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*Nenad Vušović**, *Milica Vlahović***, *Milenko Ljubojev****,
*Miljan Vlahović*****, *Daniel Kržanović*****

SOFTWARE SOLUTION FOR THE MINE SUBSIDENCE PREDICTION BASED ON THE STOCHASTIC METHOD INTEGRATED WITH THE GIS****

Abstract

Mining induced the ground subsidence and consequently, damages on objects above excavation works is a serious problem all over the world. In this paper, a new approach for subsidence and deformation prediction based on the stochastic Patarić-Stojanović method is presented. Since the calculation using the equations of this method is very complex, the original computer program package with the title MITSOUKO has been purposely designed. The MITSOUKO program enables calculating at any point of the land surface and representing the results owing to the possibility of their integration and further processing in the Geographical Information System (GIS). The components of the GIS are used to realize the spatial analysis.

Keywords: *coal mining; surface subsidence; stochastic prediction method; GIS, spatial analysis*

1 INTRODUCTION

Mine surveying in coal mines all over the world was initiated with the underground coal mining- induced land subsidence and building damage in the Ruhr Basin in the middle of the 19th century. Based on the obtained results, different methods for predicting subsidence and deformation parameters, such as the empirical methods, the profile function methods, the influence function methods, and the void diffusion method were developed [4].

Also, numerous theoretical studies were performed using the *stochastic method*, the *elastic methods*, and the *visco-elastic method* as well as the *finite-element methods*, the *boundary element method*, and the *distinct element method* for the ground subsidence and deformations prediction. Most of these methods cover the horizontal and slightly sloped coal seams. The methods for seams with greater slopes are less reliable but with a high professional improvisation. Further

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more, *the numerical methods* were used for subsidence modeling and calculating the rock strata movement [3,4]. The shape and position of subsidence trough in relation to the excavated area depend on the geological and technological conditions of underground exploitation; for the horizontal coal seams, it is symmetrical, while for inclined it becomes asymmetrical. The available methods reliably prognose both vertical and horizontal subsidence components and offer deriving other displacement factors of movement, such as the tilt, curvature, and horizontal strain.

Prediction of the final subsidence is simpler compared with the displacements induced by sequential mining processes. Also, many factors affect and conduct moving of the rock mass thus making the behavior of overlying strata complicated. Therefore, different idealized media were used for the subsidence prediction in the middle of the 20th century. The stochastic theory of ground movements proved to be a universal method for subsidence prediction [1].

The first application of the stochastic model was in the soil mechanics for sand, gravel and severely cracked ground. Pokrovsky (1929) concluded that the change in pressure due to the concentrated force at the horizontal plane as a function of depth can be represented by the standard Gaussian distribution curve, also known as a normal distribution curve. According to J. Litwiniszyn, with a presumption that the rock mass is a stochastic medium, the stochastic method interprets the displacement of rock massif related to mine subsidence [2].

Geoinformation technologies offer the management of spatial data with their integration in the Geographic information system (GIS) [6,12]. The computer-based analytical methods that realistically simulate subsidence processes are needed for the reliable design of mining layout to minimize the underground excavation influence on the land surface. Integrative modeling, interac-

tive spatial analysis and understanding different processes are supported by the GIS. Based on the simulation of spatially distributed and time-dependent subsidence processes, innovative thematic maps containing the land-surface properties can be designed [7-11].

2 STOCHASTIC METHOD BY PATARIC AND STOJANOVIC

The stochastic Pataric-Stojanovic method applies the mathematical statistics and assumes the multi-layered massif, split by a series of cracks into a large number of elements with movements having stochastic character.

2.1 Movements in a massif with horizontal seams

The environment is presented by the symmetrically arranged elements with similar dimensions. Such an area is not real, but the assumption is statistically correct because the pressure change curve in a homogeneous medium is symmetrical, thus elements in the profile must be symmetrical [1]. Owing to this symmetry, the force got by one element is transmitted and equally divided into two parts on which it relies (Figure 1). For simplicity, a unit force is observed, so if the surface layer is marked as zero, the element in this layer receives the entire force, the two elements in the first layer, on which the element from the zero layer relies, receive half of this force. In the second layer, the edge elements receive a quarter, and the middle two quarters of the force, etc. Following the process further, it is noticed that the distribution of forces obeys the binomial law. When $i, j \rightarrow 0$, the binomial distribution asymptotically tends to normal, then the pressure changes according to the law of normal distribution, and can be represented by a Gaussian curve [2].

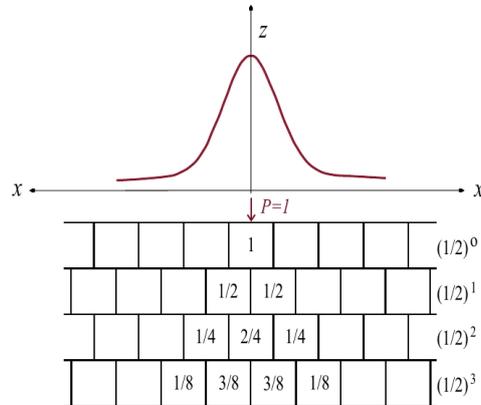


Figure 1 Pressure distribution according to the stochastic model [2]

The mathematical model from Figure 1 can be used to study the plane subsidence of a layered massif [3]. The subsidence will be plane if a long area of constant width ($2a$) and height (d) has been

excavated. The assumption is that the rock massif consists of the horizontal layers divided by a series of cracks into equal, symmetrically arranged elements (Figure 2).

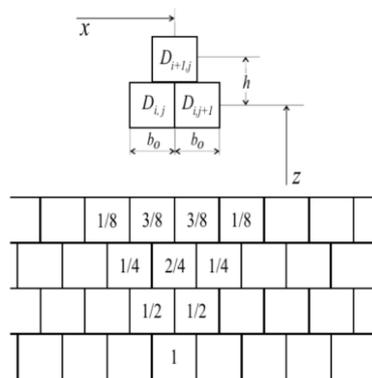


Figure 2 Symmetrically arranged elements in horizontal seams divided by cracks [3]

When the element from the lowest layer is removed, the elements in the higher layers begin to move. Their movement is assumed to be stochastic, so instead of studying the displacement, the probability of the element passing into the lower layer is determined. A place that remains vacant in the lowest layer can be occupied by one of the elements that lie directly above it. Owing to symmetry, the

probabilities of these events are the same, so their value equals $1/2$. With further following the probabilities for moving elements from higher layers, the same regularity is valid [2]. Since the subsidence is plane, two coordinates are sufficient: an abscissa x (parallel to the layers) and an elevation z (vertically with the upward direction) to determine the position of the elements in the massif.

For the boundary transition from a discrete division to a continuous massif, the starting point is the position of the elements that are defined by the coordinates, ie:

$$F(x, z + h) = \frac{1}{2} [F(x - b_0, z) + F(x + b_0, z)] \quad (1)$$

where $F(x, z)$ is the *function of subsidence probability* [3].

The assumption is that the excavated area Ω_2 has a rectangle shape with width $2a$ and thickness d , so if a coordinate origin is placed in the intersection of rectangle diagonals, it will be:

$$U(x) = \iint_{\Omega_2} F(x, \bar{x}, H, \bar{z}) d\bar{x} d\bar{z} \quad (2)$$

Since the thickness d is negligible with respect to the depth H of the seam, instead of the integral, its mean value can be taken without a significant error:

$$\int_{-d/2}^{d/2} F(x, \bar{x}, H, \bar{z}) d\bar{z} = d \cdot F(x, \bar{x}, H, 0)$$

Using the function from the Eq. (1) the subsidence is:

$$\Phi(t) = \frac{2}{\sqrt{2\pi}} \int_0^t e^{-\frac{1}{2}s^2} ds \quad (3)$$

the subsidence is definitely calculated by the formula [3]:

$$U(x) = U_0 X_0(x) \quad (4)$$

where:

$$X_0(x) = \frac{1}{2} \left[\Phi\left(\frac{a+x}{n}\right) + \Phi\left(\frac{a-x}{n}\right) \right]$$

2.2 Movements in a massif with inclined seams

In the case of inclined seams, the starting assumption that the massif is divided by a series of horizontal and vertical cracks into elements of the same dimensions. Equation (4) can only be applied to profiles along the strike. However, the subsidence curve is not symmetrical by the seam dip, so there is anisotropy unlike the process in a massif with horizontal seams. The same mathematical model can be used assuming that the elements, with still identical dimensions due to homogeneity, are no longer symmetrically arranged, but the center of each element is shifted by the dip for a certain length e , whereby $0 < e < b_1$ (Figure 3). The coordinate origin is placed at an arbitrary point O of the seam that is being excavated, the z -axis is directed vertically upwards, the x -axis is directed horizontally along the seam strike, and the y -axis is in a direction of the seam dip. The direction of x -axis is chosen in a way that the coordinate triedar is right.

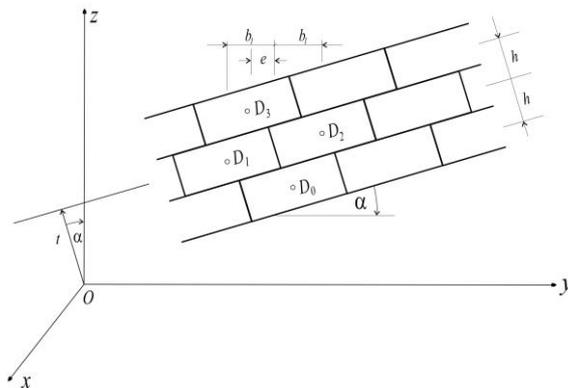


Figure 3 Moving process in the massif with inclined seams [3]

The equation of the plane of the seam at the distance t from the coordinate origin is:

$$t = z \cos \alpha - y \sin \alpha \quad (5)$$

In this case, the place of the lowest removed element D_0 will be occupied by the element D_1 or by the element D_2 , but owing to the disturbed symmetry, the probabilities of these events are not equal. Their values can be calculated as the resistances of simply supported beam of span $2b_1$ loaded with a unit eccentric force, so the probability is determined as follows [3]:

$$\left(\frac{1}{2} + \frac{e}{2b_1} \right) F(x, y + b_1, t) + \left(\frac{1}{2} - \frac{e}{2b_1} \right) F(x, y - b_1, t) = F(x, y - e, t + h) \quad (6)$$

The massif is assumed to be anisotropic, therefore the subsidence curves in the profiles by the seam strike are symmetrical, and asymmetrical in the profiles by the seam strike [3].

When deriving the equations, it is assumed that the centers of elements remain in the same vertical plane during subsidence. In the general case, the center of element during the subsidence will move both by the strike and dip, so the function of subsidence probability F depends on all coordinates. Due to the independence of the influence of individual coordinates, the equations:

$$F(x, \bar{x}, y, \bar{y}, z, \bar{z}) = F(x, \bar{x}, t, \bar{t}) F(y, \bar{y}, t, \bar{t}) \quad (7)$$

represents the total subsidence probability for inclined seams [3].

2.3 Basic formulas for subsidence calculation of the horizontal seam

When excavating layered deposits, the used excavation methods that remove the rectangular excavation panels of the layer, whereby the sides of rectangle are parallel to the coordinate axes- O_ξ by the seam

strike and O_η by the seam dip. The subsidence in a point $M(x, y, H)$ of the terrain surface $z=H$ of the undermined massif based on the Eq. (7) will be a double integral:

$$U(x, y) = \iint_{\Omega_2} F(x, \bar{x}, y, \bar{y}, z, \bar{z}) d\bar{x} d\bar{y} d\bar{z} \quad (8)$$

If the sides of the excavation panel Ω_2 are $2a$ by the seam strike and $2l$ by the seam dip, the coordinate origin is at the intersection point of the rectangle diagonals will be: $-a \leq \xi \leq a$; $-b \leq \eta \leq b$ and using the function:

$$\Phi(x) = \frac{2}{\sqrt{2\pi}} \int_0^x e^{-\frac{1}{2}t^2} dt \quad (9)$$

a definite formula for calculating the subsidence during horizontal seam excavation is obtained [3].

$$U(x, y) = U_0 X(x) Y(y) \quad (10)$$

where:

$$X(x) = \frac{1}{2} \left[\Phi \left(p \frac{a+x}{\sqrt{H}} \right) + \Phi \left(p \frac{a-x}{\sqrt{H}} \right) \right]$$

$$Y(y) = \frac{1}{2} \left[\Phi \left(p \frac{l+y}{\sqrt{H}} \right) + \Phi \left(p \frac{l-y}{\sqrt{H}} \right) \right]$$

The function Φ from expression (9) represents the standard Gaussian distribution curve.

2.4 Basic formulas for subsidence calculation of the inclined seam

If during the excavation of inclined layers, the exploitation area (Ω_3) is of arbitrary shape, the total subsidence $M(x, y, H)$ on the surface of the undermined massif based on (7) will be,

$$U(x, y) = \iiint_{\Omega_3} F(x, \bar{x}, y, \bar{y}, H, z) d\bar{x} d\bar{y} d\bar{z} \quad (11)$$

If the seam dip angle (α) and the seam thickness (d) are constant, the area Ω_3 is prismatic with the base Ω_2 (Figure 4).

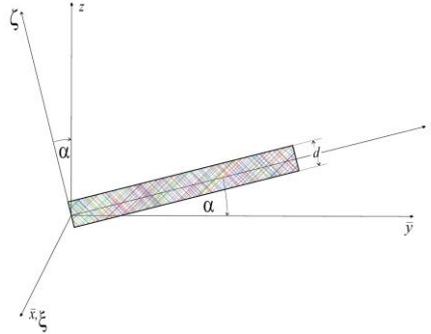


Figure 4 Plane subsidence of inclined seam [3]

By introducing the new variables: $\bar{x} \equiv \xi$; $\bar{x} = \xi$; $\bar{z} = \eta \sin \alpha - \zeta \cos \alpha$, the subsidence calculation can be simplified, because if $\xi = 0$, $\bar{y} = \eta \cdot \cos \alpha$ and $\bar{z} = \eta \cdot \sin \alpha$, the difference when $z = H$ is:

$$\begin{aligned} t - \bar{t} &= (z - \bar{z}) \cdot \cos \alpha - (y - \bar{y}) \cdot \sin \alpha \\ &= H \cdot \cos \alpha - y \cdot \sin \alpha \end{aligned}$$

and no longer depends on the variable η .

If the sides of the excavation panel Ω_2 are $2a$ by the seam strike and $2l$ by the seam dip, with the coordinate origin at the intersection point of diagonals of the rectangle it will be: $-a < \xi < a$, $-l < \eta < l$, the expression for calculating the subsidence during inclined seams excavation is obtained [3]:

$$U(x, y) = U_0 X(x, y) Y(y) \quad (12)$$

where:

$$\begin{aligned} X(x, y) &= \frac{1}{2} \left[\Phi \left(p \frac{a+x}{\sqrt{H \cdot \text{ctg} \alpha - y}} \right) + \Phi \left(p \frac{a-x}{\sqrt{H \cdot \text{ctg} \alpha - y}} \right) \right] \\ Y(y) &= \frac{1}{2} \left[\Phi \left(q \frac{b+m+y}{\sqrt{H \cdot \text{ctg} \alpha - y}} \right) + \Phi \left(q \frac{b-m-y}{\sqrt{H \cdot \text{ctg} \alpha - y}} \right) \right] \end{aligned}$$

where:

$$\begin{aligned} p &= \frac{P_0}{\sqrt{\sin \alpha}}, \quad q = (1 - \lambda \sin \alpha) Q, \\ b &= \frac{l \cos \alpha}{1 - \lambda \sin \alpha}, \quad m = \frac{H \lambda \cos \alpha}{1 - \lambda \sin \alpha} \end{aligned}$$

The subsidence curve will be the same in any profile by the dip, so it is a plane subsidence:

$$U(y) = U_0 Y(y) \quad (13)$$

where $Y(y)$ is calculated from the formula (12).

In the case that $\alpha = 0$, the formula (12) is reduced to the basic formula (10) for calculating the subsidence of horizontal seam.

2.5 Geometric interpretation of parameters for the subsidence predictive calculation

The subsidence calculation formulas based on the stochastic method, formulate two types of parameters:

- Parameters a, l, H, d, α, b that are known and determined;
- Parameters U_0, p, m, q, δ that are not determined in the physical sense. These parameters describe the behavior of an undermined rock massif during consolidation and need to be determined previously to find their relationship with some unit that can be measured.

The following terms, definitions, and symbols are adopted:

Dimensions of the excavation panel a, l [m] are determined from the project and depend on the exploitation area.

Seam depth (H) represents the mean seam depth for each excavation panel. It is calculated from:

$$H = H_T - H_S$$

where H_T is the elevation of terrain over the excavated seam [m] and H_S is the depth of excavation panel [m].

Angle of seam dip α [°] varies. For the predictive calculation of the movement parameters, the mean values of the seam dip for each excavated area are taken.

Maximum subsidence U_0 [mm] defines the maximum possible subsidence (Figure 5) that can occur at the full excavation surface. Only one point M at the ground surface has a maximum possible subsidence. It is calculated from the expression [3]:

$$U_0 = d \cdot q_u \cdot i \cdot \cos \alpha \quad (14)$$

where: q is the rate of caving represents the coefficient of subsidence of the hanging wall and is taken as a real value based on the analysis of former excavation. The most commonly adopted value is $q = 0.7-0.9$ which corresponds to the value that would be taken based on an analogy from a basin with the similar physico-mechanical properties of a hanging wall. The parameter q is calculated from the expression:

$$q = \frac{f + 2}{\sqrt{300 \sin \alpha}} \exp \left[(0,0027 - 0,0076 \sqrt{f}) \alpha \right]$$

where: f - is a strength coefficient of the rock massif by Protodjakonov; i - coal deposit recovery is determined with losses g (%), which corresponds to the designed excavation method, whereby $i = 1 - g$.

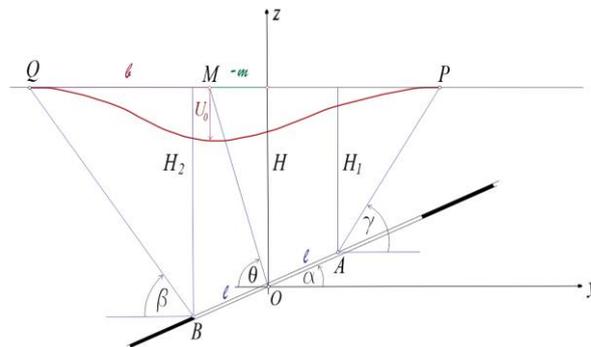


Figure 5 Parameters for mine subsidence prediction [4]

Parameter p [m^{-1}] depends on the relationship between the side a and the hypothetical element h . It is calculated from the expression:

$$p = \frac{f + 2}{\sqrt{300 \cdot tg \alpha}}. \quad (15)$$

Parameter m -to determine this parameter, it is necessary to know the position of the point with the maximum subsidence U_0 which is in the point M , with the ordinate $Y_M = -m$. The parameter m is in direct connection with the angle of full subsidence θ (Figure 5), which is related with the angle of draw δ , ie. with auxiliary angles β and γ . Parameter m is calculated according to the empirical formula:

$$m = H \operatorname{ctg} \theta \quad (16)$$

Parameter b is not independent and is calculated from the known data: the seam dip α , dimension of the excavation field l ,

seam depth H and parameter m (Figure 5). It can be expressed through the angle θ and calculations according to an empirical formula:

$$b - l \cos \alpha = \frac{m}{H} \sin \alpha$$

by entering the value $m = H \operatorname{ctg} \theta$ it will be: $b - l \cos \alpha = l \sin \alpha \operatorname{ctg} \theta$, so the parameter b is calculated from the expression:

$$b = l \frac{\sin(\alpha + \theta)}{\sin \theta} \quad (17)$$

Angles of draw ($\delta_1, \beta_1, \gamma_1$) are angular characteristics of the moving process that determine the ground surface area affected by the displacements caused by excavation, assuming that the deformations can be neglected beyond that displacement boundary. These are angles between the horizontal and line joining the excavation boundary in the pit with some boundary point at the land surface (Figure 6).

