

No 6  
2010



**Management Business Innovation** is a scientific journal (ISSN 1734 – 1590) published annually by Wyższa Szkoła Biznesu – National Louis University, Zielona 27, 33-300 Nowy Sącz, Poland.

The journal is primarily published on line at <http://www.mbi.wsb-nlu.edu.pl>

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<b>Piotr Czarnecki, Robert Szarota, Dariusz Woźniak</b> MEASURING THE RELATIVE EFFICIENCY OF ECONOMIC SECTORS. ADVICES FOR POLICY MAKERS IN POLAND	4
<b>Małgorzata Baran</b> DIFFUSION OF INNOVATIONS IN THE SYSTEMS THINKING APPROACH	16
<b>Justyna Myszak</b> ORGANIZATIONAL CULTURE AND ITS INFLUENCE ON THE EFFECTIVENESS OF THE COMPANY	25
<b>Aleksy Pochtowski, Alicja Miś</b> HUMAN RESOURCE MANAGEMENT PRACTISES IN POLISH COMPANIES DURING THE ECONOMIC SLOWDOWN	30
<b>Natalia Potoczek</b> EMPOWERING EMPLOYEES IN PROCESS-ORIENTED ORGANISATIONS	42
<b>Kazimierz Śliwa</b> STOCK-AND-FLOW THINKING IN DECISION MAKING. TOWARDS SYSTEMIC PROCEDURE OF PROBLEM SOLVING	52

# MEASURING THE RELATIVE EFFICIENCY OF ECONOMIC SECTORS ADVICES FOR POLICY MAKERS IN POLAND

*Piotr Czarnecki<sup>1</sup>, Robert Szarota<sup>2</sup>, Dariusz Woźniak<sup>3</sup>*

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## **Abstract**

*The main goal of the paper is to present an idea of the Data Envelopment Analysis model and its potential as a method of evaluation of economic sectors efficiency. An empirical part is concentrated on the use of the DEA model to assess efficiency of the construction industry in Poland from 1999 to 2007.*

*The first part of the article addresses the concept of DEA (CCR model) and the next section presents data and results of the analysis. To obtain the outcomes DEA solver software was applied.*

**Key words:** *efficiency, regional policy planning, Data Envelopment Analysis, construction sector.*

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## **Introduction**

Recently, one can observe a tendency to measure various aspects of human activities. In the European Union (EU) such an interest has its roots in aspiration of the EU members to raise competitiveness of the European economy, compared to the US and Far East countries. One of the most important issues for comparing the competitiveness level is the problem of objective measuring and assessing the entities which are confronted. In the case of national economy such a comparison can be made with reference to various sectors, parts of economy, regions, branches, etc. and can be conducted dealing with different criteria. From the economists' point of view there are many different evaluation criteria that can be examined for such a purpose, for example utility, coherence, relevance, and effectiveness. Efficiency seems to be a particularly important and hard to evaluate criterion

In the praxeological sense, the entity's efficiency<sup>4</sup> can be defined as its productiveness or economy (Kotarbiński, 2000). The entity is more productive if it produces the bigger total output (its value) with given investment. On the other hand, the entity may also be called more efficient when it produces the given output with the smaller input. Generally speaking, efficiency can be defined as a ratio of total outputs to total inputs. This feature of the entity is gradable, which means that the entity can be more or less efficient.

Measuring the entity's efficiency is especially difficult when it has a multidimensional structure of inputs and outputs. One of the methods that attempt to address that problem is a relatively new method of Data Envelopment Analysis (DEA).

Considering all of the above, the purpose of this article is to present the main idea of the DEA model and use it to assess efficiency of the construction industry in Malopolska voivodship<sup>5</sup> in relation to other regions from 1999 to 2007. Such an analysis (DEA) may be especially useful for regional planners. Measuring efficiency seems to be very important in Poland during a period of a great absorption of EU funds. The paper is organised as follows:

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<sup>4</sup> We can also evaluate efficiency of action undertaken by the entities or human beings.

<sup>5</sup> In this paper the terms: „voivodship” and „province” will be used interchangeable and will refer to the II level units (NUTS nomenclature) of territorial division in Poland.

the next sections cover the fundamentals of the DEA methodology, application of the model to assess the performance of the chosen sector and finally, conclusions.

## The DEA model

Data Envelopment Analysis (Charnes, Cooper, Rhodes, 1978) is an approach for measuring the relative efficiency of various decision-making entities (called here decision-making units -DMUs) with multiple outputs and multiple inputs structure. Moreover, an important strength of the method is that it doesn't require functional relations between inputs and outputs and data may be multi-dimensional. So far, it has been used for assessing a broad range of various DMUs, for instance countries (Malhotra, Malhotra, 2009), banks (Brockett, Charnes, Cooper, Huang, Sun, 1997), sectors (Dinc, Haynes, Tarimcilar, 2003), hospitals (Matawie, Assaf, 2010), etc.

The DEA calculates the efficiency of a DMU relative to the best performing DMU or DMUs (when more than one DMU are the most efficient). Moreover, the DEA assigns an efficiency score of one (100 percent) to the most efficient unit, and the low-performing DMUs efficiency can vary between 0 and 100 percent in comparison to the most efficient DMU(s).

In order to describe the basics of the DEA model, some notations and definitions are to be made. Let  $n$  be the number of DMUs,  $j$  be the index referring to the given DMU,  $i$  be the index referring to the input variables and  $r$  be the index of output variables.

The DEA method measures the efficiency of each DMU as the ratio of weighted outputs to the weighted inputs. Charnes et al. (1978), calculate the efficiency measure as one that allocates the most favourable weights to each unit. Generally, each unit does have different weights. If a unit is inefficient (comparing to the others) and most favourable weights are chosen, then it is inefficient, independent of the choice of weights. Having a set of weights, we define the efficiency with which a  $DMU_o$  transforms the inputs into the outputs as the ratio of the weighted sum of output to the weighted sum of inputs:

$$E_o = \frac{\sum_{r=1}^s u_r y_{ro}}{\sum_{i=1}^m v_i x_{io}} \quad (1)$$

where:

$E_o$  – efficiency of the  $DMU_o$  (observed DMU)

$x_{io}$  – amount of input  $i$  for the unit  $o$ ,  $i = 1; 2; \dots, m$  and  $o = 1; 2; \dots, n$ .

$y_{ro}$  – amount of output  $r$  for the unit  $o$ ,  $r = 1; 2; \dots, s$  and  $o = 1; 2; \dots, n$ .

$u_r$  – weight assigned to the output  $r$ ,  $r = 1; 2; \dots, s$ .

$v_i$  – weight assigned to the input  $i$ ,  $i = 1; 2; \dots, m$ .

Taking the above considerations, the assessment of the weights is a very important issue in the DEA applications. A mathematical programming can be used to calculate a set of weights that maximize the efficiency of a DMU subject to the condition that the efficiency of other DMUs (computed using the same set of weights) is restricted to values between 0 and 1. The linear program chooses the weights in such a way that only the most efficient units reach 1. From the mathematical point of view, to compute the DEA efficiency measure for  $n$  DMUs (for each one separately), we have to solve the following fractional linear programming

model:

$$\max \frac{\sum_{r=1}^s u_r y_{r0}}{\sum_{i=1}^m v_i x_{i0}} \quad (2)$$

Subject to:

$$\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1, \quad j = 1, \dots, n \quad u_r \geq \varepsilon, \quad r = 1, \dots, s, \quad v_i \geq \varepsilon, \quad i = 1, \dots, m. \quad (3)$$

where  $\varepsilon$  is an infinitesimal constant.

By solving the above program, we can find the efficiency of each DMU. If the efficiency is one, then the entity is said to be efficient, and will lie on the efficiency frontier. The efficiency frontier is plotted by connecting points representing all efficient DMUs. and is said to “envelop” points representing all units. (Cooper, Seiford, Tone, 2006)

Due to the fact that the purpose function has non-linear form, we must convert the above fractional model into a linear program format. Then we can easily find the solution, using e.g. computer software.

As the weighted sum of inputs is constrained to be unity and the objective function is the weighted sum of outputs that has to be maximized, we get the converted output-maximization DEA model:

$$\max \sum_{r=1}^s \mu_r y_{r0} \quad (4)$$

Subject to:

$$\sum_{i=1}^m v_i x_{i0} = 1, \quad \sum_{r=1}^s \mu_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0, \quad (5)$$

$$j = 1, \dots, n, \quad \mu_r \geq \varepsilon, \quad r = 1, \dots, s \quad v_i \geq \varepsilon, \quad i = 1, \dots, m.$$

This model is known as the Charnes, Cooper, and Rhodes (CCR) model (Charnes et al., 1978)<sup>6</sup>. Obviously, the fractional program formulated in (2) and (3) is equivalent to linear program presented in (4) and (5). A general input minimization CCR model can be derived in the same way.

Proceeding, we are able now to formulate the dual problem to (4) and (5). So we get:

$$\min \theta = \theta^* \quad (6)$$

Subject to:

$$\sum_{j=1}^n x_{ij} \lambda_j \leq \theta x_{i0} \quad i = 1, 2, \dots, m \quad \sum_{j=1}^n y_{rj} \lambda_j \geq y_{r0} \quad r = 1, 2, \dots, s$$

$$\theta, \lambda_j \geq 0 \quad j = 1, 2, \dots, n \quad (7)$$

By finding  $\theta^*$  we are able to define the efficient DMU lying on the efficiency frontier. This DMU is efficient in terms of Farrell’s definition of efficiency (also called weak, radial or technical efficiency). In these terms a DMU is to be rated as fully (100%) efficient on the basis of available evidence if and only if the performances of other DMUs does not show that some of its inputs or outputs can be improved without worsening some of its other inputs or outputs. However, some DMUs lying on the efficiency frontier ( $\theta^*$ ) may be not fully efficient since they may have non-zero “slacks”. Slack will represent excess in inputs ( $s^-$ ) or shortfall in

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<sup>6</sup> CCR model is one of two commonly used DEA models. The other one is called BCC (Banker, Charnes, Cooper) model. For evolution and other extensions of the DEA model see: Tavares, G., (2002). A Bibliography of Data Envelopment Analysis (1978-2001), RUTCOR, Rutgers University.

outputs ( $s^+$ ). Taking optimal  $\Theta^*$  from (6) we will formulate the next linear problem which can be used to calculate the efficiency in terms of slacks:

$$\max(\sum_{i=1}^m s_i^- + \sum_{r=1}^s s_r^+) \quad (8)$$

Subject to:

$$\sum_{j=1}^n x_{ij}\lambda_j + s_i^- = \theta^* x_{io} \quad i = 1, 2, \dots, m \quad \sum_{j=1}^n y_{rj}\lambda_j + s_r^+ = y_{ro} \quad r = 1, 2, \dots, s$$

$$\lambda_j, s_i^-, s_r^+ \geq 0 \quad (9)$$

By using (8) and (9) we are able to find efficient DMUs in terms of DEA, which means a DMU(s) that fulfils the following requirements:  $\theta^*=1$  and  $is_i^-, s_r^+ = 0$ . Such defined efficiency meets the Pareto-Koopmans understanding of efficiency which is in our model called CCR or DEA efficiency.

In the empirical part of the article the authors focus on the efficiency in construction sector, taking into account possible improvements in results. So we need to adopt the output oriented version of the model.

It is worth knowing that an optimal solution for that version can be derived directly from the input oriented model. In terms of input oriented version of the model (6), the optimal solution for the output oriented model is equal:  $1/\theta^*; \lambda^*/\theta^*$  (10)

## Data and the model application

The data for this study have been obtained from the Central Statistical Office of Poland ([www.stat.gov.pl](http://www.stat.gov.pl)). The data cover period from 1999 to 2007. Five economic variables are used to evaluate the effectiveness of construction industry (according to Polish Classification of Activities 2004) between sixteen voivodships. In this article a Decision Making Unit (DMU) represents construction industry in a voivodship.

The variables have been defined by the Central Statistical Office as follows:

Inputs:

- gross value of fixed assets in sector F (private sector) – referred to as PRC,
- gross value of fixed assets in sector F (public sector) – referred to as PBC,
- employed persons in sector F (in the main workplace) – referred to as EMP;

Outputs:

- gross value added in sector F - referred to as GVA,
- new total usable floor space (m<sup>2</sup>) – referred to as SPP.

Due to the nominal data were obtained for GVA, PRC and PBC the GVA deflator was used in order to convert the data to the real terms (2007 prices) as shown in figure 1.

**Figure 1. GVA deflator (2007 as a base year)**

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
GVA deflator	77,9	83,5	86,4	88,4	88,7	92,4	94,8	96,2	100,0

Source: Own calculation based on [www.stat.gov.pl](http://www.stat.gov.pl) (15.10.2010).

For the purpose of the article CSR (constant returns to scale) model of DEA was chosen. All calculations were conducted in DEA Solver. Figure 2 presents scores calculated for all 16 DMUs in the selected period.

**Figure 2. The scores (1/score, see equation 10) for 16 units from 1999 to 2007.**

DMU	999	000	001	002	003	004	005	006	007
Łódzkie (LD)	1,000	1,000	1,000	1,000	1,000	1,039	1,000	1,000	1,022
Mazowieckie (MZ)	1,000	1,000	1,000	1,072	1,103	1,119	1,055	1,000	1,000
Małopolskie (ML)	1,179	1,154	1,105	1,134	1,049	1,260	1,140	1,119	1,093
Śląskie (SL)	1,089	1,117	1,202	1,194	1,142	1,248	1,197	1,115	1,101
Lubelskie (LB)	1,053	1,064	1,007	1,000	1,083	1,109	1,036	1,066	1,035
Podkarpackie (PK)	1,122	1,053	1,000	1,000	1,000	1,000	1,000	1,080	1,108
Podlaskie (PD)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Świętokrzyskie (SW)	1,000	1,000	1,000	1,000	1,000	1,000	1,033	1,000	1,014
Lubuskie (LS)	1,000	1,003	1,034	1,000	1,000	1,000	1,035	1,000	1,017
Wielkopolskie (WP)	1,162	1,000	1,083	1,127	1,115	1,163	1,120	1,046	1,133
Zachodniopomorskie (ZP)	1,111	1,059	1,077	1,094	1,050	1,063	1,008	1,000	1,000
Dolnośląskie (DL)	1,120	1,073	1,015	1,002	1,023	1,137	1,017	1,000	1,000
Opolskie (OP)	1,000	1,002	1,086	1,097	1,009	1,000	1,000	1,000	1,000
Kujawsko-pomorskie (KP)	1,060	1,038	1,107	1,063	1,060	1,108	1,066	1,040	1,030
Pomorskie (PM)	1,001	1,000	1,000	1,000	1,017	1,064	1,000	1,000	1,034
Warmińsko-mazurskie (WM)	1,000	1,000	1,000	1,000	1,027	1,000	1,000	1,000	1,000

Source: Own calculations.

As shown in Figure 2 there is only one voivodship (Podlaskie) that has been 100% efficient for the selected period. And in Figure 3 a set of references for all voivodships was presented. During the time of the analysis Podlaskie voivodship was a benchmark for other DMUs 56 times.

**Figure 3. A set of interactions between 16 DMUs**

DMU	1999	2000	2001	2002	2003	2004	2005	2006	2007
Łódzkie (LD)	5	2	5	0	6		6	0	
Mazowieckie (MZ)	9	3	2					0	4
Małopolskie (ML)									
Śląskie (SL)									
Lubelskie (LB)				0					
Podkarpackie (PK)			0	0	3	0	0		
Podlaskie (PD)	7	4	9	8	8	3	10	2	5
Świętokrzyskie (SW)	8	8	6	7	2	10		0	
Lubuskie (LS)	0				6	7		5	
Wielkopolskie (WP)		6							
Zachodniopomorskie (ZP)								2	5
Dolnośląskie (DL)								2	5
Opolskie (OP)	2					0	1	0	0

Kujawsko-pomorskie (KP)									
Pomorskie (PM)		2	2	3			1	0	
Warmińsko-mazurskie (WM)	0	4	3	2		6	2	3	4

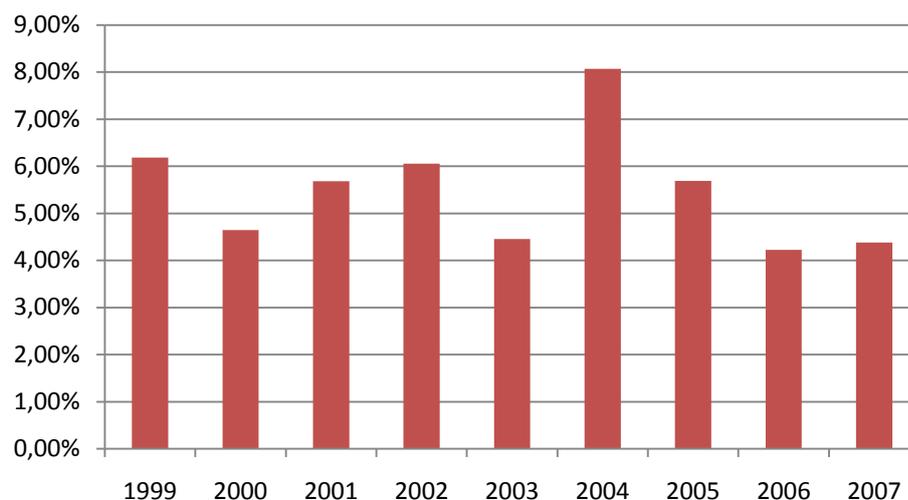
Source: Own calculations.

The Swietokrzyskie voivodship was a DMU with the second frequency of references. Some voivodships were permanently inefficient within the timeframe of the analysis. Among them we can find: Malopolskie, Slaskie and Kujawsko-Pomorskie. In Figure 3 we can see some voivodships with the number of references equal zero which means that such a DMU is efficient in the terms of the DEA analysis however, it never was a benchmark for other DMUs. Analysing reference sets for every year of the study we can also notice that the average number of benchmarks for each inefficient DMU was not greater than 3. The poorest efficiency during the period 1999-2007 was noticed for the Malopolskie voivodship in 2004. In order to be recognized as efficient, having a given set of inputs, that DMU ought to have outputs 1,26 times greater than it had.

It should be born in mind that one cannot compare the obtained results through the years, but there may be made such comparisons within one year.

In Figure 4 coefficient of variation for the DMU scores are presented.

