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From the Editorial Committee

We are giving you the next 20th (3/2013) issue of the Quarterly of the Faculty of Management of the Rzeszow University of Technology entitled “Modern Management Review”.

The primary objective of the Quarterly is to promote publishing of the results of scientific research within economic and social issues in economics, law, finance, management, marketing, logistics, as well as politics, corporate history and social sciences.

Our aim is also to raise the merits and the international position of the Quarterly published by our Faculty. That is why we provided foreign Scientific Council, as well as an international team of Reviewers to increase the value of the scientific publications.

The works placed in this issue include many assumptions and decisions, theoretical solutions as well as research results, analyses, comparisons and reflections of the Authors.

We would like to thank all those who contributed to the issue of the Quarterly and we hope that you will enjoy reading this issue.

With compliments
Editorial Committee

MODERN MANAGEMENT REVIEW **2013**
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HIGHWAY AND RAILWAY INFRASTRUCTURE, REAL INCOME AND STRUCTURAL BREAKS

Infrastructure systems affect economic development directly or indirectly depending on their structure, type, quality and quantity. Transportation infrastructure is one of the most important types of infrastructure systems since the improvements in transportation infrastructure has tangible and intangible benefits to economy such as reducing costs, increasing productivity and outputs. Therefore, investment in transportation infrastructure is important, while this contributes to economic development directly by lowering transportation costs and facilitating trade. All sectors include services provided by transport infrastructures are fundamental to economic activities due to enhanced mobility of goods and services. This reflects that the whole economy is related to transportation and the relationship between transportation infrastructure and economic growth has been analyzed in many studies by using different methodological approaches. The aim of this paper is to analyze the relationship between the transportation infrastructure and economic growth in Turkey for the period 1970-2006. Empirical analysis from cointegration tests with and without structural break show that the long run affects of real income, highway length, railway length and labor force on real income vary within tests with respect to sign and significance. However, the relationship between share of transportation in fixed capital investments and real income is positive and significant for all tests including dynamic OLS. This shows that private and public policies toward transportation infrastructure should target investments and improvements in the quality of transportation, not quantity.

Keywords*:* Highway infrastructure, Railway infrastructure, Cobb-Douglas production function, Co-integration tests, Structural breaks, Transportation investments, Jel Classification: C54, E23, H54, L92

1. INTRODUCTION

Infrastructure systems affect development directly or indirectly depending on their structure, type, quality and quantity. Transportation infrastructure is one of the most important types of infrastructure since the improvements in transportation infrastructure has tangible and intangible benefits to economy such as reducing costs, increasing productivity and outputs.

Investment in transportation infrastructure contributes to economic development directly by lowering transportation costs and facilitating trade. Services provided by transport infrastructure are fundamental to economic activities due to enhanced mobility of goods and services. Lower costs and ease of access to markets causes a range of sectoral, spatial and regional developments from the private sector point of view

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(Aschauer, 1989; Munnell, 1990; Gramlich, 1994; Bougheas, et al. 2000). Improvements in transportation cause increased accessibility, specialization and market expansion thus causing increasing returns to scale and spatial agglomeration effects as well as innovation. As a result, total factor productivity and GDP growth increases (Bougheas et al., 2000; Lakshmanan, 2007). The effects of transportation infrastructure to economic development are argued to be more interpretable in developing countries rather than developed countries (Zhou, Yang, Xu and Liu, 2007).

The aim of this paper is to analyze the relationship between the transportation infrastructure and economic growth in Turkey for the period 1970-2006. Empirical analysis is carried through time series analysis; cointegration tests with and without structural breaks.

The rest of the paper is organized as follows: the second section provides the literature survey, while the third section consists of data and methodology and the fourth section shows the empirical results. The last part concludes the paper with interpretation of the findings and policy implications.

2. LITERATURE SURVEY

The relationship between transportation infrastructure and economic growth has been analyzed in many studies for regions, countries and continents by using production function or cost function approaches. The theoretical framework which argues that improvements in transportation infrastructure has positive effects on economic development, is supported with many empirical studies where transportation infrastructure is measured by highway lengths, railway lengths, transportation spending per capita and transportation capital such as water and sewer, electricity and gas, hospitals and passenger rail stations. These measures are selected according to the observed area (local, county or national). The improvement measures regarding economic development are generally per capita income, growth, investments (e. g. foreign direct investment, manufacturing industry), manufacturing costs, productivity, and rate of return, output, employment, and labor force. The evidence from empirical studies shows, in general, a positive relationship between transportation with all its components (investment, infrastructure) and development (productivity, economic growth, quality). There is a vast amount of literature on the relationship between transportation infrastructure and economic development. Therefore, Table A1 shows some selected studies with respect to infrastructure and development measures, observed area, period and results, while these studies are briefly summarized below.

Most of the research dealing with the economic effect of transport infrastructures has relied on the estimation of aggregated Cobb-Douglas production function. The initial novelty of including public capital as an input, along with labor and private capital, put aside many of the econometric problems that had been identified in the estimation of production functions, both at the firm level or on the aggregate. Therefore, in the first generation of studies on the effect of public infrastructure, the specification commonly used is a Cobb-Douglas production function estimated by OLS, despite the well-known econometric problems posed by this type of production function estimation (Griliches and Mairesse, 1998).

Production function approach has been first used by the most known researcher of that topic, Aschauer, also the pioneer of the relationship between infrastructure and development. Aschauer (1989) investigates the effects of public capital on the productivity of private sector. The results indicate that the elasticity of private sector productivity with respect to public capital is positive. Munnell (1990) also finds a positive (elasticity of 0.35) relationship between transportation investment and private sector productivity. Munnell and Cook (1990) investigate the impact of highways on Gross State Product (GSP) where they show that the elasticity of GSP with respect to highways 0.06 on the positive side. Duffy-Deno and Eberts (1991), Eisner (1991), Garcia-Mila and McGuire (1992) and Moonmaw, et al. (1994) similarly obtain positive relationships between transport infrastructure and per capita income by using production function approach.

Jones (1990), Mofidi and Stone (1990) and Reynolds and Maki (1990) study the effects of highway spending per capita on three different development measures. Jones et al (1990) consider employment, income and investment whereas Mofidi and Stone (1990) takes manufacturing investments and employment into account and Reynolds and Maki (1990) investigate new manufacturing plants. First two studies' results are positive but the latter one's result is neutral. Singletary, et al. (1995), Grihfield and Panggabean (1995), Garcia-Mila, McGuire and Porter (1996) and Fernald (1999) show that increases in highways raise manufacturing industry employment and productivity growth.

Berndt and Hansson (1992), Lynde and Richmond (1993), Seitz (1993), Nadiri and Mamuneas (1994), Conrad and Seitz (1994) and Boarnet (1996; 1998) use cost function approach for the investigation of the relationship between transport measures and development for Sweden, United Kingdom, West Germany and USA. The common finding of these studies is that the effects of transport measures are cost reducing elements.