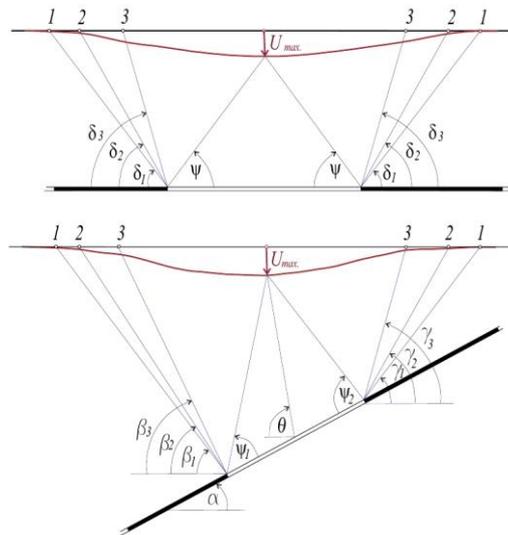


Figure 6 Angular parameters of undermined ground movement process:

$\delta_1, \beta_1, \gamma_1$ - angles of the draw; $\delta_2, \beta_2, \gamma_2$ - safety angles; $\delta_3, \beta_3, \gamma_3$ - fracture angles;
 ψ, ψ_1, ψ_2 - full movement angles; θ - angle of full subsidence; α - angle of seam dip [5]

The boundary point is defined by the value of measured displacement. Both components of the total displacement vector (horizontal and vertical), which have the millimeter values on the peripheral part, can be measured. The boundary point is easier to determine through the vertical component –subsidence. The absolute value of the subsidence $U_g = 10$ mm is adopted for the boundary condition. For predictive calculations, there is a problem of adopting the draw angles. For that purpose, Table 1 was created, in which the values are given based on the interdependence of angles: $\delta_1, \beta_1, \gamma_1, \theta$ [4].

$$U_P = \frac{U_0}{2} \cdot \left[\Phi \left(q \cdot \frac{b+m+l \cdot \cos \alpha + H_1 \cdot \text{ctg} \gamma}{\sqrt{H \cdot \text{ctg} \alpha - l \cdot \cos \alpha - H_1 \cdot \text{ctg} \gamma}} \right) + \Phi \left(q \cdot \frac{b-m-l \cdot \cos \alpha + H_1 \cdot \text{ctg} \gamma}{\sqrt{H \cdot \text{ctg} \alpha - l \cdot \cos \alpha - H_1 \cdot \text{ctg} \gamma}} \right) \right]$$

$$U_Q = \frac{U_0}{2} \cdot \left[\Phi \left(q \cdot \frac{b+m-l \cdot \cos \alpha - H_2 \cdot \text{ctg} \beta}{\sqrt{H \cdot \text{ctg} \alpha + l \cdot \cos \alpha + H_2 \cdot \text{ctg} \beta}} \right) + \Phi \left(q \cdot \frac{b-m+l \cdot \cos \alpha + H_2 \cdot \text{ctg} \beta}{\sqrt{H \cdot \text{ctg} \alpha + l \cdot \cos \alpha + H_2 \cdot \text{ctg} \beta}} \right) \right]$$

These are the general conditions for the massif inclined seams.

Table 1 Prediction values of draw angles ($\delta_1, \beta_1, \gamma_1$) and maximum subsidence angle (θ) [4]

Angle of draw		Theory is valid, stable foot wall							Theory is not valid, active foot wall				
f	$a = 0^\circ$	$a \neq 0^\circ$	$a = 10^\circ$	$a = 20^\circ$	$a = 30^\circ$	$a = 40^\circ$	$a = 50^\circ$	$a = 55^\circ$	$a = 60^\circ$	$a = 70^\circ$	$a = 80^\circ$	$a = 90^\circ$	
1.5	$\delta_1 = 55^\circ$	β_1	47	42	37	33	30	29	28	27	26	25	
		γ_1	57	60	64	67	71	73	73	57	40	25	
		θ	85	81	78	76	74	74	74	73	75	80	90
2.5	$\delta_1 = 60^\circ$	β_1	53	47	41	37	33	32	29	28	27	26	
		γ_1	63	66	69	71	74	75	75	76	59	41	26
		θ	85	81	77	75	73	73	73	71	73	79	90
4.0	$\delta_1 = 65^\circ$	β_1	59	52	46	40	46	34	32	29	28	27	
		γ_1	70	72	74	76	77	78	79	61	42	27	
		θ	84	80	76	73	72	71	72	70	70	77	90
5.0	$\delta_1 = 70^\circ$	β_1	62	54	47	42	37	35	33	32	31	29	
		γ_1	73	75	78	79	81	83	82	64	43	28	
		θ	83	77	72	69	67	66	66	67	70	77	90
8.0	$\delta_1 = 75^\circ$	β_1	63	53	46	40	36	34	33	32	31	29	
		γ_1	78	80	83	84	85	86	85	67	44	29	
		θ	82	76	71	67	66	65	66	69	76	90	

The values of draw angles in the directions β_1 and γ_1 are different. The subsidence curve is asymmetric with U_{\max} shifted in the direction the seam dip α with the angle of maximum subsidence θ . When the coordinates of the points P and Q (Figure 5):

$$y_P = l \cdot \cos \alpha + H_1 \cdot \text{ctg} \gamma$$

$$y_Q = -l \cdot \cos \alpha - H_2 \cdot \text{ctg} \beta$$

are entered into the Eq. (13), the subsidences in these points are obtained [3]:

3 DEVELOPMENT OF THE GIS BASED STOCHASTIC METHOD FOR THE MINE SUBSIDENCE PREDICTION

Since the subsidence prognosis using equations of the stochastic Patric-Stojanovic method would be very complicated and time-consuming in case of manual data processing, the original computer program package with the title MITSOUKO has been created based on this method and formulas. MITSOUKO is designed in the Python programming language and provides the mine subsidence and deformations calculation, based on the simulating excavation process according to the adopted dynamics, at any point of the land surface and representing the results owing to their integration and further processing in the GIS. It consists of three modules: PARAMETERS, SUBSIDENCE and DEFORMATIONS which represent the individual independent functions. Each module starts with form according to a textual description explaining its name and function, the tags of input data that are loaded (Read parameters) or computed (Calculate parameters) into a particular module, and the data values returned by a module through the control loop. The modules have control functions, describing what the program does according to the algorithm shown in Figure 7.

Firstly, by entering the MITSOUKO program, in the PARAMETERS module, the function given by Eq. 9 is initialized [3]. Then, through the menu, the data obtained based on geometric characteristics for each excavation panel are entered: ID , dimensions (a, l), seam depth (H), seam thickness (d) and seam dip angle (α). In the next step, in a specified subroutine of the PARAMETERS module, the following is calculated for each panel: maximum subsidence (U_0), parameters (m, b, p), rate of

caving (q), angles of draw (δ, β, γ), and angle of full subsidence (θ).

The local coordinate system is situated symmetrically with respect to the first excavation panel, with x -axis in the direction of the seam strike, y -axis in the direction of the seam dip and the coordinate origin in the diagonal intersection of this panel. The positions of all panels (x_i, y_i, F_i) are determined with respect to the defined local coordinate system. During the calculation for each panel, it is necessary to rotate its coordinate axes for the value of angle F_i (expressed in degrees) to the direction of axes of the local coordinate system.

Subsidence are calculated in the SUBSIDENCE module. A certain subroutine allows entering the coordinates of points in a grid of a given density, through the assigned distances between points ($\Delta x, \Delta y$), in the x and y axes directions of the local coordinate system. In this way, it is possible to define the calculation limits for all panels up to a limit subsidence value of 10 mm. Further, the subsidence values after mining each panel are calculated cumulatively, according to the projected mining dynamics.

The individual results for each panel can be exported (write) in tabular form in an Excel file, which is also the preparation for graphical presentation and spatial analysis in GIS.

The DEFORMATIONS module at the given points of the defined excavation panels calculates and presents in tabular form in an Excel file the X, Y components of the tilt, and the directions of the main tilt due to

the mining out all panels. First, the components of the main tilt, formed by mining one panel, are calculated in the direction of the absolute coordinate system, and then for all panels, as in the subsidence calculation. The components of the total tilt in the direction of the absolute coordinate system axes at a given point are obtained by summing the

slope components of the individual panels. Based on these components, the main tilt and its direction are calculated. The program provides calculating curvatures for the given profile points in tabular form in an Excel file and their graphical presentation in the direction of any section after mining out each panel.

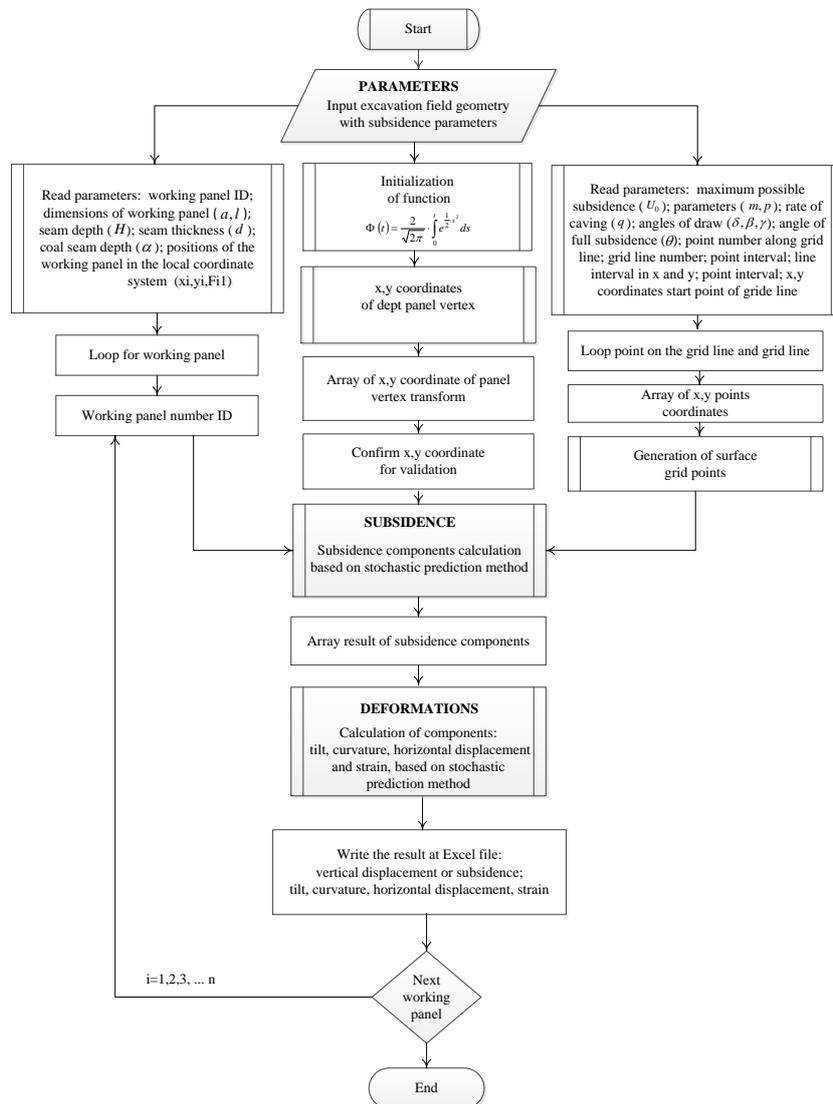


Figure 7 Stochastic prediction algorithm for the subsidence and deformations calculation using the MITSOUKO software

The program further calculates the curvature radius, as the reciprocal value of curvature in the interval, after mining each panel. Also, the values of horizontal displacements and strains caused by mining all panels are calculated and tabulated.

GIS is used for creating complex geodatabase, converting numerical data, imported from the SUBSIDENCE and DEFORMATIONS modules, in feature classes and graphical data as well as for performing the spatial analyses of subsidence and deformations [7-11]. Since the pit consists of multiple panels with complex geometry, spatial analyses requires a long time without GIS because for each panel subsidence or deformations must be presented cumulatively. Implementing the stochastic method for spatial analyses of subsidence and deformations in the GIS is performed in three steps:

The first step, **Data module**, involves creating a geodatabase of the coal mine in ArcCatalog, within the ArcGIS application (ESRI Software Inc. <http://www.esri.com/software/arcgis/>) with feature classes, tables, and rasters. The feature class is a set of homogeneous spatial attributes in the form of digitized vector data, in the same National Coordinate System (MGI Balkans7). In order to integrate the feature classes thematically and spatially into the mine model, within the given excavation panels, feature datasets have been created, in which all types of feature classes are entered. Feature datasets with the feature classes related to the spatial geometry: terrain topographies, buildings, mining facilities, old mining works and new exploitation area in pit, excavation panels with mining dynamics, active and old mining premises, and geological interpretation of the coal seam are created in geodatabase of mine. Outside the feature datasets, tables with subsidence, tilt, curvature, horizontal displacement and strain,

calculations from the SUBSIDENCE and DEFORMATIONS module in the MIT-SOUKO program (Figure 8), rasters for the subject area in the form of orthophoto, geographic maps, situational plans of mine and photographs are imported in the geodatabase. Feature Datasets have been created, in which all types of feature classes are entered. Also, using ArcMap, an integrated part of the ArcGIS software package, to create layers for displaying feature classes from the ArcCatalog (ESRI) is included. All tables of the subsidence calculations have been transferred from the geodatabase coal mine to the ArcMap.

The second step, **Subsidence module**, involves using the Display XY Data command, the selected table of the excavation panel, which contains the x, y coordinates of the points and the calculated subsidence values, is added as a new layer in the Table of Contents. Thereby, a new feature class, panel ID_events, was formed, which for panel contains many points with values of x and y coordinates and associated subsidences, georeferenced to the adopted coordinate system MGI Balkans7. Following the same procedure, new feature classes were created for all panels. The created feature classes contain x and y coordinates of all points in the grid 10x10 m with associated subsidence values. The Spline interpolation method from the Spatial Analyst Tools palette is then used to create new layers with contour subsidence lines for each panel, by the cumulative subsidence transformation from the previous to the new state. This provides successive following of the subsidence process on the map at all mining stages. Digitization and formation of feature classes for all panels in the global MGI Balkans7 coordinate system are performed in a map.

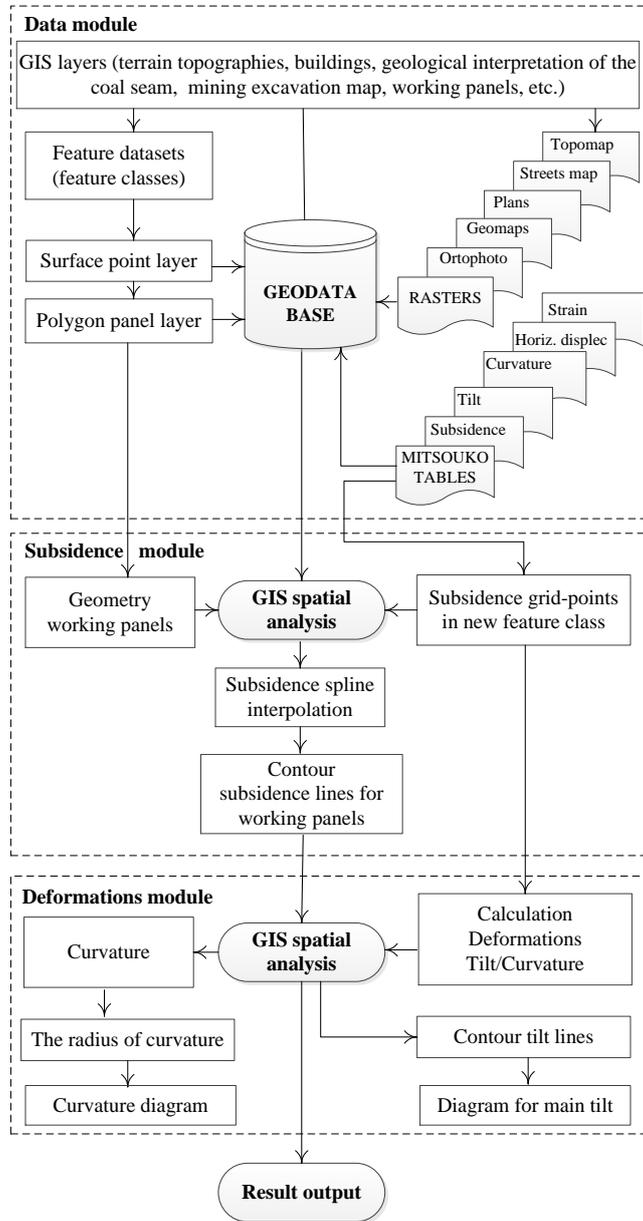


Figure 8 Algorithm connecting stochastic prediction analysis with the GIS spatial analysis function

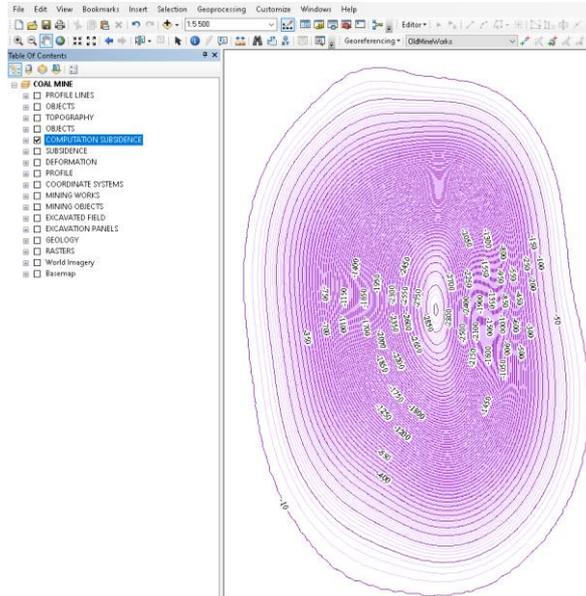


Figure 9 Interpolation of subsidence contour lines after mining excavation panels

In the third step, **Deformations module**, based on the subsidence values for individual panels obtained in the GIS spatial analysis, tilt is calculated cumulatively as subsidence increment after mining each panel.

The Spline or Kriging interpolation method from the Spatial Analyst Tools palette is then used to create the new layers with the contour tilt lines (Figure 10). It is possible to draw the tilt diagrams and the main tilt according to a given profile.

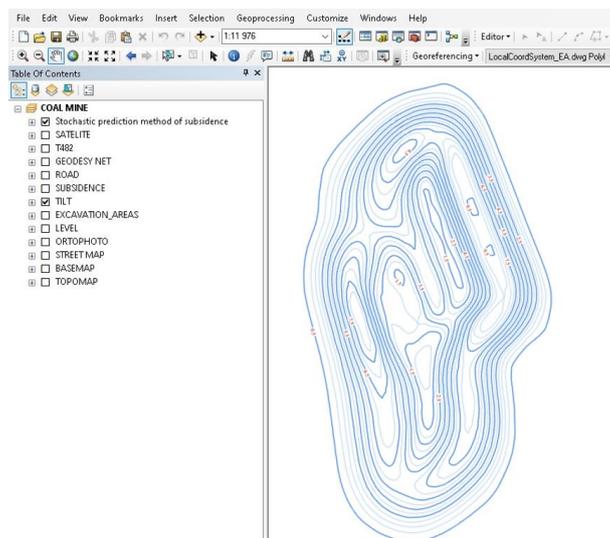


Figure 10 Interpolation of tilt lines after mining out all excavation panels

Based on the subsidence increment, after mining each panel, for the profile points, the curvature is calculated and presented, i.e. the curvature radius as its reciprocal value.

4 CONCLUSION

The calculation of subsidence by the stochastic Patarić-Stojanović method and originally developed MITSOUKO program package integrated with the GIS are powerful tools for predicting subsidence and monitoring the impact of underground mining works on the land surface.

Benefits of this approach are:

- reliability of the method for calculation of subsidence and deformations for inclined seams;
- equations for inclined seams, in cases when $\alpha \rightarrow 0^\circ$, give solutions for horizontal seams;
- definition of draw angles in terms of the possibility of their application when seam thickness and excavation depth increase, and
- mutual connection between the angular parameters of the displacement process.

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BOUNDARY CONDITION OF THE MINING SUPPORT ON AN EXAMPLE OF THE ARC-INFLEXIBLE SUPPORT**

Abstract

Underground structures and tunnels as buildings cover a wide range of the areas in constructions that are closely intertwined and mutually conditioned. The geological environment conditions are a choice of excavation technology, which in turn indirectly affect the pressure level of rock mass and the choice of supporting structure (temporary and permanent).

Calculation for the support metal elements capacity is presented in this paper.

Keywords: *limit state, metal support units, exploitation demands*

1 INTRODUCTION

By the boundary state of the support is meant the stress state at which the support loses its functionality, i.e. no longer meets the exploitation requirements. Two groups of boundary conditions have been adopted:

- The first group is based on the bearing capacity of the support,
- The second group is based on technological functionality.

Calculation of the support according to the first group of the limit state is carried out on the calculated load taking into account the calculated resistance of material and aims to prevent the loss of structure stability, and thus the support collapse.

Calculation of the support according to the second group of boundary condition is carried out on the normative load taking into account the normative resistances of material and aims to prevent the excessive deformations and displacements of struc-

ture and thus ensure the crack stability and limit the width of open cracks.

The calculated limit state of the support is selected in cooperation with the exploitation, technological and technoeconomic requirements.

The boundary state of the cross section of support corresponds to the transition from one state to another and quantitatively characterizes the limit values of internal forces, which the cross section of support accepts in this or that transition stage.

At the same time, the limit value of internal forces is related to the certain dependencies on the basis of which the support material, shape and dimensions of the cross section are chosen.

It must be always kept in mind the knowledge gained from experience that the appearance of boundary condition in one or several sections does not always lead to the exploitation exhaustion of su-

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port. Thus, the appearance of cracks in a cross section of support and joint plasticity prolongs the service life of support.

Calculation of the boundary condition of the support depends on a number of factors, such as: the requirement of an underground room, its duration, degree of importance of the object (whether it is a capital or a temporary facility), etc. The starting point is that the maximum load that the support can receive corresponds to the first boundary state and determines its bearing capacity. For a substructure in which we do not allow the occurrence of cracks or whose radial displacement is limited, the calculated limited state precedes the occurrence of the first boundary state.

As a rule, the first boundary condition of support is preceded by the occurrence of boundary condition in one or several of its sections and therefore it is necessary to determine the qualitative criterion for determining the limit state of the section and appropriate transition from one stage of operation to another, the emergence of these boundary conditions.