**Figure 4: Coefficient of variation for the DMU scores**

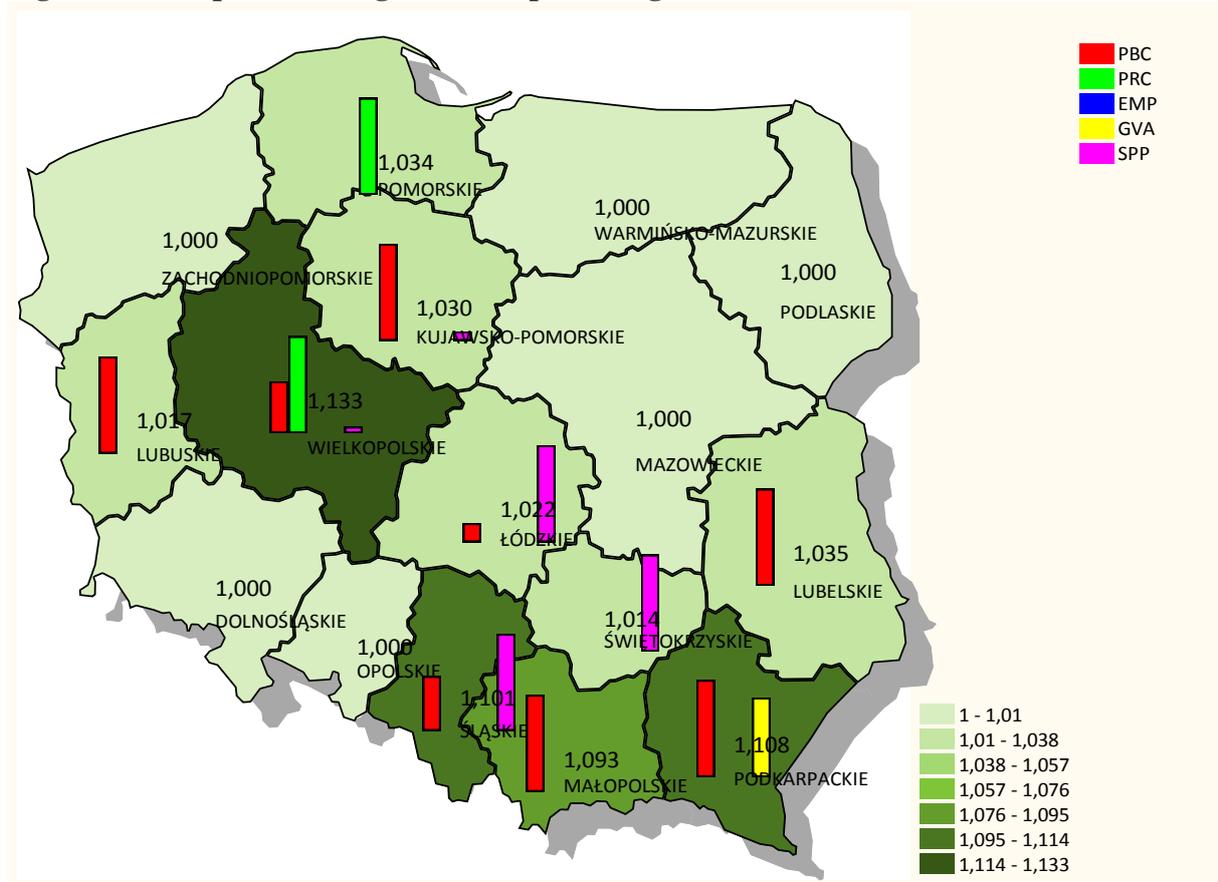


Source: Own calculations.

As shown in Figure 4 there have been slight volatility of scores during the period of 1999-2007. The maximum variation of scores can be observed in 2004 which was the year of Poland's accession to the European Union.

For the further analysis we will concentrate on data for the year 2007, and then will focus on specific results obtained for the Malopolskie voivodship.

Figure 5. A map illustrating voivodship ranking and slacks.



In Figure 5 we have presented the relative effectiveness of the construction industry in 16 voivodships. On the map above value 1 represents the most effective units in terms of technical efficiency. Bars shown on the map represent slacks for all five variables. As the voivodships with score 1 have zero slacks, we can consider them as CCR effective.

It is worth noticing to be noticed that only 6 voivodships have slacks in outputs which means that they can improve their effectiveness by increasing effects of their activities. For instance, the Slaskie voivodship should raise its SPP factor for 306 thousands of square meters. And 10 DMUs have slacks in inputs which means that they have to reduce inputs in order to be more effective. For instance, the Lubelskie voivodship should reduce its PBC for almost 3 billion zlotys. DMUs with input and output slacks can make a choice between reducing inputs and increasing outputs, i.e. Lodzkie, Slaskie, Podkarpackie, Swietokrzyskie, Wielkopolskie, Kujawsko-Pomorskie.

In Figure 6 weighted data for the year 2007 are presented.

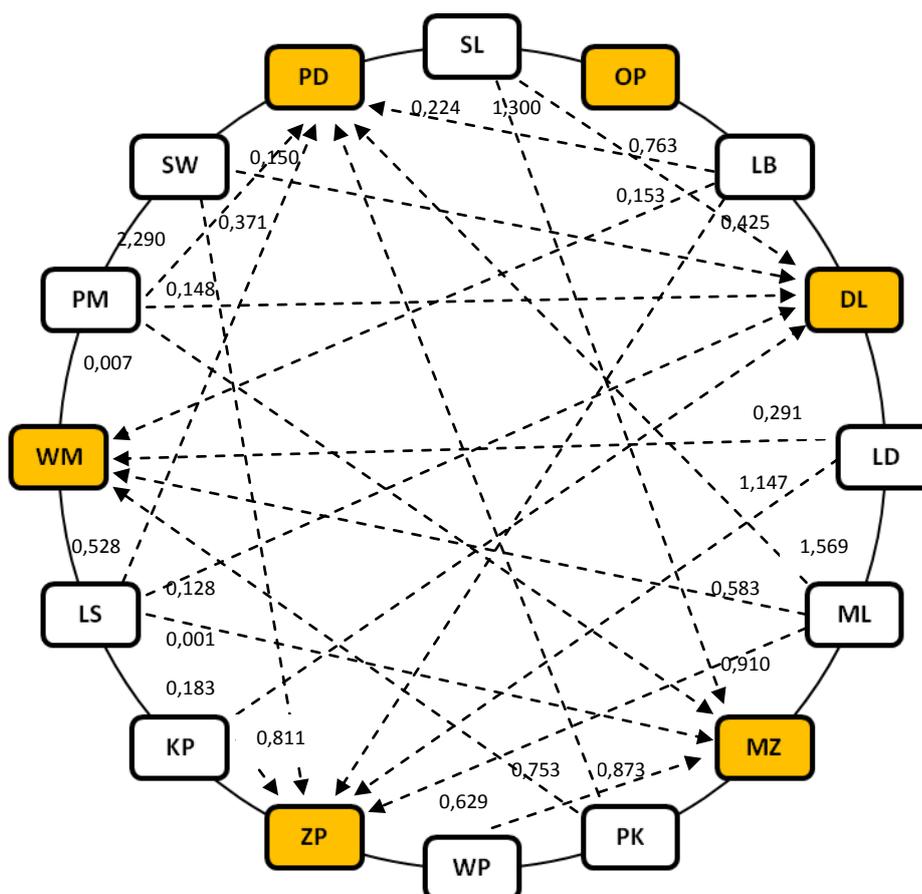
**Figure 6. Weighted data for 2007.**

DMU	Score	VX(1) PBC	VX(2) PRC	VX(3) EMP	UY(1) GVA	UY(2) SPP
Łódzkie (LD)	0,978647	0,0000	0,7229	0,2989	1,0000	0,0000
Mazowieckie (MZ)	1	0,0000	0,0239	0,9761	1,0000	0,0000
Małopolskie (ML)	0,9150704	0,0000	0,5125	0,5803	0,8315	0,1685
Śląskie (SL)	0,9079268	0,0000	0,0198	1,0816	1,0000	0,0000
Lubelskie (LB)	0,9660648	0,0000	0,4903	0,5448	0,8318	0,1682
Podkarpackie (PK)	0,9027812	0,0000	0,7672	0,3405	0,0000	1,0000
Podlaskie (PD)	1	0,0000	0,0000	1,0000	0,6338	0,3662
Świętokrzyskie (SW)	0,9862498	0,0000	0,4915	0,5225	1,0000	0,0000
Lubuskie (LS)	0,9833531	0,0000	0,0823	0,9347	0,9226	0,0774
Wielkopolskie (WP)	0,8825015	0,0000	0,0000	1,1331	1,0000	0,0000
Zachodniopomorskie (ZP)	1	0,0000	0,7120	0,2880	1,0000	0,0000
Dolnośląskie (DL)	1	0,0500	0,5538	0,3962	1,0000	0,0000
Opolskie (OP)	1	1,0000	0,0000	0,0000	1,0000	0,0000
Kujawsko-pomorskie (KP)	0,9712278	0,0000	0,4939	0,5358	1,0000	0,0000
Pomorskie (PM)	0,9672082	0,0084	0,0000	1,0255	0,9113	0,0887
Warmińsko-mazurskie (WM)	1	0,3743	0,6257	0,0000	1,0000	0,0000

Source: Own calculations.

As shown in Figure 6 in 2007 there were 6 leader voivodships, i.e. Mazowieckie, Podlaskie, Zachodniopomorskie, Dolnośląskie, Opolskie, and Warmińsko-Mazurskie. By solving the output oriented model of DEA we obtained optimal weights for each variable in our analysis. According to (1) we can calculate the efficiency score for each DMU. Using these data one can compile a ranking of all voivodships. As we can see in Figure 6 some of the variables must have weights equal to zero which does not mean that such a variable is not important. As a matter of fact it implies that in case of substituting such a weight by non-zero value given DMU would never get a higher score. And in the case of six leading voivodships, as they all have zero slacks, weights equal to zero as shown in Figure 6 have in fact infinitesimal Archimedean values.

Figure 7. A set of interactions for 2007.



Source: Own calculations.

In Figure 7 a set of benchmarks for each DMU is presented with values of lambdas. The lambda represents the benchmarking coefficient. For each inefficient DMU we can see a set of connections (dotted arrows) with reference DMUs (represented by rectangles painted grey). Adequate weights are presented along the arrows.

For further analysis of relative efficiency the Malopolskie voivodship was chosen. Basing on (6) and (7), with given inputs and outputs for the Malopolskie Province, we can obtain score efficiency (1,093) and a set of lambdas. The score of 1.093 indicates that the Malopolskie Province compared to other 15 DMUs is not efficient. And non-zero lambdas suggest reference DMUs (benchmarks), i.e. Podlaskie, Zachodniopomorskie and Warminsko-Mazurskie Provinces. These results are presented in Figure 8.

As suggested by B. Guzik (2009) empirical data of all variables for each reference DMU may be called empirical technology vector  $t$  (coordinates in columns 2-4 in Figure 8). For example, technology vector for the Podlaskie Province  $t_{PD}$  equal  $[56,37; 530,977; 16,818; 1499; 430,826]^T$ . Therefore, an optimal technology for the Malopolskie voivodship can be calculated according to the following formula:

$$t_{MP} = 1,569t_{PD} + 0,91t_{ZP} + 0,583t_{WM}$$

The results of these calculations are shown in column 8 in Figure 8 and are referred to as projection (weighted sum).

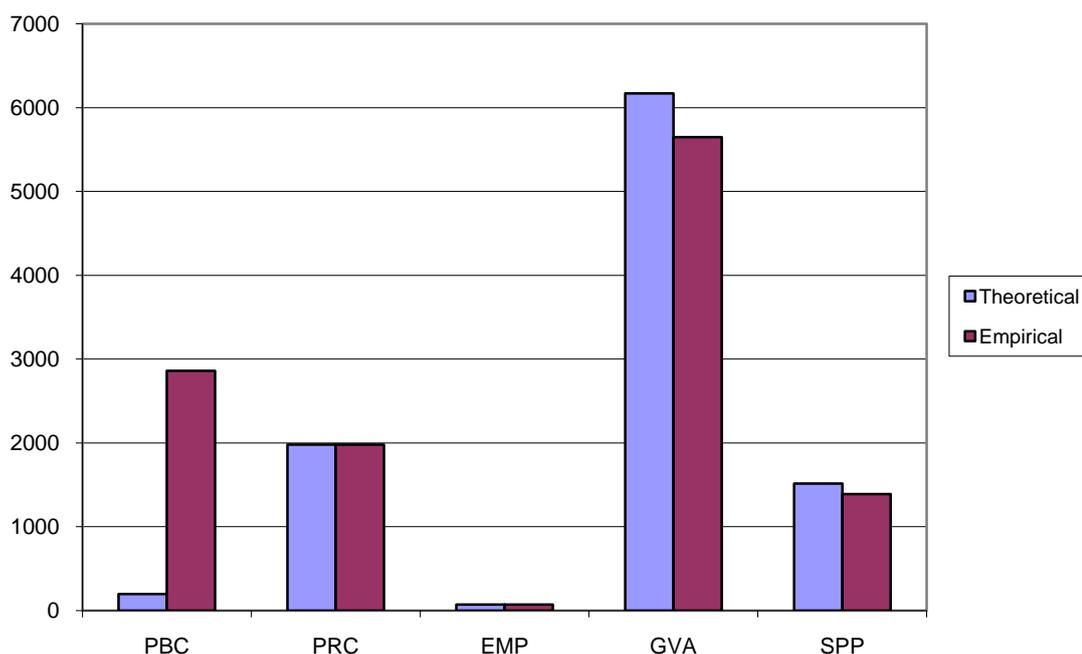
**Figure 8. Optimal technology (projection) for the Malopolskie voivodship**

Variables	Benchmarks			Lambdas			Weighted sum (Projection)	Empirical data	Ratio
	PD	ZP	WM	1,569	0,91	0,583			
(I)PBC	56,37	97,9	36,233	88	89,1	21,12	199	2862	0,069
(I)PRC	530,977	911,8	545,357	833	830	317,9	1 981	1982	1
(I)EMP	16,818	34,55	24,133	26	31,4	14,07	72	71,93	1
(O)GDP	1499	2992	1876	2 352	2723	1094	6 168	5647	1,093
(O)SPP	430,826	609,9	490,333	676	555	285,9	1 517	1389	1,093
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10

Source: Own calculations

By comparing empirical data for the Malopolskie Province with weighted sums we can clearly notice reasons for this DMU inefficiency (as shown in Figure 9).

**Figure 9. DEA results for the Malopolskie voivodship**



Source: Own calculations.

For example, empirical value of GVA for the Malopolskie Province equals 5 647 Mio. PLN whilst an optimal level of that variable is 6 168 Mio. PLN which represents 1.093 of empirical value, i.e. measure of DEA efficiency.

## Conclusions

1. DEA method is still unappreciated in regional research and planning for evaluating efficiency in Poland. Such a non-parametric approach of study can be especially useful in

conditions of short time series of data which is the case of Polish voivodships. DEA model provides important policy implications. It is possible to evaluate the management of a DMU or performance of an input or output sector over time. Such applications provide information about objective values of inputs and outputs making it possible to utilise this information for limited projection purposes. This gives policy makers the opportunity to estimate future inputs and outputs needed to achieve efficiency.

2. Taking into account the results of the article it is worth to be noticed that during the period of years 1999 - 2007 there was only one permanently efficient voivodship (section F), i.e. Podlaskie. There were also some permanently inefficient voivodships, i.e. Malopolskie, Slaskie and Kujawsko-Pomorskie.

3. Taking a closer look at 2007 we can observe six DEA efficient provinces and ten DMUs having slacks in either inputs or outputs. In the Malopolska case a set of references comprises Podlaskie, Zachodniopomorskie, Warminsko-Mazurskie. In future actions Malopolska's decision makers in order to improve efficiency in construction sector should pay attention to inputs and outputs levels in the benchmarks.

4. In evaluating practice an approach used in this paper may and should be developed by DEA model extensions, such as BCC, CEM, SE-DEA, CEP, and so on.

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## Abstrakt

*Głównym celem opracowania jest zaprezentowanie modelu Data Envelopment Analysis (DEA) oraz jego potencjału jako metody oceny efektywności sektorów ekonomicznych gospodarki. Część empiryczna artykułu dotyczy oceny efektywności budownictwa (definiowanego według sekcji PKD) w latach 1999-2007.*

*W pierwszej sekcji artykułu zaprezentowano istotę modelu DEA (w ujęciu CCR). Następnie przedstawiono charakterystykę zmiennych wykorzystanych w analizie oraz wyniki badania. W analizie wsparto się programem DEA solver software.*

# DIFFUSION OF INNOVATIONS IN THE SYSTEMS THINKING APPROACH

*Małgorzata Baran<sup>7</sup>*

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## Abstract

*This article presents the process of innovation diffusion in the context of Systems Thinking. The Bass diffusion model is built and converted into a computer simulation model with all variables defined in terms of the System Dynamics (stocks and flows). The computer simulation on the Bass' model confirms a typical for real-life innovations behaviour. Various initial assumptions and their impact upon the innovation diffusion are tested.*

**Key words:** *diffusion of innovations, systems thinking, System Dynamics, computer simulation.*

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## Introduction

The ubiquitous market competition compels enterprises to create new products and technologies offering innovative character and enhanced usefulness that will be appreciated by the customers. We may assume that innovations are the basic factor of enterprise development. Diffusion of such innovations depends on different conditions, i.e. market capacity (absorptiveness) and quality and velocity of the information targeting potential customers. The holistic approach towards the process of diffusion of innovations is possible thanks to systems thinking. Its tools enable us to explore interrelationships between the factors determining such a process. The decision making process may be enhanced by the good use of those tools, especially in case of decisions about the actions supporting diffusion processes.

This article aims at presenting the Bass diffusion model in form of a simulation model, constructed according to the System Dynamics method, which is one of the systems thinking tools. It also offers the results analysis of the simulation modelling made using software for simulation of dynamic models - Vensim<sup>®</sup>, PLE version.

### The essence of diffusion of innovations

In a broad sense, diffusion can be described as a physical spreading of a given phenomenon in a certain environment. This term is adopted by various sciences; thus, we may use it in physics as a spreading of some substance or matter; in anthropology, as a spreading of a given cultural pattern or an idea. In economics, diffusion is inextricably bound up with the spreading of an innovative product or technology in a human and organizational environment (Gomułka, 1990, p. 71). Moreover, the term 'innovation' may have different economic meanings, and most frequently it concerns (Szatkowski, 2001, p. 17-18):

- 1) launching into market new, yet unknown to the customers, goods or an improved version of such goods,
- 2) launching a new untried production method,
- 3) reaching a new market, where a given production branch was absent,
- 4) reorganization of production processes,
- 5) securing a new source of raw materials or semi-finished products.

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The research on diffusion of innovations most frequently focuses on the identification of factors, both hindering and facilitating the diffusion process, which influence its duration and range.

The most common models describing diffusion of innovations are: the Rogers model, the epidemic model and the Bass model. Rogers divided customers according to the rate of receipt (adoption) of new products or technologies in a time. The first group, called *innovators* (about 2.5 % of society), are the people who are not afraid of risk and willingly undertake ventures connected with innovations. The second group constitute *early adopters* (about 13.5% of society), who follow the innovators. The third group - *early majority* (about 34% of society) is driven by a strong feeling of practicality. The next, fourth, group - *late majority* (about 34%) is formed by so called innovation sceptics. The last group are *laggards* (about 16%), who employ innovation only when, after some time, it becomes indispensable or very common (Mahajan, Muller and Wind, 2000, p. 6). According to Rogers, the adoption curve during diffusion resembles regular pattern, which reveals certain stages in the process of adoption for particular customers groups, i.e. slow increase, acceleration, reaching the peak and slow decrease.

Another approach to diffusion of innovations is based on the theory of epidemic. People who acquired an innovation and who appreciated it, 'infect' others to acquire it. The mathematical model of the epidemiological theory takes the following assumptions: there should be a constant population (number of individuals prone to infection) during the whole process of diffusion; constant frequency of relations between infected and 'healthy' individuals (potential purchasers); constant - definite probability that the innovation will be transferred in case of a contact between infected and healthy individuals and the premise that we get infected only once (acquired innovation cannot be lost). The diffusion of innovations follows a logistic curve (Gomułka, 1990, p. 72).

The basic Bass model (1969) is a prevalent diffusion model in such fields as management and marketing. It is also used as a tool for new products forecasting. Diffusion process according to Bass may be described with the following equation:

$$dN(t)/dt = p[m-N(t)] + (q/m)N(t)[m-N(t)] \quad (1)$$

where:  $N(t)$  – cumulative number of purchasers at time  $t$ ,  
 $m$  – size of potential purchasers,  
 $p$  – coefficient of innovation,  
 $q$  – coefficient of imitation,

This equation assumes that diffusion of innovations may occur thanks to external communication channels, such as advertising, media reports or others and imitation effect, e.g. word of mouth.

Systems Thinking and Systems Dynamic method.