Bougheas, Demetriades and Mamuneas (2000) also introduce infrastructure as a cost reducing technology in their cross country study and according to their approach, transportation infrastructure cause specialization and long run growth. Infrastructure as a technology which reduces costs in the production of intermediate inputs has more impact rather than as an input in the production of final goods. Bougheas, et al. (2000) argue that variation across countries is an important criterion due to the lack of infrastructure in less developed countries and abundance of infrastructure in developed countries.

Boopen (2006) and Zhou, Yang, Xu and Liu (2007) examine the growth impact of transportation capital for developing countries of Africa and China, respectively. The former study uses a Cobb Douglass production function which regress total output on labor, physical capital and transportation capital. The findings show that investment in transportation capital is more productive than investment on average in Africa. The second paper investigates China with regional perspective. The correlation matrix for highways, growth and exports shows that highway construction has significant and positive effect on economic growth. The study also stresses that the quality and the quantity of transportation infrastructure is crucial in terms of its contribution to economic development.

3. DATA AND METHODOLOGY

The data set for the analysis consists of three parts. The first part is infrastructure data (highway lengths in km, railway lengths in km, share of transport in fixed capital investment) which is obtained from the Canning database[1] and Turkish State Railways and General Directorate of Highways. The second part, labor data (labor force) and the third part, economic measurement data, (real GDP per capita), are obtained from OECD database[2]. All of the data is annual and covers the period 1970-2006.

In the light of the literature on the relationship between infrastructure and economic growth, a Cobb-Douglass production function model is used as the econometric model for this analysis:

$$GDP_t = A_t \cdot HW_t^{\beta_1} \cdot RR_t^{\beta_2} \cdot LF_t^{\beta_3} \cdot TS_t^{\beta_4} \cdot U_t \quad (1)$$

where GDP is the per capita GDP, A is total factor productivity, HW is the highway lengths in km, RRW is railway lengths in km, LF is the labor force, TS is the transportation share in fixed capital investment and U is the error term of the regression equation. To estimate and interpret the coefficients β_1, β_2, β_3 and β_4, the natural logarithms of both sides of the model is taken to get.

$$lgdp_t = a_t + \beta_1 lhw_t + \beta_2 lrr_t + \beta_3 llf_t + \beta_4 lts_t + u_t \quad (2)$$

In line with the theory, we expect β_1, β_2, and β_4 to be positive. Increases in highways and railways in length and investment in transportation help the cost of production to fall and lead to a rise in output. β_3 could be positive or negative depending on the productivity of the labor force which depends on many factors such as education, human capital etc.

Time series analysis requires that the variables are stationary or not. For example, for cointegration tests the variables should be non-stationary and integrated of the same order because the tests may falsely give evidence of cointegration if one or more of the variables are stationary. The time series properties of the variables are determined by the use of ADF (Augmented Dickey-Fuller), Phillips-Perron and KPSS unit root tests. We use these three different tests to check the robustness of the results. ADF is more efficient in large samples whereas KPSS is in small samples. KPSS and ADF tests should support each other, if the fractional stationarity does not exist. The rejection frequency of the ADF test falls dramatically in the presence of a break in the cointegration vector (Gregory and Hansen, 1996b). In addition, auto-regressive process is suitable for ADF but moving average process fits Philips- Perron (PP) unit root test.

After the unit root tests, we conduct the Engle-Granger two-step cointegration test which does not take structural breaks into account. The Engle-Granger test applies ADF unit root test on the residuals of the equation with variables that are integrated of the same order. If the residuals are stationary, then the variables in question are cointegrated. Johansen-Juselius cointegration test is also performed to compare and add a new

[1] http://www.hsph.harvard.edu/faculty/david-canning/

dimension to the results of Engle-Granger two-step cointegration test. Johansen-Juselius approach provide the possibility of multiple cointegration relationships. This test offers trace and maximum Eigen-value statistics for the rejection of the hypotheses.

As the data covers 37 years, the existence of structural breaks should also be investigated to make the analysis more robust. The Zivot-Andrews unit root test takes the structural breaks into account endogenously. This unit-root test has three models, which are shown below:

$$Model\ A: y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\lambda) + \hat{\beta}_t^A + \hat{\alpha}^A y_{t-1} + \sum_{j=1}^{k} \hat{c}^A \Delta y_{t-j} + \hat{e}_t \quad (3)$$

$$Model\ B: y_t = \hat{\mu}^B + \hat{\gamma}^B DT_t(\lambda) + \hat{\beta}_t^B + \hat{\alpha}^B y_{t-1} + \sum_{j=1}^{k} \hat{c}^B \Delta y_{t-j} + \hat{e}_t \quad (4)$$

$$Model\ C: y_t = \hat{\mu}^C + \hat{\theta}^C DU_t(\lambda) + \hat{\gamma}^C DT_t(\lambda) + \hat{\beta}_t^C + \hat{\alpha}^C y_{t-1} + \sum_{j=1}^{k} \hat{c}^C \Delta y_{t-j} + \hat{e}_t \quad (5)$$

Zivot-Andrews actually follow the Perron's ADF testing strategy and use during testing the unit root regression equations. Their three model unit root testing differs with the exception of DT_B is to increase in absolute value the magnitude of the t statistic for testing $\alpha^i = 1$. According to model A for a one time change in the level of the series, which is called crash model by Perron, this model detects the mean break, i.e the change in the intercept of the trend function at break time. Model B covers the change in the slope of the trend function occurring at break time, which is called changing growth by Perron, detecting the slope break. The last model C detects changes in both mean and slope at the break time. In these models, DU and DT are dummy variables that respectively capture a break in mean and slope occurring at the break time. The break point is TB where $DU = 1$ if $t > TB$, and zero otherwise. DT is equal to $(t - TB)$, if $(t > TB)$ and zero otherwise. The null hypothesis is rejected if the coefficient is statistically significant. Each model is estimated by ordinary least squares (OLS) with the break fraction $\lambda = {}^{TB}/_{T}$. For each value of λ, the number of extra regressors, k is determined using the model selection criterions and the t-statistics for testing $\alpha = 1$ is computed.

Based on the results of this test, the long run relationship between the relevant variables is tested by the Gregory-Hansen cointegration test. The null hypothesis of Gregory-Hansen cointegration test is similar to the Engle-Granger test and the effect of an unknown structural break year is included by three types of models which are; shift in intercept (model C as level shift), shift in trend (model C/T as level shift with trend) and both trend and intercept shifts (model C/S as a regime shift).