An example of calculation and boundary conditions for an arch support will be described below.

$$\delta_{11} = \frac{1}{E \cdot I} \cdot \left[\frac{2}{3} \cdot h^3 + r \cdot h \cdot (\pi \cdot h + 4 \cdot r) + \frac{\pi \cdot r}{2} \left(r^2 + \frac{I}{F} \right) \right] \quad (5)$$

where:

- E is a modulus of elasticity for steel,
- I is a moment of inertia of the girder profile,
- F is a cross-sectional area of the girder profile.

2 CALCULATION FOR THE STEEL ARCHED RIGID SUPPORT

The steel arched rigid support is a bent girder with two joints loaded with a continuous load.

This construction (curved rod with two joints) is considered to be a statically indeterminate system. The method by which it will be solved is the method of force.

$$\delta_{11} \cdot X_1 + \Delta_{1p} = 0 \quad (1)$$

from which is got:

$$X_1 = -\frac{\Delta_{1p}}{\delta_{11}} \quad (2)$$

Unit displacements Δ_{1p} and δ_{11} are determined without the participation of a horizontal force, by equations for:

- Displacement caused by unit force

$$\delta_{11} = \int_A \frac{(M_1^0)^2 \cdot dS}{E \cdot I} + \int_A \frac{(N_1^0)^2 \cdot dS}{E \cdot F} \quad (3)$$

- Displacement from external load:

$$\Delta_{1p} = \int_A \frac{M_p M_1^0 \cdot dS}{E \cdot I} + \int_A \frac{N_p N_1^0 \cdot dS}{E \cdot F} \quad (4)$$

1. Displacement caused by the unit force (δ_{11})

In determination the unit displacement, the system is loaded by the unit force $X_1 = 1$. Parameters that have to be determined are the unit moment M_1^0 and unit axial force N_1^0 . The final equation for δ_{11} is:

2. Displacement from the external load (Δ_{1p})

For determination the unit displacement, the system observed under its external influence has calculated the bending moment M_p and normal force N_p . Equation for Δ_{1p} is:

$$\Delta_{1p} = \frac{2}{E \cdot I} \int_0^h \frac{1}{6} \cdot (3 \cdot q_{h2} - K \cdot x) \cdot x^3 \cdot dx$$

$$+ \frac{2}{E \cdot I} \int_0^{\frac{\pi}{2}} \left\{ R_A \cdot r \cdot (1 - \sin\varphi) - \frac{1}{2} \cdot q_v \cdot r^2 (1 - \sin\varphi)^2 - \frac{1}{6} \right.$$

$$\cdot [2 \cdot (K_1 - K_2 \cdot r \cdot \cos\varphi) + q_{h2}] \cdot (h + r \cdot \cos\varphi)^2 \cdot (h + r \cdot \cos\varphi) \cdot r \cdot d\varphi$$

$$+ \frac{2}{E \cdot F} \int_0^{\frac{\pi}{2}} \left\{ [q_v \cdot r \cdot \sin^2\varphi + \frac{1}{2} \cdot (q_{h2} + K_1 + K_2 \cdot r \cdot \cos\varphi) \right.$$

$$\cdot (h + r \cdot \cos\varphi)] \cos\varphi \cdot \cos\varphi r d\varphi$$

Figure 1 shows a schematic representation of the two-joint support arcless.

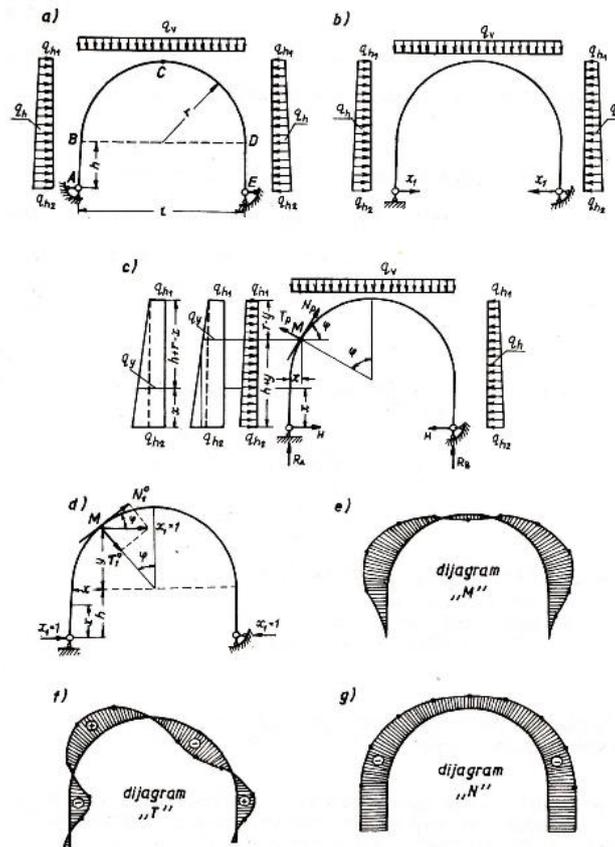


Figure 1 Schematic representation of the two-joint support arcless

CONCLUSION

As already mentioned, the condition of support and its functionality, i.e. the satisfaction of exploitation requirements, is of a great importance for the normal operation of mines with the underground exploitation. For that reason, it is important to determine its limit stress state, i.e. the stress state of the metal elements of support, in order to prevent the loss of its stability, and thus its failure. It is also important to take into account the normative resistances of materials that is aimed to prevent the occurrence of excessive deformations and displacements of structures, and thus provide the crack stability and limit the width of open cracks.

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ASSESSMENT AND ANALYSIS OF THE SLOPE STABILITY LANDFILL MINING WASTE ON THE LOCATION "BRVENICA" – RAŠKA

Abstract

For the purposes of the Project Cadastre of Mining Waste in the Republic of Serbia", implemented by the association PLEJADES GmbH – Independent Experts and DMT GmbH & Co. KG, Germany, the Mining and Metallurgy Institute Bor has performed the geotechnical exploration and testing in order of the slope stability assessment of the mining waste facilities.

Keywords: *stability analysis, geo mechanical tests, mining waste*

1 INTRODUCTION

For the purposes of the Project "Cadastre of Mining Waste. Republic of Serbia", the research has been performed at the MWS 060 Brvenica, MWF 10212/1, where an observation of the field situation and geomechanical soil sampling were carried out. Subsequently, the geomechanical laboratory tests on samples, as well as the slope stability calculation for selected cross-sections were performed.

2 TYPE AND SCOPE OF THE PERFORMED EXPLORATIONS, TESTS AND CALCULATIONS

Within the framework of exploration, the stability of mining waste facilities according to the set task, the following field exploration works were carried out on August 23rd, 2018 on the MWS 060 Brvenica, MWF 1021/1:

- Field observation and selection of the critical slopes: based on the previously prepared geomechanical sampling plan and assessed state of the slope on the facility in the field.

- Construction of exploratory trenches performed mechanically – depth up to 1.5 m (with trenchers/excavators).

The scope and types of performed laboratory tests were determined on the basis of the types of envisaged tests in the geotechnical works and harmonized with the geomechanical composition of taken samples.

The tests were carried out in the Laboratory for Geomechanics in the MMI Bor, according to the applicable standards. The total of three samples were tested and processed.

3 OVERVIEW OF RESEARCH RESULTS

The results of the laboratory geomechanical testing are shown in Table 1. According to the ordinal numbers in this Table, the samples present the following media:

- No. 1 – sub-soil of the facility
- Nos. 2, 3 – disposed material

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Table 1 Overview of the geomechanical test results

No.	Sample label	Grain-size distribution								Water content	Density			Direct shear
		Entrails	Gravel	Sand	Dust	Clay	d ₆₀	d ₃₀	d ₁₀	w	γ	γ _s	φ	C
		%	%	%	%	%	mm	mm	mm	%	[kN/m ³]	[kN/m ³]	°	[kN/m ²]
1.	60 10212-1 MW_G B-1 1.2-1.5 m	-	51.89	43.86	4.25	-	7.95	0.552	0.200	27.44	18.46	20.75	27	17,4
2.	60 10212-1 MW_G B-2 1.0-1.5 m	-	81.22	15.57	3.21	-	48.00	6.400	0.530	32.76	18.76	21.76	26	0
3.	60 10212-1 MW_G B-3 1.0-1.5 m	-	72.94	20.50	6.56	-	17.00	2.700	0.126	30.65	18.85	21.67	25	0

3.1 Stability analysis

The adopted calculation parameters for the stability calculation were defined on the basis of the results of laboratory testing of samples, on-site observations, as well as the analogy with data from the projects with the material of similar characteristics.

The following values of geomechanical parameters, shown in Table 2, were used to calculate the safety factors of slopes at the cross-section A-A', as well as to determine the cohesion of materials in the massif.

Table 2 Calculation parameters for the stability of the site No. 060, facility No. 10212/1

Geotechnical environment	Cohesion, kN/m ²	Internal friction angle, °	Density, kN/m ³
I – Disposed material	45	25	18.81
II – Sub-soil	17.40	27	18.46

Based on the adopted values of physical and mechanical parameters, a safety factor calculation was performed on the characteristic cross - section A-A' with the maximum slope height. A geomechanical model on the cross-section A-A' is shown in Figure 1.

Stability calculation was performed using the *SLIDE v6.0* program of the company *ROCSCIENCE*. The stability calculation is carried out under the conditions of a limit equilibrium using the *SLIDE*

progRAM. The calculation was done using the Janbu method.

On the seismological map, published in 1987, for the return periods of 50, 100, 200, 500, 1000 and 10000 years, which shows the expected earthquake maximum intensity with an occurrence probability of 63%, the area of Raska Municipality is on the oleate for a return period of 500 years, located in the MCS scale zone 8. The earthquake impact on stability is modeled by the seismic coefficient, which is $K_s = 0.15$ for the Raska region.

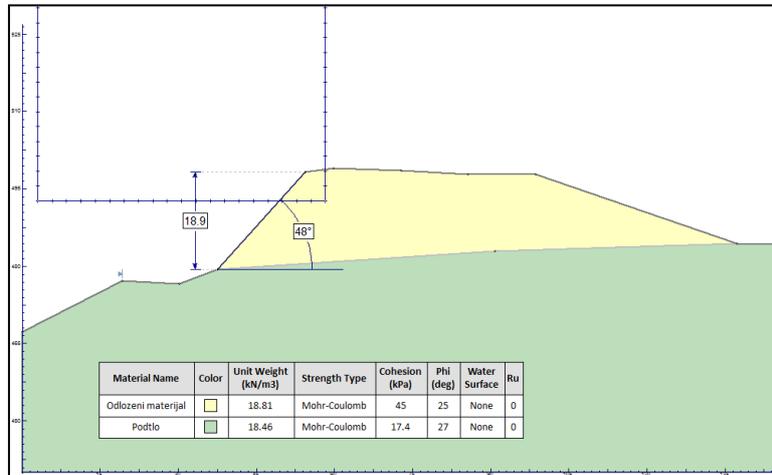


Figure 1 Geomechanical model on the cross-section A-A'

The results of calculation the safety factors on the cross-section A-A' are provided as the output forms of the program: Figure 2 for the static loading conditions, and Figure 3 for the dynamic loading

conditions. These Figures show the slide levels with minimal stability coefficient. In all other slopes, the stability coefficients are higher than the shown ones. Summary overview of the results is shown in Table 3.

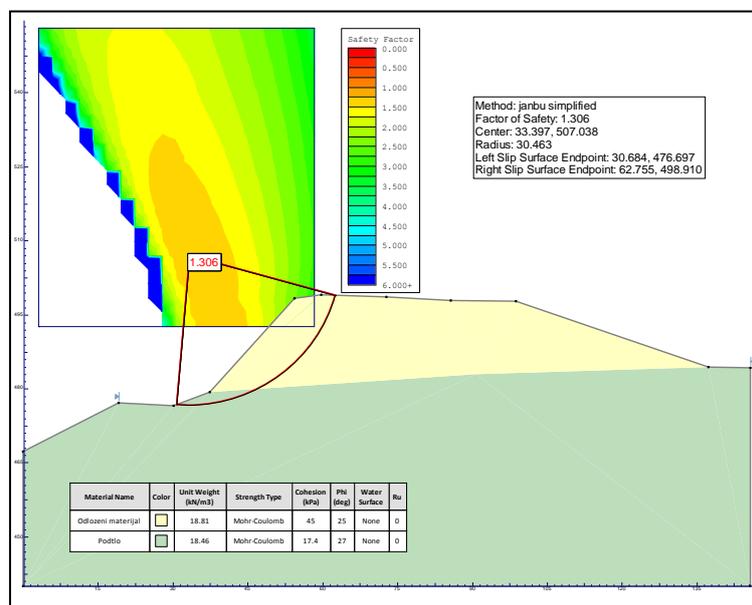


Figure 2 Minimum safety factor on the cross-section A-A' under the static loading conditions

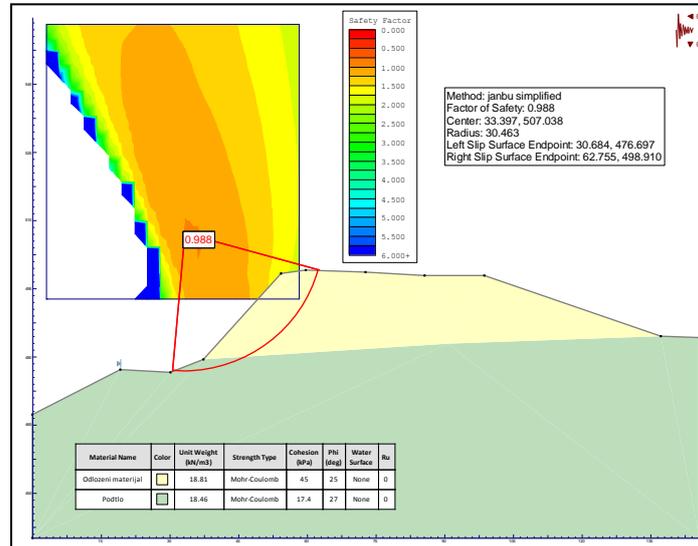


Figure 3 Minimum safety factor on the cross-section A-A' under the dynamic loading conditions

Table 3 Summary overview of the stability coefficient by A - A' profile

A - A' Profile	F_s static	F_s dynamic
Values	1.306	0.988

The permitted values of the safety coefficient are defined by the Rulebook on Technical Requirements for Surface Mineral Exploitation (Official Gazette of RS, No. 96/2010). For the stability calculation of individual slopes, the slope system and final slopes for soft rocks on the facility - if the open pit is out of operation, the minimum permissible $K_s = 1.30$.

The minimum safety coefficient of the final slopes for periodical dynamic loads in the event of earthquake is not defined by this Rulebook.

CONCLUSION

Based on the value of calculated slope safety factor, it can be concluded that the stability coefficients, according to the analyzed profile for the mining waste facility No.1021/1 on the site 60 Brvenica, are higher than the minimum prescribed value for the static loading conditions.

Regarding to the safety of slopes of the waste facility in the conditions of dynamic loading, based on the calculated safety factor, it can be concluded that in the event of earthquake of the maximum expected intensity, there will be the instability of the mining waste facility, since the calculated safety factor is less than 1.

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PROSPECTIVE IMAGE OF THE INDUSTRIAL FUTURE

Abstract

World and facts that will structurally organize it, in the future will be much different from a position in which they are nowadays. Dynamics of development is a result of rapid events and implementation of change. If technology generates a change, a question of survival of functioning and controlling mechanisms for managing businesses in past is being imposed. Chain reaction will show as necessary.

The new information will represent the basic of decision of predictive character. The laws of construction and functioning of cybernetic systems are supported. Evolutionary economy [1] and digital Darwinism will mark, from a historical aspect, the content of work and communication. If the natural systems came to be in a spontaneous order, the social organizations are constructed, which especially stands for enterprise, that is set to be efficient and useful creation and whose shaping and management is based solely on a rational behaviour, which means a goal-oriented business direction.

In accordance with the topic, the industrial policies, dying industries, propulsive industries in making, occurring technologies will be evaluated that are characterized by AI as well as tendencies of the evolutionary character and digital Darwinism. The result of work should represent the whole model and partial models of industry of the future. IT and communication process (networking) create a symbiosis and that will be a necessity for functioning the organizational systems.

Keywords: *industry, future, digitalization, evolutionary economy*

INTRODUCTION

The factual state shows that from this moment there are reactions of countries and financial sectors on a degree of developed European and global economies in rehabilitating from the consequences of the depression caused by the virus pandemic, which has caused numerous disorders in the workings of overall and structural parts of economies of countries which have been effected by this disaster.

It shows that the global, especial the developed capitalistic system is not ready for the surprises of this kind in terms of preven-

tive response, which is the reason why there are the chaotic behaviour, mismanagement, threat of catastrophe and absence of a clear path and a set of changes to exit the current situation and find a new path and model of development. The old rules are not applied anymore, the old books have already been read, defending something that cannot be retained like the current world economic system is no longer possible. A new approach is needed for development the problems and a new philosophy of implementing the development of economic and

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social systems. Instead of a digital “take-off”, we will have to curb the “flood” or “fire”, and tame the “tsunami”. The disruption of world trade causes economies to revert to the national frames. A new kind of confinement is emerging, all with the goal of healing. Markets are disturbed. Financial market will surely profit, but for how long? Installed capacities will prove to be oversized and the main operational directions of their functioning will be directed to defining the lower boundary of their economic rationality. Unemployment can increase and social welfare will increase. Budget burdens will grow, there will be no net incentives in the investment modernization and modernity until recovery. It may happen that the digital processes will go down a bit, but it is our view that they will flare up as a developmental compensation for the classic real sectors that are lagging behind. The aim will also be directed towards efforts to restore the processes and connections to their original state. Realization of the radical innovative breakthroughs will come to a standstill, and the “take off” will occur with certain delay. However, the speed of realization in the future can heavily compensate for the current state of stagnation and lag. Theories of value creation also fall through. That is to say, the main factors of value creation are coming to light: man, worker, previous, current, and future creators of capital and values. From the standpoint of classical, neoclassical, liberal and neoliberal economists, capital, including money, is shown to have no value regardless of its appearance, and represents only one of the links, but no longer the most important one. “Labor is a measure of value. But living labor has less value in exchange with capital than the specific work for which it is exchanged.” [5] On the other hand, in a pandemic situation, we will have the non-productive costs of both living and tangible labor, but they will also be add-in cost formation for the unsold goods in terms of creating value for the capital owners [5]. On the functional level,

with the lack of the new productive investments, the start will be from the fact that the technical progress is embedded in the existing capital fund, thus maintaining the average age and increasing its share in a new technology. In the claustrophobic situations, the term “arms” industry does not refer to the military industry, but to the commissariat and chemical industry. Fortunately, from the aspect of production rhythm and the degree of determination of the installed technology in these segments of social economy, they have the characteristics of process alignment, high level of automation, so the losses, due to their capacity engagement, are negligible. Fixed costs are in found in capacity, so the level of their work activity in coordination with time is desirable, at least to the level of cost coverage. The primary objective in crisis situations is the economic rationing of labor and capital. It is possible to achieve a high degree of business integration in this respect, which is a situation where different sectors of the economy, usually agriculture and industrial sector, work effectively together and are mutually dependent. As such part of the development process, these situations become a function of the sustainable future development that they match [6]. Other parts of the economy with products of a different purpose, other than input for the agricultural production, face challenges in terms of: how to prevent and stop cumulative losses over time and how to reorient themselves in terms of maintaining the clientele.

1 INCENTIVE CHALLENGES AND DEVELOPMENT REORIENTATIONS

The interventional funds of 5.3 trillion dollars, which the US government has earmarked to “conserve” and further halt economic downturns, will not be donated but committed and in the future should be earned and repaid. Does this mean that we

will be paying more and more for what is considered a subject of personal and productive consumption? The European Union intervention measure of over 500 billion euros have a protective character of preserving economic infrastructure. What about the halt in the functioning of trade and international commodity markets? If the economies of the European union countries and other developed economies take on a national dimension, then the economies of underdeveloped countries will self-organize internally in the sense of self-sufficiency and there will be some interruption in the business communications. This will present a signal for repeated questioning of interrelationships on the relation developed-underdeveloped and relation labor-capital. Moving employment from the primary and secondary to the tertiary sector will stagnate, but the pressure on the tertiary sector will increase due to the increasing unemployment. The reactions of states in terms of maintaining the attained level of development, employment and social standard, deny the free-market flare, and the labour market becomes a social category and not a demand category for the problematic profession. Monetarism is shown to be a failure as a category of growth and even more as a category of development. Free trade is a symbol of the developed west today. "And if trading falls, so does free trade. The stories about free trade, like all the other libertarian declarations of our bourgeoisie, only make sense in relation to bonded trading in relation to a subordinate citizen..." [4]. As soon as labor can no longer be satisfactorily transformed into the capital, money, land rent, in short into monopoly social power, there will be a capital flight, favored by the globalization, to the new geographic locations and demographics. The internationalization of capital has brought with it the assumptions of the functioning and behaviour of globalization. We will view globalization as an

expression of power and might. The basis for development reformulation should be the concept of rational expectations combined with the concept of the natural rate of unemployment resulting from the effective equilibrium in the market. We can freely write that today's markets are more obsessed with events than geopolitical risks. (Afghanistan, Libya, Iraq, Iran, Syria, North Korea, China, Russia). By imposing sanctions on Russia and strictly controlling their enforcement by their vassals, (Great Britain, Germany, New Zealand, Australia, France, Japan.) America has steadily increased its trade with Russia, skillfully jumping into the vacant posts of its hearers. We are sure that there will be the periodic changes and moods, which will disturb the behaviour of the market, which will be compounded by more serious geopolitical risks, weakened capacities of institutions and policies based on fear, regardless of the possible benignity of political events and changes.