For a definition of systems thinking we may quote Senge (2006):

It is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static "snapshots." It is a set of general principles—distilled over the course of the twentieth century, spanning fields as diverse as the physical and social sciences, engineering, and management. It is also a set of specific tools and techniques, originating in two threads: in "feedback" concepts of cybernetics and in "servomechanism" engineering theory dating back to the nineteenth

century. During the last thirty years, these tools have been applied to understand a wide range of corporate, urban, regional, economic, political, ecological, and even physiological systems (p. 86).

In the light of such a definition, we may understand holistic systems thinking as a transition (Cempel, 2004):

- 1) from a part to the whole, bearing in mind the role of a part in the whole,
- 2) from system structure to its processes,
- 3) from objective to epistemic science (depending on the frame of reference),
- 4) from a concept of science as a "building" to a concept of "net" as a scientific metaphor,
- 5) from confirmed to approximate knowledge, as the next stage in approximation of reality perception,
- 6) from linear perception and implementation: *general sciences - applied sciences - development works - new process and product technologies*, to network interaction model, where each stage interacts with others,
- 7) from absolute truth to contextual statements that are locally true.

This means that systems thinking is directly connected with the notion of a system. A system can be defined as a set of interrelated parts (variables) isolated from the surrounding because of their connections. The system parts form its structure which is responsible for the behaviour of this system.

The basic principles of systems thinking are (Kauffman, 1980, p. 2ff):

- 1) every system is a subsystem of some larger system,
- 2) we are parts of some larger systems,
- 3) system structure is based on the network of feedbacks,
- 4) balancing feedbacks are responsible for the stability and balance in a system,
- 5) reinforcing feedbacks causes increase processes in a system,
- 6) complex systems behave anti-intuitively,
- 7) systems behaviour should be considered both in short and long time span.

The discipline of systems thinking aspires to comprehend and improve systems. During improvement processes, it is advantageous to use lever and reinforcement effects, i.e. ability to notice and locate actions and such changes in system structures which result in durable and essential effects (Meadows, 1999).

Systems thinking may cause many problems. Richmond (1996, p. 26) suggests that the reason for this phenomenon may be a cognitive overload, caused by the current process of school education, which focuses more on a teacher rather than students and their creative discovering of knowledge. He also points out that in systems thinking, it is indispensable to operate on seven categories of thinking. The first category is *closed-loop thinking*, which consists in perceiving a system as a set of continuous, mutually dependent processes, not a unidirectional relationship between a group of coefficients and a phenomenon that is caused by them. Such thinking informs us that we are a part of the system and that we are responsible for its behaviour. The second category is *dynamic thinking*, which is connected with the accurate interpretation of a system structure in context of given behaviour patterns or their combinations. It is aimed at understanding and analysing such behaviours in time for particular coefficients making up the system. It cannot be identical to the behaviour forecasting. It rather should be enhanced by tracking behaviour patterns that change in time and by considering the processes as closed-loops that, while following cyclical pattern, trigger specific events. The next category is *generic thinking*, which demands the ability to notice in

a system both general and particular information responsible for its behaviour. It enables the proper response to a challenge of complexity and variability. The fourth category is *structural thinking*, which is responsible for determining basic feedbacks between variables that illustrate the cause and effect chain in a system, and for presenting them in form of casual loop diagrams. Without feedback analysis we cannot understand system behaviour, not to mention intentional influencing it. It represents thinking in terms of units of measurement, assigned to particular variables in a system. The fifth type of thinking is *operational thinking*, closely bound up with structural thinking. It assumes real reflection of actions, information flow and interrelationships in a system, without theoretical aspects and forecasting. The sixth category is *continuum thinking*, which is an expansion of generic thinking and is most frequently used for simulation modelling of a system. It determines the ability to select variables making up a given system which constitute logical function of other variables. It combines relations and correlations between variables. The last category of thinking is *scientific thinking* which allows quantification of processes and phenomena in systems. Yet its main role consists in formulating and testing hypotheses concerning system modelling processes and examining models' correctness (Richmond, 1996, pp. 34-43).

The System Dynamics method is directly connected with systems thinking. This method was devised by J. W. Forrester at the end of 1950s in Boston, at the MIT Sloan School of Management. The basis for the analysis in System Dynamics is a mental model which becomes a casual loop diagram. The diagrams lead to a formal system model, which is constructed according to traditional management theories, employing the laws of cybernetics and computer simulation.

Traditional management facilitates the identification of a problem that is subject to system modelling, the selection of variables influencing the examined problem and considering information flow between these variables. The variables are in descriptive form that appears in minds of people modelling and in reports, statements, etc. They may also occur as numeric data, i.e. quantitative data for the examined system (Kwaśnicki, 1998, p. 9). The main drawback of the traditional management is the lack of ability to detect holistic system behaviour.

Cybernetics, relying on the feedback theory, puts an emphasis on dynamic relations between variables, exploring their interrelated behaviour and variability. It helps discerning significant and insignificant information, and then it facilitates its structuralization and formalization in the mathematical models. Solution of such models (often consisting of non-linear relations) demands proper numerical method, which, in case of System Dynamics, is computer simulation. It allows to examine inter-correlations of variables in a ready-made model and to forecast their behaviour in the future.

The core of this method is the research on behaviours of whole systems as well as of their particular parts. The most frequent behaviours distinctive for systems are: exponential growth, goal seeking, oscillation, S-shaped growth and S-shaped growth with overshoot.

### **The Bass diffusion model with dynamic variables**

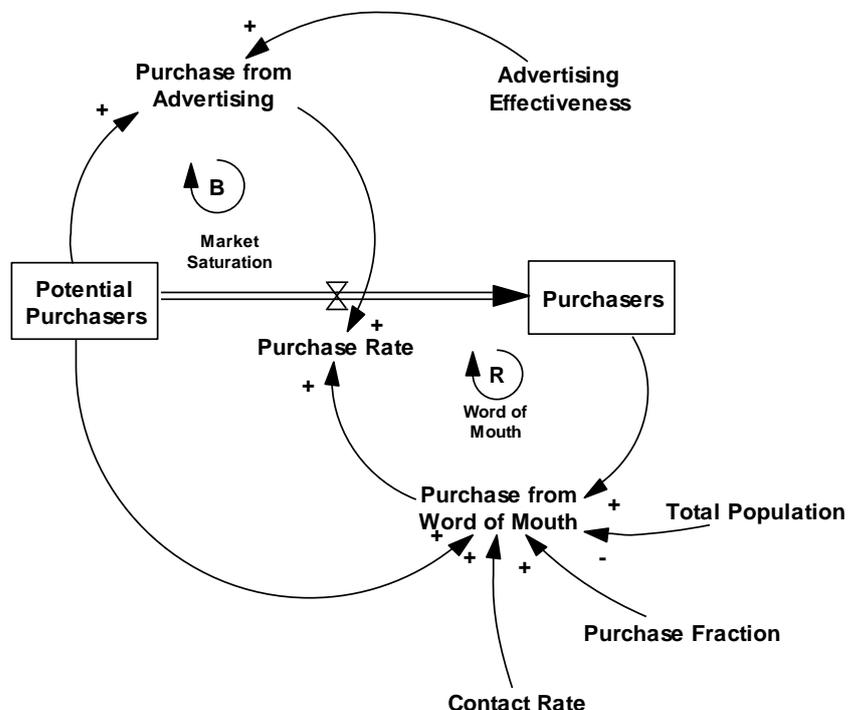
Systems models represented with the System Dynamics method consist of three types of variables:

- 1) stocks - describing a condition of a given system and generating information for all decisions and actions,
- 2) flows - directly influencing the value of stock variables,
- 3) auxiliary variables- which link with one another using informational bonds allowing to determine unambiguously the cause and effect direction in a system.

They complete the full system image and indicate the importance of its components.

Therefore, taking into consideration the requirements of this method, we may present the Bass diffusion model as follows (Figure 1):

**Figure 1. Dynamic Bass Model.**



Source: Author's elaboration on the basis of Sterman (2000, p. 333).

The model consists in two stocks: *Potential Purchasers* and *Purchasers*. *Purchasers* variable is increased by *Purchase Rate* flow, being the total of such auxiliary variables as: *Purchase from Advertising* and *Purchase from Word of Mouth*. *Purchase from Advertising* variable is influenced by *Potential Purchasers* variable and *Advertising Effectiveness* constant. *Purchase from Word of Mouth* variable consists of *Purchasers* variable and the following constants: *Total Population*, *Contact Rate* and *Purchase Fraction*.

In the model, there are two typical feedbacks: reinforcing feedback consisting of such variables as: *Purchasers* → *Purchase from Word of Mouth* → *Purchase Rate* → *Purchasers* and balancing feedback consisting of the following variables: *Potential Purchasers* → *Purchase from Advertising* → *Purchase Rate*.

The variables are linked according to the following mathematical equations:

$$Potential\ Purchasers = INTEG(-Purchase\ Rate, Total\ Population - Purchasers) \quad (2)$$

Units: Persons.

$$Purchasers = INTEG(Purchase\ Rate, 0) \quad (3)$$

Units: Persons.

$$\text{Purchase Rate} = \text{Purchase from Advertising} + \text{Purchase from Word of Mouth} \quad (4)$$

Units: Persons/Year.

$$\text{Purchase from Advertising} = \text{Advertising Effectiveness} * \text{Potential Purchasers} \quad (5)$$

Units: Persons/Year.

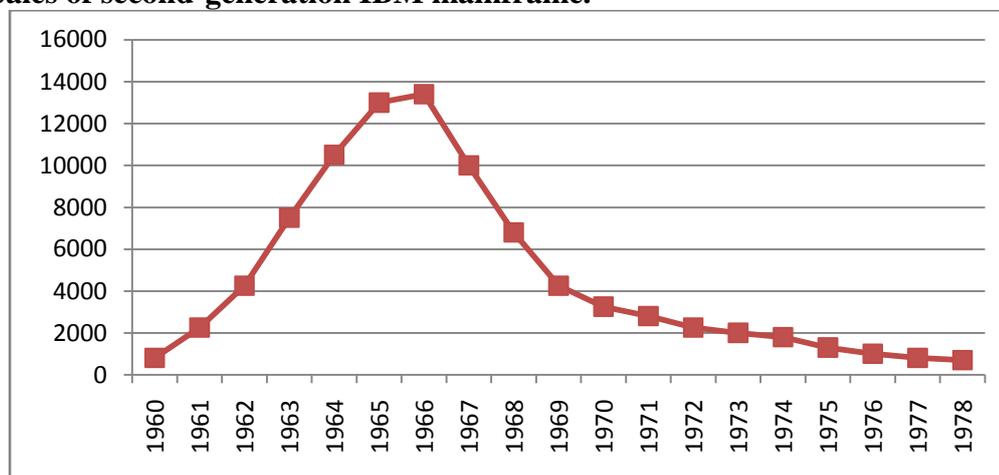
$$\begin{aligned} \text{Purchase from Word of Mouth} &= \text{Contact Rate} * \text{Purchase Fraction} * \\ &\text{Potential Purchasers} * (\text{Purchasers} / \text{Total Population}) \end{aligned} \quad (6)$$

Units: Persons/Year.

### Simulation on the Bass model

For simulation purposes, let us consider the example of the sale of second-generation IBM mainframes (transistor-based), in the years 1960-1978. The quantitative sales amount was presented below (Figure 2).

**Figure 2. Sales of second-generation IBM mainframe.**

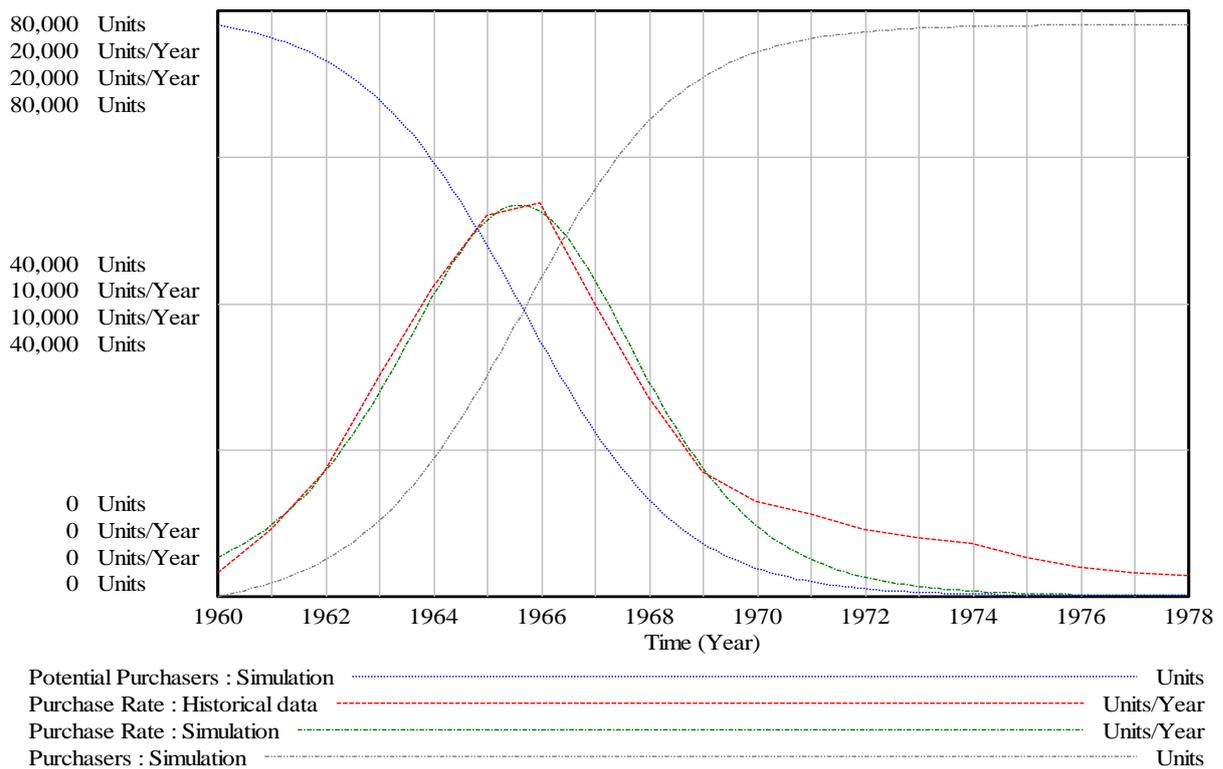


Source: Author`s elaboration on the basis of Mahajan and others ( 2000).

If we assume that: *Total Population* = 78000; *Purchase Fraction* = 0,0013; *Contact Rate* = 500; *Advertising Effectiveness* = 0,017 and if we set simulation step 0,125; we obtain the simulation results which are presented in Figure 3.

After the analysis of the showed results, we can notice that while the number of *Potential Purchasers* decreases, the number of *Purchasers*, who initially learn about the innovation from external sources, in this case from the advertisement, and then from internal sources, i.e. word of mouth, increases. In the early stage, when *Purchasers* curve grows, up to the intersection with *Potential Purchasers* curve, *Purchasers* variable value increases are growing. In the same time, sales value, described by *Purchase Rate* variable increases as well. *Purchase Rate* reaches its maximum in the second half of 1965, which coincides with the numbers of *Potential Purchasers* and *Purchasers* being equal. After this time, the increases of *Purchasers* curve are diminishing. It is caused by the fact that after 1965, the *Potential Purchasers* values are lower than the values of *Purchasers* variable and less *Potential Purchasers* "switch" to *Purchasers* (the reserves of *Potential Purchasers* stocks decrease slower and slower to the complete depletion). *Purchasers* curve becomes a logistic curve, typical for diffusion of innovations.

**Figure 3. Behaviour of the Bass Model selected variables.**



Source: Author's elaboration (Vensim® PLE).

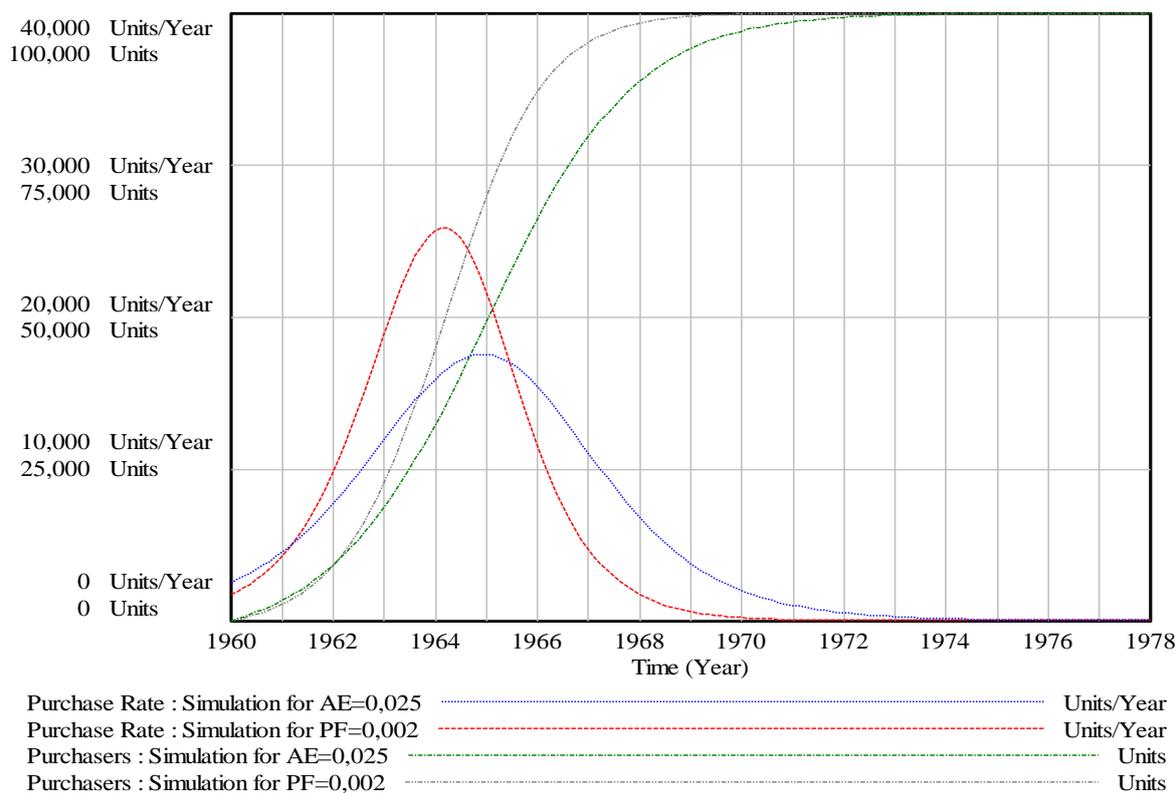
While comparing sales values presented by *Purchase Rate* simulation curve with historical data, we may claim that they are almost identical, except for the years 1969-1978, when the simulation curve has lower values than the real one. It results from the model structure, which determines *Purchase Rate* curve behaviour according to the bell curve.

One of the opportunities of the computer – based simulation and modelling is the fact that we can change the initial assumption and examine different simulation results. Therefore, we may see what the sale of the second-generation IBM mainframes would be, if we changed the following values:

- 1) *Total Population* = 100000; *Advertising Effectiveness* (AE) = 0,025;
- 2) *Total Population* = 100000; *Advertising Effectiveness* (AE) = 0,017;  
*Purchase Fraction* (PF) = 0,002.

We obtained the following simulation results (Figure 4):

**Figure 4. Simulation results with changed coefficient values.**



Source: Author`s elaboration (Vensim<sup>®</sup> PLE).

The obtained results indicate that in the first case, when the *Advertising Effectiveness* constant was increased, IBM mainframes sale would have reached the maximum in 1965, amounting to 17500 units, and the market would have become saturated already in 1972. The second case illustrates even faster diffusion of the innovated product, thanks to the increase of *Purchase Fraction* constant. Thus, the maximum sales value (equalling about 23000 units) would have fallen on the beginning of 1964, and the market would have become saturated in the first half of 1969.