Standard cointegration model with trend and no structural break can be shown as:

$$y_{1t} = \mu + \beta_t + \alpha^T y_{2t} + e_t \ where\ t = 1, \dots, n; y_{2t}\ is\ I(1) and\ e_t\ is\ I(0) \quad (6)$$

The motivation for this test is that there may be occasions in which the researcher may wish to test that cointegration holds over some (fairly long) period of time, but then shifts to a new 'long-run' relationship (Gregory and Hansen, 1996b). Gregory and Hansen treat the timing of this shift as unknown. The general kind of structural change considered in Gregory and Hansen (1996a) permits changes in the intercept μ and/or changes to the slope coefficients α but not the trend coefficient β.

To model the structural change, they define the dummy variable;

$$\varphi_{t\tau} = 0, if\ t \leq [n\tau] \tag{7}$$

$$\varphi_{t\tau} = 1, if\ t > [n\tau] \tag{8}$$

where the unknown parameter $\tau\epsilon(0,1)$ denotes the (relative) timing of the change point, and [] denotes integer part. The level, level shift with trend and regime shift alternatives are:

$$Model\ C: y_{1t} = \mu_1 + \mu_2\varphi_{1\tau} + \alpha^T y_{2t} + e_t \tag{9}$$

$$Model\ {}^{C}/_{S}: y_{1t} = \mu_1 + \mu_2\varphi_{1\tau} + \beta_t + {\alpha_1}^T y_{2t} + {\alpha_2}^T y_{2t}\varphi_{t\tau} + e_t \tag{10}$$

$$Model\ {}^{C}/_{T}: y_{1t} = \mu_1 + \mu_2\varphi_{1\tau} + \beta_1 t + \beta_2 t\varphi_{t\tau} + {\alpha_1}^T y_{2t} + {\alpha_2}^T y_{2t}\varphi_{t\tau} + e_t \tag{11}$$

In this case μ_1 , α_1 and β_1 are the intercept, slope coefficients and trend coefficient respectively before the regime shift and μ_2 , α_2 and β_2 are the corresponding coefficients changes after the break. For each τ, the above models are estimated by OLS, yielding the residuals e_t. From these residuals, the ADF test statistics and the Phillips' (1987) test statistics $Z_\alpha(\tau), Z_t(\tau)$ are estimated. $Z_\alpha(\tau)\ or\ Z_t(\tau)$ statistics are acquired at the breaking point where the minimum ADF is found. Next, the null hypothesis of no co-integration is tested by using the smallest values of these statistics in the possible presence of breaks.

After Gregory-Hansen cointegration test, break years are used to estimate the coefficients by Stock-Watson (1993) Dynamic OLS model:

$$X_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 D1_t + \alpha_3(D2_t Y_t) + \alpha_4\Delta Y_{t-1} + \alpha_5\Delta Y_{t+1} + u_t \tag{12}$$

The dummy variables D1 and D2 are determined according to the break years. As there are four independent variables in this study, the Stock-Watson Dynamic OLS model becomes:

$$gdp_t = \alpha_0 + \alpha_1 hw_t + \alpha_2 D1_t + \alpha_3 (D2_t hw_t) + \alpha_4 \Delta hw_{t-1} + \alpha_5 \Delta hw_{t+1} + \alpha_6 rr_t + \alpha_7 (D3_t rr_t) + \alpha_8 \Delta rr_{t-1} + \alpha_9 \Delta rr_{t+1} + \alpha_{10} lf_t + \alpha_{11} (D4_t lf_t) + \alpha_{12} \Delta lf_{t-1} + \alpha_{13} \Delta lf_{t+1} + \alpha_{14} ts_t + \alpha_{15} (D5_t ts_t) + \alpha_{16} \Delta ts_{t-1} + \alpha_{17} \Delta ts_{t+1} + u_t \quad (13)$$

4. EMPIRICAL RESULTS

4.1. Unit Root and Cointegration Testing without Structural Break

The results of unit root test (ADF, PP, and KPSS) are shown in Table 1. According to the ADF and PP tests, all of the variables have one unit root (i.e. integrated of order one, I (1)), but KPSS test signals that the effect of structural breaks should be examined. For the analysis without structural breaks, we conclude that all variables are I (1).

Table 1: Unit-Root Tests

Unit Root Test	*lgdp*	*lhw*	*lrr*	*llf*	*Lts*
ADF	-2,78**	0,01**	-1,99**	-1,86**	-2,39**
PP	-20,15	-0,74**	-2,02**	-1,63**	-2,28**
KPSS	0,72**	0,45*	0,69**	0,72**	0,71**

Note: *, **, and *** indicate the rejection of null hypothesis as stationary at 10%, 5% and 1% significance levels, respectively.

The long run relationship between real GDP per capita, transportation measures and labor force is tested with Engle-Granger (1987) two step modeling where the results are shown in Table 2. According to the first step, the ADF test for the residuals (unit root test) signals that the null hypothesis that the residuals have a unit root is rejected. This means that there is no long run relationship between the variables. The possibility of spurious results is ruled out as R-squared is less than the Cointegration Regression Durbin Watson (CRDW). The possibility of cointegration in the long run increases when CRDW is greater than R-squared.

The second step is the error correction mechanism (ECM), where the first differences of the variables and the residuals in period t-1 are included in the estimation. The magnitude of the residual e_{t-1} is the derivation from long-run equilibrium in period (t-1). The coefficient of residuals in period (t-1) is found to be -0,132, which indicates that the ECM is working and there is a short run relationship between the variables. All of the independent variables have positive coefficients with only the share of transport in fixed capital investment being statistically significant.

Table 2: Engle-Granger 2-Step Cointegration Test

1st Step	**Regressor**	**Coefficient**	**T-Stat**
	Constant	-12,146	-0,753
	lrr	4,227	3,277***
	lhw	3,918	1,848*
	llf	3,071	11,443***
	lts	0,327	2,938***
	R^2 = 0,984 and CRDW = 1,144		
2nd Step	**Regressor**	**Coefficient**	**T-Stat**
	Constant	0,054	5,143***
	dlrr	0,553	0,574
	dlhw	0,379	0,339
	dllf	0,272	0,601
	dlts	0,224	3,511***
	res(-1)	-0,132	1,231
	ADF: -3,72		

Note: *, **, and *** indicate the rejection of null hypothesis at 10%, 5% and 1% significance levels, respectively. Critical values are based on MacKinnon (1991) and at 5% significance level are -4.413; models include constant and no trend; *k* is the lag length used in the test for each series and number of lags are determined according to the AIC and given in parenthesis.

After determining the appropriate lag length by Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC), Johansen-Juselius cointegration procedure is applied on the variables. Table 3 below reports the results of this test.