With the aim of preserving what has been achieved for many years, and now to intervene because of the pandemic, there is an unselective pumping of money. Today's money without coverage, which banks place and which does not objectively exist, is emerging as an incentive resource that is not being used appropriately because there is no progress [2]. Development is absent, and now the primary concern is to preserve what has been achieved in terms of production readiness and clientele. It is known from history that it is easier to reach new clients than to rebuild a broken business relationship, where someone else, because of the duration of business interruption, sat down instead of you.

The moment may present a chance for economies, which have shown relatively more resistance to the pandemic because of their (under)development and will thus suffer less damage than the economies of highly developed countries, to try to catch

up with them, or at least approach them in a level of development that would give them a chance for more equal negotiation and more equal relations in international business relations.

Countries affected by the pandemic are enacting sets of measures to stem the cumulative decline, largely by relying on the financial sector. First of all, the economic measures are aimed at preventing the production sector from stopping and efforts to maintain the achieved level of employment, while reducing the duration of the measures. Donations, grants, financial instruments, loans, etc. should represent a development factor. Sectors which depend on import, as well as export-oriented sectors, must count on the current absence of stability in the international trade and strive to restore functioning of previous business and establish the new business processes.

Rules of behaviour for managing development in times of crisis are not arbitrary norms, but represent the most important form of adapting a person to an environment of whose details he can never know enough that he can exclusively direct his behaviour in accordance with cause and effect and in this causal sense can act rationally. Behavior of system's elements does not happen by a chance, but these behaviours are governed by the rules that can be completely understood by analogy with the rules of the game. Theories and rules that actually work and have been supplemented and modified in the relatively late stages of sociocultural evolution by consciously set or enacted rules are one of the most important mechanisms for the actual control and regulation of a system [10]. From the point of view of management, the degree of importance should be given to the deduction which forms the basis of rational coordination of the constituent parts of the enterprise as well as of the system of greater coverage.

The economy of Serbia, but also of the surrounding countries are poor in supply. Their markets are small and too open. The development of a domestic complex product does not exist, without which there is no supply, or it is impoverished to complete innovative disinterest. The import lobby is dominant, whose necessary companion is corruption. There is no jumping growth and development. There is a gradual downward trend. The condition for this is: "creating the conditions for productive employment of the workforce" and "protecting one's own manufacturer" [7]. vlf the European Union specifies the process of granularization through adaptation, the state and the economy should also accept it as a recipe for their own behaviour. Determinants of the institutional responsiveness and behaviour are necessary, regardless of how their opponents declare them. Self-interest, both as an imitation and as a project, is above other interests and behaviour. This kind of behaviour is imposed on us. And this only needs to be imitated because it is a function of the survival of small economies and their states.*

Should Balkan countries set boundaries between themselves and the destructive intrusion of trade, impaired technology, transnational companies and educational and ideological influences, thereby striving to design their own growth model, which would break the bamboo or slate curtain and dependency (recipe) the rich) and led us perhaps into isolation in the international relations, or maybe it was just transient myopia?

Perceptions are changing, things which have been emphasized are changing and there no large-scale fast conversions. We have accepted or have returned to the or-

*We used to have: Germany above all, today America above all. It still goes: "I am your Lord God, have no gods but me." Maybe it will happen again: "The proletarians of all countries unite (become serious).

thodox way of thinking. Fear of a new isolation, as a psychological moment, was probably dominant, including the risks of such an approach. Attitudes and opinions may alternate and interact, but the reconciliation of views may stem from the standpoint that development can be accelerated by the international system, and that underdevelopment is caused by that system [9]. Developed industrialized countries emit a large number of impulses of two types: those that provide chances for faster and better development than might otherwise be needed, and those that impede development - those that impede growth.

After 2000, growth in our country, as well as in the other economies of the former Eastern bloc, has concentrated on the narrow area of modern "urban industry" and has shown that the governments were unwilling to use the taxes and public services to counter growing inequalities, and to prevent concentration of capital in the hands of a small number of rich. There were no general and partial development policies as well as new institutional conditions for development.

It will show that the problem is not "unemployment", which is in fact a western concept that assumes: employment in the modern sector, labor markets, labor exchange and social benefits in a case of unemployment. The problem is unpaid, unproductive labor of the poor, especially the working and rural poor. The emphasis on "working poor" has led to an interest in redistribution of productive fixed assets as a route to less inequality. Capital penetration occurs regardless of location. Some other globalist type factors are prevalent. Their own economic defense system does not have clear orients to define the future. Is the fog getting denser and the dead end increasingly muddy and impossible? To lead a business or economy through the dynamics of change while remaining in progress and avoiding recourse is both

knowledge and skill. Discontinuities imply the need to overcome them, and crises should be managed, because crises just occur as errors in assumed continuity.

The opportunity can be expressed by diverting capital based on redefined industrial and economic policies in general. The state response is inevitable and can be successful regardless of the will of the majority owners of the capital, due to the incentives that can be defined by a high financial investment. The interest of both society and capital should be insured without going one without the other. The urban industry should be regionally and structurally reoriented in accordance with the co-comparative advantages, developmental commitments and interests of society and capital.

If we advocate the development of the food industry, we do not depend on anyone from the international environment from the point of view of mechanical engineering in the design of technology and technological processes and recipes. It is only necessary to realize the development of reproductive raw materials of agricultural origin, to raise the level of output quality, to achieve the necessary exclusion of products and to be competitive with the aim of winning, maintaining and owning prestigious markets. It is about defining growth genders, where we mean a set of industrial and raw material capacities concentrated and linked to one driving economic sector, which creates the moves, goals and dynamics of growth. The concept was once developed by the French economist François Perrou, and in our literature was developed by Kosta Mihajlovic as the "development nucleus". It is about production and business links which are mutually close, but also in terms of geographically broad concentration. Regional development is a presumption for acceptance of this approach and a chance for gradual structural and demographic harmonization.

2 PHILOSOPHY OF INTERRELATIONSHIPS IN THE INDUSTRIAL DEVELOPMENT

Today we have the intellectualization of the production process. Technology culture dominates with the work culture as a prerequisite of all other cultures. We prove that the future lies on the other side of reality, but it is human to meet it, make it certain, eliminate the possibility of surprise and react "before the fact". "Western systems are great when it comes to 'producing' the financial derivatives, time-consuming tools on social networks, for Hollywood brain-washing products." [3] Money-issuing tactics will have their reach. There are many dangers of the system breaking down when it stops working. Banks, insurance and financial markets think they are in profit. It borrows money from banks that do not have that money. No deposit. The system works for now in both Europe and America. The results will surely deny it. These types of activities have the characteristic of "totalitarian experiments", which, under conditions of mass hypnosis due to the state of the environment are accepted, while forgetting that there are no experiments in the social systems and that the induction-based conclusions are not possible. The economy and citizens are continuously indebted. This produces a crisis. The new borrowing for the sake of repayment is only delaying it. The chances for development are found most in the national environment. There are no compensation debt absorbers for building. The realistic economy is an area where viruses are created, developed and spread. It is often left to itself through a system of self-preservation, while its core activity is almost always the "saving the financial sector". The state, which is the world's largest net debtor in the world, is still at an ad-

vantage, simply due to the fact that it can still print the dollar as a reserve world currency. Hopefully, sanctification is on the horizon.

With formation of various problem-oriented funds, agencies, comities, groups, we can satisfy the instrumental form for implementing the chosen economic policies, but if systems and its subsystems fail to accomplish their missions through standardized procedures and controls, the system becomes absurd and falls apart. Everyone fears the future, because of its absolute uncertainty, regardless of its prognosed outcomes.

Economic globalization - it has four forms, which are the flow of goods and services, so-called free trade, flow of people and migration, flow of capital and technology. The problem is that its unidirectional and has no equal partnership and no equal cooperation.

Proponents of globalization have evolved through the protectionism and other measures to protect their interests, and now they insist on the so-called. Various freedoms that are nothing more than a new capitalist colonial appearance to increase their powers and wealth of the few privileged.

Since 2017, by continually increasing their balance sheet by more than 4 trillion euros, the European Union Central Bank has set a world and historic precedent from the position on interventions, to help stagnant and significantly shaken Eurozone economy. Now, in 2020, what could not be justified will be justified by the pandemic measures. Simply because the development was missed. The emphasis is now on the facts that the economies that have also been affected by the "economic pandemic" put in effect measures that will minimize cumuli-

tive losses and create a starting position for a new growth. The question that would be asked is: how to put an end to monetary policy emergency in a pragmatic way? Stable economic growth and controlled inflation may be the answer to this question.

If the central banks of countries in development would apply the approach of the European Bank, it would have the opposite effects. Inflation could only be controlled if the effects of the invest inflation result would come before the negative effects of inflation would take place [8]. We have forgotten about the old books.

Today we observe the modern development of the company, through its ability, to apply the technology and behaviour of society to the development itself through digital transformation, following the process actions and the achieved level of working culture. An enterprise with the advanced digital technologies is becoming a living organism capable of evolving and thus acquiring the characteristic of a self-learning, adaptive and self-organizing system.

Production and export of ICT products indicates a high quality of human resources in this industry. This is not a negligible fact when deciding on the foreign direct investment and flows and internationalization of capital. Prognostic expectations may suggest that exports will increase several times in two to three years. The export of these services per capita in Serbia is around 90 euros, while in Estonia, Hungary and the Czech Republic, it is 182 euros. We can progress at a faster pace and with a greater intensity.

Investment selection occurs as the largest possible form of savings, and investment funds hired, based on the capital sensors and investment decisions, appear as the selection factors. Today's selective approaches indicate (3D printer time and 5G network) that emphasis should be placed on Industry

4.0. and to make good use of its characteristic ability of the universal diffusion.

Until recently, industrialization was considered to be the most promising way to develop the underdeveloped countries. Today, however, it contradicts some elements of a corporate-oriented development strategy where businesses have an element of discretion over the goals they set. The role of investment as a component of aggregate demand and as an adjunct to the equity fund is tied to the enterprise rather than the branch, and potential development options need to be explored in the enterprises. In this sense, removing territorial obstacles to the circulation of assets is a precondition for creating a financial market in general and making investment decisions. A large number of developed countries in the world are redefining the role of the state in economic development. The delusions of neo-colonial (neoliberal) character slowly disappear and democratic awareness slowly emerges.

Pandemic conditions and disruptive factors socially affirm the role of economic, social and political organizations in functioning of the economy in determining the economic events. Emphasizing the role of institutions in the economic affairs is a critique of the conventional economy that can be said to ignore the non-economic environment in which a decision must be made in accordance with the existing conditions. Many economists (Myrdal, von Hayek) have emphasized the importance of the social and political structure within which the economy operates and have tried to use the comprehensive methods of economic analysis that include the political science and sociology [6].

On the other hand, the foundations of a normative economy are formed on the foundations of a positive economy as to what the goals of society should be. The estimated costs derived from the individual costs of

manufacturing companies in times of crisis can serve, in addition to the elements of tax policy, in terms of support and incentives, as a measure of social behaviour. Particular attention is required to the working capital ratio, due to the fact that it is desirable for net working capital to be above the value of short-term liabilities. It is essentially about indicators of liquidity and solvency, especially when observing and analyzing in relation to the other financial indicators in the form of financial statements.

3 PROFILING PRODUCTION DEFINITIONS

The degree of general development and organization of the economy, especially industry, indirectly affects the choice of production profile of the company. This action is accomplished in the sense that, at a lower level of industry development, such product groups are favored that satisfy less developed dependencies on the other industries. It is only at the higher stage of industrialization that, as a rule, capacities with a production profile are formed, which require a wide-ranging production cooperation and which set the high demands in relation to the technical and organizational level of development the capacity of reproductive material - specialized subcontractors and development level of the economic environment [7]. In crisis conditions as well as developmental definitions, the measures of economic policy, especially subsidiary policy of domestic industry, and other activities of social economy, strongly influence formation of conception on production profile choice and business philosophy and orientation profiles overall. Thereby, we need to critically value existence and expectancy of applied economic policy, e.g. import-savings or export oriented industrial policies, behaviour of

dependent and other accompanying capacities, and regional and international economic relations. Exterior environment behaviour prognostics, in conditions of emphasized closure, gets on importance, as a mean of need for adoption and personal organization. Degree of integrity and self-organizing of an enterprise is a significant factor that is respected when choosing profiles of business orientation. The achieved high level of integrity and self-organization of an enterprise can speed up progress on the line of efficient integration and conquering intense products in technical progress that are characterized by a high rentability and high level of complexity that have, due to that, developed in the industrialized countries with developed material and technical base. In some industrial branches, that rely on the mechanic technology for the most part, with some types of products at lower levels of mass production and systems of production of lower levels of competition, there are wide ranges of possible combinations of products with application of, for the most part, same or similar raw materials. Orientation of investing enterprise can be pointed on achieving the cheapest production of products, that are already on the market (from other producers) and who are still in the phase of growth in enterprise life cycle. Forming production profile can be based on products that are yield of self-research-development activity, and are protected with patents, which gives expectations from this kind of production to achieve the above average economic effects. That production is followed by the above average risk, but on a base of efficient functioning the existing installed capacity of determined production orientation, with seeing all possibilities for growing level of flexibility of capacities through upgrades, reconstruction, modernization and creation of conditions for desired diversification. Possibilities of modern sciences and technics come to expression in the

subject specialized equipment that is determined for production of the higher mass levels, where it is possible to achieve a high level of integration and aggregation of driving mechanism and tools of the basic processing with measuring technic, regulation and managing machines work or systems of machines. Rendering profiles of production and enlarging concentration of same production better conditions are created for more intense research and developmental activities and growth of efficiency of materialization of their results through better products and more efficient process'.

Dangers have brought us in situation where the chances of development options have widened and enlarged.

CONCLUSION

Institutions will behave in a direct correlation and in accordance with the way things function. Service sector implies the existence of absolute state of mobility, and highest number of changes, transformations, development orientations as well as declensions will happen in a production sector. Compromises between the line of influential factors on overcoming the existing and creation of new ways of growth in development are imminent. Large foreign influence should be put down to a desirable amount that will allow necessary to show need for efficient affirmation, and for protection of own citizens. Domestic capacities, and theory and practice show that from position of demand of production optimum, their projection or growth of the installed capacity needs to be at least 50% smaller in a function of export, with that, that the other 50% expresses function of enough to settle domestic needs. That measure of 50%: 50%, as a relation of domestic and export market is a function of formation an economic rational capacity. Development orienteers are desira-

ble diverse as supply and as an answer to a potential dynamic prospectively expressed demand. Relations of dependence between the profiles of capacities and profiles of production, and profiles and capacity size, capacity dependence on location, and size of capacity from profile of production, and capacity size from location, must be respected.

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CHARACTERISTICS OF THE MAIN FANS OF THE ACTIVE UNDERGROUND MINES JP PEU – RESAVICA

Abstract

Ventilation is a very important phase in mining from the point of view of continuous works in the underground mines and safety of the employees. For the ventilation of the active underground mines of JP PEU Resavica the artificial ventilation is used with the main fans installed within the ventilation in active plants. According to the characteristics of the ventilation networks, the appropriate main fans were also selected. In this paper, the characteristics of fans in the active underground mines and an analysis of their works are presented, and the suggestions for their improvement are given within the discussion.

Keywords: coal mine, underground mine, mine ventilation, fan, fan characteristics

1 INTRODUCTION

In a complex process of ventilation design of an underground mine, it is important to process systematically, followed by the phases: the selection of ventilation methods, the ventilation scheme selection, analysis of parameters of influence for ventilation system design, calculation of required quantities of air by parts of ventilation network and total, air velocity, analysis of depression ratio, the selection of main and auxiliary fan, definition of separate ventilation, method and organization of ventilation control and presentation the economic parameters for the designed ventilation system.

For the choice of the main fans, the basic element is a dynamic development of mining (exploitation) works, there the fan should satisfy the safety and economic effects. This primarily refers to a slight change in the air volume flow, depression and coefficient of efficiency.

The purchase of the main fan is associated with the age of mine, which complicates the selection process. Also, the operation of fan must be constant and stable, and in case of excessive situations the procedure of manipulation with the fan and during the air flow in response to the resulting disturbances should be developed.

In the active mines of JP PEU Resavica, the main ventilation systems have been established artificially, depressed with the main fans, while a diagonal air control system is present in the all facilities. In this case, different types of fans from different manufactures have been applied in practice, and in this paper, systematization of the types and characteristics is performed, considering that so far this not been done in the technical and project documentation. Namely, the ventilation projects were done partially in the mines, and there was a need to show the applied

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main fans in one place and give the suggestions for improvements.

2 MINING FANS

Turbomachines used for mechanical ventilation of the mines by establishing the air flow called the mine fans. The mine fans are used for the main ventilation (main fan), special-separate ventilation (pipe fans) and regulation the air distribution in the ventilation network (auxiliary fan).

The mine fans are classified into a number of groups and categories according to the principle of construction (centrifugal, axial), location of installation (above ground and underground), capacity (small, medium and large), depression (small, medium and high), power of the drive motor (low, medium and high power), coefficient of efficiency (low, medium and high economic).

In relation to its working possibilities, one fan is defined by a diagram of characteristics that correspond to the different speeds and different angles of blades rotation, and consist of three curves: curve of the air flow dependences on depression,

power motor curve and efficiency curve. Today, the predominant types of axial fans are in use, since they are defined as the multistage by their construction, which creates an adequate depression, and they have a drawback of construction the centrifugal fans.

During the operation of the main fan, changes in the air flow and depression are achieved in several modes:

- changing the speed of the main fan,
- changing the angle of rotor blades,
- changing the equivalent opening of the mine (characteristic of the ventilation network).

In a larger mine, ventilation is sometimes established by the joint operation of several fans (serial, parallel operation), which requires the careful regulation. Figure 1 presents a layout of one fan for the main ventilation, while Figure 2 presents a diagram of the operating characteristics.

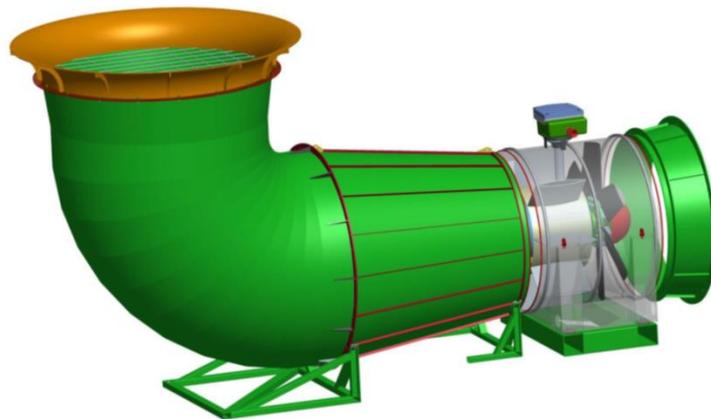


Figure 1 Layout of the main fan type AVJ 1500-6-75 in the Štavalj mine

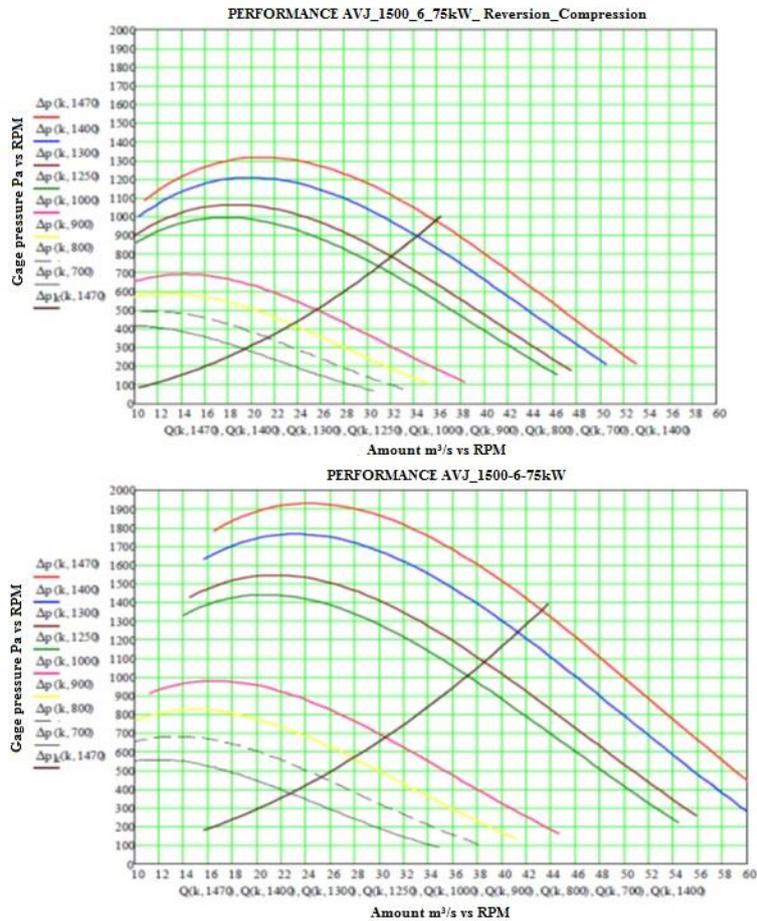


Figure 2 Diagram of the operating characteristics of the main fan type AVJ 1500-6-75

3 RESEARCH OF THE CHARACTERISTICS OF THE MAIN FANS INSTALLED IN THE ACTIVE MINES IN JP PEU

In the mine ventilation design, it is important to take into account the technological scheme of the underground mine, applied systems and dynamics of exploitation and especially the analysis of natural conditions.