## Conclusions

Systems thinking tools enable us to have an insight into interactions between particular variables forming a given system. In case of the Bass diffusion model, they allow to discover the dynamics resulting from quantitative transition of customers from Potential Purchasers to Purchasers level. That is possible due to the observation of the first, external factor, i.e. the advertisement (which is responsible for diffusion of innovations) and the gradually appearing second - internal factor, i.e. word of mouth. The above presented model is very general and it concerns the basic diffusion of the innovations model introduced by Bass in 1969. It ignores such factors as: innovation price, possibility of repeat innovation purchase and range of minimum expenditure indispensable for the realisation of innovation. Undoubtedly, taking the above parameters into consideration would result in more reliable research on diffusion of certain innovation. That would provide an invaluable clue for the strategic plans prepared by the enterprises.

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### Abstrakt

Powyższy artykuł przedstawia proces dyfuzji innowacji w kontekście myślenia systemowego. Model dyfuzji Bassa pokazany jest w formie modelu symulacyjnego, zawierającego w swojej budowie dynamiczne zmienne, takie jak: zmienne akumulacyjne i zmienne przepływowe. Komputerowa symulacja przedstawionego modelu potwierdza charakterystyczne zachowania poszczególnych zmiennych modelu w czasie oraz bada ich zmianę w odpowiedzi na przyjmowane różne założenia początkowe.

# ORGANIZATIONAL CULTURE AND ITS INFLUENCE ON THE EFFECTIVENESS OF THE COMPANY

*Justyna Myszak*<sup>8</sup>

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## Abstract

*Not so long ago, the crucial factor on the road to success was believed to be found within the perfect understanding and application of organizational strategies. This turned out to be incomplete when the influence of the organizational culture came to daylight. Today this force constitutes the core of the present organization. It determines the unwritten rules and values, which allow stakeholders to better comprehend the way the company works, what it stands and aims for. Understanding and accepting the above enables creating a 'member-company' relationship, bringing benefit in form of involved employees, and a company which provides confidence and security.*

**Key words:** *organizational culture, strong and weak organizational culture, company, management of the company*

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## Introduction

The concept of organizational culture has recently become the subject of many discussions and analyses. It arises, among other things, from the fact that culture is an equivocal concept, and it is also the subject of interest for many different scientific domains such as psychology, law, management or sociology. Each of those domains considers the definition of culture in a different way, inserting in it the elements essential for this particular domain. Due to this fact it is impossible to formulate the universal definition of culture, because there will always be some inaccuracies.

The purpose of this consideration is to present the role of organizational culture in the lifetime of each enterprise and also to answer the question: How does organizational culture affect the effectiveness of particular enterprise? The answer to this question is neither simple nor unambiguous, and that is why I consider it necessary to look closer into this issue.

## The essence of organizational culture

Not so long ago, the representatives of the traditional approach to management claimed that the main factor deciding on the company's success is the perfect knowledge of the organization's strategy and structure on each of its levels. After some time, it was noticed that even the perfect strategy and structure are not enough to affect the effectiveness of the company to a truly satisfying extent. We are taking here into consideration the factors belonging to so called "soft management issues" [Peters , Waterman (2000; quoted after Potocki, 2005, p.163)] including attributes such as people, skills, managing styles, values and the crucial for this analysis – organizational culture. We are dealing here with a social category where the people's behaviours in their working place are subordinated to common models and patterns, including role models. In a sense, organizational culture can be treated as a personality of the company, which manifests itself in behaviours, attitude, the way of solving problems, organizing work-place, etc. In other words, organizational culture provides

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some behaviour models, which are more or less shared by all members of the company (Wajda, 2003, p.253). New employees have to face the challenge of learning and accepting at least a part of *principles* of the company, making possible the mutual acceptance in the worker – company relation.

To sum up, organizational culture is a set of values which substantially make it easier for workers to understand how the company works, what it is subscribed to and what is valuable for it. Thanks to such orientation, employees are working more efficiently, because the culture improves the communication, which is conducive to faster decision making. What is more, it allows to decrease the staff supervision and lets the workers show themselves at work. Organizational culture is therefore a living formation moulded by workers. It undergoes changes and modifications while the organization is learning how to deal with problems connected with internal and external adjustment.

### **Focusing the company's organizational culture**

It is time to ask: How come even in large organizations all workers know and understand the organizational culture of their company? Majority of the companies have one dominant culture with many subcultures operating within. The dominant culture establishes some standards, thanks to which it is known which behaviours are considered proper and praiseworthy, and which are considered unacceptable and punishable. Those standards are followed and accepted by the majority of workers, and that is why talking about organizational culture, we bear in mind the dominant culture. The subcultures arising around it are the reflection of common problems, experiences and situations encountered by particular workers. They include only the basic values of the dominant culture and additional values typical of a specific group of workers e.g. marketing or production department. So if the organization did not have an organizational culture and consisted only of many subcultures, would the value of the culture in the organization decrease? Probably yes, because there would be a lack of the uniform interpretation of which behaviours are appropriate and which are not. Organizational culture is then a powerful tool facilitating the management and moulding behaviours (Robbins, 2000, p.245).

### **Managers' personality**

In literature on our subject, authors very often enumerate the factors affecting organizational culture of the company. One of them is the culture of the nation, which even though is a far different phenomenon, it surely affects the creation and structure of an organizational culture. Standards, models and values in different ranges or regions are interpenetrating and they are an internal part of *life* in the company. Main rules, principles of behaviour, customs or communication system are established and imposed by founders of the company, who are the primary source of the organizational culture. Their personality, charisma and temperament have definite influence on the vision of what organization should be; for instance, if we have to deal with an enterprising and aggressive founder, the company is willing to risk and it is able to take advantage of ideas and resources unnoticeable for others. If on the other hand, there is a bureaucrat in front of the organization, the relations inside it are formalized, routine and the development is limited. Management chooses the branch the company is operating within and the workers who bring to it their own values. Outstanding managers should be aware of the relation between the company's success on the market and its organizational culture being "the peculiar core of the company's activity, that almost all strategic moves result from" (Nogalski, 2001, p. 586).

## **Determination of strength of organizational culture**

Management has to face a really difficult challenge. It has to find the connection between their own goals and the nature of the organization, and to decide which culture will be conducive to the company's effectiveness.

If one wanted to show the force of organization's culture graphically, one would have a spectrum, where one end shows the weak culture, while the other strong. The first range of created set of workers is presenting too much loosened bonds, because workers do not have a clearly specified image of the company – what is desirable and what is not – and preferred values are not deeply ingrained. The second range is presenting the exaggerated constraint resulting from the ease of absorbing workers by the company, affecting their decisions and behaviour, which does not give them much freedom. Organizations with strong culture are not willing to accept other opinions, because they are afraid of destroying the company's identity. Such attitude makes the development and making changes in the company difficult, because even the most objective criticism will not be assessed properly and discussed. In such a situation workers are not analyzing performed activities, they fall into a rut and they stop searching for new and more profitable solutions. They know that the key to obtaining a promotion is the complete subordination to their company's culture and not the creativity or innovativeness. Performing the activities mechanically decreases the vigilance of all workers and, what follows, the whole organization, which stops noticing the necessity of implementing inevitable changes in the fast developing environment. Does this mean that strong organizational culture of the company should just be the subject of theoretical considerations, because it is a serious threat for a real company?

Management in general aims at moulding the organizational culture with deeply ingrained and commonly recognized values by workers. Such behaviour allows to create a peculiar *climate*, thanks to which subordinates identify with the organization and its goals. Mutual agreement in pursuing a goal and the acceptance of standards and opinions lead to the increase of the engagement and coherence, which weakens worker's susceptibility to changing a job. It should be stressed that low personnel rotation is a desirable factor in every organization. There is nothing more important for the employer than a loyal worker who is sharing his experience and identifies with the company. It should be thought over what benefits for the company can be brought by one or a group of such workers. Organizational culture omits individualism in favour of the team work, which is conducive to the creation of synergy effect. A set of various personalities with different experience, temperaments and characters helps the creativity and group cooperation. It manifests, among other things, in increased effects in broadened market range or the possibility of lowering the costs in the field of research and development. It should be remembered that achieving the desirable result is only possible when a group consists of suitable workers and the whole team has the right leader.

Strong culture and tradition of the organisation is conducive to searching for new employees. Very often college or university graduates put attention to the company's reputation, because most of them think that organizational culture based on the history and tradition gives the feeling of safety, and also augurs well for the future. The company is then presented with the possibility of hiring a young employee who can bring not only some fresh ideas, but also dynamism, more susceptibility to risk, a new look at the present situation and willingness to change.

## Balance is the key

As it can be seen, it is hard to give an unequivocal verdict on strong or weak organizational culture. A situation when the worker's beliefs are equal to the organization's requirements is comfortable, because without any problems he can react to various information and events so that he can successfully plan his future actions. This relationship brings mutual benefits. The organization gives the worker the feeling of safety and certainty, and he responds with full engagement. When the worker's cultural models differ significantly from the values represented by the organization, reaching an agreement and achieving higher effectiveness of the organization is almost impossible. The worker feels alienation, dissatisfaction and mental discomfort, which very often leads to leaving work. The greater the unanimity between the worker's beliefs and values imposed by the organization, the greater the chance for efficient functioning of the organization. This state of agreement is called the balance occurring between an organization and its culture. It is worth stressing that this balance is often upset, due to the fact that both culture and organization are dynamic and constantly developing systems. As we mentioned before, culture is a living formation moulded by workers, so that its changes are connected to the organization's social life affected by new workers with new experience, new models or new behaviours. The organization should constantly react to changes occurring in innovativeness, technology and also in economical, legal or market environment. Keeping the organizational culture balanced is a difficult challenge for management. On one hand they are aiming at the balance in organization and culture and trying to keep it as long as possible, but on the other hand, the necessity of development and adjustment to the environment forces them to introduce changes, which are destructive for the balance (Sikorski, 2008, p. 39- 40). Weak culture, which is helpful when implementing desirable changes, as well as strong culture, which helps to make use of the state of balance, have a number of advantages and disadvantages. One thing is certain. Each organization has its own specific organizational culture, whose intensity depends on the leaders of an organization. That is why it is worth thinking (from theoretical and practical point of view) about *striking a balance* between the strong and the weak organizational culture, which is certainly a very challenging activity.

## Conclusions

At present, authors of many books more often present the positive aspect of the organizational culture in management emphasizing the fact that it is going to be one of the most valuable management techniques as it is an important ingredient, crucial for the proper functioning of every institution. Organizational culture minimizes the misunderstandings of complex commands and expressions often used by managers as it offers a common language and conceptual apparatus specific for a particular company. It is an integral bond between workers or particular subcultures who have got a peculiar expressions making the communication among them significantly easier; it is the slang, which characterizes the company or its part. According to Nogalski (2001, p.592), "a basic condition for communication is the existence of common language, which is understood and used by all members of the organization". It is similar to the people applying for a job in a specific company. From the beginning *new* people are informed about the expectations of the job, and then they are introduced to the organizational culture through many professional trainings. Companies do not stint on such actions, because trainings and integration trips are connecting people and increase the productivity. Even the recruitment process is based on detailed selection, which gives the candidates information about the company. The criteria of effectiveness assessment, system of promotion, rewarding or punishing, make a potential worker accept or refuse the job offer. Only people who fit to the specific culture and will

easily adjust to it can be employed. Workers who question the company's organizational culture are punished or in extreme situations fired. Thanks to it the company does not have to be afraid of shaking its own values.

### **Issue complexity**

The presented considerations show that the organizational culture is an intangible, but undoubtedly, extremely valuable asset of the company. Developing the organizational culture which is deeply ingrained and also easily adjusting to environment, is a difficult and sometimes even impossible task. Everything depends on the people who create it. There are many cases when companies consisted of very talented and intelligent people have not succeeded, because it came out that for a long time the organizational culture was slowing down the effectiveness. So can the intangibility of the organizational culture lower the company's effectiveness? Why do the management very often forget about it or what is more, disregard it?

There is no one specific answer to these and many other questions. The fact is that managers will be interested in the issue of organizational culture as long as it will be considered the way to the creation of a perfect company with a perfect organizational culture, which will work beyond reproach in every conditions.

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### **Abstrakt**

*Jeszcze całkiem niedawno sądzono, iż głównym czynnikiem decydującym o sukcesie firmy jest doskonała znajomość strategii oraz struktury organizacyjnej. Pogląd ten szybko uległ zmianie, kiedy zaczęto dostrzegać siłę kultury organizacyjnej, która bez wątpienia stanowi sedno istnienia współczesnej organizacji. To właśnie ona ustanawia niepisany zestaw wartości, który w dużym stopniu ułatwia pracownikom firmy zrozumienie jak organizacja pracuje, za czym się opowiada i co jest dla niej wartościowe. Zrozumienie i przede wszystkim zaakceptowanie powyższych założeń umożliwia stworzenie wzajemnej relacji pracownik-firma, co daje obopólną korzyść w postaci zaangażowanych pracowników, chętnie dzielących się własnymi doświadczeniami oraz firmy, która to docenia i nagradza, a także daje poczucie pewności i bezpieczeństwa.*

# HUMAN RESOURCE MANAGEMENT PRACTICES IN POLISH COMPANIES DURING THE ECONOMIC SLOWDOWN

*Aleksy Poczowski<sup>9</sup>, Alicja Miś<sup>10</sup>*

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## Abstract

*The objective of the paper is to present how companies operating in the Polish market faced challenges in the field of HR-function during the economic slowdown. As a source of data for the analysis two empirical studies have been used, which were conducted in 2009. In both studies structured questionnaires were used.*

*The first study deals with turnover and retention issues and the second one focuses on trends in reward systems. Efforts have been made in the paper to examine how companies adapt their HR policies and practices while coping with changes in the environment. After presenting some general adaptation strategies, the authors will focus on two issues mentioned above.*

*The findings of the empirical research indicate that typical reactions of the examined companies as a response to the crises in the financial markets were: freezing of recruitment actions, cuts in training budgets, changes in reward systems, limitations of benefits as well as restrictions of HR-departments budgets. The research evidence reveals that changes in the labor market caused by economic slowdown forced 46% of the firms to plan reductions of employment but on the other hand 41% did not plan to do that. The uncertainty in the business context of HRM makes HR-professionals rethink practices they have been using so far.*

**Key words:** Human Resource Management, HR-Department, Economic Slowdown, Turnover, Retention, Reward.

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## Introduction

The development of human resource management in Poland after 1989 has been interwoven in the processes of privatizing, modernizing and internationalizing the Polish economy. After twenty years it has reached a condition evoking some afterthought on the development level of this sub-discipline of management theory and practice, the evidence of which is provided in empirical research results [Funkcja...,2007], [Poczowski, Buchelt..., 2008], [Listwan, Poczowski, Stor..., 2009]. Reading the research results leads to the conclusion that the image of the 'Polish' human resource management is differentiated in (relation to) both the level of theory creation and the HR practices implementation in enterprises. It is beyond doubt, however, that we witnessed changes, that is the specific HR function restructurization in majority of enterprises. This fact has been confirmed by both the above-mentioned empirical research [Funkcja..., 2007] and the experiences of the managers and specialists dealing with the human resources management [HR..., 2002]. The conclusion arising from the research points out to progressive HR professionalization in Poland, which does not change the fact that new challenges continually emerge and the change becomes a norm also in the area of human resource management. It is therefore justified to ask to what extent structural and tool solutions take the long-term changes of the working world into

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account, and to what extent, on the other hand, they are a reaction for immediate problems arising from the labor market changes.

The aim of the article is to present the methods of adapting HRM practices in Polish enterprises which are functioning in conditions of the global, financial-market crisis, as a result of which economic slowdown in Poland occurred. The source of information was the subject matter literature as well as two empirical researches conducted at the Department of Human Capital Management of the Cracow University of Economics in 2009. In both researches a structured survey questionnaire was used.

The first research regarded the issue of workers retention and turnover, both constituting one of the greatest challenges in the HR function area of many Polish enterprises before the economic crisis<sup>11</sup>. 46 companies participated in the research, 35% of which were small and medium companies and 65% - large enterprises employing over 250 people. The largest share among the investigated companies constituted trade and service companies (48%), followed by industrial and construction firms (39%). The remaining 13% of firms represented administration, education, culture and health care sectors. 85% of the researched cases were private companies, whereas 15% - state enterprises.

The second research focused on identifying remuneration system trends<sup>12</sup>. It encompassed 45 enterprises, out of which the biggest share belonged to the industry sector companies (56%), while the remaining firms represented various branches of business in a widely understood service sector, among others: trade (11%) and financial institutions (7%). The structure of the studied enterprises according to their size measured by a number of employees can be presented as follows: 77% of the companies were large companies employing over 250 workers, and the remaining 23% were small and medium enterprises. 78% of the researched cases were private companies, whereas 22% - state enterprises. Further part of the paper deals with (in turn): the context of the human resource management in Poland while carrying out the research; some general strategies of the personnel policy adaptation to the changes on the labor market; and the influence of those changes upon two detailed issues, that is the attitude to workers' retention and turnover and the attitude to remuneration.

## **The context of Human Resource Management**

The solutions for particular problems in the human resource management area are directly or indirectly determined by numerous factors of an economic, technical, legal and social character, which, altogether, constitute the context of the reached decisions. A few of them, especially those which were crucial in the research time period, have been summarised below.

The indication of the economic slowdown in Poland was the slow GDP rate increase in 2009. Although the GDP was still positive and amounted to 1.7%, it underwent a noticeable decrease in comparison to the previous years (2008 - 4.9%, 2007 - 6.8%). One of the changes in the labor market which should be emphasized is the unemployment rate increase, as compared to the earlier period, especially in the years 2004-2008, when the unemployment rate had systematically been decreasing, from 19% at the end of December 2004 to 9.5% at the end of December 2008, which was the lowest unemployment level in the whole transformation period. The unemployment rate amounted to 11.9% at the end of December 2009. Average gross remunerations indicated a constant growing tendency and

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<sup>11</sup> The research results were published in form of a book [Procesy płynności..., 2009].

<sup>12</sup> Its detailed results can be found in the report [Trendy..., 2009].

their rate was , for instance, 8.7% in 2007 and 10.2% in 2008. The remuneration increase rate dropped to 4.3% in 2009.

Numerous problems related to the personnel function are regulated by law. The Labor Code determines some of the terminology questions (employee, employer, wage and minimum wage); it also stipulates the rights and duties of the employees and employers, both of whom constitute the employment relationship parties [Gadomska et al., 2009]. Presently, however, several shortcomings can be observed in the regulations of employment referring to other employment forms (e.g. civil-law contracts or management contracts). They are ever more attractive and more and more frequently used by organizations in practice.

The Polish Labor Code does stipulate the issue of employing workers abroad; nevertheless, it seems that in the event of more intensified activity of Poles as employees abroad, it would be beneficial to widen statutory regulations. Polish jurisdiction is dominant in this respect, with the approval for foreign regulations merely in case when they are not contradictory to the Polish Labor Code (with the exception of 'Other Provisions' Art.6 §1 and 2.).

A substantial number of statutory regulations are connected with employee remunerations. The Polish Labor Code brings up the question of 'fair remuneration' which remains compatible with the European Social Charter (ratified by Poland) and considers such remuneration to be at the level of 68% of the average earnings in a given country. The guarantee of the fair remuneration institution in Poland is the established of the institution of the 'minimum wage' which remains the subject of detailed regulation in the Minimum Wage Act of 10.10.2002. The minimum wage level is discussed in league with the Trilateral Commission and annually announced. The minimum monthly wage for a full time job in Poland in 2010 is PLN 1317 (about 320 Euro). It was until 2009 that the institution of annual wage indexation (wage increase factor in relation to inflation processes) functioned in public sector enterprises; it was rescinded on 1<sup>st</sup> January 2010.