Table 3: Johansen-Juselius Cointegration Test

Trace Test		
Null	**Alternative**	**Stat**
r = 0	r ≥ 1	135,090***
r ≤ 1	r ≥ 2	79,126***
r ≤ 2	r ≥ 3	44,995**
Maximum Eigen-value Test		
Null	**Alternative**	**Stat**
r = 0	r ≥ 1	55,964***
r ≤ 1	r ≥ 2	34,131**
r ≤ 2	r ≥ 3	26,245**

Note: *, **, and *** indicate the rejection of null hypothesis at 10%, 5% and 1% significance levels, respectively. List of the variables included in the cointegrated vector is $lgdp, lhw, lrr, lts$ and intercept; and 37 observations from 1970 to 2006.

Maximum Eigen-value and trace test statistics reject the null hypothesis of no cointegration at all significance levels. Johansen-Juselius cointegration procedure suggests three cointegrating vectors at 5% and 10%. However, maximum eigenvalue test indicates only one vector at 1%. This long run relationship normalized for $lgdp$ is estimated as:

$$lgdp = 19{,}591(lhw) - 51{,}239(lrr) + 3{,}174(llf) + 3{,}35(lts)$$

(4.333) (-6.903) (1.252) (7.686)

The t-values in parentheses show that except railway length all of the variables affect real GDP per capita positively, with the exception of the coefficient of labor force being statistically insignificant.

4.2. Unit Root and Cointegration testing with Structural Break

To investigate the possibility of structural breaks, Zivot and Andrews (1992) test is applied over the period 1970-2006. The results presented in Table 4, reporting the minimum t statistics and their corresponding break times, confirm the results of the previous tests that all series are I(1). Break points coincide with the Military Coup years; 1980 for GDP per capita and 1982 for highways. For railways, labor force and transportation share in fixed capital investment; break points are 1988, 1993 and 1994, respectively which seem to coincide with the economic crisis.

Table 4: Zivot-Andrews Unit Root Test

	lgdp	*lhw*	*lrr*	*llf*	*Lts*
Break Year	1980	1982	1988	1993	1994
Y (t-1)	-0,39 (-3,14)	-0,61 (-4,43)	-0,58 (-3,76)	-0,84 (-4,61)	-1,28** (-5,05)
t	0,04 (2,72)	0,001 (1,72)	0,001 (2,56)	0,014 (4,65)	0,028 (4,64)
B(t)	-0,08 (-1,61)	0,036*** (6,45)	0,003 (0,49)	-0,08*** (-5,56)	-0,49** (-5,12)
D(t)	0,03 (0,99)	-0,02 (-4,79)	-0,01 (-1,67)	0,04 (3,11)	-0,01 (-0,07)
DT(t)	-0,02 (-2,25)	0,001 (1,59)	0,0001 (0,2)	-0,005 (-4,34)	-0,015 (-1,93)
k	0	0	0	4	4

Note: *, **, and *** indicate the rejection of null hypothesis at 10%, 5% and 1% significance levels, respectively. Critical values at 1%, 5% and 10% significance level are –5.57, -5.08 and –4.82 respectively (Zivot and Andrews, 1992), k is the lag length used in the test for each series and selected criteria based on AIC, t statistics of the related coefficients are given in parenthesis.

Gregory and Hansen (1996) extended the Engle-Granger cointegration test to allow for breaks in either just the intercept or both the intercept and trend of the cointegrating relationship at an unknown time. As stated by Gregory and Hansen (1996), their testing procedure is of special value when the null hypothesis of no cointegration is not rejected by the conventional tests. The results of this test (Table 5) shows that for all models there is evidence of a cointegration with the exception the results of Z_{α}^{*}.

Table 5: Gregory-Hansen Cointegration test

Model	ADF	Break Year	Z_t^*	Break Year	Z_α^*	Break Year
C	-7,911***	1982	-14,596***	1985	-59,221	1997
C/T	-8,777***	1994	-16,117***	1994	-59,255	1981
C/S	-8,043***	1987	-14,491***	1985	-59,251	1998
Critical Value	-6,840				-88,471	

Note: *, **, and *** indicate the rejection of null hypothesis at 10%, 5% and 1% significance levels, respectively. Critical values for ADF and Z_t at 5% significance level is -6.84, and for Z_α is -88.47 respectively (Gregory and Hansen, 1996).

We then proceed to Stock and Watson Dynamic OLS model shown in (13) to estimate the coefficients of cointegrated variables. The estimation results are presented in Table 6. It can be seen that highway length and labor force has a negative and significant relationship with income while railway length affects it positively but the coefficient is not statistically significant. The coefficient of the share of transportation in fixed capital investment is both positive and significant as expected.

Table 6: Stock-Watson Dynamic OLS model

	α_1	α_3	α_6	α_7	α_{10}	α_{11}	α_{14}	α_{15}
Coeff.	-2,38	5,75	0,397	-12,96	-0,27	1,37	0,29	-0,12
T-stat	-2,184**	1,413	0,303	-3,965***	-0,570	1,827*	3,286***	-0,787

Note: The numbers in parentheses are the t-statistics for the. *, ** and *** denotes the rejection of null that the corresponding coefficients are zero at 10%, 5% and 1% significance levels respectively. Dummy variables are as follows $D1_t$ is 0 up to 1982 and 1 thereafter, and $D2_t$, $D3_t$, $D4_t$ and $D5_t$ are 0 up to 1994 and 1 thereafter.

4.3. Overall Results

When the empirical results from cointegration analysis without and with a structural break are considered, we see that the effects of highway length, railway length and labor force on real GDP per capita are contradictory. The results are summarized in Table 7. The effect of share of transportation in fixed capital investment is positive and significant all through.

Table 7: Overall results

Variables	Cointegration Test Without Structural Break		Cointegration Test With Structural Break
	Engle-Granger Test	Johansen Test	Stock-Watson DOLS Model
Highway length	+	+*	-*
Railway length	+	-*	+
Labor force	+	+	-
Share of transportation in fixed capital investment	+*	+*	+*

* indicates statistical significance.

5. CONCLUSION

This paper analyzes the relationship between the transportation infrastructure and economic growth in Turkey for the period 1970-2006. In order to determine the features of this relationship, cointegration tests with and without structural breaks are applied through time series dimension. The results obtained rom Engle-Granger, Johansen-Juselius, Gregory-Hansen and Stock-Watson procedures show that while the effects of highway length, railway length and labor force on real income per capita vary across tests with respect to sign and statistical significance, the effect of *share of transportation in fixed capital investment* is positive and significant for all tests.

These results can be interpreted as follows. The amount and type of investment in transportation rather than length of infrastructure (highways and railways), is crucial for increasing real GDP per capita. As an example, public investment on highway infrastructure in Turkey was on average 2.36 % of the government budget for 1970-2005. Highway length in kilometers increased from 59,000 kms in 1970 to 61,000 kms in 2005 (Kuştepeli, Gülcan, Akgüngör, 2008). The effects of transportation on real economic activities in manufacturing and service based sectors have visible benefits such as time consumption in shipping of both raw materials, semi-finished goods and produced goods. In that sense, private and public policies toward transportation infrastructure should target investments and improvements in the quality and quantity of transportation.

