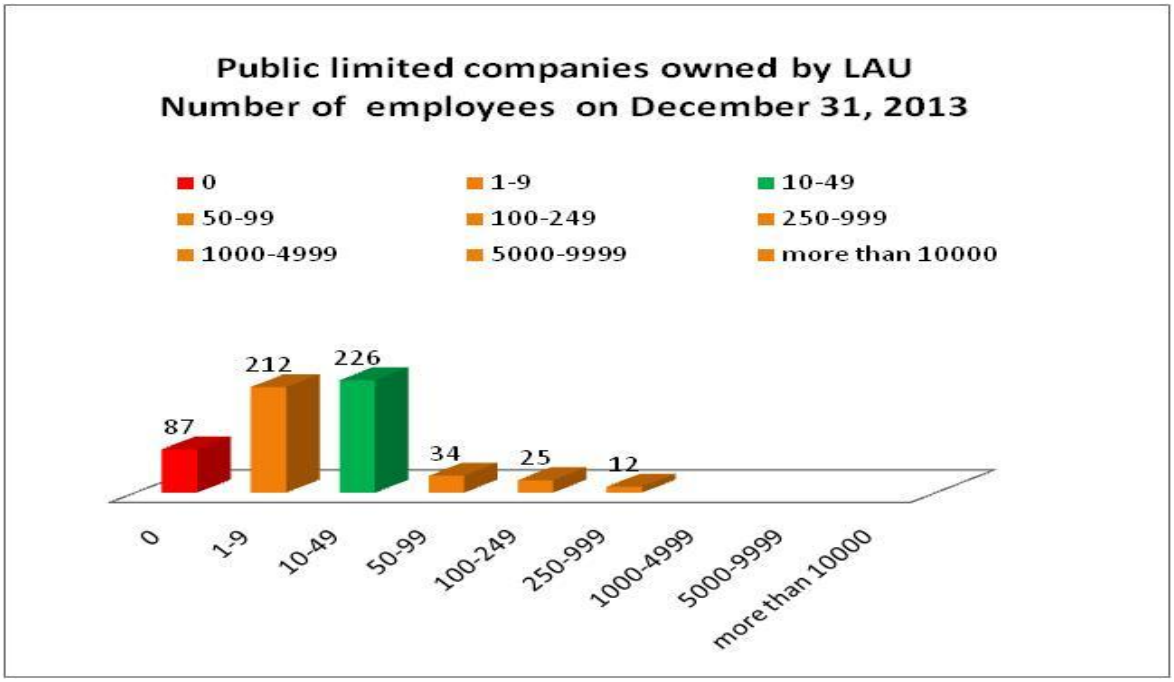

Fig. 7 Number of employees in private limited companies on December 31, 2014

The 87 companies that in the balance sheet of December 31, 2013, were recorded without employees have as the main (i.e., the top five) objects of activity:

- Undeclared activity 29 Ltd.

- Water abstraction, treatment and supply 14 Ltd.

- Collection of non-hazardous waste 7 Ltd.

- Various construction works 4 Ltd.

- Landscape maintenance 3 Ltd.

The graph presented above shows that most private limited companies have between 10 and 49 employees. The activities they carry out are very diverse, the top five representative ones being

- Collection of non-hazardous waste 53 Ltd.
- Water abstraction, treatment and supply 43 Ltd.
- Construction works of residential and non-residential buildings 29 Ltd.
- Landscape maintenance activities 13 Ltd.
- Other maintenance activities n.o.c. 8 Ltd.

The 12 private limited companies that have more than 250 employees engage in pursuits that the classification of national economic activities groups under the following headings:

- Construction works on roads and motorways 3 Ltd.
- Landscape maintenance activities 2 Ltd.
- Security and patrol activities 2 Ltd.
- Collection of non-hazardous waste 2 Ltd.
- Water abstraction, treatment and supply 1 Ltd.
- Steam and air conditioning (heating agent) supply 1 Ltd.
- Urban, suburban and metropolitan passenger transportation 1 Ltd.

3. Conclusions regarding the possibility of implementing corporate governance in majority LAU-owned public companies

Taking into consideration the provisions of the Government Emergency Ordinance 109/2011 about the organisation of corporate governance in majority LAU-owned public companies and the need to introduce administrative councils, in the case of one-tier governance systems, and supervising and administrative councils, in the case of two-tier governance systems, one can undoubtedly state that

- commercial entities without employees cannot invoke before their guardianship agency any grounds to account for their being kept active, as they do not generate income. The guardianship agency must urgently decide on the businesses' dissolution, liquidation and deregistration. According to the balance report presented on December 31, 2013, this situation characterised 102 public companies, as follows:

  - 1 autonomous administration;

  - 14 public limited companies;

  - 87 private limited companies;

- companies that have between one and nine employees cannot meet the provisions of the Government Emergency Ordinance 109/2011, unless they waive the governance principles stated in the management act. Guardianship agencies must analyse whether they support these entities or opt for their privatisation. This was the case of 244 LAU-owned public companies, which included

  - 4 autonomous administrations

  - 28 public limited companies

  - 212 private limited companies;

- public enterprises with 10 to 250 employees are suitable for the implementation of one-tier corporate governance (with variations regarding the number of the members in the administration board relative to the number of employees in the company). It should be noted that two-tier management systems entail insubstantial bureaucratic actions and additional administrative

expenses that most of these entities cannot afford. In this group of public companies, one can find 611 economic entities, of which there are

- 76 autonomous administrations

- 166 public limited companies

- 279 private limited companies;

- public entities that have more than 250 employees pertain to the category of large taxpayers, in which dismemberment of the right of ownership is firmly manifested. These enterprises are also defined by diverse activities and complex economic and financial operations, which accounts for the (optional) implementation of the two-tier governance model. Among these majority LAU-owned public companies, there are 12 public entities:

- 3 autonomous administrations

- 9 public limited companies.

The actual organisation of corporate governance in the aforementioned majority LAU-owned public companies will be the object of subsequent research, as official financial reports, which were the main source of information for the present study, do not refer to the aspects of the governance adopted in these entities.

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