What seems to be crucial in the situation of the economic slowdown is the lawful establishment of the 'notice of change' institution, allowing organizations for labor cost reduction without resorting to individual or collective dismissals (Art. 42 of the Labor Code) [Lachiewicz, Walecka, 2010, p.410].

The Labor Code brings up the issue of equal treatment and discrimination ban in employment as well. However, a package of laws multi-dimensionally stipulating the rights and duties of the employers towards the disabled persons exists merely in the sphere of disability. Additionally, an important party herein is the state. Other symptoms of discrimination are taken into consideration by the Polish legislation insufficiently and the constitution entry is regarded to be excessively general in this matter. This area of personnel activity should receive stronger legal support.

The Labor Code and its accompanying documents (The Trade Unions Act of 1991 and the Employers Organizations Act of 1991) contain a provision on the right to coalition, understood as a possibility of setting up organizations representing and defending the rights and interests of employers and employees. The consequence of those regulations was the appointment of the Trilateral Commission in 1994. It was set up in order to stimulate social dialogue and maintain social peace by reaching consensus in macroeconomic issues, such as determining factors for a maximum wage increase and working out the concept of a pension reform [Pocztowski, 2008, p. 388]. The existing legal solutions have lead to constituting strong trade unions with two dominating headquarters: The Solidarity (Solidarność) and the All-Poland Alliance of Trade Unions (OPZZ). What is characteristic in the Polish coalition market is the employer's stronger position in relation to the trade unions' position at small companies and privately-owned companies as well as managerial staff being the most

influential subject of the labor relations. Such substantial differentiation impedes personnel activity based on equal employee treatment. It is also a challenging area for the HR services.

An important factor influencing the choice of strategy and methods for solving HR issues is the level of organization and competence of the services dealing with those tasks. It is useful to invoke some empirical research results while undertaking an attempt at showing characteristic personnel function transformation in Poland. The image presented in the results is differentiated with regards to the rules and tools of the human resource management in specific enterprises; however, we witnessed some changes in most of them [Funkcja, 2007, p. 20], which has also been confirmed by managers and specialists dealing with the human resource management. The factor responsible for the increase of the HR function importance in an organization and redefining the range of personnel managers' tasks connected with the issue, was noticing the growing importance of people in building the competitive advantage. Popularization of the awareness of this fact has led to the evolution of roles performed by the specialist sections dealing with personnel matters and compatible with the general global trend, starting from some typical administrative tasks connected with employee service, through specialist functions, such as recruitment, retention, trainings, remuneration, to participation in strategically important processes [HR..., 2002, p. 17].

The subject matter literature offers various suggestions for the classification of roles performed by the human resource managers and specialists. The most frequently mentioned HR specialists are: administrators, business partners, strategic partners, innovators, internal consultants, change agents, cost controllers, monitoring, supporting, business integrators, employee champions, trainers, mentors, knowledge creators [Caldwell R., Storey, 2007], [Ulrich, Brockbank, 2005], [Pocztowski, 2008]. Assigning specific roles to HR specialists depends on the way their position is perceived in certain organizations. There is no doubt, however, that along with the growing importance of the human capital as competitiveness factor and along with organizational changes, such as, among others, decentralization, involving line managers in the human resources management processes, moving from functionalism to result orientation, it is also essential to restructure the roles performed by the human resource department in an enterprise.

Some interesting data regarding the evolution of the HR department position as well as the roles performed by the specialists in this area in Poland after 1989 can be found in empirical research results. The research confirms the tendency of the ever consolidating position of the specialist divisions dealing with personnel questions. It also shows that HR managers and specialists undertake new functions beyond a traditional administrative role; though the range of administrative role is still wide in the above-mentioned departments' functioning.

**Table 1. HR department position and roles in the process of changes**

<b>HR DEPARTMENT POSITION</b>		
Before	Now	In the future
Subordinate Supportive	- Supportive - Key	Key - Supportive
<b>RANGE OF ROLES PERFORMED BY HR DEPARTMENT</b>		
Role definition	Before	Now
Administrative	Wide	Wide
Social	Medium	Wide-medium
Strategic partner	None-medium	Wide-medium

Change agent	Medium - none	Wide-medium
Internal consultant	Medium	Wide

Source: [Funkcja..., 2007, p.64-66]

### General HRM adaptation strategies

Each change of the market situation influencing an enterprise leads to the change of personnel policy or, at least, to its revision and introduction of certain corrections. Personnel policy encompasses activities connected with the human capital in a given organization. These are, among others, human resources allocation, motivating and employee development, including questions related to planning and building employment structure. 65% of the researched companies claim that the crisis contributed to the change of policy as well as practice in the HR function area. It is mostly evident in blocking new admissions, reducing training costs, lowering salaries, reducing additional benefits as well as lowering personnel department budget (Tab.2). 33% of the surveyed companies reckon that the economic slowdown does not influence the change of policy and personnel practice [Procesy..., 2009, p.131].

**Table 2. The influence of crisis on personnel policy**

NO	TYPE OF INFLUENCE	% OF INDICATIONS
1.	New workers' admission blockage	48
2.	Training costs reduction	39
3.	Changes in remunerations (lower)	17
4.	Additional benefits reduction	15
5.	Personnel department budget reduction	17
6.	Others (lay-offs, freezing of pay increase, outplacement)	20

Source: [Procesy..., 2009, p.133].

It should be underlined at this point that the changes in personnel policy and practice should be executed with great care to avoid worsening the organization's image which has sometimes been created for years. Especially little importance is attached to the way in which dismissals are executed. Workers leaving an organization create its external image by their opinions, frequently negative emotions and the sense of grievance. The mechanism is similar in case of employees not directly affected by workforce reduction. They witness the process, which, after all, influences their state of being, effectiveness and negative opinions on the employer. Symptoms such as fear, anger, depression, sense of guilt or distrust point to *survivor sickness* [Pocztowski, 2008, p. 172]. The syndrome of those who survived consists of four phases. It starts with persuading oneself not being involved in the matter up to the increasing sense of anger, guilt and isolation resulting from retaining a job. The next stage involves employees' thinking about the possibility of negotiating their position and safety. Later we have to do with depression and the feeling of threat resulting from fear of losing a job. The last stage involves coming to terms with the existing state of things. Losing a job is a difficult experience for the dismissed people. It may not only result in lowered self-evaluation but a difficulty in finding new employment as well. That is why the employers should remember to follow outplacement programs, especially in case of collective dismissals. The main outplacement tasks are: psychological support, looking for employment opportunities, building competence profile, additional trainings, supporting occupational retraining and

offering legal assistance [Berg-Peer, 2004]. Programs of this kind not only offer active support for the dismissed employees but they exert positive influence on the workers remaining in the company as well. Additionally, they help retaining a positive image of the company on the market. Difficulties with applying them are linked to the costs which they require. But the negative influence of inappropriately executed dismissals costs a lot as well, e.g. the cases submitted to court by the dismissed persons or the negative attitude of the remaining workers. Furthermore, the range of the program may be adjusted to the company's financial means and personnel number, not to mention help in form of EU subsidies.

The communication process is vital not merely in case of dismissals but it should be an essential element of any changes of personnel policy typically influencing personnel either in a direct or indirect way. Introducing a cost-cutting policy, either in form of getting rid of pay rises or in form of reducing personnel department budget, should be clearly presented. Employees should know what its range is and what it may lead to. In case of, e.g. cutting training funds, it is essential to inform which trainings are still available, which employee groups may participate in them and how the savings are allocated.

Research showed that within the cost-cutting policy framework, enterprises plan to use alternative solutions instead of employment reduction. Collective dismissals have been pointed out by merely 4% of the firms. What the companies mostly do is blocking personnel inflow by refusing to admit new workers. 2% of the companies mentioned voluntary redundancy programs which are to encourage employees to hand in their resignations in return for severance pays [Procesy..., 2009, p.134]. Their application should go along with pointing out very clearly which employees the programs are aimed at, in order to avoid losing the best workers, without whom the further functioning of an organization would be impossible. The three above-mentioned methods of coping with the crisis lead to changes within employment quantities. Also personnel turnover streams are changing – the employee inflow is withheld and the employee outflow increased - in this case on company's own initiative.

Lowering salaries (39%) is one of the three methods for reducing costs and avoiding collective dismissals pointed out in the literature. Some other methods are encouraging employees to leave voluntarily or go on unpaid leaves [Sidor-Rządkowska, 2003, p. 76-80]. Lowering salaries allows for breaking down the company difficulties arising from the crisis to all employees and thus avoiding redundancies. However, there are some negative aspects to it as well, such as the risk of losing precious workers for whom such form of cost-cutting is unjust and unacceptable; it may also lead to a decrease in motivation and effectiveness. In the face of the deepening crisis, it may be an insufficient remedy to avoid dismissals. Lowering salaries is a temporary action and one should not confine merely to this solution. Employers have to be informed that these are actions undertaken ad hoc in order to avoid layoffs and improve the organization's position.

## **Turnover and retention as a challenge for HRM**

Economic slowdown exerts influence on the disturbance of employment stability and the change of the character of the personnel turnover phenomenon. 2007 and 2008 were the years connected with the problem of effective employee retention in organizations. Workers often left for companies which offered higher remunerations, abundant social benefit packs or better career building opportunities. 65% of the companies admitted that voluntary redundancies constituted a significant problem for their normal functioning. It was mainly evident in the effectiveness drop, the job performance drop (57.5% of the surveyed companies), problems with planning actions (52.5%) and difficulties with managing workers (42.5%). The majority of the surveyed firms (64%) have recently experienced problems with

retaining employees as well as problems with the employees who leave [Procesy..., 2009, p.128]. This phenomenon confirms the change of powers which had been taking place on the labor market in the last two years preceding the period of trade recession.

Research shows that economic slowdown influenced the change of the personnel turnover process as compared to 2008. 54% of the surveyed companies pointed to this phenomenon, 39% of which were large companies and 15% - small and medium enterprises. The above data confirms that crisis and recession first affect large companies operating on a large scale and sometimes on the foreign markets as well. 30% of those companies operate in trade and service sectors and the remaining 24% - in the industry, energy and construction businesses. Changes in personnel turnover have not - so far - been clearly registered in administration, education, culture and health protection, that is in most budgetary units. Moreover, 35% of the surveyed enterprises did not notice any changes in the turnover phenomenon and 11% were of no opinion. It's worth pointing out that 41% of the companies where the problem of retaining employees and the problem of employees leaving the company had not been registered in the previous year, have now experienced a change in this respect.

According to the surveyed group of enterprises, crisis influenced the streams of personnel turnover phenomenon mainly in the form of reduced admission of new workers. The second ranked was lower willingness of the employees to leave the company on a voluntary basis, followed by the increased number of employees leaving as a result of the company's initiative. Additionally, some other factors pointed out by the respondents were: pay rise freeze, voluntary redundancy programs, overtime liquidation, collective dismissals, as well as fewer people willing to undertake employment. The chart below presents the most frequently indicated symptoms of crisis.

**Table 3. Symptoms of crisis in the area of retention**

NO	SPECIFICATION	% OF INDICATIONS
1.	The company restricted number of admissions	35
2.	Lower willingness to voluntary redundancy	33
3.	Higher number of workers leaving out of company's initiative	15
4.	Others	13

Source: [Procesy..., 2009, p.129]

The financial crisis and the necessity of its consequential cost cutting, lead to assigning the areas of the organization which require application of a cost-cutting policy. Personnel is often one of such areas. Such a situation is usually named worker excess and it normally results in employment reduction. Employment reduction is understood as reducing the number of employed people within departments or particular groups of workers, leading to termination of employment contracts. Apart from economic factors, such as business recession, employment reduction may also result from the will to get rid of the so called 'problematic workers' who do not meet their superiors' expectations.

46% of the surveyed companies planned employee reduction, understood as lowering the number of employees. 33% of them were large companies and 13% - small and medium enterprises. As for the ownership, a vast majority of redundancies are planned by private companies (41%) and the remaining 5% of the enterprises belong to the state. Most redundancies are planned in trade and service sectors - as many as 22%. The second largest group (20% of indications) is industry, energy and construction sectors. A 2% group constituted companies operating in administration, education, culture and health care sectors -

they are planning to reduce employment to the smallest extent of all the respondents [Procesy..., 2009, p. 129].

Employee reduction connected with cost reduction used to refer mainly to blue collar workers in the past. During the research, i.e. in the beginning of 2009 it referred to almost all working groups, among others: administration, production, sales or management. Research showed that the employees most frequently destined for reduction were administration workers (44%), followed by production workers (32%) with sales workers coming in the third place.

The process of employment reduction has to be well-judged in the long-term perspective. Also communication within organization is a crucial factor. In the time of crisis, informing workers precisely what direction the organization is heading, what the foreseen changes are and why they take place, allows for reducing anxiety, increasing motivation and, consequently, facilitating effective organization management. The consequence of the employment reduction process is the employment reduction shock [Pocztowski, 2008, p. 176] which can be overcome in four stages. In the first stage, workers are updated on the employment reduction course of action. In the second stage negative emotions linked to the process are eliminated, so that the new look and motivation to further work can be achieved in the third one. The last, that is the fourth stage, consists in reorganization which, thanks to variable elements included in employment contracts, guarantees avoiding negative effects of prospective employment reduction in the future.

Employment reduction is a difficult process. On the one hand, it helps reducing costs and getting rid of employees who do not meet the leaders' expectations. On the other hand, however, in the face of a difficult economic situation, it may lead to the loss of precious workers who are hardly replaceable in the future. It may also generate severance pay costs or court trials and exert negative influence upon the remaining staff. Therefore, the importance of planning this process calls for a lot of attention. The most essential tasks in this respect are: determining the total number of people to be dismissed, specifying which departments they are in, and taking into account the natural employment changes connected with retirement, pension or longer holiday. Additionally, the choice of dismissal implementation dates and specifying dismissal implementation terms are vital matters [Armstrong, 2005, p. 425-426]. They should be convenient from the organization's point of view and should allow proper employee preparation. A univocal procedure of informing employees about the upcoming changes should be determined. Announcements should be directed both at the dismissed workers and employees who do not undergo reduction.

Employment reduction should include actions connected with appointing the most valuable employees and retaining them in an organisation. It frequently happens that highly qualified workers, knowing about the planned redundancies and the company's difficult position, decide to change their workplace on their own. Therefore, employment reduction and the consequential dismissals should be conducted by implementing clearly defined criteria. This, on the other hand, is not that simple. What seems to be a fair attitude is taking into account such aspects as: the number of years that a person worked in the company, their skills and achievements, but also individual factors like family situation or easiness of finding a new job [Sidor-Rządkowska 2003, p.83]. Such criteria as location and importance of position in the structure are pointed out as well. Dismissal of a person who performs a crucial role in a team may not only disturb the team's functioning but simply lead to its utter paralysis.

## Changes in reward systems

Remunerations are an especially sensitive area of the human resource management and they are susceptible to the influence of numerous factors, among others: changes in legal regulations, business conditions, labor markets state or socio-cultural factors. Economic slowdown noted in Poland in 2009 also influenced changes in the attitude to remunerating employees. It should be reminded at this point that the basic principles shaping remunerations in an organization are its business strategy as well as internal and external equity [Kessler, 2007, p. 159]. The empirical research carried out by the authors allowed for specifying the main factors determining changes in the remuneration system. Research shows that the factors connected with the company strategy, in this case the company policy and its financial situation, jointly constitute 41% of indications; factors connected with the market, such as business situation and labor market trends mentioned in the research constitute 35% of the answers, and internal factors, that is employee expectations, and trade unions' pressure - 24%.

**Table 4. Factors evoking changes in remuneration systems**

NO	FACTOR	% OF INDICATIONS
1.	Company policy	21
2.	Labor market trends	20
3.	Company financial situation	20
4.	Economic situation	15
5.	Employee expectations	12
6.	Trade unions' pressure	12

Source: [Trendy..., 2009, p.50]

The researchers attempted to define the influence of the financial market crisis and its consequential economic slowdown upon changes in people's attitudes to remunerations. Let us remind in the beginning that 15% of the respondents pointed to the economic situation as a factor determining employment system in an organization, while 20% pointed to the company's financial situation (Table 4). The answer to a general question whether economic slowdown was a factor inducing modification of the possessed remuneration strategies was positive for 42% of respondents and negative for 42% of companies; 16% of the enterprises did not respond to this question at all. As can be observed from the presented answer distribution, the influence of economic slowdown is clearly visible, although the proportion of the opposite indications was the same. It may indicate a selective influence of economic slowdown on the remuneration sphere, depending on the type of business which the companies operate in.

Changes in enterprise surrounding, including changes on the labor market, often constitute grounds for undertaking modifications of the existing human resource management systems, including the remuneration system as well. Depending on the level to which crisis situations influence competitive position of the companies, but also depending on specific management philosophy represented by the management, the range of the above-mentioned changes may be very different. The issue was also taken into account in the research and the results obtained can be seen in Table 5.

**Table 5. Typical approach to remuneration during economic slowdown**

NO	ATTITUDE CHARACTERISTICS	% OF COMPANIES
1.	Reactions to changes within the existing remuneration system	31
2.	Adjusting to changes by modifying certain elements of the remuneration system	58
3.	Using environment changes for thorough reconfiguration of the remuneration system	4
4.	No answer	7

Source: [Trendy..., 2009, p.53]

The above table shows that the majority of the surveyed companies (58%) are trying to use the crisis situation to introduce modifications in certain elements of their remuneration systems. What it implies is, for instance, developing new principles for awarding bonuses or granting different employee benefits. Such an attitude can be defined as a reduced activity strategy.

The second (with 31% of indications) ranked is an attitude which can be defined as a reactive-preservative strategy consisting in actions undertaken within the existing remuneration systems without their - at least - partial modification. The examples of such activities are: deferment of rises, bonuses and other benefits without changing the rules of granting them.

Only in two cases (4% of the surveyed companies) it was pointed out that changes in surrounding had been used for comprehensive reconfiguration of the existing remuneration systems through, e.g. changing rules, criteria or remuneration structure. Such actions point to the use of proactive remuneration strategy utilizing the crisis situation to introduce thorough changes, a specific revitalization of the existing remuneration system in order to make it an effective tool for building the company competitiveness for the future. As shown by the research, this type of attitude is exceptional, at least in the group of the surveyed companies.

Remuneration system changes introduced during economic slowdown may arise from various reasons and serve different aims. Analyzing this problem in a group of surveyed companies, the following results have been obtained and presented in the table below. Lowering remuneration costs was most often (48%) indicated by the companies as a priority change. 39% of the companies considered increasing the power of motivating influence of remuneration as their highest priority. Those two opinions have by far dominated in the survey as the most important aims in remuneration systems change. It is worth pointing out the answer distribution in case of lowering remuneration costs as a priority change in remunerations. Not only did it score the highest number of indications being the most important task, but it also scored a high number of indications as the least important task (35%). This seems to point to the selectiveness of the economic slowdown influence on the changes in employee remuneration systems. Those 35% clearly correspond to 42% of indications of economic slowdown not influencing remuneration system changes.

Securing employee earnings as a prerequisite for remuneration changes was mentioned in the third place. Last among prerequisites for introducing changes in remuneration systems came the 'concern about harmonious labor relations' - 48% of respondents pointed to this option as the least important.

Research results indicate that motivation function and cost function of remuneration dominate as prerequisites for introducing changes in remuneration systems during economic slowdown. Third came the profit-making function and fourth - the social function.

**Table 6. Priorities of changes introduced in remuneration systems as a result of economic slowdown**

NO	PRIORITIES OF CHANGES INTRODUCED IN REMUNERATION SYSTEMS	THE IMPORTANCE OF PARTICULAR CHANGES				WEIGHTED MEAN
		1	2	3	4	
1.	Securing employee earnings	13%	35%	39%	13%	2,5
2.	Increasing (maintaining) motivating function of remuneration	39%	26%	31%	4%	2,0
3.	Lowering remuneration costs	48%	17%	0%	35%	2,2
4.	Concern about creating harmonious labor relations	0%	22%	30%	48%	3,3

1 - most important task, 4 - least important task

Note: Only 51% of the surveyed companies responded to the above question.