More generally, the results indicate that there is a (positive) relationship between the transportation infrastructure and real GDP per capita. Models designed to assess this relationship should be formed in a scrutinized manner in terms of economic theory, econometric and empirical tools.

Future research should be directed at explaining transportation infrastructure effects on different measures more directly related to up-to-date issues such as innovation performance, social network analysis, and online economic activities. Regional and national properties such as geographical characteristics, information systems play an important role and thus should be taken into account. Applying econometric methodology with cross-section dimension could supply more comparable results for policy implications; however this would only be possible whenever statistical institutions produce consistent time series data across countries.

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Supplementary bibliography is given in table A1.

INFRASTRUKTURA DROGOWA I KOLEJOWA, DOCHÓD REALNY I ZMIANY STRUKTURALNE

Systemy infrastruktury wpływają na rozwój gospodarczy bezpośrednio lub pośrednio, w zależności od ich struktury, rodzaju, jakości i ilości. Infrastruktura transportowa jest jednym z najważniejszych typów systemów infrastrukturalnych, gdyż jej poprawa przynosi zarówno materialne i niematerialne korzyści dla gospodarki, takie jak obniżenie kosztów, jak również zwiększenie wydajności. Dlatego inwestycje w infrastrukturę transportu są ważne, a to przyczynia się do rozwoju gospodarczego, bezpośrednio poprzez obniżenie kosztów transportu oraz ułatwienie handlu. Wszystkie sektory usługi świadczonych przez infrastrukturę transportową są podstawą działalności gospodarczej ze względu na zwiększoną mobilność towarów i usług. Zatem cała gospodarka jest związana z transportem, a relacja pomiędzy infrastrukturą transportową i wzrostem gospodarczym została przeanalizowana w wielu badaniach za pomocą różnych podejść metodologicznych. Celem tej publikacji jest analiza zależności występujących między infrastrukturą transportu a wzrostem gospodarczym w Turcji na przestrzeni lat 1970-2006. Analiza empiryczna przeprowadzona w oparciu o testy adaptacyjne uwzględniająca zarówno zmiany strukturalne jak i ich brak dowodzi, iż na dłuższą metę wpływ realnego dochodu, długości dróg publicznych, linii kolejowych i siły roboczej w kontekście rzeczywistych dochodów zmienia się w obrębie różnych testów w zależności od rodzaju wskaźników i ich znaczenia. Jednakże, zależność pomiędzy udziałem transportu w ustalonych inwestycjach kapitałowych a dochodem realnym jest korzystna i znacząca dla wszystkich wspomnianych testów. Wynika z tego, że zarówno prywatny jak i publiczny sektor infrastruktury transportu powinien obierać za główny cel inwestycje oraz poprawę jakości przewozu a nie jego ilość.

Słowa kluczowe: Infrastruktura drogowa, infrastruktura kolejowa, funkcja Cobb-Douglasa, testy kointegracyjne, zmiany strukturalne, inwestycje transportowe, klasyfikacje Jel: C54, E23, H54, L92

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Table A1. Literature Review

Author and Year	Infrastructure Measure	Development Measure	Area, Period and Model	Results
Deno, 1988	Highway capital	Output	USA, Production Function	+
Aschauer, 1989	Transportation, water and sewer, gas and electricity	Productivity of private sector	USA, 1949-1985	+
Aschauer, 1990	Highway miles	Income per-capita	USA, 1960-1985, Production Function	+
Munnell, 1990	Transportation, water and sewer, gas and electricity	Productivity of private sector	USA, 1949-1987	+
Munnell and Cook, 1990	Highways	Gross State Product (GSP)	USA, 1970-1986, Production Function	+
Jones, 1990	Highway spending per-capita	Employment, income and Investment	USA	+
Mofidi and Stone, 1990	Highway spending per-capita	Manufacturing investment and employment	USA	+
Reynolds and Maki, 1990	Highway spending per-capita	New manufacturing plants	Labor market areas	No effect
Duffy-Deno and Eberts, 1991	Transportation, water and sewer, public hospitals	Income per-capita	Twenty-eight metros, 1980-1984	+
Eisner, 1991	All state and local public capital	GSP	USA, 1970-1986	+
Hulten and Schwab, 1991	Highways	Manufacturing output	Nine regions, 17 years	No effect
Coughlin, Terza and Aromdee, 1991	Highway miles per square mile	Foreign Direct Investment (FDI)	USA	+

Author and Year	Infrastructure Measure	Development Measure	Area, Period and Model	Results
Garcia-Mila and McGuire, 1992	Highway miles per square mile	GSP	USA, 1970-1982, Production Function	+
Berndt and Hansson, 1992	Transportation, water and sewer, electricity	Private sector costs	Sweden, 1964-1988	-
Tatom, 1993	All public capital	Private sector productivity	USA, 1949-1990	No effect
Lynde and Richmond, 1993	Nonresidential public capital	Manufacturing costs and productivity	UK, 1966-1990	+
Seitz, 1993	Highways	Manufacturing costs and productivity	West Germany, 1970-1989	+
Nadiri and Mamuneas, 1994	All public capital	Manufacturing costs, labor demand	Twelve Manufacturing industries, 1955-1986	+
Luce, 1994	Highway and railroad access	Employment, labor force	Local governments	+
Evans and Karras, 1994	Highways and highway spending	GSP	USA, 1970-1986	No effect
Holtz-Eakin, 1994	All state and local government capital	GSP	USA	No effect
Conrad and Seitz, 1994	Transportation infrastructure	Sector output, costs and production	West Germany, 1961-1988	+
Holtz-Eakin and Schwartz, 1995	Highways, water and sewer, gas and electricity	Productivity growth	USA, 1971-1986	No effect
Dalenberg and Partridge, 1995	Highway spending / per income	Employment	Metro areas	-
Moonmaw, Mullen and Martin, 1995	Highways	GSP	USA, 1970-1980-1985	+

Author and Year	Infrastructure Measure	Development Measure	Area, Period and Model	Results
Grihfield and Panggabean, 1995	Highways	Income per-capita growth	282 metro areas	No effect
Singletary et al 1995	Highways accessibility	Manufacturing employment growth	477 areas in South Carolina	+
Morrison and Schwartz, 1996	Highways, water and sewer	Manufacturing costs	USA, 1970-1987	+
Grihfield and Panggabean, 1996	All public capital	Manufacturing output	222 metro areas	+
Boarnet, 1996	Highways	Private output	California USA, 1969-1988	+
Holleyman, 1996	Highways	Manufacturing costs	USA, 1969-1986	+
Garcia-Mila, McGuire and Porter, 1996	Highways	Private sector output	USA, 1970-1983	+
Morrison and Schwartz, 1996	Highways, water and sewer	Manufacturing costs	New England USA, 1970-1987	+
Harmatuck, 1996	All public capital	Gross National Product (GNP)	USA, 1949-1986	+
Bruinsman, Rienstra and Rietveld, 1996	Highways	Employment and firm growth	Netherlands	+
Haughwout, 1996	Highways	Output	2SLS spatial equilibrium model	+
Bollinger and Ihlanfeldt, 1997	Passenger rail stations	Population and employment	Atlanta USA	No effect
Boarnet, 1998	Highways	Output	California USA, 1969-1988	+