From the aspects of ventilation, the following natural conditions related to the coal seam and surrounding rocks are important

- depth of incline,
- gas content (especially methane content and methane abundance),
- characteristics of coal dust (explosiveness, flammability),
- natural tendency towards to self-ignition.

The analysis of the natural conditions led to the results given in Table 1.

Table 1 Overview of the basic natural conditions influencing to the ventilation design and choice of the main fan

Mine-underground	Natural conditions				
	Depth of inline (m)	Methane bearing (m ³ /tru)	Dust explosiveness (g/m ³)	Dust self-ignition (°C)	Coal self-ignition (°C/min)
Vrška Čuka -underground mine Avramica	up to 270	10	Non-explosive	Not self-ignition	Not self-ignition
Ibar Mines -undeground mine Jarando	470	0,24	70-110	630-700	69-98
RMU "Rembas" – underground mine Senjski rudnik	350	Registered appearance	200	260-290	118-140
RMU "Rembas" – underground mine Strmosten	480	Registered appearance	180	280-290	110-120
RMU "Rembas"– underground mine Ravna Reka	250	Registered appearance	75	250	55-95
Mine Bogovina – underground mine Ist. polje	240	Registered appearance	225	250	80-120
Mine Soko – underground mine Soko	450	1.8-7.1	230	250-350	115-188
Mine Jasenovac – underground mine Jasenovac	220	Non-methane	225	260	80-100
Mine Lubnica – underground mine Osojno	200	Registered appearance	110	215-235	80
Mine Štavalj – underground mine Štavalj	280	Non-methane	-	220-280	103-111

According to the depth of the works, which determines the lengths of air flow line, most of the underground mines belong to the medium deep mines, with the deepest underground mines as Strmosten, Jarando and Soko.

By measuring the gas condition, the mines Avramica, Jarando and Soko were categorized as methane and with a methane mode of activities, while in the mines Štavalj and Jasenovac no methane appearance was found. In the other mines, only methane

appearance was registered, and in low limits which categorized them as the non-methane.

Coal dust in all mines, except the Avramica mine, shows the explosive and flammable characteristics in certain conditions, which are reflected in the solutions in the field of ventilation. Coal of coal seams in all mines, except the Avramica mine, showed a risk of endogenous fire, which was confirmed by the results of numerous tests and large number of fires in almost all mines.

The fans for the main ventilation of mines, especially those with appearance of explosive gases and explosive coal dust are constructed precisely according to the regulations, standards, norms and rules. The fan plants consist of the main and auxiliary fan, a device for changing the air flow, ventila-

tion duct, energy supply equipment and equipment for registration and control of fan operating parameters. By control the mine ventilation plants revealed that the main and auxiliary fans of different types and several manufacturers were installed, which is shown in Table 2.

Table 2 Layout of the characteristics of installed fans for the main ventilation in the mines of JP PEU

Mine	Fan	Parameters					
		Fan type	Manufacturer	Capacity (m ³ /s)	Depress. (Pa)	Rating (kW)	Engine speed (°/min)
Vrška Čuka -underground mine Avramica	main		Ventilator-Zagreb	12	488	37	520
	auxiliary		Ventilator-Zagreb	12	488	37	520
Ibar Mines -underground mine Jarando	main	AV-1000		20	1200	45	1460
	auxiliary	AV-1000		20	1200	45	1460
RMU "Rembas" – underground mine Senjski rudnik	main	AVV-12-154-2	Klima Celje	23	1030	55	1480
	auxiliary	AVV-12-125-4	Klima Celje	28	500	22	985
RMU "Rembas" - underground mine Strmosten	main	AVV-12-125-4	Klima Celje	40	2700	75	1500
	auxiliary						
RMU "Rembas" – underground mine Ravna Reka	main	N-HVV-D-125	Klima Celje	40	1000	30	1460
	auxiliary						
Mine Bogovina - underground mine Istočno polje	main	N-AVV-D-125	Klima Celje	23	800	30	975
	auxiliary	N-AVV-D-125	Klima Celje	23	800	30	1460
Mine Soko – underground mine Soko	main	GVh-15-160	Turman	83	2800	160	1460
	auxiliary	CN-125	Termo-elektro	38	1460	50	1460
Mine Jasenovac - underground mine Jasenovac	main	N-AVV-D-125	Klima Celje	23	800	30	1460
	auxiliary	N-AVV-D-125	Klima Celje	23	800	30	1460
Mine Lubnica – underground mine Osojno	main	AVJ-1500(45)	Delta Air	10-40	2800	55	1470
	auxiliary	SC-160	Minel BG	15	500	30	1445
Mine Štavalj – underground mine Štavalj	main	AVJ-1500-6-75	Delta Air	10-40	2800	55	1470
	auxiliary	NAVV-D-140/56	Klima Celje	40	880	75	980

4 DISCUSSION

Mine ventilation has the main task of constantly changing the air flow in all mines through a continuous movement of air to maintain a climate suitable for work, to

dilute harmful and dangerous gases and take them to the surface. In the all mines of JP PEU, the main fans with associated equipment are used, which establishes the appro-

appropriate artificial ventilation. The equipment and devices inspection and appropriate measurements within ventilation systems of the characteristics of fans and their operation mode of the existing intensity of work have determined. Based on the above, for the first time, the data of the main fans were systematized in one place and a comparison of the determined parameters was performed.

The analysis of development options of active underground mines in JP PEU estimates that the prospective underground mines Soko, Štavalj, Lubnica and Strmosten have the adequate coal reserves, while the other underground mines are about to close, outsourced of the remaining reserves, and a special attention should be paid to the equipment and devices for ventilation of the prospective underground mines.

The obtained results indicate that in the Soko mine, when designing the intensity of mining operation and natural-geological conditions, the limitations may appear, related to the characteristics of the main fan and increased intensity of the mining operations.

5 CONCLUSION

The subject of research within of this topic are the characteristics of the main and auxiliary fans, as well as other equipment within the ventilation plants of the active underground mines of JP PEU Resavica, in order to assess their operational readiness for the normal support of ventilation systems.

For the current intensity of mining operations in the mines, the ventilation systems are able to provide the necessary amount of air for work and dilution of the harmful gases concentrations. No restrictions are expected from the analysis of the development plans, except in the Soko mine, where the amount of air delivered by the main fan at the upper limits is for the current scope of work.

Installed fans are mostly of older constructions and have been in operation for many years (over 40 years), except in the mines Štavalj and Lubnica (up to 10 years) and Soko (30 years), and the process of air current reversion is slow and difficult to satisfy the regulations on the main fans. This requires the changes that would address these shortcomings.

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SUPPLIER RANKING IN THE PUBLIC COMPANY FOR UNDERGROUND COAL EXPLOITATION RESAVICA IN AN ASPECT OF DELIVERY

Abstract

The aim of this paper is to show the application of multi-criteria analysis (PROMETHEE method) in the selection of suppliers that operate in the mining systems, specifically in the Public Company for the Underground Exploitation of Coal Resavica (PCUEC Resavica)- Serbia. The company ranking was done in terms of delivery according to five criteria. The criteria cover the most prominent aspects of the delivery management of suppliers. Accordingly, 5 suppliers were taken into consideration. In the ranking process the expert knowledge of specialists from the PCUEC Resavica was used. Firstly, the determination of importance and impact of certain criteria to the process of supplier selection was done, and after that the assessment of suppliers according to each criterion is performed by the company experts. The PROMETHEE method is used for the final ranking of suppliers. The obtained results show that the applied combined method gives the excellent results and it can be used for solving a large scale of complex problems in mining systems.

Keywords: *supplier selection; production systems; ranking; mining systems; PROMETHEE*

1 INTRODUCTION

Suppliers selection is one of the most important tasks for mining managers with aim to create a long-term sustainability and stability of the company. The supplier selection process implies application of different statistical techniques, as well as the Multi-Criteria Decision Making methods [1,2]

The multi-criteria analysis methodology represents a good basis for solving the proposed problem. This methodology allows managers to obtain a priority list, based on ranking the alternatives by many different, opposite and often contradictory criteria at the same time. Also, the decision maker must have a big amount of relevant data for analysis in order to obtain the correct results. The most well-known methods are the analytic hierarchy process (AHP), analytic network process (ANP), TOPSIS and PRO-

METHEE. The PROMETHEE method has many advantages compared to the other methods. The most important advantage is its capacity for obtaining the results in the contradictory condition and criteria.

The basic aim of this paper is to solve the supplier selection problem applying the PROMETHEE method based on the expert knowledge of specialists from the mining company for ranking of their suppliers in terms of delivery. The researches have been done in the PCUEC Resavica (case study).

The ranking process is done by the Decision Lab software which supports the PROMETHEE method and enables sensitivity analysis. Also, this software supports the visual tool called the GAIA plan for identification of conflicts among criteria and for grouping of the alternatives [3].

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2 PROMETHEE METHOD

The PROMETHEE is a ranking method based on the selection of the best preference function and the weight coefficients for each criteria (Brans et al., 1984). Preference function determines the way of ranking a certain alternative according to another alternative and translates the deviation between them. The PROMETHEE method has at its disposal 6 forms of preference (Usual, U – shape; V- shape; Level, Linear, Gaussian). Each form depends on two indifference thresholds (Q and P). Threshold (Q) represents the maximum deviation which the decision maker sees as unimportant, while the indifference threshold (P) represents the minimum deviation which is considered to be important for the decision maker. Threshold Q must not be higher than P. Gaussian threshold (s) is the intermediate value of P and Q thresholds [4,5].

The PROMETHEE method calculates the positive-entrance flow ($\Phi^+ \rightarrow 1$), and the negative-exit flow (Φ^-) for each alternative according to the outranking relations, in accordance with weight coefficients for each

criterion. The positive preference flow shows the significance of a certain alternative, i.e. the higher value ($\Phi^+ \rightarrow 1$), the more significant is the alternative. The negative preference flow (Φ^-) shows how a certain alternative is preferred in accordance with the other alternatives. The smaller value of the exit flow ($\Phi^- \rightarrow 0$) indicates more significant alternative.

Complete ranking (PROMETHEE II) is based on the value of the net flow (Φ), which represents the difference between the positive and the negative preference flow. The best ranked alternative is the one with the highest value of the net flow [6].

3 CASE STUDY

The Public Company for the Underground Exploitation of Coal Resavica (PCUEC Resavica) - Serbia is a very complex system for coal exploitation and processing in Serbia. This system has eight mines located in the central part of Serbia (Figure 1).



Figure 1 Mines of PCUEC Resavica

The complex system like this demands a wide range and reliable suppliers which can meet its needs. In this paper is proposed the model of supplier selection according to the provided delivery of services and goods to the PCUEC Resavica. The model consists several phases – Figure 2.

Creation of selection committee is the first step. It consists of procurement experts and technical executives from the company. They identify the criteria and determine their impact, as well as the supplier's assessment of each criteria.

Criteria identification is the next step, which is extremely important for supplier selection. The criteria represent one of the most important factors for the process of supplier ranking. In this paper, the focus is on the delivery of services by suppliers to PCUEC Resavica. The most important criteria of delivery defined by selection committee are: the time required for the manufacture of products (C1), delivery reliability (C2), component safety and security (C3), adequacy of packaging standards (C4) and degree of product match (C5).

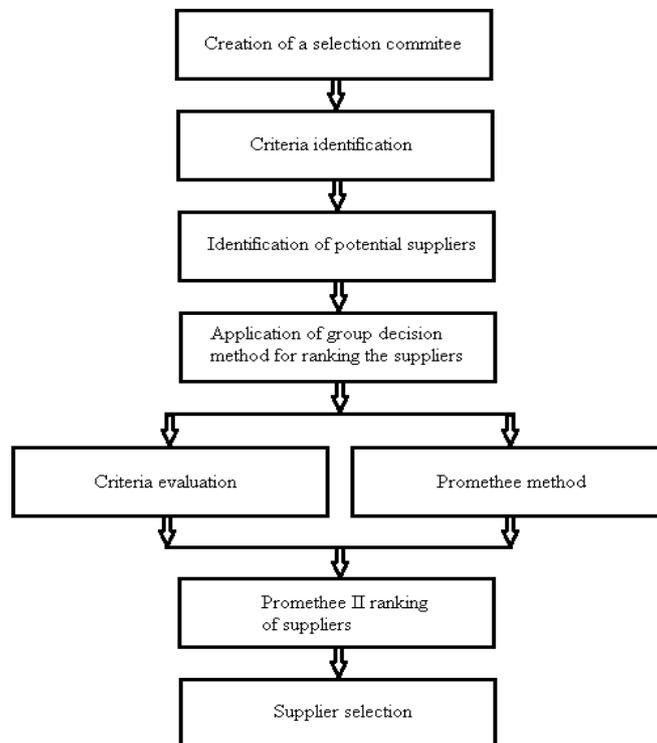


Figure 2 Proposed model for supplier selection

Identification of potential suppliers is next step of a selection model. For supplying of the PCUEC Resavica apply several suppliers. In this paper are identified five potential suppliers which are labeled 1; 2; 3; 4 and 5.

The next step is application of a group decision method for ranking the suppliers. This is the most important, but also the most complex stage of the proposed decision model. This is executed by ten experts from the PCUEC Resavica (E1 – E10) who are

directly involved with suppliers and who use the products and services provided by the suppliers (members of the selection committee – managers, supervisors, employees in the procurement departments, employees in the manufacturing and maintenance sectors).

Their first task was to evaluate criteria, i.e. to determine the weight coefficients

which represent their magnitude of the impact to the result of ranking of the suppliers. The weight coefficients of a criteria is determined by each expert, by filling the table grading the importance of the criteria from 0 to 1, where the sum of all weight coefficients should be 1. Table 1 shows the results of criteria evaluation, as well as the middle value of their weight coefficients.

Table 1 Value of criteria weight coefficients obtained from the experts, as well as their middle value

Expert Criteria	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	Middle value
C1	0.2	0.3	0.3	0.35	0.45	0.4	0.28	0.3	0.25	0.3	0.313
C2	0.3	0.35	0.3	0.35	0.25	0.35	0.25	0.35	0.25	0.3	0.309
C3	0.3	0.15	0.2	0.1	0.15	0.15	0.18	0.15	0.25	0.2	0.169
C4	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.20	0.1	0.118
C5	0.1	0.1	0.1	0.1	0.05	0.09	0.09	0.1	0.05	0.1	0.090
Sum	1	1	1	1	1	1	1	1	1	1	1

After criteria evaluation, the PROMETHEE method is used for evaluation of the suppliers. Due to the qualitative or uncertain structure (assessment of suppliers) of the decision process, the appropriate qualitative

five levels scale is used to enable quality comparison of the suppliers. Table 2 shows the qualitative scale with the numeral value for each qualitative mark.

Table 2 Qualitative scale

Qualitative value	Very low	Low	Middle	High	Very high
Numeral value	1	2	3	4	5

In order to create the evaluation matrix for PROMETHEE method, the evaluation of the suppliers in respect to the criteria has to be done. This is done by the same ten experts from the PCUEC Resavica. They have filled the table thus assessing the suppliers with marks given in Table 2. Table 3 shows the results of supplier assessments expressed through the middle value of all marks based on the marks given by all the experts.

After evaluation of the suppliers, the evaluation matrix for the PROMETHEE method is created (Table 4). The level shape of preference function is chosen according to the qualitative character of data for criteria and alternatives. The indifference and preference thresholds (Q and P) values are chosen in 5% and 30% zones, respectively.

Table 3 Middle value of supplier marks in respect to the criteria

Supplier Criteria	Supplier 1	Supplier 2	Supplier 3	Supplier 4	Supplier 5
C1	2.8	4.2	4.3	4.1	4.5
C2	3.1	4.8	4.9	4.2	4.7
C3	3.6	4.6	4.6	4.7	4.5
C4	3.0	4.4	4.5	4.6	4.8
C5	3.1	4.5	4.3	4.6	4.7

Table 4 Evaluation matrix

Criteria	C1	C2	C3	C4	C5
Max/min	max	max	max	Max	Max
Weight coeff.	0.313	0.309	0.169	0.119	0.090
Function of preference	Level	Level	Level	Level	Level
Supplier 1	2.8	3.1	3.6	3.0	3.1
Supplier 2	4.2	4.8	4.6	4.4	4.5
Supplier 3	4.3	4.9	4.6	4.5	4.3
Supplier 4	4.1	4.2	4.7	4.6	4.6
Supplier 5	4.5	4.7	4.5	4.8	4.7

Base on the evaluation matrix, the software Decision Lab is used for evaluation the suppliers (alternatives). Table 5 shows

the value of the positive (Φ^+), negative (Φ^-) and net flows (Φ) for suppliers ranking taken from the Decision Lab software.

Table 5 PROMETHEE preference flows

Alternatives	Φ^+	Φ^-	Φ
Supplier 1	0.0000	0.4367	-0.4367
Supplier 2	0.1039	0.0000	0.1039
Supplier 3	0.1039	0.0000	0.1039
Supplier 4	0.1039	0.0000	0.1039
Supplier 5	0.1250	0.0000	0.1250

The complete ranking of suppliers is done by the PROMETHEE II (Figure 3).

Here, the values of flows (Φ) from the last column of Table 5 are used for ranking.

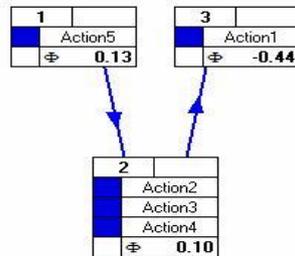


Figure 3 PROMETHEE II complete suppliers ranking

According to the PROMETHEE II complete ranking, the best alternative is the supplier 5. The other suppliers are ranked in this order: supplier 2, supplier 3, supplier 4 and supplier 1 (Figure 3).

The last step of the proposed model is a supplier selection. On the basis of realized complete procedure defined by the applied model of decision making, i.e. choosing the best supplier in terms of quality of goods

and services for the PCUEC Resavica, it was decided that the best one is supplier 5. So, the supplier 5 is finally selected for the future procurement,

4 ANALYSIS OF THE OBTAINED RESULTS

The analysis starts from criteria. All criteria can be divided into two global groups

in terms of their importance for suppliers ranking. The first group of criteria consists of the most influential criteria – (C1) the time required for manufacture of products, (C2) delivery reliability, (C3) component safety and security.

The second group of criteria consists of less influential criteria (about 10% for each one) – (C4) adequacy of packaging standards, (C5) degree of product match. This indicates that adequacy of packaging standards, degree of product match is much less acceptable by the experts. According to this, for experts are much more important the criteria that enable the selection of better suppliers – criteria from the first group.

As far as suppliers are concerned, the best one is supplier 5. This supplier has the best marks from the aspect of criteria C1- the time required for the manufacture of products, C4- packaging standards and C5- degree of product match. From the aspect of the rest of the criteria, this supplier has got good marks. They are a little below level comparing with the second ranked suppliers 2, 3 and 4.

On the second place in ranking are supplier 2, 3 and 4. Those suppliers have a bit weaker or almost the same marks, compared to the first ranked supplier in all criteria. They have very similar marks, compared to each other. Based on the overall rating, they are identical in strength and ranked on the second place.

The last place is taken by the supplier 1, which is the lowest rated in terms of all criteria.

Based on the obtained results, the advantage needs to be given to the supplier 5 which is the best compared with the other suppliers.

CONCLUSION

In this paper is applied the PROMETHEE decision method for ranking of suppliers in the PCUEC Resavica in terms of the delivery of their goods and services. Based on the ranking results, the best suppliers are selected in order to provide a long-

term sustainability and stability of the company. Five suppliers (supplier 1, 2, 3, 4 and 5) are analyzed in this process in terms of five criteria for ranking – the time required for the manufacture of products (C1), delivery reliability (C2), component safety and security (C3), adequacy of packaging standards (C4) and degree of product match (C5). Based on the obtained results by the PROMETHEE method, the best supplier is selected which is supplier 5. The most influential criterion for ranking is the criteria C1 (the time required for the manufacture of products).

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ILLUSTRATION AN ADVANTAGE ASSESSMENT OF THE QUALITY MANAGEMENT SYSTEM IMPLEMENTATION INTO METALLURGICAL ORGANIZATIONS**

Abstract

Implementation of the quality management system (QMS) in organizations is directly linked to the performances and business activity relative to a competition. With increasing market competition and changing markets, the quality system becomes a significant component and is increasingly being researched and identified as a major factor in cooperative advantage over competition, stakeholder satisfaction and maintaining the good customer relationships in almost all organizations connected with metallurgy. This paper implements a multi-criteria approach to a decision-making based on the Analytic Hierarchy Process. The aim of this paper is to illustrate the assessment of benefits of the quality system implementation ranking the criteria for a sustainable development by the MCDM models.

Keywords: *Quality System, Analytic Hierarchy Process, advantages*

1 INTRODUCTION

ISO 9001 is an international standard and contains all the requirements where a company can plan and manage by the best way. By implementing the QMS, the organization harmonizes business activity with the international norms and requirements. [1]

This paper is aimed to present an evaluation of implementing benefits into the quality management system in the field of metallurgy, which would encourage managers of the organization to apply it.