Source: [Trendy..., 2009, p. 55]

The subject matter literature studies undertaken within the conducted research show that the last two constitute a strategic problem of the human resource management in contemporary organizations.

Research indicates as well that economic slowdown exerts influence on remuneration strategy, most often leading to reactive actions, that is actions adjusting the existing elements of remuneration to market changes or attempting at modifying certain elements of those systems to a limited extent.

## Conclusions

The conducted research shows that the worsening of the economic situation and the related labor market changes influence personnel policy as well as human resource management practices applied within its framework to a large extent. This influence, however, is of a selective character, which is proved by the fact that along with enterprises forced to, for instance, reduce employment or lower remuneration costs as a result of crisis, there is an equally large group of enterprises where crisis effects are not noticeable to an extent which would lead to undertaking the above-mentioned actions. Real life observation gives right to state that economic slowdown has become an excuse for some enterprises to introduce the previously planned projects rationalizing employment and work organization. However, the dynamics of the occurring changes makes one careful when formulating conclusions. It requires further research in order to check the discovered tendencies within the human resource management strategies and methods.

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#### **Abstrakt**

*Celem artykułu jest przedstawienie sposobów radzenia sobie przez przedsiębiorstwa z wyzwaniami w obszarze funkcji HR w okresie spowolnienia gospodarczego. Źródłem danych wykorzystanych w analizie były dwa badania empiryczne z wykorzystaniem techniki ankiety, przeprowadzone w 2009 roku. Pierwsze z nich dotyczyło kwestii płynności i retencji pracowników, a drugie trendów w systemach wynagrodzeń.*

*W obu tych badaniach podjęto próbę odpowiedzi na pytanie: w jaki sposób przedsiębiorstwa dostosowują politykę i praktykę zarządzania zasobami ludzkimi do zmian zachodzących w ich otoczeniu, w szczególności na rynku pracy. Autorzy przedstawili w kolejności ogólne strategie adaptacji praktyk HR do zmian by następnie skoncentrować się na wspomnianych wcześniej dwóch kwestiach tj. retencji i rotacji pracowników oraz systemach wynagrodzeń.*

*Wyniki badań wskazują, że do typowych działań w okresie spowolnienia gospodarczego należały: blokady etatów, cięcia budżetów szkoleniowych, zmiany w systemach wynagrodzeń, ograniczenia świadczeń dodatkowych, tzw. benefitów. Badania wskazały też, że zmiany na rynku pracy spowodowane spowolnieniem gospodarczym doprowadziły do redukcji zatrudnienia w 46% badanych firm, z drugiej strony w 41% badanych firm nie planowano takich działań. Na podstawie przeprowadzonych badań można stwierdzić, że zmiany w otoczeniu biznesowym funkcji HR powinny skłaniać menedżerów i specjalistów do spraw zarządzania zasobami ludzkimi do krytycznego spojrzenia na stosowane praktyki w dziedzinie funkcji HR.*

# EMPOWERING EMPLOYEES IN PROCESS-ORIENTED ORGANIZATIONS

Natalia Potoczek<sup>13</sup>

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## Abstract

*Empowerment is one of key management methods in contemporary organizations. The implementation of this method, however, is connected with creation of appropriate organizational conditions. In this article the characteristics of classical function-oriented organizations and contemporary process-oriented ones were presented, then the possibilities of applying empowerment in these organizations were analyzed. Barriers, costs and benefits of empowering employees were identified. The implementation of empowerment proves high competencies of an organization as well as it contributes to their development. Special attention was paid to the speed of making decisions and flexibility of acting and reacting to changing expectations of external and internal customers.*

**Key words:** *empowerment, process organization, functional organization, competencies, involvement.*

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## Introduction

Empowerment of employees as a management method is a development of the concept of delegating authority. Contemporary organizations, forced to increase their flexibility in reacting to the environment needs, have to rely on the employees who are the closest to external and internal clients. Therefore, workers have to be more and more independent, which makes it necessary to increase their competencies and accountability for their work. Delegating authority in a classical function-oriented organization consists in granting the employees the right to make decisions in place of the manager or the supervisor. Empowerment is a new approach to sharing decision powers. The employee obtains the power which is established in the law, not through delegating, which means the possibility of making decisions for somebody else (Brilman, 2002; Potoczek 2006).

Many organizations have tried to implement empowerment, with various degrees of success, quite frequently resigning at the early stage of the implementation of the method. To explain this phenomenon we should, first of all, refer to basic barriers deeply enrooted in the organization. The aim of this paper is to identify and analyze the conditions of empowerment implementation. Among them, there are structural, relational, and organizational aspects shaping the place and the role of an employee in the company. We will analyze the conditions created by the process-oriented organization for empowerment implementation. We will also discuss here the costs connected with empowerment implementation, and the final part of the paper will present the benefits both the organization and its employees enjoy.

## Barriers to empowerment implementation

The idea of empowerment appeared in the American language of management quite recently, its importance has grown together with the development of TQM. The necessity of shortening production cycles showed the weakness of organizations in quick decision making. Therefore, the need to develop new management methods originated, the methods which would lead the organization to greater flexibility of reacting to customers' needs. In the

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classical organization, vertically- and hierarchically-oriented, decisions are taken by people on executive posts. Flexibility and speed of decision-making by executives in such organizational conditions depends mainly on the ability to delegate authority to subordinates. However, we should remember that the executive delegating authority does not become unaccountable for these decisions. That is why a basic barrier in delegating authority is the unwillingness of executives to share the power. Empowerment as an organizational method allows the company to make a further step, to streamline the decision-making process and to increase the employees' participation in it. Empowerment means a totally new concept. The employee is given the power (the rights to make decisions) which has legal foundation, not through authority delegating, which means the possibility of making decisions while substituting for someone else. The revolutionary character of the empowerment concept is manifested in placing the right to make decisions in the hands of an employee who is closest to the customer and who, simultaneously, realizes operations located in the place which is the most conducive to making the given decisions. This right should be given to employees in principle. Due to such actions the company has the opportunity to improve all its processes, because by definition, it decreases the area of causes of wrong decisions and dysfunctions (Brilman, 2002).

Managers who have not been successful in using empowerment are prone to pronounce it as a contemporary fad. There are, however, circles, in which this method enjoys great respect. F.G.Harmon (1998, p.269), a well-known American consultant of social sector organizations, stated that empowering will reform the shape of every organization in the 21<sup>st</sup> century. As a fundamental idea of the future, empowering forces classical companies to adapt to social changes and to widening intellectual horizons of their workers. Better educated employees reject the 19<sup>th</sup> century-style authoritarianism at work, just as they have already rejected it in many aspects of their lives. According to Harmon, the disappointment with the concept of empowerment can be attributed to the failure of executives implementing it as a temporary solution evoking changes, not as a strategy for the organization.

The implementation of this method is connected with high costs. In this aspect empowerment is just like other professional management methods. Many authors, such as Block, Howard, Thomas and Velthous, Yukl (Yukl, 2002), examining the mechanisms connected with empowerment, pay special attention to several subgroups of costs, which the organization has to bear:

- 1) higher costs of selection and training,
- 2) higher costs of employing qualified workers,
- 3) costs connected with differentiated quality of the services provided by employees,
- 4) costs connected with the feeling of unequal treatment the customers have,
- 5) costs of solving problems and wrong decisions of some employees,
- 6) costs of the resistance of middle managers resulting from their feeling of being threatened.

Taking all these points into consideration, we should notice the growing challenges in managing organizations, connected both with external factors – the environment, and with internal factors. The analysis of particular groups of costs requires macro- and micro-economic perspective.

Empowerment should concern employees of high competencies. If the company wants to be successful, it should give strategic importance to the process of recruitment. The companies, it turns out, perform more and more conscious actions in this field. It can be visible, for example, in the growing interest of employer branding. Research in this field, led by Polskie Towarzystwo Zarządzania Kadrami (Polish Human Resources Management

Association) and Szkoła Główna Handlowa (Warsaw School of Economics) (2008) shows that nearly 90% of Polish companies have problems with obtaining candidates for work, 76% plan to revise or implement employer branding, and 93% of companies think that the image of the employer has all-important influence on the recruitment of employees. Efforts connected with attracting appropriate candidates for work are ever-growing as there are fewer and fewer candidates on the market. Demographic forecasts for Poland show that in the next 10 years there will be a significant shift in proportions of people in productive and post-productive age. In the period before 2035, the number of people in productive age will be systematically falling, whereas the number of people in post-productive age will be increasing. This means that the post-productive population will increase by over 30% at the expense of productive population (Central Statistical Office, 2010).

Obtaining an appropriate candidate for work does not mean his or her readiness to independent decision-making. Empowerment must be preceded by numerous trainings concerning the company's mission and objectives, its products, competitors, specific work on a given post, communication with clients, knowledge and abilities to make decisions. The costs connected with obtaining independence on a job position, are commonly treated as recruitment costs, which, as the business practice proves, amount to at least full annual remuneration of a newly employed worker. The company has much to win, but also a lot to lose. Each negligence in the recruitment process has its consequences in future decisions of empowered employees.

Higher costs of employment of empowered workers are connected not only with their higher competitiveness on the market but also with their burden resulting from individual responsibility for decisions made. Many organizations strive at easing these burdens, applying team empowerment (Adair & Murray, 2002). The horizontal character of communication in a team creates considerably fewer barriers in comparison to vertical, hierarchically-determined communication.

The costs resulting from differentiation in quality of the services provided by employees must be significant and quite easily measurable. Increasing the rights of the employees to make decisions proves that there is a need to decrease the degree of process standardization. As it is well-known, it is the level of process standardization which differentiates the classical approach to processes from the contemporary approach, consisting in lowering the degree of standardization for the benefit of empowering employees and teams. The scale of standardization in classical organizations is reflected by the typology created by Hill, Fehlbaum and Ulrich (1974, quoted after: Trocki, 2004) in the 70-ties of the twentieth century. The authors selected 5 levels of work standardization: starting with the first level, at which process standardization is not subject to any regulation, to the fifth level, where there is a detailed, rigid regulation, practically eliminating any freedom of the employee's actions. There are many factors determining the choice of the standardization level, such as:

- the required level of the process susceptibility to changes, guaranteeing enough flexibility of actions,
- the necessary level of safety and stability of the process,
- the level of complexity of the process, the more complicated the process, the fewer unpredictable consequences,
- the level of competencies the process performers possess.

The costs connected with the customers' feelings of unequal treatment also result from low standardization of the process and high independence of the employee in creating offers for customers. Customers possess ever-better means of obtaining information about the product, through the Internet they can obtain and compare the information supplied by the

customers and other, competing or cooperating companies. Conflict-free creation of the offer for customers requires the workers to have knowledge of not only the product and the customers' expectations, but also of the plans of long-term cooperation with the customer, synchronized with the strategy of the company.

The costs of solving problems and wrong decisions of some employees, though they really deter the management from implementing empowerment, can be controlled. Also implementation of empowerment in the company should take place as a process, flexible by its nature. The needs of teams and jobs connected with empowerment are not the same, and the preparation of employees to increased decision rights may consist of many stages and bring various results.

The necessity of bearing costs connected with implementation of empowerment is an obvious consequence of applying a new management method. Initiating new actions would not make sense if the costs exceeded the expected profits. Empowerment as a management method is to serve the development of organizational competencies, to develop the company's potential to compete in increasingly unpredictable conditions. As Hammer and Champy (1990) pointed out in their first paper, managers should create organizations able to function in the increasingly unpredictable future.

### Competencies of process-oriented organizations

The competencies of an organization are mostly understood as some potential existing in the organization, expressed in abilities, processes and resources, which are the source of the organization's successes (Potoczek, 2007). Organizational competencies determine the organization's ability to realize its mission, vision and strategy, to initiate contacts and to cooperate (Oleksyn, 2006). The current incredible dynamics of the environment of each organization forces the companies to adjust and to develop new competencies. The directions of changes in organizational competencies were vividly presented by Kiezuń, who contrasted the features of classical organizations and the features of the 21<sup>st</sup> century organizations (Kiezuń, 1999).

**Table 1. Features of the organizational structure of the 21<sup>st</sup> century enterprise.**

Old characteristics of success	New characteristics of success
Orientation on ability or goal	Vision – long-term perspective
Organizational structure	
Functional Hierarchical Local, regional, national Vertical integration Focused on machinery Focused on shareholders Rigid and formalized Focused on product Focused on the quality of product Based on monetary measure Efficient and stable	Integrated Flat and decentralized Global Network integration Technological information Focused on all stakeholders Flexible, adaptive, prone to changes Focused on the customer Focused on total quality Based on time measure Innovative, entrepreneurial

Source: Kiezuń (1999).

The features in the right-hand column are consistent with the contemporary concept of process management, developed since the 1980-ies, firstly within Total Quality Management (TQM) and later Business Process Reengineering (BPR) promoted by Hammer and Champy (Jeston and Nelis, 2008). Radical approach to process management is still being confronted with the evolutionary approach of T.H.Davenport. Whereas these authors differ in the method of restructuring (reorienting) the organization from the functional to the process one, the expected effects coincide in many respects. Quick and flexible reaction to customers' expectations is provided by proper work organization, based on process integration, advanced information technology, high competencies of employees and empowered teams and individual workers.

The contemporary process management has been determined mainly by information technology. In classical organizations the attention was focused mainly on processes in manufacturing areas, whereas the contemporary approach assumes the company's operation based on processes identified in all areas. The contemporary information technology enables us to integrate all processes, and therefore it allows quicker decision-making and higher flexibility of operations.

The enterprises which have applied modern technology in process management, obtained a satisfactory short-term return on investment). The application of modern technology requires, however, good organization, appropriately prepared people and new organizational roles (Jeston and Nelis, 2008).

Business Process Management = organization + people + technology
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The acceptance of process orientation in management means initiating or restructuring the company's operations on the basis of new process structures. Reaching the new structures can be achieved in a radical way stipulated by Hammer and Champy in their first publication (Reengineering the Corporation). More popular, however, is an evolutionary approach, more predictable and safer. The experiences in this matter have been well researched and described in the scientific literature. Usually, 4 stages in the process of restructuring the organizational structure are differentiated (Grajewski, 2007, p.161).

1. Creation of temporary task teams in a functional organization. Temporary teams naturally fill the gap in the areas in which no organizational cells operate. The meeting vertical areas mostly require multi-functional competencies and inter-specialist insight into the organization. The team is usually composed of representatives of organizational units on the meeting areas of which organizational problems appear. The aim of the team is to create new rules/ procedures defining cooperation of appropriate cells.

2. Project management in a functional organization. The new organization consists in implementing in the structure a steady element in shape of a project team. The team members are appointed from employees representing various functional areas in an organization. Functional managers and project managers jointly supervise the work of their subordinates.

3. Creation of matrix solutions, in which a single employee, located in functional vertical sections of the company, simultaneously participates in team tasks realized within already distinguished processes. Functional managers concentrate on perfecting human resources and employees focus mostly on realizing processes.

4. Consolidation of process solutions and elimination of functional division. Competencies of functional managers are taken over by process managers. All tasks realized in the company are covered by processes.

The restructuring of organizational structure from the functional into the process one is the next phase in the evolution of work organization and probably not the last one. It is hard to state at present in which direction the evolution will proceed, however, one thing is sure, it will be even more strongly determined by modern information technologies and will aim at developing autonomy and responsibility of particular performers of the process. Application of present process solutions at the present stage enables the organization to develop competencies, which in quite a short time will increase the distance between the organizations which operate on the basis of functional structures.

The process-oriented organization, basing its operations on teams, for the first time forces the real interdisciplinary cooperation, which is not only a declaration or readiness to cooperate, expressed enthusiastically by managers or specialists. Work in interdisciplinary teams simultaneously forces us to perfect particular new abilities, also communicative ones. Process organization changes the status of contemporary line employees into process performers, horizontal relations become more frequent and more important than hierarchical relations, which tend to become more occasional or sporadic. The owner of the process, participating in realization of the task should have defined customers: external or internal, the level of task realization should enable the satisfaction of expectations of a particular group of clients. Process performers, having better contact with their clients, take real responsibility for the results of their work.

Empowerment of people managing processes is seen as one of the most important competencies of contemporary organizations. The fact that the method was adapted accounts for high maturity of an organization, high competencies of employees and managers who often constitute a basis barrier to empowerment implementation. Development of independence and increasing the autonomy of process performers leads to the development of the ability of the structure to self-organize. Creation of organizational structure and new forms of work organization is no longer an exclusive privilege of managers. Therefore, real conditions are created for development of employees activity in searching for effective realization procedures.

In accordance with the initial assumption of this part, the potential of an organization is created by its abilities, processes and resources. The above-mentioned competencies of a process-oriented organization should lay a solid foundation for satisfying the customers' expectations and for obtaining a strong competitive position on the market.

### **Creating organizational conditions for empowerment**

Implementation of empowerment as a management method requires creating specific organizational conditions. Empowerment cannot be the first step in building the employees' involvement (Potoczek, 2006). G. Yukl (2002) first gave the characteristics of an organization which creates favorable conditions for empowerment. He distinguished several attributes of an organization, such as organizational structure, competitive strategy, tasks and technology, customer relations, corporate culture, features of employees, their abilities, forms of employment, employees participation in profits, programs of employee involvement, level of trust in the company. Analyzing each of them, he identified favorable and unfavorable conditions for empowerment.

**Table 2. Conditions for empowerment**

State of an organization	Unfavorable conditions	Favorable conditions
Organizational structure	High centralization, formalization	Decentralization, low formalization
Competitive strategy	Low costs and standards of products and services	Customer orientation, high differentiation of products and services
Tasks and technology	Single, repetitive tasks and reliable technology	Complex, routine-free tasks, openness to new technologies
Customer relations	Short transactions in short periods of time	Repetitive transactions, continuation of cooperation.
Corporate culture	Reliability, effectiveness of operating without mistakes	Flexibility, learning, participation
Features of employees	Low motivation, external control, emotional instability	High need for achievement, internal control, emotional stability
Abilities of employees	Low abilities, lack of experience	High, professional abilities
Forms of employment	Temporary employment	Steady, long-term employment
Employees ownership, profit-sharing	None or very small	Employees are stakeholders or co-owners
Programs of employee involvement	None	Costly programs strongly supported by top management
Mutual trust	Low	High

Source: Yukl (2002).

The above characteristics allow us to make a key conclusion for empowerment implementation in an organization. Empowerment should be implemented gradually and should support the processes of restructuring the company. The idea of empowering employees should be included in the organizational structure, in work organization, personnel policy, the strategy of attracting, developing and motivating employees. In consequence, it should create a new corporate culture, based not on hierarchical structure but on the cooperation of process performers.

The favorable conditions for empowerment implementation listed by G.Yukl correspond to the direction in which process organizations grow up. Hammer (2007) in the proposed process audit distinguishes 5 factors enabling the realization of the process and four organizational abilities. The evaluation of the process maturity of an organization is made according to the mentioned criteria on four-point scales. Among five factors enabling the realization of the process we have: process design, process executives, process owner, infrastructure and process efficiency measures. Four organizational abilities are: leadership, culture, competencies and supervision.

From the perspective of empowerment implementation, of great importance is strong orientation to changes initiated by performers. The highest level of process advancement of an organization means that the process performers who have the ability to initiate changes know the market in which the company operates and its trends really well and are able to describe in which way their tasks influence the results of cooperation between enterprises. They are also able to identify the signals to start necessary process changes and they can manage the change. The performers of processes are supported by module IT systems, which facilitates cooperation of various teams. As far as human resources management is concerned, the systems of recruitment, professional development, rewarding and giving credit strengthen the

importance of cooperation inside the company and between firms, individual learning and readiness for changes. The space for real decision-making by employees is created in this way, they can influence not only their personal situation, but also the effects of the whole company's operations.