Author and Year	Infrastructure Measure	Development Measure	Area, Period and Model	Results
RESI ,1998	Highways	Industry costs and output	Maryland USA, 1982-1986	+
Fernald, 1999	Highways	Industry productivity and output	USA, 1953-1989	+
Lobo and Rantisi, 1999	Local government capital spending	Wage growth	Metro areas	+
Haughwout, 1999	Highways	Residential property values	Metro areas	+
Bougheas, Demetriades and Mamuneas, 2000	Transportation and communication infrastructure	GDP growth	USA, 1978-1992	+
Boopen, 2006	Transportation capital	GDP	38 Sub-Saharan countries and 13 SIDS, 1980-2000, Cobb-Douglas Production Function	+
Zhou, Yang, Xu and Liu, 2007	All public capital	GDP, export and investment	China, 1997-2004	+
Garcia-Mila and Montalvo, 2007	National roads and Highways	Firms located near highways	Spain, 1980-2000	+
Lakshmanan, 2007	All public capital	Private sector productivity and output	USA, Japan, UK, France Germany, India and Mexico, 1951-1987	+

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THE COMPARATIVE ANALYSIS OF THE COMPANIES FROM THE TSL SECTOR OPERATING IN POLAND AND SLOVAKIA

The article presents a comparative analysis of the companies operating in Transport-Shipping-Logistics sector in Poland and Slovakia. The statistical analyses included examination of logistic companies taking into consideration the size of the company, the type of business and its character. In particular, there had been presented a characteristic of the structure of logistic companies in Poland and Slovakia in terms of the region of the business, the business branch, its legal form and the size of the company. With the use of statistical methods, on the basis of the selected financial rates the comparison of financial condition of the companies operating in the TSL sector in Poland and Slovakia in the period of 2009-2012 had been made.

For the companies operating in Slovakia, thanks to applying the taxonomic methods, comparative examinations had been made in order to isolate the accumulation of the companies similar to each other in terms of the selected rates describing their economic and financial condition. The rates characterizing the financial condition of the companies included the following groups of rates: liquidity (describing the liquidity of the companies), debt (the companies proclivity for repaying their liabilities), profitability (describing the companies proclivity for generating profits), the ability to act (describing the ability and efficiency of managing the company) and other rates describing the capital structure of companies and the effect of the financial leverage.

On the basis of the selected rates and applying the methods of multidimensional comparative statistics (the ranking method – linear ordering) with the use of generalized measure of distance GDM the examination of the ranking of the TSL sector companies operating in Slovakia in 2011 had been made. The analysis of the determined rankings allowed to distinguish the best companies in terms of their financial condition and the potential companies at risk of bankruptcy. The ranking results, as far as Slovak companies are concerned, had been referred to clusters of companies with similar financial conditions designed using taxonomic methods. The comparison of rankings within the clusters had been examined according to the size of the surveyed companies. The achieved results had been shown in the form of practical conclusions.

Keywords: TSL sector, comparative analysis, statistical analysis, taxonomic methods.

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1. INTRODUCTION

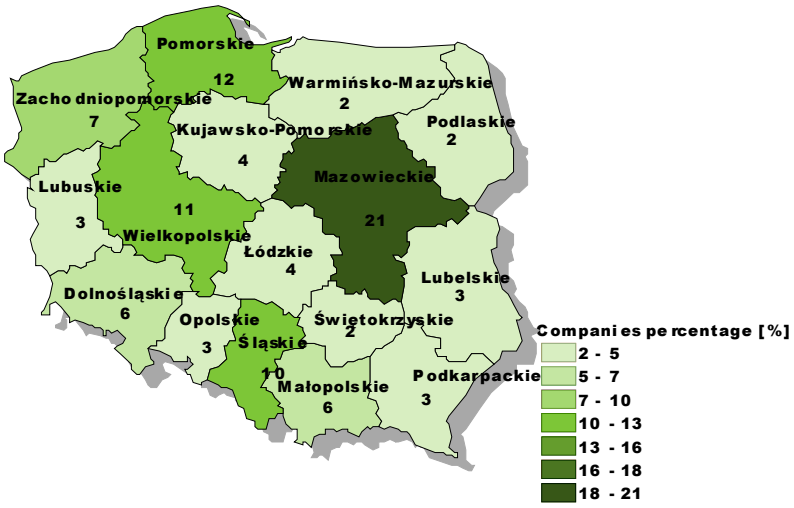
The sector associated with logistics operation is currently a very rapidly growing type of the business activity. The purpose of the article is to compare the logistics companies in Poland and Slovakia. The companies had undergone a thorough multilevel statistical analysis in terms of selected aspects of their activities in the logistics market. The essence of the analysis was to compare the structure of Polish and Slovak companies, and the next step of analysis was to extract the important diagnostic variables diversifying the companies in terms of economic and financial situation through the factor analysis method. For companies operating in Slovakia by using taxonomic methods there had been extracted the clusters of similar companies in terms of selected rates and they had been ranked using a generalized measure of distance GDM. A similar analysis had not been made as far as Polish companies are concerned, because of a very large number of surveyed companies (over 3000) and appearing therefore difficulties with the presentation of the results in this study. Multi-criteria comparative analysis of Polish companies is the subject of further investigation and the results will be presented in subsequent articles. Data for the study was taken from the Database of EMIS (Emarging Markets Information Service)[3]. To carry out the research the program of Statistica 10 PL as well as EXCEL spreadsheet had been used.

2. THE CHARACTERISTICS OF THE TSL SECTOR COMPANIES IN POLAND AND SLOVAKIA

In Poland in the TSL sector the operating activity was led by 3602 companies. The majority of the companies had their legal address in Masovian Voivodeship (21%). Every tenth company operates in Pomeranian Voivodeship (12%), Greater Poland Voivodeship (11%) and Silesian Voivodeship (10%). The smallest number of companies from TSL sector operates in Warmian-Masurian, Świętokrzyskie and Podlaskie Voivodeship (2% each).