Evaluation of the advantages of implementing the ISO 9001-Quality Management System into organizations is important for its positioning, assessment of where it is in relation to a competition, improvement of products and services,

dissemination of markets and products, improvement the performance, increasing profits and sustainable development.

This international standard specifies the requirements of the quality management system, as follows:

a. When an organization needs to demonstrate its ability to consistently provide a product or service that meets the requirements of users and applicable laws and regulations;

b. When an organization is aimed to increase a customer satisfaction with the effective system implementation, including the processes of continuous system improvement and demonstrating a compliance with the customer requirements and applicable laws and other regulations, and

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c. When all the requirements in this International Standard are generic and intended to be applicable to all organizations in the field of metallurgy, regardless of their type, size and the products they provide.

The purpose of the quality management system (QMS) is to increase the company efficiency through the process approach application [1]. The goal of QMS implementation is for the company to demonstrate the ability of providing the products and services that provide satisfaction to the customer using legislations and regulations. The company that implements the QMS in accordance with the standard requirements is aimed to identify the expectations of users (customer, seller, supplier, employees).

Evaluation of the implementation advantages was done applying the AHP method (Analytical Hierarchical Process), one of the methods of Multiple Criteria Decision Making (MCDM).

The MCDM methods are auxiliary tools for the decision makers, managers in the decision-making process to solve real, diverse problems in various areas of business activities as well as in the field of metallurgy.

In the past decades, several methods have been proposed in the field of MCDM, such as TOPSIS [2], AHP [3], ELECTRE [4], VIKOR [5], COPRAS [6], ARAS [7] and other methods. There are a number of software programs that help the MCDM methods to quickly solve tasks; the most famous are: QM for Windows, Electra, Expert Choice, Decision Lab, Criterium Decision Plus.

2 THEORETICAL FRAMEWORK

The multi-criteria decision-making techniques, MCDM methods, have been used and developed by many researchers and applied in many real problems.

The goal of the researchers is to use the MCDM method to evaluate alternatives or criteria, and find the best solutions to the current problem.

The MCDM methods are multi-criteria decision-making methods that can be defined as the process of selecting the most appropriate solution from a range of available alternatives, based on their performance in relation to a set of evaluation criteria [8].

The choice of MCDM methods is important for the decision makers, but much more important is the proper structuring of the problem itself, which includes the assessment of appropriate alternatives and selection of the most important criteria [9,10].

These methods have their advantages for their application, they consider different criteria in the selection process, namely: financial and non-financial; qualitative and quantitative, and others.

The most common of these models are evaluation methods, Analytical Hierarchical Process (AHP). Thomas Saaty [3] gave the conceptual and mathematical setting of the AHP method.

Methodologically, the AHP is a multi-criteria technique that belongs to the class for soft optimization and is based on decomposition a complex real problem in the hierarchy.

The goal of decision maker to be addressed is at the top of the 0-level hierarchy. The criteria that are compared with each other are at the lower level I, while the alternatives that are compared with each criterion are at the level II, Figure 1.

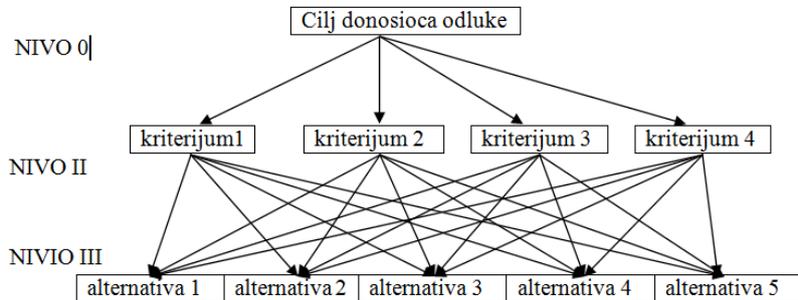


Figure 1 Analytical process of hierarchy

Using the Saaty scale, two elements (criteria or alternatives) are compared, Table 1.

Table 1 Saaty scale

Evaluation	Description	Explanation
1	Same significance	Two elements are of identical importance in relation to the goal
3	Weak dominance	Reasoning slightly favors one element over another
5	Strong dominance	Reasoning significantly favors one element over another
7	Very strong dominance	Dominance of one element confirmed in practice
9	Absolute dominance	Dominance of the highest degree
2,4,6,8	Intermediate values	Compromise is needed

So first, the criteria are compared with each other in relation to the goal of decision at the top.

Then, each criterion is compared with each alternative in relation to the goal of the decision maker (assessment of significance); the order of alternatives by importance (ranking) is determined.

The synthesis of all evaluations is performed according to a mathematical model where the weight coefficients of all elements of the hierarchy are determined. The sum of the weight coefficients of elements is equal to 1, which enables the decision maker to evaluate or rank all elements in the horizontal and vertical sense [11,12].

The AHP is one of the methods where the inconsistencies of decision makers in the process of reasoning and evaluation of elements of hierarchy are identified and analyzed.

The degree of consistency (CR) represents the ratio of consistency index (CI) and random index (RI):

$$CR = \frac{CI}{RI} \lambda \quad (1)$$

where the CI consistency index is calculated from the form:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (2)$$

where λ_{\max} is the maximum eigenvalue of the comparison matrix and the rule is that the closer λ_{\max} is to the number n , the less inconsistency will be.

The random index (RI) depends on the order of matrix, and is taken from Table 2, in which the first row represents the order of comparison matrix, and the second the random indexes [3].

Table 2 Random indexes [3]

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.0	0.0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

The consistency degree (CR) is less than 0.10 and then the result is correct, there is no need for re-analysis. If the CR is greater than 0.1, then a re-analysis of inconsistency is required until the consistency degree less than 0.1 is obtained.

3 NUMERICAL ILLUSTRATION

The idea of the author is to illustrate the AHP method application for assessment the importance of the advantage criteria of implementation the quality management systems in the field of metallurgy. The AHP method is used as an auxiliary tool for the decision makers (DO) to solve the real semi-structural and non-structural decision problems using the Criterium Decision Plus software.

The goal is defined by the decision maker. By evaluation the importance of criteria, the advantages of implementing the quality management system are further defined by the criteria.

The criteria contain the most important characteristics for assessing the benefits of implementing a quality management system.

The evaluation criteria are defined as the evaluation criteria that are of great importance for decision makers to resolve the real conflict problems and making a final decision.

There are the following rules in defining the criteria:

1. The criteria are closely related to the objective;

2. They relate in a great detail and precision to the quality structure of decision;
3. They are simply formulated and understood;
4. They are operationalized in relation to the level of achievement; and
5. They are known to the decision makers.

The selected criteria for evaluation the benefits of implementation the quality management system are as follows:

1. Increasing the customer satisfaction;
2. Increasing the employee safety;
3. Market penetration and product diversification;
4. Participation and tendering;
5. Measuring the company performances;
6. Company image; and
7. Company development and improvement of products and services.

Criterion 1. Criterion of increasing the customer satisfaction is important for the survival of an organization. Quality service and product of the organization means that the customer is satisfied with the choice of products and services. By increasing the customer satisfaction, the organization takes a better position in relation to the competition, becomes more competitive, reduces the servicing costs, reduces the complaints and

reclamations, increases the production and sale of products, and thus increases the profits. Dissatisfied users of products and services are a threat to the organization.

Criterion 2. Increasing employee safety. The implementation of the QMS increases the safety of employees and enables employees to use the ISO standards with which they perform work tasks more efficiently. Standardized QMS procedures help employees to improve the way they do the business activities, give them instructions for work, provide models for creating better quality products and services with constant control of the work process. The advantage of this criterion is reflected in the establishment of a better organizational culture.

Criterion 3. Market penetration and product diversification: By implementation the quality management system, organizations receive the certificates on introduction the ISO 9001 standard. Organizations make their own advertisements and websites. Advertisements and websites provide organizations with market expansion increasing the sales of current products (market penetration) and expanding the range of products and services (product diversification).

Criterion 4. Participation and tendering. This criterion is important for organizations and one of the conditions for cooperation with organizations that have already implemented the ISO standards. Possession of a certificate is a condition for participation and winning a tender; it is also a condition for organization to be able to work. Implementation of the QMS is a safe business for organizations and constant improvement and management the quality system of working processes.

Criterion 5. Image of the organization. This criterion is important for the present and future of an organization. With the QMS introduction, the organizations gain a well-positioned place in the market. The metallurgical organization enters the business world with a recognized certification that deals with the constant improvement of the quality of products and services. This criterion is reflected in improvement the image of organization, improvement the organizational culture, striving to the quality products and services, continuous improvement the production processes, work processes, harmonization of products and services with the customer requirements and constant checks.

Criterion 6. Measuring the organization performances. This criterion is important for the organization business activity. With the QMS introduction, the performance of an organization is constantly checked on the basis of eight principles of the quality management system. Verification is performed by the senior management in order to meet the needs of all stakeholders.

Criterion 7. Development of the organization and improvement the products and services, introduction of the ISO 9001 standard, quality management systems, increases the customer satisfaction with the effective system application. This criterion includes the constant improvements in the work process of organizations and proving a compliance with the requirements of all users.

The criteria defined in this way are compared with each other in relation to the goal using the Saaty scale shown in Table 1. Values of the mutual comparison of criteria are entered in Table 3.

Table 3 Matrix of criteria comparison

Criteria	C ₁ (Increasing of customer satisfaction)	C ₂ (Increasing of employee safety)	C ₃ (Market penetration and product diversification)	C ₄ (Participation and tendering)	C ₅ (Company image)	C ₆ (Measuring an organization performances)	C ₇ (Company development and improvement of products and services)
C ₁	1	5	3	7	5	7	5
C ₂		1	1/2	1/3	1/3	1	1/2
C ₃			1	1	1/3	5	3
C ₄				1	1/2	1/5	1/3
C ₅					1	1	1/2
C ₆						1	1/3
C ₇							1

This paper requires 7 comparisons. The number of comparisons is equal to $n \times (n-1)/2$. So it should correspond to the number of combinations of n elements of the second class, but without repetition. The value 1 is written everywhere on the main diagonal.

Criterion Decision Plus software was used to determine the weighting coefficient

for easier mathematical calculation and more precise evaluation of the criteria.

Table 4 shows the results obtained by the AHP calculation. The consistency degree according to the calculation should be less than 0.1, which is also obtained here; its value is 0.053.

Table 4 Results obtained by the AHP calculation

Criteria	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇
Weighting coefficients of criteria	0.393	0.068	0.146	0.068	0.128	0.085	0.113

Consistency coefficient $0.053 < 0.1$

The following results were obtained by the data processing.

Criterion C₃, market penetration and product diversification are at the second place in importance for the needs of introduction the quality management system, because its weighting coefficient is 0.146. The implementation of QMS enables the organization to expand the market and increase production while constantly monitoring the quality of products and services. The expansion of the market and increased sales of products and services of the metallurgical organization are beco-

ming more profitable. The advantages of this criterion bring the organization to a better position.

Criterion C₅, the image of metallurgical organization is at the third place in importance for the needs of QMS implementation, because its weighting coefficient is 0.128. The advantages of this criterion for decision makers are: the ability of metallurgical organization to improve the organizational culture in the future, to improve the quality of products and services with constant checking of work processes and constant striving to improve the image.

Criterion C₇, development of metallurgical organization and improvement the products and services are at the fourth place, because its weighting coefficient is 0.113. The advantages of this criterion for the QMS introduction are: increased satisfaction of all stakeholders including the constant checks of employees, suppliers, users, customers by the internal and external auditors. One significant advantage of this criterion is the verification of the use of QMS standards and compliance with the user requirements.

Criterion C₆, measuring the performance of metallurgical organization ranks the fifth place in advantage for the QMS implementation, because its weighting factor is 0.085. The advantages of introduction the QMS are: constant checking of the organization performance based on the eight principles of the quality management system performed by the senior management in order to meet the needs of all stakeholders (employees, users, distributors, suppliers, and others).

Criterion C₂, increasing the employee safety and **Criterion C₄**, participation and tendering, rank the sixth place in the assessment of benefits of the QMS introduction, because their weighting coefficients are 0.068. These two criteria are equally important for decision makers when deciding to introduce the ISO standards.

The advantages of evaluating the QMS introduction of these criteria are: procedures that employees must follow when performing their work duties and applying and obtaining the tenders. Without procedures, the metallurgical organizations cannot do business activities with other organizations that have implemented the QMS, there is no participation and tendering. Not following the procedures prescribed by the QMS, many work processes cannot be accredited, while the scientific research institutions (institutes and faculties) cannot be accredited for work.

Table 5, illustration of criteria, shows the order of criteria advantages as an aid to decision makers in deciding on introduction the quality management system.

Table 5 Illustration of criteria

Ord. No.	Criteria	Result
1.	C ₁ (Increasing of customer satisfaction)	0.393
2.	C ₃ (Market penetration and product diversification)	0.146
3.	C ₅ (Image of metallurgical organization)	0.128
4.	C ₇ (Development of metallurgical organization and improvement the products and services)	0.113
5.	C ₆ (Measuring of metallurgical organization performances)	0.085
6.	C ₂ , C ₄ (Increasing the employee safety; participation and tendering)	0.068

Figure 2 shows the decision hierarchy obtained using the Criterion Decision Plus

software, while Figure 3 shows a diagram illustrating the criteria advantages.

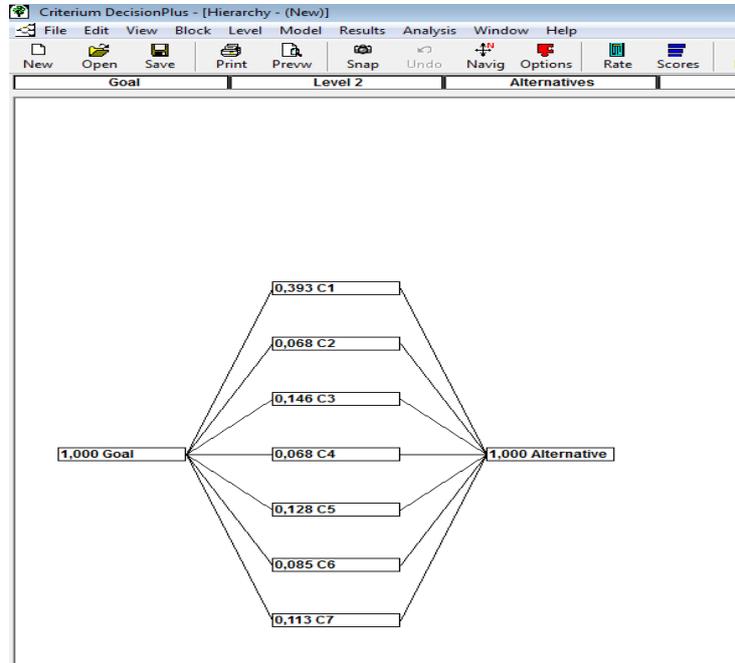


Figure 2 Hierarchy of decision making



Figure 3 Diagram of graphical representation the illustration of advantages of implementing the quality management system

4 CONCLUSION

Based on the realized research, it was concluded that the assessment of advantages of implementation the quality

management system gives a clear picture to the decision makers in the metallurgical organizations about the criteria.

Illustration of criterion evaluation was done by the AHP method using the Criterion Decision Plus software and the following results were obtained:

- Numerical illustration shows that the biggest advantage for the QMS introduction has the criterion C_1 , user satisfaction whose weighting factor is 0.393.
- Then, criterion C_3 , market penetration and product diversification, with a weighting factor of 0.146.
- Criterion C_5 , the image of the metallurgical organization, with a weighting factor of 0.128. Criteria C_3 and C_5 have approximate values so that their impact on decision makers acts almost equally.
- Criterion C_6 , measuring the performance of metallurgical organization, with a weighting factor of 0.085 and criterion C_2 , increasing the employee safety and criterion C_4 , participation and tendering, with a weighting factor of 0.068 act identically on decision makers when deciding to implement the quality management system.

Methods of multi-criteria decision-making have application in the decision-making process in various economic branches, including in the field of metallurgy.

This methodology in science is subject to a constant improvement and upgrading in various scientific branches that are based on several diverse criteria and alternatives.

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DEVELOPMENTAL TENDENCIES FOR THE DIGITAL PERSPECTIVE

Abstract

Development processes are ongoing. Jumping growth and development in the social systems is not possible. It is possible to accelerate the technological and technological progress in accordance with the evolutionary laws of gradualism. The existence of created values throughout the history of creation must correspond in a harmonized form with nature. More knowledge and less distrust is the formula for the survival of human civilization. Rational intentions of survival and duration are the results, not profits. Is the ecological movement a revolt against a conspiracy to destroy natural resources and its natural laws based on the evolutionary functioning? For the purpose of active response, it appears that the material aspect of development will increasingly be replaced by the non-material and innovative achievements. What is in sight: intellectual capitalism or the destructive power of mind and capital? Due to the fragmentation of knowledge, we have to rediscover the theory of systems and systems approach, as well as cybernetics. A comprehensive, interdisciplinary approach to innovative issues emerges as the first scientific, professional and systemic prerequisite for the success of a business in which an organization is intent on innovating. Due to the fact that the evolutionary trends, including digitalization, have led to the significant revisions of many current understandings, research into these topics is linked to accelerating the materialization of the scientific and technical developments. Industry 4.0 happened to us. That is not a surprise. These are the evolutionary processes that are a function of the emergence and disappearance of certain technologies (mechanical, energy, informatics) on the principle of the dual effect of technical progress: affirmative and devaluing. Will digitization squeeze out a market like the market eliminated feudalism? The digital perspective comes to us at the speed of acceleration (the first derivation of the velocity vector). It is the result of innovative processes that take place under the evolutionary laws. It is a symbiosis of information, cyber and digitized structures as the paradigms of digital perspective. The new non-industrialized economies have emerged and will emerge that will characterize the coming time. Every economy will strive to create the elements of its protection through the power of appearances or the laws of defense.

Keywords: innovation; evolution; digitalism; the future; technology; technical progress.

INTRODUCTION

We start from the fact that the principles of operation of the process of evolution, although not yet thoroughly researched and clarified, and achievements in relation to the natural organ systems are almost universally

accepted and socio-economically implemented.

Contrary to the organ systems, their emergence and evolutionary survival (continuous adaptation and active feedback), the

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problems of socio-cultural evolution are more controversial, since it is shown that the existence of purposefully rational social organizations is attributed solely to the rational human action on the basis of planning.

The difference is that the natural systems are created by a spontaneous order, social organizations are regarded as made, constructed order. This observation is applied in particular to an enterprise that we regard as an efficient and meaningful creation, shaped by the organizational structure of its structure based on goal-directed action. Companies, in terms of their size and complexity in organizational terms, are the result of rational behavior of decision makers and therefore numerous and varied forms of production and business cooperation, depending on the degree of complexity of product development.

A holistic, interdisciplinary approach to the innovative issues emerges as the first scientific, professional, and systemic prerequisite for the success of a business in which an organization intends to innovate. The reservoir of knowledge is a consequence of the educational process. Assumptions are created from total human resources to create a critical - desirable level of user and knowledge creator. The task of higher education institutions is not to recruit, but to produce from that production, to make the positive scientific selection to increase the power of knowledge.

Trade competitiveness and the role of technological innovation and technological transfer are becoming a central issue of an enterprise growth and development today, as the core of modern economic development is precisely the phenomenon of innovation. Its formation requires a lot of prior knowledge, which means that the laws of evolution still work here. Knowledge grows much like a population. The population grows in proportion to the last generation. Knowledge grows in proportion to the mass of knowledge left by the last generation. And what is impossible for science and innovation!? Upgrades are continuous both in

the form of achievements and in shortening the time of realization. Influenced by the Industry 4.0; We have defined a slogan that is generally accepted: "who adjusts will last, who does not adjust will disappear." The acceleration is contributed by the information technology and digitalization-based processes. When to react? Immediately! Because if not us - who? If not now - When? A slogan we have taken from a decision theory.

It is only under the assumption of their own innovative capacity that it is possible to ensure satisfactory development performance and a competitive position in the world market. In this context, the essence of innovation management, understood, points to the conclusion that its basic task is not to develop the science and technology "per se", but to put the scientific and technological solutions into the function of economic and even wider social development [11].

The onset of technology and innovation-driven change necessitates the need for the new technology for managing the complex dynamic systems. Management technology is the oldest (created long before mechanical, energetic and informatics) and it emerges as the key to everything, even business success.

We recognize two major types of technological change: quantum and developmental (incremental). Quantitative (quantum) technological change is a fundamental shift in technology that results in innovation the new types of goods and services. Two examples of such technological change are the development of the Internet, which has revolutionized the computer industry, and the development of genetic engineering (biotechnology), which promises a revolution in the treatment and treatment of diseases of medicines so made that have the characteristic of smart drugs, because they focus their activity only on the diseased place. McDonald's development of the fast food supply principle is also an example of a quantitative technological shift. In a world

of growing insecurity, change is a direction with no clear purpose [2]. As the nomadic tribes, contemporary companies, within their capabilities, define their development for a competitive level, while in the external environment they move from market to market, seeking a position to maintain their capabilities. Winners are those who have the knowledge and energy to develop the exceptional abilities and values for particular parts of the market. Measures of business success are shown at the right time by the finances.