Shaping organizational conditions for empowerment also means defining the areas and the scope of decision-making by employees. In process-oriented organization, the empowerment space is determined by customers and processes in which employees participate. Hammer relates the competencies on the highest level of organizational ability to re-designing processes, implementing changes in processes, project management, program management and change management. Introducing changes, and consequently making decisions is conditioned by the ability to observe the environment, plan changes, the ability to implement and innovate which is concentrated on the process (Hammer, 2007).

Contemporary process management is based on modern information technology. The integration of processes is possible due to application of specialized programs for business process management. It should be noticed that the information tools also facilitate empowerment implementation. Introducing a personalized interface allows us to define the space for developing initiative and making decisions by every employee as well as to monitor the effects of decisions made by employees by process managers and owners.

## **Conclusion**

Why should we implement empowerment if the costs are high and effects of independent decision-taking so doubtful? For many organizations empowerment may become a fad if the inspiration from the method will not come from the real needs of an organization. In a function-oriented organization empowerment plays only a correcting role in inefficient and inflexible activity. On the other hand, in a process-oriented organization empowerment becomes the prime power of processes and their self-organization. Empowerment seems inevitable in process organizations and almost impossible in classical, function-oriented organizations.

Application of empowerment should bring numerous benefits to organizations and their employees. Such authors as Block, Howard, Thomas and Vethous (Yukl 2002) list the following basic benefits of empowerment: 1) stronger involvement of employees in task realization, 2) greater initiative and responsibility on the post, 3) more innovation and learning, 4) greater optimism for successes at work, 5) greater satisfaction from work, 6) deeper involvement in organization, 7) fewer redundancies. There is, however, a basic condition concerning the involvement of employees. Each activity of employees should be expected and appropriately stimulated. The management experience shows that involving employees is still a serious managerial problem. The seriousness of this problem can be reflected in Gallup Organization survey carried out in over 500 organizations all over the world (<http://www.gallup.com/>). Apart from involved employees, there are groups of uninvolved and actively uninvolved workers, which definitely lower the effectiveness of each organization. Empowerment may become a management method which will have substantial influence on financial results of an organization that will want to use and direct the activity of its employees.

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#### **Abstrakt**

*Empowerment jest jedną z kluczowych metod zarządzania we współczesnych organizacjach. Wdrożenie metody związane jest jednak z tworzeniem odpowiednich warunków organizacyjnych. W artykule przedstawiono charakterystyki organizacji klasycznych zorientowanych funkcjonalnie i współczesnych zorientowanych procesowo, a następnie zanalizowano możliwości zastosowania w tych organizacjach empowermentu. Zidentyfikowano bariery, koszty i korzyści jakie wiążą się z uprawamianiem pracowników. Wdrożenie empowermentu świadczy o wysokich kompetencjach organizacji, a także przyczynia się do ich rozwoju. Szczególną uwagę zwrócono na szybkość podejmowania decyzji i elastyczność działania i reagowania na zmieniające się oczekiwania klientów zewnętrznych i wewnętrznych.*

# STOCK-AND-FLOW THINKING IN DECISION MAKING. TOWARDS SYSTEMIC PROCEDURE OF PROBLEM SOLVING.

Kazimierz Śliwa<sup>14</sup>

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## Abstrakt

*The article presents fundamental rules of the systemic thinking in decision making and it proposes a unified problem solving procedure. The Partitioning Method is presented and it is shown how that method can be used in discovering system structure or problems. The problem structure is a critical factor in solving them. Special attention is paid to the variables described as Stock-and-Flow which absorbs the problems' dynamics and determine its feedback structure. The analysis is presented as part of the Dynamic Decision Making theory.*

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## Introduction

The work that steers the fate of societies and their economic and governmental organizations is largely the task of making decisions and solving problems. It is the work of seeking problems that require attention, setting their goals and criteria, designing suitable solutions, and choosing from available solution alternatives. The first three activities - finding problems, setting criteria, and designing solution alternatives are commonly called problem solving; the last, evaluation and choice, is usually called decision making.

The abilities and skills that determine the quality of decisions and appropriateness of problem solutions depend not only on human minds, but they also are supported by physical tools and machines (computers, in particular) and many mind-like constructs that we call decision models. In psychology, economics, statistics, operations research, political science, artificial intelligence, and other cognitive science, problem solving and decision making have gained considerable interest and space in science development.

Two research currents have been developed; the first one, of prescriptive nature, centers decision making knowledge around the concept of subjective expected utility, a mathematical model of choice making. Accordingly, most contemporary economics, statistics, and operations research recommendations set the decision theory either in a world of perfect utility-maximizing rationality in a world of certainty or in a world where decision makers can define the probability distributions of all relevant variables. This perspective deals only with decision making; it does not explain how problems are discovered, goals set, or solution alternatives developed. Empirical research works do not support the prescriptive approach. They show that human mind, while coping with high complexity and vast psychological space in which problem solving is carried out, shelters into limited rationality, where solutions quality satisfies more subjective criteria and psychological comfort than their optimum.

The other current, descriptive theory of problem solving and decision making is concerned with how people gain knowledge of problems and how they heuristically cope with the complexity of problems. When the goals themselves are complex and sometimes ill-

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defined and when the nature of problems must be transformed in the course of exploration, the recommendations of prescriptive theories fail. Those problems, sometimes called “ill-structured”, require different approach. The whole process of problem design characterizes by new emerging conceptions which provides constant feedback that enrich further work towards its solution.

With new modeling tools (e. g. Systems Dynamics, Learning Organization) it is just beginning to be possible to build environments that simulate this kind of flexible problem-solving process. Most management strategy and public policy problems are ill-structured. In this article we argue that external (tools) and internal (decision models, e. g. linear programming) assistance are of limited use unless we embed them into a broader problem solving methodology, called “stock-flow thinking” (SFT), hereafter.

### **Failures in problem solving and decision making.**

For decades decision making and problem solving have been a pillar of interest for the theory and practice of the organization and management. Beginning with classic works by H. Simon (bounded rationality), through provocative seminal works by J. March, M. Cohen, and J. Olsen (Garbage Can Model), and more recent developments, a continuous effort has been made to understand the nature of decision making and problem solving. Unlike research works developed in past decades, recent interest seeks assistance in viewing these processes in the context of complexity and dynamic properties, where both these concepts are intimately interrelated. Complexity can take either non dynamic form (represented by the number of components constituting an entity, e. g. problem to be solved) or dynamic one; dynamic complexity is interpreted as the behavioral variability – problem ability to show behavior that changes over time. Certainly, the dynamics of the problem behavior stems from the number of its elements and relationships existing among them (Senge 1990: 72).

Two problems arise here. First – human mind is not suited to correctly perceive changes. Instead, we tend to see changes as a sequence of states the value of which make a change possible to detect. Rooted in educational system and teaching philosophy, our language has acquired stationary character and it has not developed towards change representation and interpretation. Language captures and elicits knowledge of problems in a specific, static way – problem description cannot be more precise than language used for doing this. It is often called “generative power of language” and it affects not only problem description but, first of all, problem perception.

All of us have been explicitly or implicitly trained in the Cartesian view of knowledge, and it has dominated Western science for centuries. Its essence is the belief that there is a clear separation between mind and body, between thinking and doing, between management and the employees. On top of that dogma there is the notion that knowledge is a substance which can be separated from any other substance. Thus, knowledge can be encapsulated and locked in many compartments with clear separation among them. Each capsule can be taught and it can be taught with almost no relation to other capsules. The theory of pedagogy, educational process, or corporate training is following this path and reducing learning to how we find a way to optimally pour knowledge into people’s heads with the recognition that there is already something already in their heads. This “something” is frequently an obstacle to new substance; thus, in order to learn we first frequently must unlearn what we have learned earlier...

Humans live in two worlds – one is the world of events and processes and the other is the world of our perception and cognition operating as a map giving sense to events and processes. While telling stories we organize our cognitive and perceptual space creating our territory of action. Three questions arise here: 1) how do we do that, and 2) what is the

context for mapping our perception, and eventually 3) what instruments can we use for “what we do in that context”.

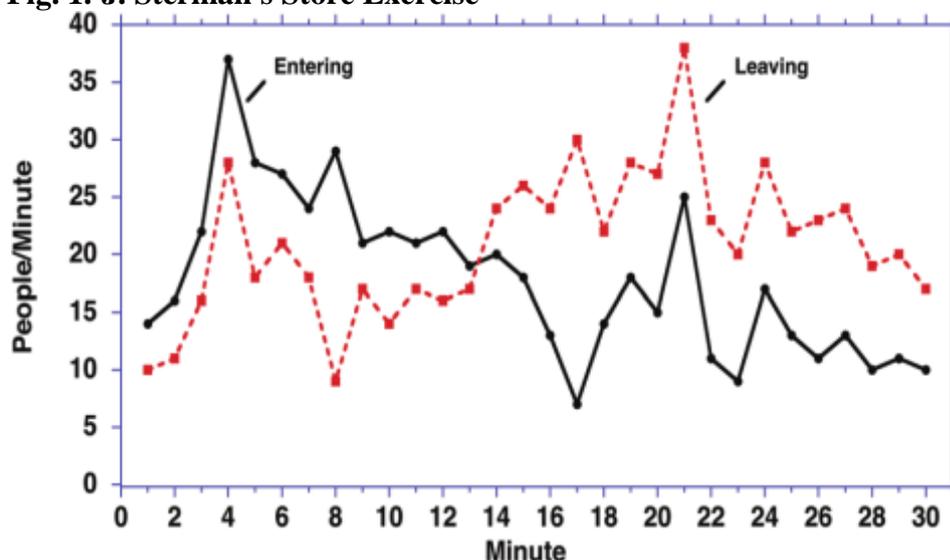
Kofman and Senge (1993) say that in our everyday sense of the world, we see reality as "out there" and ourselves as observers "in here." Our Western tradition compels us to "figure out" how nature works so that we can achieve what we want. But what if what shows up for us as "reality" is inseparable from our language and actions? Therefore, we use available language for mapping our territory where the map makes sense only when it depicts differences and conceptually distant phenomena. We think through differences and linking different concepts into a more coherent picture we understand our world. This is clearly related with knowledge representation and learning embedded into the contemporary current of knowledge management in corporations as well at schools. In both, new information incorporation and in coding and storing existing information we use the already existing maps of our cognitive territory, using language as a vehicle and a sense making tool. Such is the contents of the learning process. Individual perception and social context can be purposefully arranged and assisted by many methods and instruments.

In a rather anecdotic experiment we may ask for precisely telling the contents (notes) of the Beethoven's Fifth Symphony (using natural spoken language) or to present with tunes the contents of an inventory problem – each type of problem calls for an appropriate language.

Second – our language rooted cognitive limitations affect our understanding of dynamic phenomena. Well-known experiments ( Cronin, Gonzalez 2007), Sterman 2000, Sterman 2010) ask students to answer simple questions about the number of customers in a store based on the following graph (see: Fig. 1).

The graph below shows number of people entering and leaving a store over a 30 minutes period.

**Fig. 1. J. Sterman's Store Exercise**



Source: Sterman 2010.

Questions, among others, were about when maximum number of people *enter* and *leave* the store and when maximum and minimum number of people *whereas in the store*. Most answers about entering and leaving customers were correct; very few, however,

ascertained correctly the time of having the highest and the lowest number of customers in the store – originally it was 36% of correct answers<sup>15</sup>.

This simple experiment is very educational. It shows us a common difficulty in discerning change process from change results when the latter is not directly accessible but must be derived from gradual changes (which in turn are observable – customers entering and leaving store). In one experiment performed by the author the original experiment was followed by another one. Data were the same, yet the original graph was split into two - one presenting only number of customer entering the store and the other one showing the number of customers leaving the store (with an initial number of customers in the store). In these cases students did not have any problem answering questions – they correctly pointed to the end of a 30 minutes time as the time when either the number of customers was the highest (for customers entering) or the lowest (for leaving), respectively. The combination of both makes the exercise much more difficult and even highly trained in mathematics and sciences students do not perceive correctly dynamic properties of the store.

Correct interpretation of the store dynamics requires understanding of a “change language”. Change language makes a distinction between gradual changes and their accumulated results. In the experiment gradual changes are entering and leaving customers, their number in the store is an accumulated result. Correct answer (for original graph) is that the store has maximum number of customers at time=14, and at time=30 their number is the lowest. Whenever the number of entering customers is higher than the number of leaving customers, its total number is increasing; in the contrary situation (leaving>entering) the total number of customers is decreasing through the end of the whole period of time. Poor interpretation of the store dynamics cannot be attributed to an inability to interpret graphs, contextual knowledge, or cognitive capacity. It is more related with our limited (and promoted by our language) capability to discern gradual changes from their results.

As gradual changes and their results are common in systems of all types (Forrester 1961), we can expect that most decisions involving them will be incorrect. That is why this distinction has played a central role in many disciplines, ranging from management to epidemiology. The ability under interest is called “graphical integration” and it helps to determine how the accumulated quantity changes over time given certain rates of change flowing into and out of it. Gradual changes are called “rates” and they flow into or out of the resulting value called “stock”. Stocks cannot change without flows (rates).

Another shortcomings in problem solving comes from the feedback structures frequently underlying problems structure. In his insightful paper Sterman (1987) showed how managers in a simulated industrial production and distribution system ("Beer Distribution Game") seek to minimize total costs by managing their inventories appropriately under uncertain demand. Simple structure of the simulated environment contains multiple actors, feedbacks, nonlinearities, and time delays. The interaction of individual decision makers with the structure of the simulated firm produces aggregate dynamics which diverge systematically from optimal behavior. They generate large oscillations in the inventory getting away from the planned goal – inventory cost minimization. They clearly misperceive the feedback involved in the situation - they fail to control actions which have been initiated but not yet terminated; they also fail in understanding impact by other subjects participating in the game.

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Repeated several times this experiment in the classroom (WSB – NLU) yields the highest score of 42% and 23% the lowest

They blame external factors for their poor performance when in fact the dynamics they experience are internally generated by their own actions. They misperceive feedback loops existing in the problem structure.

### **The dynamics of problem solving in theory**

The complex and dynamic nature of problem solving and decision making has been extensively researched by recent development of the Dynamic Decision Theory. For our aims four issues raised by this current are important:

a) Dynamics – resulting from continuous changes within a problem constituting multiple loops through which a variable can influence itself or other variables over time. These feedback loops underlie major processes in systems - growth, fluctuation, and decay. They can be self-reinforcing (positive feedback loops), while those that are self-correcting are referred to as negative feedback loops. Concomitant with these feedback loops caused both by a decision maker's actions and by the interactions among the system variables, problem acquires new qualities – its internal dynamics.

b) Complexity - dynamic problems comprise parts that interact or interconnect in an intricate manner, making it difficult to understand or predict system behavior. As discussed earlier, among factors that contribute to problem complexity we have the number of components, the number of relationships among the components, and the types of relationships among them. The latter determine the type of feedback existing in the problem, thus resulting in the problem dynamics.

c) Opaqueness - it refers to the “invisibility” of some aspects of the problem (Brehmer 1992). Although information about the problem may be available (i.e. observable), it is accessible only if the decision maker knows where to find it. Furthermore, the usefulness of the available information depends upon what the decision maker knows about its relationship to current goals.

d) Feedback - for controlling dynamic problems, decision makers must access information about

its state by monitoring feedback loops. Such monitoring does not search for the existing information but rather relies on mental simulation of the problem behavior. Decision maker's imagination, mental model of the problem, and testing problem structure with the use of available tools are instruments and ways of accessing that information. It is very common that feedback loops existing in the problem structure are interrelated and they collectively form the problem's “feedback structure”. Further part of the article shows how we can use certain sequence of operations to learn about feedback structure. The problem's feedback structure encompasses and combines two previous concepts of the dynamics and complexity to emphasize the effect of feedback structures on a decision maker's ability to control dynamic problems.

Diehl and Sterman (1995) claim that three elements of the problem's feedback structure are particularly relevant. The first feature are side effects generated by feedback loops. A side effect is an unexpected result of an action that has been undertaken to produce some desired results. Side effects usually accompany desired effects and erroneously tend to be treated as mistakes produced by the decision maker's behavior. In reality, there are no side effects, there are just *effects*. When we take action, there are various effects. The effects we thought of in advance we call the main, or intended effects. The effects we didn't anticipate are these which through the feedback mechanism undercut our policy and the ones we claim to be side effects. Side effects are not a feature of reality but a sign that our understanding of the system is narrow and insufficient. Systems perspective in seeing problem structure does exclude such an “unplanned deficiency”, claiming that side effects are natural consequences

of any feedback structure. The third element is feedback delays. Time plays a specific role in the problem's feedback structure; any process or action takes a certain amount of time to complete, resulting in delays between the decision making time and the time at which information about the effect of the decision results is available.

Interpreting problem solving and decision making as dynamic phenomena, several conditions must be fulfilled. Brehmer (1992) stated that:

1. Dynamic decision making relies on stock-flow thinking.
2. Goal attainment requires a series of decisions, where the next decision can be understood only in context of the previous one; thus:
3. Decisions are not independent
4. Problem evolves over time as the consequence of itself and previous decisions
5. Most important part of psychological framework affecting problem solving is the capability to see patterns in problem structure. There are four general preconditions for controlling problem solving process:
  - there must be a goal (goal condition),
  - must be perceivable state of the system represented by problem (observability condition); this includes:
    - access to flows causing changes in the system,
    - access to information about results of these changes (stocks)
  - there must be a possibility to affect the system (action condition),
  - the problem must be a model of system (model condition),

## **Stocks and flows**

In the last decades much effort has been put into understanding benefits and shortcomings of thinking patterns in problem solving. A long list of research works includes Bakken, Cavaleri&Sterman, Vennix, Doyle, Ossimitz, Roberts - just to mention a few. Unfortunately, these studies have not led to a major consensus regarding required decision maker's native thinking abilities and many important questions remain unanswered.

Studies belonging in systems sciences stress different concepts – capabilities deducing behavior patterns and circular cause–effect relations, revealing a system's structure, “seeing wholes?”. They all emphasize the importance of the ability to represent and assess the problem's dynamic complexity. Specific systems thinking skills include (in addition to more formal, “teachable” skills):

- understanding how the behavior of a system arises from the interaction of its components over time (dynamic complexity),
- discovering and representing feedback processes (both positive and negative),
- understanding observed patterns of problem behavior, their nonlinear nature in particular,
- identifying stock and flow relationships,
- recognizing time delays and understanding their impact upon a problem,
- constructing and challenging the boundaries of mental and formal models underlying problem solving.

All studies show that decision making performance deteriorates rapidly when even the slightest contents of dynamic complexity are introduced. Despite the usual explanation blaming human bounded rationality, there is a strong suggestion that the problem's dynamic complexity overwhelms our cognitive capabilities, basically because of our unpreparedness to discern among various and different types of variables forming a problem. The mismatch between cognitive capabilities and problem dynamics has frequently led to inappropriate

scientific analysis, and even to the formulation of erroneous theories; as Joan Robinson wrote in 1982: ... "(economics) it is the science of confusing stocks with flows. It is this confusion that has kept the Quantity Theory of Money alive until today."

If we think of the variables in terms of what type of behavior they may present and analyze possible behavior of variables over time, there are only three patterns:

- variables with present states depending on their previous states; those variables show the accumulation or depletion of certain resources important for the problem. Those variables are called stock, state, or level variables: stock variables represent resources within a problem,
- variables that are responsible for the conversion of resources; stock variables change over time according to a certain transformation rules contained in another variable, linked with level variable; those variables are called flow or rate variables and they directly increase or deplete resources level in stock variables,
- variables that are neither stock nor flow variables; they usually intervene between stock and flows and convert internal or external influences into a language understandable for stock and flow variables, they are called conversion variables (converters).