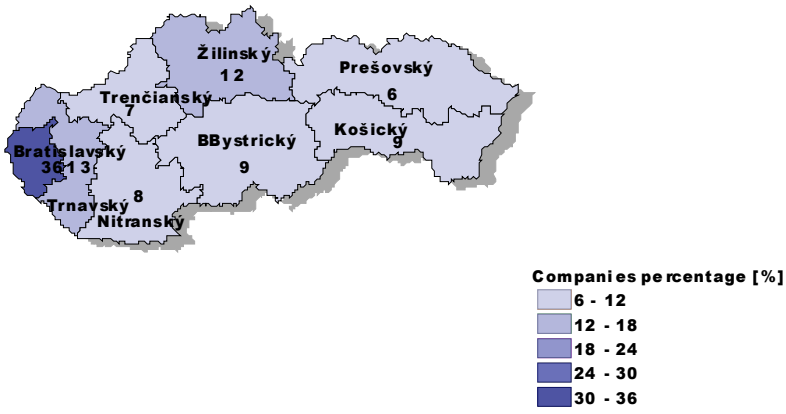
[3] http://www.securities.com

Fig. 1. Place of doing business of the surveyed companies in Poland



In the area of Slovakia the operating activity is led by 190 companies. The highest percentage of companies has their legal address in the Bratislava Region 36%. A large percentage also operates in the Trnava Region (13%) and in the Zilina Region (12%). The smallest percentage of TSL sector companies operates in the Presov Region (6%) and in the Trencin Region (7% each).

Fig. 2. Place of doing business of the surveyed companies in Slovakia

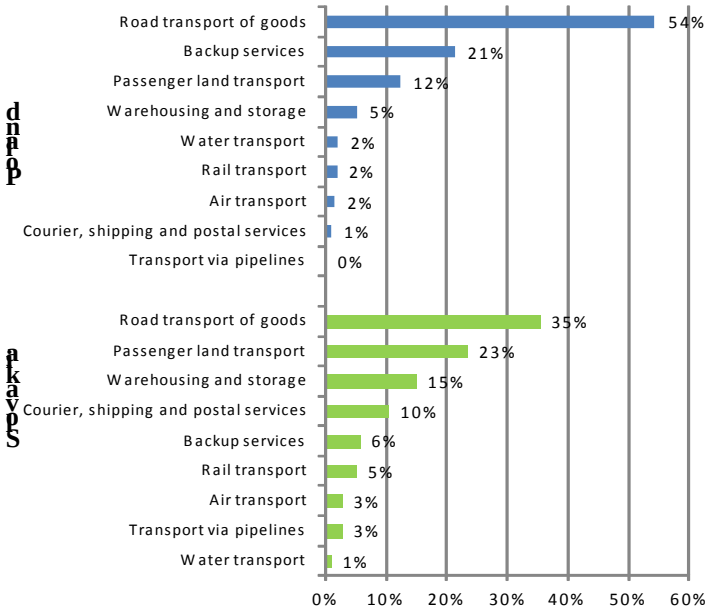


TSL sector shows a significant variation in the type of business activity in the surveyed countries $p<\alpha$ ($p=0,0000$). In Poland (fig. 3), the largest percentage of companies operates in the road transport of goods (54%), the second largest services are the backup services – such activity is led by every fifth company. About 12% of the surveyed companies operates in the passenger land transport.

Every third company operating in TSL sector in Slovakia (fig. 3) is engaged in the road transport of goods (35%). In the passenger land transport operates approximately 23% and 15% is engaged in warehousing and storage. A large percentage, which is about 10% are the companies dealing with courier shipping and postal services.

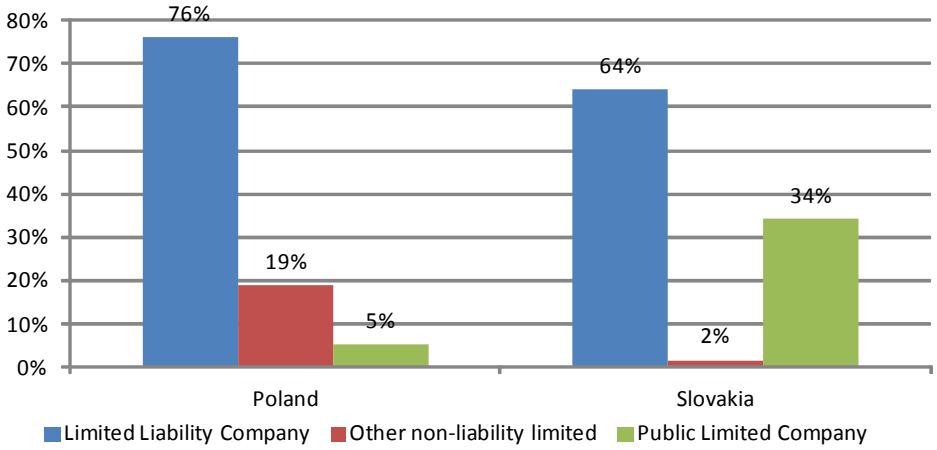
Companies from TSL sector in Poland and Slovakia differ in a statistically significant way because of the legal form $p<\alpha$ ($p=0{,}0000$). Both in Poland and Slovakia most companies operate as Limited Liability Company (fig. 4), although a higher percentage of companies is located in Poland (76%) – whereas in Slovakia 64%. Huge differences had been recorded in other categories. As a Public Limited Company in Poland operates only 5% of companies and as far as Slovakia is concerned, it concerns every third company.

Fig. 3. Branches in which the companies of TSL sector operate in Poland and Slovakia



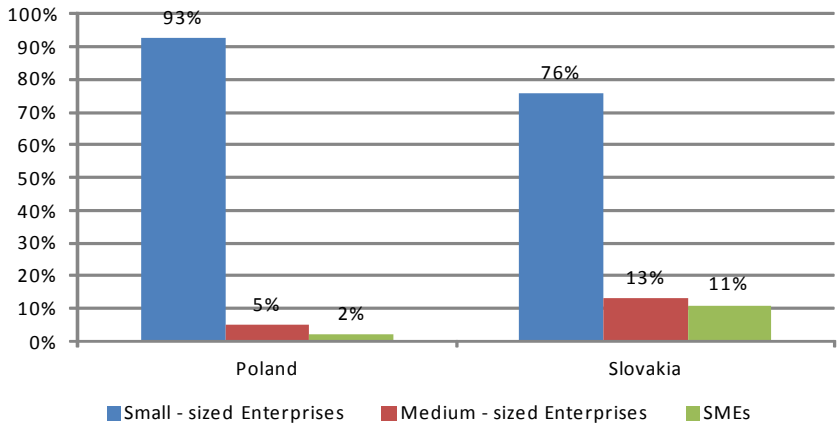
As Other non-liability limited in Poland operates every fifth company and in Slovakia it concerns only 2% of the surveyed companies. In Poland, on the stock exchange there are listed 16 companies operating in TSL sector whereas in Slovakia only two.