We are on the threshold of a fundamental achievement. It was recently reported that Google had indeed achieved quantum supremacy, which would mean that it had the "unlocked" the ability of quantum computers to solve problems that the classic computers either failed or needed much more time.*

The anticipated success in this area would lead to a turning point and an incentive in the field of quantum machines, as they would achieve the set goals much faster. Their tremendous processing power could help find new smart drugs, medical solutions, new materials, and create much more efficient supply chains and lead to a highly advanced artificial intelligence.†

* *In 2018, Google agreed with NASA to use their supercomputers as a benchmark for their quantum power experiments. According to the Financial Times, the report said that Google's quantum processor was able to complete in three minutes and 20 seconds the calculations that take about 10,000 years in today's most advanced super-computer, the Summit. In a withdrawn report, experts said that "the trial represents the first computation that can only be performed by a quantum processor."*

† *Quantum computers are so powerful because they use "quantum bits", so-called qubits. Unlike the usual bits, which are either 1 or 0, cubic, in simplistic terms, can be both at the same time. Thanks to the quantum phenomenon, quantum computers can simultaneously process huge amounts of information, while traditional computers have to process them sequentially or gradually. Such success would lead to much needed incentives in the field of quantum machinery.*

The evolutionary trends that include digitalization have led to significant revisions of many current understandings. Radical change is happening from an evolutionary perspective. This perspective reminds me of modesty, restraint and thinking about the limits of the possible. Cyber systems always inaugurate a control. This is also true of leadership as the most important social function of shaping.

The digitalization of the economic and social sectors, with the use of modern technologies in business processes, raises the issue of information and cyber security of the digitalized structure and achieves a significant development in this direction.

"Cognitive cybernetics is a new scientific discipline that, on the basis of cognitive sciences and cognition as a mental human charge, connects cybernetic understanding of everything as a system (technical, social, natural,) with the new intelligent technologies to point to the knowledge of interaction on the captological anthropomorphization of today's man"[1]. From the point of view of the operation of general laws, economics of social work, the fields of science and education are the levers of accelerated development of productive forces, and through the culture of work and production relations in the processes and processes of expanding the material basis of labor.

1 INNOVATION CHANGES AND PROCESSES

The world economy is undergoing the "tectonic shifts" and "floods and transformations". This is due to the fact that there is no universal model for change, and that there is no recipe [17].

The general methodology of innovation technology consists of three parts: system identification; system analysis; and research analysis [5].

The methodology of innovation technology is derived through a system of projects that are interdisciplinary linked to the specific scientific fields and technologies.

Education is an intermediary in understanding and applying the scientific out

puts and "strengths" of personnel in resource management. In fact, the science and education are "the germs of growth that must be fermented in every human activity today [6]."

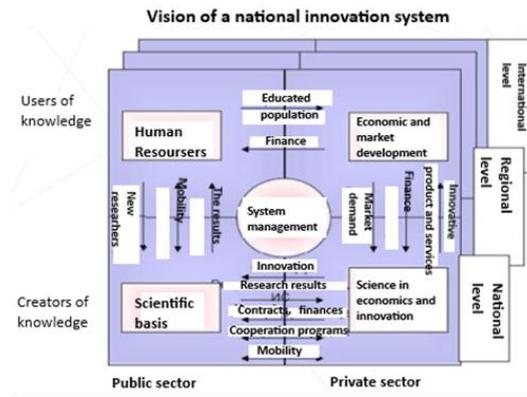


Figure 1 A general model of innovative activity (UNESCO's General Model for Innovative Activity)

There is no absolute progression without relative recourse. With the new knowledge, obsolescence comes into being and also the second-class position of the existing knowledge is impaired. This implies the need for so-called life-long education, continuing education and work-to-work education (return education). The authors of this paper have long asked the following question on this topic: "tell us how you spend your free time and let us tell you who you are"? The answer is, "Learning is eternal." On the other hand, by their economic functions, the education and science are characterized by the work of reproduction. Investments in science and education are proving to be the most profitable investment both in terms of return period and quality of output [15].

The technology advancement strategy, and the overall economic environment, is basically an absorbing milieu for implementing the results of research and development activities. It is about knowledge. In technological development there is a basic premise for more favorable international economic relations as well as for the policy of innova-

tion and independence, which are always the requirements of a progressive society.

In all rich industrial nations, more and more people are worried about rising unemployment and stagnant wages. The alleged causes are globalization and amazingly rapid technological change. Computers and robots, along with the management techniques, are said to destroy jobs. At the same time, the free flows of trade and capital and huge advances in telecommunications have increased the international competition (competition) and made it easier for firms to transfer production to the developing countries with low wages. Differences between rich and poor are increasing, and drastic reduction of differences is impossible because the rich find ways to protect their own interests. Many feel that Adam Smith's invisible hand is trying to push them off a cliff. It is doubtful that today's government policies are no longer functioning as they are not suitable for the new global, digital economy [4]. The general question that may be asked is: Does the technological revolution also require an economic revolution?

Permanent training of employees and expertly oriented teams are a function of precondition for the successful business. The goal is not profit but result. The level of modernity of business organizations and other economic entities presupposes the modernization of the business operations of enterprises, as well as of all other sectors of the large social and economic system, due to the causal connection. Such behaviors are merely a response to the need to survive and last, which is the primary condition of evolution.

Industry 4.0, dubbed the Fourth Industrial Revolution, although content-wise it is neither industry nor revolution, accelerated change but also responded as a challenge to those changes, which radically disrupted but also directed and mobilized organizational and technical-technological efforts to meet the challenges of this of the oncoming boom. It is an evolutionary process of developing science and technology, knowledge, as part of the totality of the cyber economic milieu [13].

Over the last twenty-five years, the global network of computers, telephones and televisions, as well as other business and consumer electronics devices, has increased its information transmission capacity by about two million times. Computer power doubles approximately every 18 months

according to the Moore's Law [16]. Several economies, from different countries, have opened their markets to trade and capital. Is this their way into deeper poverty?

Decisions on the basis of which the developmental changes are to be made should focus on both risk and the essence of functional differentiation. Danger always signifies something external that happens independently of our will, while at risk we examine the possible shortcomings of our decisions. Unwillingness to the technique can compromise its innovation power. With the advanced "functional differentiation", the structure of society becomes more contingent. In social development, targeted, we are increasingly setting ourselves up for contingency, relying more and more on science and technologies based on it. As a result, the dimension of the future, while still a contingent factor, increasingly becomes the decisive determinant of behavior in the present, becoming more certain. The increasing strategic importance of science and technology for the social dynamism means, whether we like it or not, that our behavior is increasingly oriented toward the future. By entering both the "knowledge society" and "risk society", the dimension of the future becomes central through the greatest possible measure of risk inclusion in development decisions.

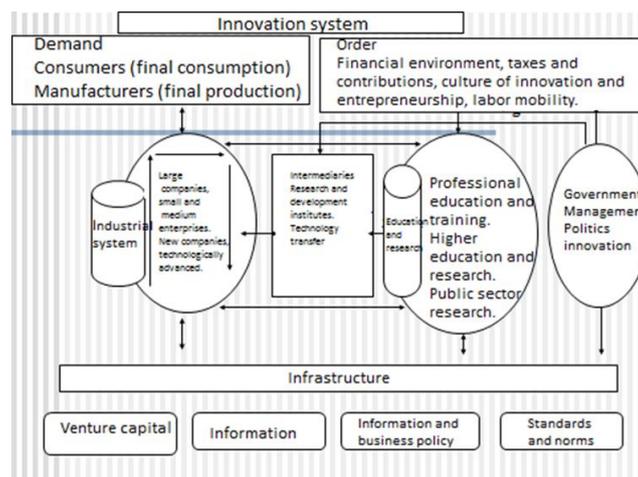


Figure 2 Model of the holistic approach to innovation [3]

We point out the entrepreneurship from a position of innovation and a tendency to accept the risks and overcome the existing and the achieved. It turns out that they are the entrepreneurs and innovators, people who are not risk averse. In order to do better and differently, the entrepreneurs must own the so-called "distinctive competence." Distinctive competency means a unique insight into the market, technology and management to compete with the competitors [14].

There are important differences between the entrepreneurship and management. Management is based on combining factors of production to produce, while entrepreneurship is based on combining factors of production to initiate a change. Management is a phenomenon of continuity and entrepreneurship is a phenomenon of discontinuity. The essence of entrepreneurship is change, and nothing today is as permanent as change [10].

The new branches of high technology characterize the small businesses in the first stages of development. These are the companies that usually combine the entrepreneurial idea, capital and management skills in an individual.

During the 1990s, a new phenomenon of the so-called "enterprise kindergarten". These are companies that use the Internet as infrastructure, whose founders are younger people with no business experience.[‡]

[‡] *Top list of innovations for the last 35 years without being in the medical field. Internet - created in 1969 as an Arpanet- military communications network. Mobile Phone, PC, Optical Fiber - Fiber Phone Calls Have Been Cheap Wherever You Are Calling Other than from Serbia, Email, GPS, Laptop, CD / DVD, Digital Camera, RFID, Microelectromechanical Systems, DNA Imprint, Airbag, ATM , Advanced Batteries, Hybrid Car, OLED, Display Panels, High Definition TV, Nanotechnology, Spacecraft, Flash Memory (micro version of computer disk drive), Voice Messages, Hearing Aids, Low bandwidth radio, drone, smartphone. Smart technology, 3D printer ...*

The concept of Industry 4.0 in the world has existed since the fall of 2011, when it was defined as a model for the development of Germany as the dominant industrial economy today. It basically, in a new way, defines the concept of industrial automation (internet of things, cloud technologies, cyber systems). Germany has been a leader in this field and the national programs of Industry 4.0 in the US, England, Japan, China and the EU indicate that there is no unique approach to this program in the world, but each country, based on its national priorities, defines its model as a strategic technological development framework . Serbia currently has a defined framework for the National Industry 4.0 Program, set up through the US-EU-Japan-Serbia Technology Summit, held in 2016 and 2017, on the global topics: National Industrial Policy for Industry 4.0 (2016) and Intelligent and Smart Products in the context of Industry 4.0 (2017), which is an opportunity for the other countries in the region to become involved in this Program.

In order to accomplish its innovative mission, the company has at its disposal Internet (IoT) as well as the cyber-physical structures. Business structures set the boundaries between the cyber and real physical world. Continuity of action is generally related to the space and time.

Robotics, telecommunications, and computers are the paradigm of information technology. Robotics, but also self-regulating supporting technical and technological systems and processes based on knowledge, solutions based on the "cloud computing" and Internet data of a functioning system, affirm at least two positive aspirations. In the physical sense, the products are created, while in the digital realm, the processes of creative action take place in order to improve the characteristics that have the quality and dominant information in the field to which the action relates.

2 EVOLUTION AND DIGITAL PROCESSES

We are witnessing the transition of an evolutionary change in the knowledge economy into an economy of many sizes, definitions and frequent changes [14]. Evolutionary appearance is a natural continuation of previous relationships in the world of work and an introduction to the digital Darwinism.

The evolutionary further development of the system-oriented management science as a generic sum of knowledge starts from the view that both the enterprise and its environment are subject to similar processes of development and principles of action as we can determine in the natural evolution [12].

There are a number of moves in the science of enterprise economics that point to an evolutionary direction that underlies the concepts and methods that emerged within the organizational development movement. So nothing would be easier to push the evolutionary conception of management aside without comment and without explanation. But the concept of evolutionary management goes far beyond spiritually related attempts in the enterprise economics, as it relies in its implications on a not entirely new theory of social systems that goes far beyond enterprise and shows clear differences with respect to the dominant perceptions in most economic and social scientific discipline, and which, in recent years, has undergone a systematic treatment within the framework of some not yet well known works.

The new non-industrialized economies have emerged, and will characterize the coming times. Every economy will strive to create elements of its protection through the power of appearances or through the laws of defense.

We believe that today's markets are more obsessed with events (European Union, Britain, North Korea, Syria, Iraq ... and the Russia-US and China-US relations) than the

geopolitical risks. We are sure that there will be the periodic changes and moods, which will disturb the behavior of the market, which will be compounded by more serious geopolitical risks, weakened capacities of institutions and policies based on fear, regardless the possible benignity of political events and changes. In an evolutionary sense, if the market eliminated feudalism, then the digitalism would certainly eliminate the classic market. In fact, we point out that the evolutionary processes and changes are aided by the digitization at the speed of acceleration level. The second derivation of the velocity vector [12] (*The second derivation of the velocity vector*).

The intellectualization of the production process has happened to us. Technological culture dominates with the work culture as a prerequisite of all other cultures. We need a viable competition, which is manifested in a set of relevant criteria that provide a guidance regarding the competitive nature of the market, in order to formulate and execute the competition policy. The structure-management-results trajectory emerged in the industrial economy and defined a representative set of competitiveness criteria [11].

In the evolutionary terms, the collaborative R&D focuses on applications related to the industry profiles, manufacturing, services, and virtual systems in the areas of autonomous process control, status monitoring, and predictive technical and technological maintenance and enhancement. Other focal points are IoT (Internet-of-Things) platforms, digital infrastructures and standards for connecting elements of the system structure to the higher-level systems or peripherals.

Digital technologies: IoT, robotics, cloud computing, cyber physical systems and big data are the key in implementing Industry 4.0. Industry 4.0 involves the complete digi-

tization of all production processes and implementation of the aforementioned digital technologies when creating an idea of a product, product engineering, production organization, production realization, process control and the provision of industrial services.

The new strategies are needed, without imitation and recipes, which should be the result-oriented with respect to both economic and social goals. Corresponding to the philosophy of the basic needs is the strategy of normative economics, which starts from an economic analysis that presents proposals or claims related to "what should be" rather than "what is." [2]. We can see that there are contradictions with the positive economy that deals with the economy as it is. Essentially, a normative economy is derived from a positive economy and some estimates of what the goals of society should be. It is possible to challenge the claims of a normative economy if there is disagreement with subjective assessments and presented analyzes [7]. However, the Evolutionary Approach in Economics becomes generally accepted and with it, at the level of development achieved, the digital Darwinism has occurred to us.

Along with discussions on policies and directions for growth and development, the need to respond as a form of reconciling microeconomic and macroeconomic paradigms is indispensable. The new classical macroeconomics increasingly corresponds to the "new microeconomics". The new classical macroeconomics insists on reformulation in the narrow sense of the orthodox classical economy. The basis of reformulation is the concept of rational expectations combined with the concept of the natural rate of unemployment resulting from the effective equilibrium in the market. The starting point is that any attempt to stabilize output or employment below or above the natural unemployment rate through fiscal or monetary policy will prove ineffective and will not change the

value of real variables in the long or short term. The basis of this paragraph is the view that there is no compromise between the inflation and unemployment even in the short term, that is, both the aggregate supply curve in the short term and the Phillips curve in the short term are vertical. Whatever is properly seen as a development of monetarism, which in turn is both a development strategy and growth strategy, these views abandon the arguments of leading monetarists who argue that the demand-side economic policies will result in deviations of output and unemployment from the natural short-term unemployment rate. In this regard, it is shown that the new classical macroeconomics seeks to show the futility of Keynesian demand management policy and instead focuses on supply economies [7].

Societies and their economies that are on the verge of hopelessness and chaos, facing the escape of people and capital, must create strategies to strengthen institutionalism and institutions if they do not want to enter the chaos that is absolute. Capital does not flow to those countries from which capital escapes. The question we might ask is: do we and how much do we need the role of social, political and economic organizations in determining economic events?

The free-market phrase must be abandoned, as it has been proven that the markets and media everywhere in the world, and even the speculative economy, are free only as much as they are allowed. Too much openness to an under-resilient, underdeveloped and under-developed economy is more dangerous than too closed. The degree of openness of an economy can be approximated by the relative size of its international trade sector relative to the gross national product. And that is why we need the institutions, not only as a satisfaction to the "commanders" of the capital world, but as a controlling factor to ensure their functioning. Accumulation is created in certain territories,

and often there is an extreme tendency of local politicians, as a rule, economically illiterate, to use it in those same territories, even if such use is not as rational as it would be in another territory. Therefore, removing territorial barriers to asset the circulation is, in fact, a prerequisite for creating a financial market in general and making the investment decisions.

3 DIGITAL DETERMINANTS OF THE FUTURE

Digital Darwinism is an era in which technology and societies are evolving faster than companies can adapt. Today we are looking at the modern development of a company through its ability to transform digitally in the sequence of process actions and the achieved level of working culture, application of technology and behavior of society to the development itself. An enterprise with advanced digital technologies is becoming a living organism capable of evolving and thus acquiring the characteristic of a self-learning, adaptive and self-organizing system. In order for digital transformation to be successful, it is necessary to realize the process of adapting and actively re-acting the enterprise to its changing environment. The needs of the users are decisive for the behavior of the company in terms of profiling and production and capacity. These needs are diverse and unequal, requiring a differentiated approach to choosing a business orientation. Businesses are today adapting to the user through code halos, which gives them the ability to map behavior. The state of mind of the company precisely determines the ability of technical and technological innovative development. Research shows that businesses that have embraced the processes of digital transformation and embraced the existence of digital Darwinism have far outpaced competition and entered the desired future much earlier. Businesses that have succeeded in overcoming the process of

digital Darwinism have been able to achieve a significant increase in value, especially in the secondary economy.

In a digitized enterprise, it is necessary to design and process the algorithmic process and communication with precision and set up an intelligent interaction of techno-technological processes with the physical, digital and virtual world. In addition to this “networked” fact, in addition to the installed digital machines, equipment and technological systems, the digital enterprise should also have its enterprise-oriented software related to business processes, the Internet and communication infrastructure, the security system and the accompanying digitized service organizations. Software solutions can be developed in their own environment, but most companies purchase them from specialized vendors. The current development of Industry 4.0, back in the 1980s, was preceded by CIM, CAM and CAD, later by SAP and SAIGE, but due to their technological level, they could not capture the overall digitization of the business.

The Digital Darwinism, we can write freely, is in the milieu of many companies. Many have developed, lasted and survived, while those that failed to adapt to the new conditions have disappeared from the market and economic environment. Starting from the specific intelligence of the enterprise, immanent to man, as the basic management lever, to manage things and processes with the aim of producing output, based on evolutionary principle, in order to produce output.

By formulation the principle of indeterminacy, we transform the natural laws into statistical laws. Today we are becoming aware of a world whose pillars have lost the solidity of granite institutions (laws), dominated by the bundles of probabilities of smaller or larger ones, and to which the notion of certainty, or ideal probability, can be more adequately represented by an infinite decimal fraction of 0.9999 one imaginary barrier that di

vided science into the "real" or exact and "verbal" - social was demolished. Fortunately, the whole objective continuum becomes once again a whole in which homogeneous laws operate, differing in the intensity and structure, and not in their nature.

The intellectual climate favored the emergence of a knowledge-based economy. And did knowledge of economics alone favor the development of a knowledge economy? Let's go back to the mainland. There was a focus on sharp semantic barriers between the professions, on building as efficient an interdisciplinary scientific method of managing complex, stochastic systems, and on developing a general theory of management and communication.

Everyone fears the future, because of its absolute uncertainty, regardless of the projected outcomes!? Economic globalization - it has four forms, namely the flow of goods and services, the so-called free trade, human flow and migration, capital flow and technology. The problem is its unidirectionality and no equal partnership and equal cooperation. The dilemma is individualism or collectivism, or intellectual cooperation? The second dilemma is: the artificial intelligence and collective brain!? One will not face the possibility of his or her being excommunicated in the decision-making processes. The inauguration of security systems and their development is a parallel response to the digital developments to keep them under control. Networking is one of the basic features of digitalization. For example, the absence of economic and market integration of agriculture, which is the basis of industrial production, but also of other industries that use the agricultural and agricultural products, is evident to lead to a significantly higher output than the needs of the domestic market, which, we assume, implies an export orientation, but also significant product restructuring.

CONCLUSIONS

Research mobility carries with it the message of generating results. The scientific basis is determined by personnel inputs and the absence of objective selection on the one hand and the level of development of the economy on the other. Verification of the results of the R&D activity requires a developed material base, which will return to the scientific system challenging tasks that the scientific system will have to solve. The state, on the other hand, should have an integrating role in the management of knowledge on a broad economic basis creating the technological and innovation policies as an integral part of the overall economic policy. This includes:

1. Refocusing specific subjects and adapting technological and innovation policy instruments. In doing so, they gain the new importance of policies to promote the research collaboration, accelerate enterprise networking and clustering, encourage institutional connections, diffuse technology and increase employee mobility.

2. Ensuring the framework conditions for innovation management, where particular attention should be paid to: competitiveness policies to increase competitiveness through innovation but also to accelerate collaborative research; education and training policies to develop the necessary human capital; regulatory reform policies to reduce administration and institutional rigidity; and financial and fiscal policies, communications policies, foreign investment, and trade and regional policies.

Technology is involved in all organizational activities, and its rapid changes make technological change a significant factor in almost every innovation of an organization.

We are witnessing the transition of an evolutionary change in the knowledge economy into an economy of many magnitudes, definitions and frequent changes [14]. Evolutionary appearance is a natural continuation of previous relationships in the world of

work and an introduction to digital Darwinism.

The experiences of previous periods and the needs of the people, scientific technical and technological organizational, managerial as well as total social achievements, enable, to a large extent, a look into the movement on the world economic scene in the near and far future, as well as the appearance and change of a great evolutionary change and its duration. New non-industrialized economies have emerged and will emerge that will characterize the coming time. Every economy will strive to create elements of its protection through the power of appearances or through the laws of defense.