The importance of distinguishing different types of variables is justified by different contribution of these variables to the problem structure and behavior. A link between structure and behavior is perhaps the most important paradigm of the Systems Dynamics (Senge 1990). Any problem has a structure and the problem behavior is not dominated by its variables alone but it depends on the relationships existing among them. The structure must then be analyzed as a whole paying special attention to feedback loops existing in the structure. Thus, not variables themselves but what occurs in and among variables determines problem behavior (symptoms) and possible solution of that problem. In other words, solving a problem implies our intervention in its structure, particularly in its feedback elements.

The distinction between stock and flow variables is crucial here. As Sterman wrote (2002, p. 193 and further), stock variables are accumulations and they characterize the state of the system and generate the information upon which decisions and actions are based. Stocks protect problems (systems) against sudden changes and provide them with memory.

Diagramming convention for stocks and flows was originated by Forrester (1961) who used a hydraulic metaphor - the flow of water into and out of reservoirs.

The stock and flow structure has a precise mathematical meaning. Stocks accumulate or integrate their flows with corresponding integral equation:

$$\text{Stock}(t) = \int (\text{Inflow} - \text{Outflow})(dt) + \text{Stock}(t-1)$$

where (t)=final time, (dt)=time interval, (t-1)=preceding time moment. The expression Stock(t-1) provides variables with "memory" guarantying that the stock variable does not "forget" its previous state. Stock variables change according to net flow into it; therefore, the net rate of change of any stock is its inflow less outflow, defining the differential equation:

$$d(\text{Stock})/dt = (\text{Inflow} - \text{Outflow})(t)$$

and, as a consequence, we can construct the corresponding stock and flow map from any system of integral or differential equations as well as from any stock and flow map we can generate the corresponding integral or differential equation system (such a natural conversion of human thinking and formal operations is unacceptable for maths-fearing people).

Stocks are critical in generating the dynamics of systems for the following reasons (Mass 1980):

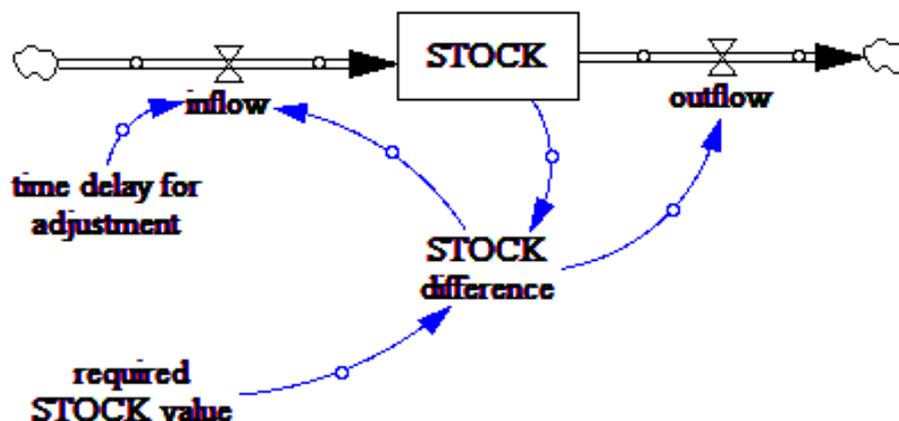
- Stocks characterize the state of the system and provide the basis for

actions. The evaluation of a problem solution must be based on the stocks' values. They do not have to be tangible; we can think of stock representing the accumulation of knowledge, experience, motivation, or perceived quality of a product,

- Stocks provide systems with inertia and memory; they accumulate past events and can only change through the net value of inflow and outflow. Keeping those values stocks provide continuity and links between previous states and present situation,
- Stocks are the source of delays – conversion of inflows into outflows produces time lag forming an important part of a problem dynamics,
- Stocks disconnect rates of flow and create disequilibrium in a problem; in static situation the total inflow to a stock equals its total outflow and the stock value is constant. Any solution is a disequilibrium introduced into a problem, thus flows decoupling is the sine qua non condition for problem solving.

Given the fundamental role of feedback loops in problem structuring, an important rule can be stated: *every feedback loop in a system dynamics model must contain at least one stock*. Consequently, it is possible to propose a basic controlling component for any problem structure called Basic Decision Structure here.

**Fig. 2. Basic Decision Structure**



Source: author's elaboration (Vensim™ format)

Feedback structures of problems work through perpetual invasions in the state of equilibrium succeeded by a new equilibrium state. State of the problem is represented by “Stock”, the value of which is compared against required one (“required STOCK value” - this is a fixed converter type variable). If there is any difference (“STOCK difference” - converter variable), a decision is made affecting either “inflow” or “outflow”. Such decision decreases the difference between the present and the required stock value which takes some time - “time delay for adjustment” represents this feature of Basic Decision Structure.

All diagrams presenting Stock-and-Flow structures are composed of four different components: Stocks, Flows, Converters, and Connectors. Relationships among these variables is not ascribed to subjective choice; instead, there is a specific “grammar” of problem modeling language, narrowing choice in accordance with the following rules:

- Flows can influence Stocks
- Stocks can influence Flows or Converters
- Converters can influence Flows or other Converters

- Flows cannot influence Converters or other Flows (it is allowed, however, to convey information from Converters to other variables)
- Converters cannot directly influence Stocks
- Stocks cannot influence directly other Stocks

### Modeling language and methodology

Our perception of a problem is influenced by thinking tradition, sustained by conceptual framework, and language we use. Typically, conceptual frameworks are presented as oscillating between two extreme traditions underlying the history of scientific thought. Those framework are analytic and systemic with some contrastive traits:

**Tab. 1. Traits of analytic and systemic framework**

Analytic Approach	Systemic Approach
First isolates, then concentrates on the elements	Unifies elements and concentrates on the interaction between elements
Studies the nature of elements	Studies the nature and effects of interactions
Emphasizes the importance of details	Emphasizes global perception
Modifies one variable at a time	Modifies groups of interconnected variables simultaneously
Independent of duration of time; changes considered reversible.	Integrates duration of time and; changes irreversibility
Experimental validation of facts within given body of a theory	Validates facts through comparison of the behavior of the model with reality
Precise and detailed models that are less useful in real-life operations	Uses models that are insufficiently rigorous to be used as bases of knowledge but are useful in decision and action; emphasize in model creation
Efficient approach when interactions are linear and weak	Efficient approach when interactions are nonlinear and strong
Leads to discipline-oriented education	Leads to multidisciplinary, problem-oriented education
Actions are programmed in detail	Actions through objectives and sensibility analysis

Source: author's elaboration

Language plays a decisive role in problem solving. We see, understand, and interpret our world through our language. As it was mentioned earlier, language influence upon our actions and problem solving consists in the natural barrier the language imposes upon: problem description and understanding cannot be any more precise than a language used for that. Unfortunately, our language has developed in a different way and is best suited to representing static values (stocks), putting on the second stage changes themselves (flows).

Thus, the main problem in Stock-and-Flow thinking is the conversion of our natural spoken/written language into modeling language, with grammatical rules and allowable

relationships among different variables. Richmond (2001) explained the meanings of basic variables giving up any mathematical explanations for the sake of natural language.

**Tab. 2. Natural versus Stock-and-Flow Language**

Stock-and-Flow Language	Natural Language
Stock variables	Nouns representing things or status
Flow variables	Verbs representing actions or activities
Auxiliary variables	Adverbs changing volume of Flow or combining two or more variables consistently

Source: based on Richmond 2001.

Due to the nonlinear stocks' behavior, multiple flows, and feedback structures of problems, understanding and correct interpretation of real problem is a very complex task. The problem solving complexity can be mitigated by 1) the acceptance of certain rules as to understanding problem behaviors, and 2) using an appropriate methodology to structure and model problem structure.

Over the years, some regularities have been identified that consistently appear in complex problems, e. g.:

- symptoms of a problem are often separated from the actual problem and its origin by time and space;
- complex systems often behave counter to human intuition (counter-intuitive behavior);
- policy intervention in complex systems can frequently yield short-term successes but long-term failure, or short-term failure but long-term success;
- feedback problem structure often counters external policy intervention;
- it is better to structure a system to accommodate uncertain external shocks than to try to predict those external shocks;
- real-world complex systems are not in equilibrium and are continually changing.

Regarding problem solving methodology - our concept of problem solving is a sequence of three phases: structuring, modeling, and simulation. Each phase contributes to our problem knowledge and is linked with problem solving through some specific mental instruments. The last stage, computer simulation, remains beyond the scope of this text.

### **Problem structuring – from storytelling to problem structure**

A story is the most natural way of expressing our knowledge of a problem. Purposeful use of narratives to achieve a practical outcome (problem solution) requires more analytical approach to stories. We learn about problems listening to, reading about, or telling stories. Stories can be of two modes, each providing distinctive ways of ordering experience and constructing mental models of our reality. One mode, paradigmatic, attempts to fulfill a formal system of description and explanation. It employs categorization or conceptualization and it proposes operations by which categories are established, defined, idealized, and related in order to form a system. Typical example includes using quantitative approach to problem solving where we seek information fitting the categories required by the mathematical model. The other mode, narrative, is the imaginative application of our language to that fragment of the reality which we consider “a problem”. Narrative mode includes individual interpretations of external events and it accounts and precedes our intentions as well as reflects our experience, locating them in time and space.

Story telling does not contain direct information about the problem structure. We need to approach a story in such a way that further work on the problem structure is feasible. Dynamic complexity of problems lies in variables forming the problem and relationships linking those variables and leading to pertinent feedback loops and systems. This can be done in an intuitive way (frequently resulting in a spider web diagram, difficult to understand) or supported by formal methods, e. g. Partitioning Method. Partitioning Method was proposed by Gerald Kron in 1963 for the purpose of structuring large equation systems. It allows us to group all problem variables into blocks, where a block contains variables linked with a feedback and where there are no feedback loops between blocks. As a detailed presentation of this method exceeds the scope of the paper, we present only basic operations using the problem of workers' motivation.

Suppose we consider the problem of workers' motivation that depends on their wage. Reading available information and talking to supervisors we make the inventory of possible variables constituting the problem: (1) workers' motivation, (2) workers' productivity, (3) pay per product policy, (4) workers' perception, (5) other workers' productivity, (6) motivation change (7) incentives system, and (8) other workers' ostracism.

Suppose that our story underlying the problem suggests that increasing productivity of the worker may provoke unfavorable reactions of other workers (ostracism). On the other hand, in spite of that ostracism, we may expect a positive change in others' productivity in a long run, providing that increasing productivity will modify a company incentive system forcing to pay more for individual productivity than for working time. With all these variables, ordering them may not be an easy task. Using the Partitioning Method we first elaborate the symmetric matrix where all problem variables appear as rows and columns; the diagonal of the matrix is crossed as no problem variable can directly affect itself. This must be accompanied by a discussion of the problem semantics; each problem variable must be confronted with any other variable (on one to one basis) with a view to determine whether or not one variable can directly affect another one; if it can, a cross is put in the intersection cell. Once we have completed the matrix we can start partitioning procedure. If the matrix is partitioned, all marks above the diagonal point to feedback loops existing in the problems structure. As we are at the beginning of the procedure, those marks show but only relations, without reference to their nature (see: Table 3).

**Tab. 3. Example of Partitioning Method (initial and last matrix)**

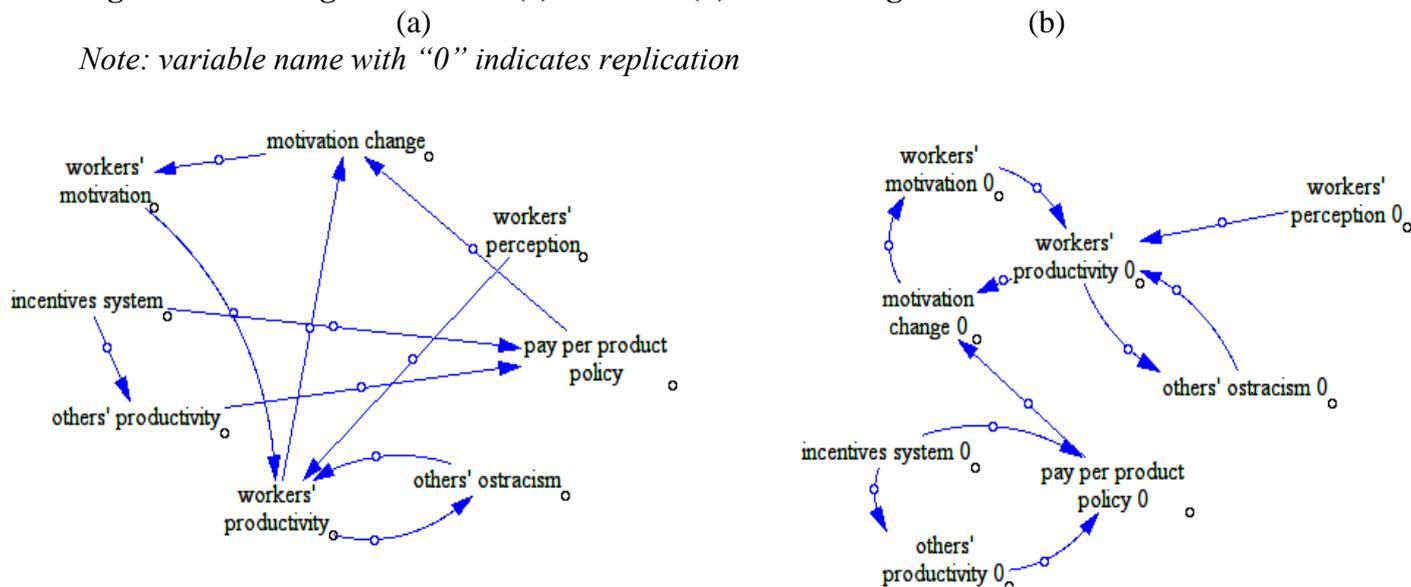
VARIABLES	Worker's motivation	Worker's productivity	Worker's perception	Motivation change	Incentives system	Others' ostracism	Others productivity
Worker's motivation				X			
Worker's productivity	X		X	X			X
Worker's perception							
Motivation change	X	X					
Incentives system							
Others' ostracism		X					
Others productivity					X		
Pay per product policy					X		X

VARIABLES	Worker's perception	Incentives system	Others productivity	Pay per product Policy	Worker's motivation	Motivation change	Worker's productivity
Worker's perception							
Incentives system							
Others productivity		X					
Pay per product policy		X	X				
Worker's motivation						X	
Motivation change			X	X			
Worker's productivity					X	X	

Source: author's elaboration.

In terms of causal diagramming the difference between ad hoc capturing variables and relationships among them could be as presented below:

**Fig. 2. Causal diagram without (a) and with (b) Partitioning Method**



Source: author's elaboration.

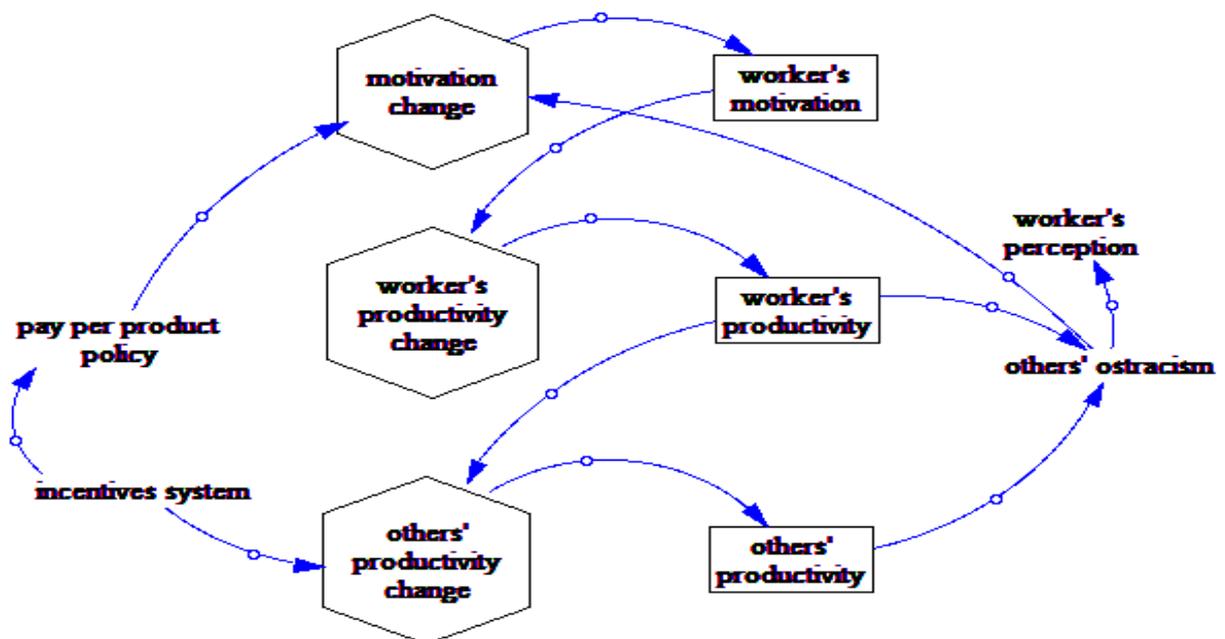
It is clear that using the Partitioning Method we receive clearer and more dynamically interpretable causal diagram. Even without further problem solving procedure (modeling and simulation) we can now make more precise insight into the dynamic character of the problem structure. First, the problem has two feedback loops that create its dynamic behavior; first – it is a positive feedback loop leading from “workers' motivation” to “workers' productivity” and then to “motivation change”. As it is the positive loop, we expect strengthening or weakening behavior here. Second – there is a negative feedback loop between “workers' productivity” and “workers' ostracism”; its behavior will be counteracting each other, thus showing oscillations and seeking an equilibrium point. These two loops are the most important from the problem solution point of view; any solution should include a possibility to monitor/control their behavior.

**Problem modeling**

It is also very helpful in the problem modeling phase to think of the variables in terms of what type of behavior they may present (variables properties). If we analyze possible behavior of a variable over time, there are only three, mentioned earlier, distinguishable patterns: stock, state or level variables, low or rate variables, and conversion variables (converters).

Problem modeling aims at presenting perceived and presented with the causal diagram problem structure in such a way that all problem variables acquire one of the above patterns and they all are conceivable in terms of definition determining their behavior. Limited scope of this paper excludes the possibility to show all details of this operation. We confine that stage of problem modeling only to presenting previous problem structure causal diagram (after applying Partitioning Method), marking with rectangles stock variables, with diamond – flow variables, and leaving converter variables unmarked (see Fig. 3).

**Fig. 3. Causal diagram with discerned variables**



Source: author's elaboration.

## Final remarks

Discovering problem structure and modeling variables and interrelationships existing between them has critical importance for problem solving and decision making. Some of many tools available to decision makers require preliminary distinction between accumulative variables (stock variables) and those changing stock variables (flow variables). Structuring and modeling is a necessary operation while using the System Dynamics approach to problem solving as without it is impossible to build a formal, simulative model of a problem.

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### Abstrakt

*Artykuł przedstawia podstawowe zasady systemowego myślenia o problemach i proponuje systemową procedurę ich rozwiązywania. Przedstawiona jest praktyczna wartość Metody Partycji w odkrywaniu systemowej (dynamicznej) struktury problemów oraz specjalne znaczenie prawidłowej interpretacji zmiennych decydujących o systemowej strukturze problemów. Tymi zmiennymi są Stock-and-Flow, absorbujące i wyzwalające sprzężeniową dynamikę zachowania problemów. Cała analiza jest osadzona w kontekście Teorii Podejmowania Dynamicznych Decyzji.*