We can freely write that today's markets are more obsessed with events (the European Union, Britain, North Korea, Syria, Iraq ... and the Russia-US and China-US relations) than geopolitical risks. We are sure that there will be periodic changes and moods, which will disturb the behavior of the market, which will be compounded by more serious geopolitical risks, weakened capacities of institutions and policies based on fear, regardless of the possible benignity of political events and changes.

Modern production and business systems to be able to function effectively should create a platform for information exchange at every moment of its appearance and operation. Then intelligent structures will be able to communicate with other systems, all for the purpose of insight and access through decentralized control. Modern industrial processes and smart organizations, without the incorporation of intelligent technologies, would not work. There would be a radical discontinuity in the performance of their business missions, crises and system downfall.

The economies of developing countries are caged by global trends that we have defined as an expression of power and power.

With the increase of the cage, does the degree of freedom increase or are you still in the cage!? There is always the question of human profitability in cyberspace.

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CHANGES IN A FUNCTION OF TRANSFORMATION AS THE CHALLENGES OF TOMORROW

Abstract

In the world of growing uncertainty, a change is the road without real purpose. Upcoming events can be successfully planned and controlled in a shorter time perspective. With time distance from the current standing point, the level of uncertainty increases while probability of outcomes of events that occurred with an effect of change decrease. Dominant challengers of changes in the enterprises are the technical progress and competition. Reaction of an enterprise is its answer on challenges of changes. At the beginning, we think that we know where the change will take us, and expressed if it will be a fact for us to last as long as possible, because of the fact that at some point end will come to the existing, because a change with some other working change is inevitable. Ability to understand changes is a condition to its implementation. Changes in terms of development require an adaptation and active recurrent action, and who manages to adapt to the developing trends and conditions of environment will last and exist, who does not, will disappear.

Keywords: *changes, artificial intelligence, digitalization, evolution, transformation*

1 INTRODUCTION

The twentieth century gave us radio, television, internet, rockets, atomic reactors, nuclear energy, and brought us to an era of electronic computers, we witnessed occurrence of applied mathematics, operative research and cybernetics. Research in the field of theory of prediction, whose pioneers were Norbert Viner and Julian Bayglo, have determined approach to this matter. We witnessed computer, sensor, chip...

Bioengineering, artificial intelligence, information technologies come with the

characteristics of universal diffusion whose paradigm is made by the computer, telecommunication and robotics. Evolutionary approach in economy becomes overall accepted and with all new things comes digital Darwinism.

Even though it deals with the "unfriendly environment", an enterprise's duty is to conduct changes up to date, better than anyone else from competition. Condition for development and survival is found in abilities, knowledge and skills

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that are better than the ones competition has. Expenditure is their symbol.¹

Just like nomadic tribes, the modern companies conduct their healthy competition within their possibilities, and on the outside with non-stop movement from one market on to the other, where their abilities, old and new can be sustained. Organizations and its competitors, as well as their markets, are in constant movement [1]. Primary goal is in business result, which occurs as a measure of success in real time expressed through finance. Diversification of activities of compounding of process imposes a need for the structural-sectoral organization and action [12]. Evolutionary economy, backed up with digitalization and methodological process of rationing capital, created a sequence of complex and mutually conditioned changes. Networked economy and communication "everyone with everyone" happened. Digitalization has brought a price downfall in communication industry and created a new approach in rationing capital and investment and developing activities. These transformation process have hit the strategies and pointed out a need that the managerial teams need to be formed interdisciplinary.

Basic collection of changes, which caused sets of transformations in all mutually connected sectors of functioning of one system, is in abandoning the "Taylorism" as the "art of mindfulness of giving orders" and affirmation of horizontal hierarchy whose the main characteristic is in ability of management to achieve the process of mobilization of right personnel for the benefit of job that has to be done [7].

Chances and possibilities for changes are found in the world of competition and technical progress. Innovative change and

technological superiority are the key to everything, even business success. "Change is nowadays a constant measure" [12] and "nothing is as steady as a change[12].

Do the new technologies and technological progress endeavor to change the world? Not only the world, but before all conscience. Digital process and on them based and put in system AI, does not show any unjustified fear of upcoming digital times, because the digital times are in the essence evolutionary times, but are trying to take control of the system of functioning of what a man has created so that the creation does not become the opposite. This is because of the fact that the cyber world and deviation of mind never stand still.

2 AI AND DEVELOPING TRANSFORMATIONS

Changes of course in managing the complex dynamic systems, will take action under the influence of abilities to accept the innovative achievements on plan of digitalization, robotization and AI. Transformation process will be a function of ability to react to the changes.

Developed world, does not only try to take control over AI, but makes a good work in doing so. Digitalization with robotics and AI will "retire markets", just like a free market eliminated feudalism at one point.

Starting with the fact that in the next 20 years transformation process and influence on trade, services, production process (that are becoming more determined as well as flexible), education system, culture will be present... and way more dynamic than the ones in the past 20-30 years, like computers, semiconductors, internet etc. Need for crea-

¹ *In the Republic of Srpska in a restaurant there was a slip of paper on the table with the following content: "It is forbidden to just sit in the restaurant"*

ting challenges is put at the first place of scene of creating and using the achieved results, no matter the sources. Economy of small countries through the transformation process, will achieve the process of adjusting in redistribution of economic power at the global level (Todosijevic R., Todosijevic Lazovic S. 2017).

Normative predictions show that the digital Darwinism and AI will in the next 20 years be biggest stimulant for the social and economic development. AI, robotization, and digitalization are seen as a critical mission by the skeptics at this point in time. But wasn't that the case with all the new things that happened through the creative world history. Resistance is always present, because many are striving toward equilibrium. However, history shows and proves that the greater the resistance toward changes is, the greater the destructing action of progress and change is. Transformation processes are the result of materialization of changes as the thoughtful experiments and research achievements.

AI creates objective conditions for overcoming the negative, stagnating or destructing actions of changes because it provides the realistic chances for affirmation the positive outcomes. Investments and time are suffering significant reduction and efficiency is growing. Digital process' and AI are not "fire escape" for evacuation, but are key aspect for developing models, process of decision making and management. Operationalization of systems is becoming superior in comparison to existing dysfunctional democracies. In the USA, a democratic presidential candidate stated that : "China is using technology in order to perfect dictatorship" [3]. But that is not a human answer to a human question. Scientific achievements are the first and foremost in a function of human harmony.

We are the witnesses of universal optimism about potential of digitalism and AI for advance of mankind. Unjustified fear is being spread from "machines with intelligence that could be more dominant than humans". Fear of future is imminent to the human behavior. However, it has always been finding elements for its protection from eventual possible claustrophobic situations and outcomes. Do AI and digitalization with robotization carry messages harmful for the existence of our world? Are we threatened with an unforeseen revolution of conscience and behavior or is evolution of truth reality normal? By confronting challenges of future in the center of attention is always wanted and projected - based on a trial of events intended future. Fear of nuclear war, fear of fire, flood, other natural disasters, fear of scientific achievements is only the humans ability to take control of occurrences and processes that are found in nature. Aren't we, today's people, result of AI of some unknown evolutionary ancestor, who we are in the absence of protection destroyed as a competition?!

Optimists agree that human greatness consists of freeing from destiny and that it will not confront with a possibility of its own destruction. They will always be able to project ways of self-defense. Pessimists would like to "lock or burn" progress. That is not possible, but a positive affirmation of the scientific achievements with elements of existing self-defense and control is always possible. Bio chip is maybe for now the far future. The new strategies are defined and formulated while the old "winning" ones are redefined. Systematic and partial research are being more and more rapid, a question is if we will experience any new revolutionary boom in the near future or if the digital Darwinism, by evolutionary laws determine direction and pace of the total social deve-

3 STRATEGIC TRANSFORMATIONS

lopment. Cybernetic doily, that exists, and that was discovered by the human and constantly improved by the human, will intend to, without destructive conscience, constantly sustain state of a long-term existing equilibrium. More radical deviations from the natural evolution, even in that world, in which situation we are today, is just not possible or to be more precise, will not happen. Robots, as the networked functioning machines are fed with information, digital process and AI are occurring as the stars in a far horizon, that do not have enough light to illuminate space on which they are focused, but they do not lose hope from a position of creation to become suns one day. Sun is as we know source of life. We are experiencing a new reveal of nature and evolution that is going its own path and it is not important for it what is it that we know about and its way of structuring and functioning, but important thing is to enlarge our knowledge powers compared to it. That will be the biggest step to self-defense of eventual negative influences. In fact, we are in a position of occurring the golden age of AI in which synthesis of many knowledge from the past characters is achieved and it has built in the scientific prediction.

Technologies that will as a base have AI, will be carriers of the future technological era and produce the real goods as well as the facts for future. Standardization and integration of the system will bring to downfall of communication expenses and affirmation the space independent from location, which will result in a higher flexibility, as in designing, building or implementation the technical systems and big contribution to that will have development of an intellectual capital. The main function of an enterprise is a result, and that will affect an integration of dominant technologies in the financial flows and 5G network.

The first step in "strategy" is defining a concept of a job and strategy of participation [1]. Personal reaction of Chinese president Xi Jinping in regards to loss of the worlds champion of the game "Go", with statement that the word is about technology in which China will have to be the leader, have set the precise goals for 2020 and 2025, which have paved the China's way to dominance of their creation of AI technologies and their use until 2030 [3]. Leading role is on private companies that have achieved a concentration of personnel, capacity and means. China's achieved result is 2.5 times patents in the fields of AI and IT than in the USA. In 2020 in China there will be 3 times more computer science graduates than in the USA. Leas are evident.

The AI and technologies integrated with it, are developed and achieved by the private companies, universities and problem oriented institutes, independent and as the fractions of universities. We can see that military establishments of the world super powers are tapping in place in regards with the dynamics of this field. Indicators of prosperity can be found in the following fields:

- development and innovation of products with market orientation;
- development and testing of products for financial markets;
- patents, licenses and scientific research magazines;
- results of population in international competitions;
- talents of national operative environment.

On Stanford, based on a theory of recognition, they have developed algorithms for AI, where with the unbelievable preciseness are discovered deviations with scanning just one photography. While San

San Francisco have just recently forbidden face recognition technology, Chinese have given an access to four leading companies for the new technologies to their data base with photos of more than 1.4 billion citizens. Estimate is that the Chinese companies that are developing the new face recognition technologies, possess million times more photos than their American competitors. Imagine what different kind of selection based on AI and algorithms with Stanford can be done by people who possess these information and technology.

AI has developed rapidly in the field of languages and linguistics. Dead languages will come to life. Plans for air traffic and unmanned aircraft, things are already going on based on the predefined software on one side and production of hardware that will react on that software on the other side. The main procurer of the US army with drones until 2017 were the Chinese companies. Company "DJI" controls more than 70% of world market with the unmanned aircraft and drones. These aircrafts and drones would in technical sense represent the small hobby toys, if they did not have the element of AI which gives them a computer sight based on which they recognize the weapons, drugs, criminals, radars etc. Smart house, smart city, smart car, smart glasses... 5G infrastructure occurs.

In the field of ecology, the sensor technologies are developed that precisely sort out a dump based on its source characteristics, based on AI and theory of recognition: glass, wood, plastic, paper and even organic waste.

Financial markets are not still, they are aware of reality. From every \$10 invested in the field of AI in 2018, \$5 have gone to Chinese and \$4 to US companies. From ten largest AI startups, a half are American and half are Chinese.

Chinese investments in research and development of technologies that are based on

AI, have come to the point of American investments, and that reflects on results as well. It is probably about the strive to implement the intellectual base for generation advantage on a plan of recognition and AI. Based on the reliable sources about trends of development of AI, China will in 2020 surpass USA on first place in the number of cite in 50% of drawings in the field of AI.

High intensity is in the plan of developing hardware. Even ten years ago, prognostics had it that after 2020 80% of people will work in the tertiary sector and IT, and barely 20% in the primary and secondary duties. Change is happening in levels and quantum of labor as well as creation of values from classic jobs toward non material activities. The secondary and tertiary sectors, that are based mostly in IT, with characteristics of invisibility and automation in occurrence and characteristics of speed, are taking over basic function in development of economy of the developed world and is shifting traditional ways by conquering them [9].

It is shown that, like industry, traffic, trade, agriculture and other activities have with their development encouraged development of secondary and tertiary activities, now we have opposite transformation process that digitalism, Darwinistic-evolutionary approach and IT are more and more being industrialized towards the cited activities, including public sector, finance and culture.

4 STATE OF THE SPIRIT AND TRANSFORMATION PROCESS

Enterprises today are adjusting to user by the "code halos" which is their ability to mapping behavior. They are the users and life cycle of an enterprise, life cycle of product and life cycle of period of dominant technology. State of spirit of an enterprise

determines ability of technical and technologically innovative development. Research has shown that the enterprises, that have accepted digital transformations and existence of digital Darwinism, are far ahead of their competition and have entered much earlier in wanted future. Enterprises that have encouraged process of digital Darwinism, have managed to achieve growth of value especially in sector of secondary economy.

Some authors have stand point that changes are taking place exponentially, but that is a characteristic of scientific development, so that cannot go too far, because in real world there are now conditions for existence of such system that could achieve extreme results, because the system like that would fall apart. Evolution either does not have same pace of changes, because every time when it comes to epochal discoveries, like in case of electricity, time is necessary for creating the conditions for implementation and spread of use of such discovery. However, the process becomes faster, and radically looking time between the discoveries and their materialization is becoming shorter. For photography it took 112 years, for radio 56 and for mazer only a week.

For use the digital Darwinism in the social economic systems, a variability is important, as well as the selection and gradual changes. We are the witnesses of change from evolutionary change of economic knowledge to economy of many sizes, definitions and constant changes [13]. Evolutionary performance is anatural continuum of former relations in the world of labor and introduction to the digital Darwinism.

For certain fields of techniques such as "Bionics", it has only become natural, for problem solutions in nature to be used as models for technical problem solutions. On that basis, in the meantime, an interesting structural model for organization of an enterprise has been developed. Howard

Bloom has written a book "The Evolution of Mass Mind from the Big Bang to the 21st Century" in which he speaks about sustaining life from bacteria to internet thanks to the grouping selections and group mind which is now seen as the "global brain". This is brilliant evolutionary idea that mankind needs in order to understand that above an individual mind there is a multiplied mind of people as a mind of mankind. The word is about strong provocative idea. It is about historical "tour de force", on evolutionary basis with accent on complexion and modernity to achieve a functional bond of elements of the system in an organizational structure.

In text "Artificial Intelligence", Garry McGovern says: "Cyber space is new space; earth and space are old space; space without matter is vacuum and nothing exists in vacuum but vacuum. What is matter of cyber space? It is digital. Atoms of that space are digital bits - digital "mater" that is non material. Did we reach and when will we reach cyber space and will we bring there our old matter?! These questions alone and much of unknown have served as motive for this work, because it is shown necessary to impose following facts which are mostly results of social and cultural evolutionary theory. Rules do not have to be brought by someone with conscious intention, they come with evolution of interaction of individuals and interaction with their surrounding through a process that is analogue to mutation and selection [12]. Rules are most of the time unknown to people who do not recognize them but act tactically. Rules of behavior in this manner are not free norms, but they represent the most important part of adaptation of man to one surrounding about which details he can never know enough in order to direct his behavior in accordance with the consequential bonds and in that way rationally act.

Rules of the game and behavior are not fixed but are subjected to evolutionary changes, meaning that new challenges for transformation can bring to new rules, and second, that groups that had non purposeful rules of behavior did not have ability for survival. Social and cultural evolution does not rely on the individuals and its congenital characteristics, but rely on the institutions, cultural background and acquired skills. Rules that actually act, and that have in relatively late phases of social and cultural evolution been modified consciously by the set rules, are one of the most important parts of mechanism of real control and regulation of one system.

In process, which reminds the observers on management of Amazon and Google, the Chinese president Xi Jinping has defined the key indicators of performance for development on AI technologies. State has given large amount of financial means for many specialized programs and projects, and concentrated research personnel has been provided as well, which made it possible to achieve the maximum realization of strategy as a whole as well as the partial strategies [2].

We point out that in the process of development every state and its government has responsibility, with interests in freedom and dignity, strive toward following: to provide, based on the net investments, productive hiring of unemployed labor force and to work on protection of their own producers. China has a way to protect companies (on domestic market), support national champions (through subsidies and availability to government information resources) and make it possible for leading corporations in the field of AI to have the main word.

In the "German Ideology", the creators of historic materialism remind us: "On the beginning of history it should recreate every invention every day in every place in a different way". [5]

Performance questions represent a stimulation for development of companies and their constitute parts. The "Sharp eyes" will monitor and control public and private property as well as the infrastructure for unmanned cars. Accent is on the "smart cities". Competition does not stand still and achievements of technological progress are moving rapidly. Speed is on the scene. Amount and quality of information are the main factors of advancement and implementation of AI.

5 STRATEGIC TRANSFORMATION

The starting point for strategic transformation is a definition of work on the fields in which the enterprises want to act. From the general strategy comes specter of partial following and operating strategies. Strategies of occurrence are based on: products/market and take into consideration functional and geo-spacing plans.

In practice, we undertake already the existing transformation process, assuming affirmation of wanted strategy with participation, that is based on companies strivings and understanding competition, technology and market.

It is shown that high value in secondary economy is a result of base of knowledge, and implementation of those knowledge into technology, process, production and people. Andrew Keen, Berkley in ook "Cult of amateur" defines reasons for fear of up-coming future. [3]

However, it is not human answer to human question, because human greatness is found in his ability to get free of destiny. Human will not confront with possibility of self-destruction by projecting robocop with software against himself, but will define his own defensive mechanism of survival.

In world of statistics "command and control" have important role in functioning of organization systems. Dynamic systems

and their structure, under the influence of technical changes, must faster transform through managing function and system of decision making. Companies, striving toward digitalization and AI, must react fast. New paradigm of management comes on scene.

The main strategy must be redefined in a function of company goals. Accent is on fortifying competition in ongoing period as a pawn for non-defined future. By facing great dynamic change in multiple aspects of competitive environment, way of functioning of organization paradigm, which types problems of management in stable timely and business conditions will not be sufficient any more. Fact changing on which paradigm relies is happening. [1]

Managing activities standpoint in an era of informatic economy are shifted in comparison to the industrialization era. For informatic era, it is not sufficient to the mass and fast implementation the new technology and manage it accordingly, is not enough. It has become more important to manage the untouchable values: ability to keep old and attracting new customers and market segments, implementing innovative services and products on targeted market, adaptation of characteristics of supply to the targeted user, mobilization of skills and knowledge of employees, and use of new IT [9].

Societies and their economies, which are on the doorstep of chaos, are facing loss of people and capital, must create strategies for strengthening institutionalism and institutions, if they do not want to enter a larger scale chaos which is absolute. In states in which capital is leaving no capital is coming. Question we need to ask could be: do we need influence of social, economic and political organizations in determining economic events? [8]

Parallel with discussions about policies and directions of growth and development, it

has shown necessary a need to react as a way of microeconomic and macroeconomics paradigms. The new classic macroeconomy is more corresponding with the "new microeconomy". The new classic macroeconomy insists on reformulation of orthodox classic economy. The basic reformulation is conceived by rational expectations combined with concept of natural rate of unemployment which occurs as a result of efficient balance on the market. Starting point is supported by the stand point that every try for output or employment to stabilize over or under the natural rate of unemployment, by the use of fiscal or monetary policy, will show inefficient and will not change value of real variables to long or short term. Base for this view point is found in the fact that there is no compromise between inflation and unemployment, not even short term, respectively if both curves, short term aggregate supply and Philips' curve on short term are vertical. No matter if it is seen as development, monetarism is failing both as a strategy of growth and strategy of development. These aspects are leaving arguments of leading monetarists, which represent a standpoint that the economic policies of management of demand will result in shifts of output and unemployment from the natural rate of unemployment in a short term. Regarding that the new classic macroeconomy is emerging and trying to show futility of the Keynes' policy of managing demand and instead of that focus on economy of supply [6].

6 CONCLUSION

In order for digital transformation and AI to be successful, it is necessary to achieve the process of adaptation and active reverse action of an enterprise on its changing environment. Digital Darwinism represents an era in which the technology and society are

developing faster than the companies can adjust. In the science of economic enterprise, there is a whole bunch of moves that show the evolutionary direction which is based on concepts and methods which have occurred in the movement of organizational development.

Modern development of an enterprise is seen through its ability to digitally transform on the trace of achieved level of working culture, technology implementation and social behavior on development itself. Enterprise with advanced digital technologies is becoming a living organism capable to evolve, and in that why it gains the characteristic of self-participating, adaptive and self-organizing system. The existence of an enterprise is achieved in the cybernetic doily. These doily theory of recognition and AI come to express whose action is more used in the decomposed systems. The current characteristic process in the world are: decomposition of systems on one side and globalization on the other. Decomposition is leading us to a growth of efficiency and certainty of managing decisions, while the globalization needs to strive to lower the risk that in fact shows that the managerial problems are decomposed to the units of subproblems and those decisions are made at the subproblem levels, and with that outcome is that we have brought a decision like it was brought on a whole level.

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[3] www: <http://www.vanguard.edu/psychology/apa.pdf> (for web document)

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