Fig. 4. Legal form of the surveyed companies of TSL sector in Poland and Slovakia



The companies had been divided into small, medium and large ones on the basis of the size of the total assets of the company balance sheet compiled at the end of the financial year. If the sum of the assets did not exceeded PLN zloty the equivalent of 10 million of Euros, the company was classified as a small one. In the case when the sum of assets was in the range from 10 to 43 million of Euros, the company was classified as a medium one. Other companies whose sum of assets exceeded 43 million of Euros was defined as a large[4] one. The structure of the size of companies is shown in figure 5.

Fig. 5. The size of the surveyed companies of TSL sector in Poland and Slovakia



[4] Centre for Strategy & Evaluation Services, Final Report: *Evaluation of the SME Definifion*, Centre of Strategy & Evaluation Services, Sevenoaks, Kent 2012, http://ec.europa.eu/enterprise/policies/sme/files/studies/executive-summary-evaluation-sme-definition_en.pdf, p. 35.

As far as the size is concerned, the structure of the companies also varies statistically in a significant way in the surveyed countries $p>\alpha$ ($p=0,0000$). Both in Poland and Slovakia, the largest percentage represents the small companies. However, their interest varies from 76% in Slovakia to 93% in Poland.

Table 1. Percentage distribution of the size of the surveyed companies divided into branches in which they operate in the TSL in Poland and Slovakia

	Poland			**Slovakia**		
	small	**medium**	**large**	**small**	**medium**	**large**
Road transport of goods	97%	3%	0%	93%	5%	2%
Backup services	90%	6%	3%	58%	8%	33%
Warehousing and storage	85%	13%	2%	77%	11%	11%
Water transport	90%	6%	4%	0%	0%	100%
Passenger land transport	91%	6%	3%	69%	27%	4%
Air transport	80%	14%	6%	0%	0%	0%
Courier, shipping and postal services	73%	8%	20%	73%	13%	13%
Rail transport	65%	17%	18%	63%	0%	38%
Transport via pipelines	0%	0%	100%	0%	0%	100%

There had been examined the structure of the size of the companies operating in TSL sector taking into consideration the division of the type of their activity (table 1). In Poland as well as in Slovakia, the differences are statistically significant $p<\alpha$ ($p=0,00000$).

3. THE SELECTION OF DIAGNOSTIC VARIABLES WITH THE USAGE OF FACTOR ANALYSIS

To analyze the condition of TSL sector companies, the financial data published by the company only from 2011 had been used. The number of the companies which published their reports in 2011 in Poland is 2294 and in Slovakia 43.

Table 2. Results of factor analysis – factor loadings– Varimax method - normalized (indicated loadings are > 0.7)

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
X1 – Current liquidity ratio	0,9450	0,0698	0,0142	0,1677	0,0484	0,0387
X2 – Quick liquidity ratio	0,9464	0,0671	0,0146	0,1634	0,0458	0,0394
X4 – Liquidity ratio (foreclosure)	0,9297	0,0477	-0,035	-0,0516	-0,0054	-0,0430
X5 – Cash liquidity ratio	0,8698	0,0465	-0,039	-0,0832	-0,0126	-0,0489
X3 – Working capital / Assets liquidity ratio	0,1353	0,8414	0,0956	-0,0340	0,2839	0,1382
X12 – The debt ratio of assets	-0,075	-0,850	0,0064	0,0138	-0,4005	0,0364
X18 – Debt leverage to total assets	-0,025	-0,953	0,0361	-0,0023	0,1401	0,0523
X19 – Assets structure ratio: Equity / Total assets	0,0261	0,9535	-0,035	0,0019	-0,1417	-0,0505

X11 – Debt equity	-0,030	0,0081	0,9528	0,0169	0,0062	-0,1499
X17- Financial leverage	-0,029	0,0075	0,9529	0,0148	0,0058	-0,1771
X14 – Efficiency: Receivables turnover [days]	0,1979	0,002	0,0534	0,7821	0,0188	0,0805
X6 – Return on assets (ROA)	0,0521	-0,047	0,1370	-0,142	0,8091	0,2559
X7 – Return on equity (ROE)	-0,038	0,007	-0,245	0,0301	0,0712	0,7568
X8 - Profitability – Return on capital	-0,037	0,021	-0,176	0,0315	0,0423	0,7719
X9 – Yields: Return on sales (ROS)	-0,049	0,036	0,0165	-0,676	0,0671	0,0534
X13 – Debt ratio: Gross profit / Short-term liabilities	0,3242	0,021	0,0606	-0,406	0,2245	0,1394
X15 - Efficiency – Assets turnover [days]	-0,046	-0,211	0,1241	-0,151	-0,693	0,2436
X16 - Efficiency – Inventory turnover [days]	-0,017	0,011	0,0076	0,3862	0,0701	0,0359
X20 – Assets structure ratio: Fixed assets / Total assets	-0,162	0,076	-0,284	0,0555	0,3490	-0,4888
Variance explained	**3,6179**	**3,318**	**2,0441**	**1,4983**	**1,6101**	**1,6492**
Percentage	**0,1904**	**0,174**	**0,1076**	**0,0789**	**0,0847**	**0,0868**

The rates of profitability, efficiency, liquidity, debt and financial leverage had been the subject of analysis. Because of the variety and a large set of rates, in order to select the variables, the factor analysis had been chosen.

The factor analysis enables the elimination of data, which contains only the marginal information and of less importance for the phenomenon study, and often allows to correlate huge amounts of information in the form of a few synthetic variables.

After the analysis, seven factors had been isolated for which the proportion of explained variance was about 72%. In order to select the appropriate set of rates to characterize the financial condition of the TSL sector companies, for the created factors there had been carried out the analysis of reliability and the α-Cronbach's coefficient had been reckoned. In the case where the α-Cronbach's coefficient was high (over 70%), from the pair of variables only one had been isolated because their accuracy and the reliability of carried information was very high. If the factor consisted of only one variable, it had been automatically introduced into the study.

Table 3. The values of Cronbach's α-factor for the developed factors

Diagnostic variable	α-Cronbach
X1 – Current liquidity ratio	0,95
X2 – Quick liquidity ratio	
X4 – Liquidity ratio (foreclosure)	
X5 – Cash liquidity ratio	
X3 – Working capital to Assets liquidity ratio	-0,94
X12 – The debt ratio of assets	
X18 – Debt leverage to assets	
X19 – Assets structure ratio: Equity to Total Assets	
X11 – Debt equity	0,99

X17- Financial leverage	
X7 – Return on equity (ROE)	0,73
X8 - Profitability – Return on capital	

Table 4. The final set of variables adopted to study the financial condition of companies operating in the TSL in Poland and Slovakia

Diagnostic variable	Financial ratios	Group of financial ratios
X1	Current liquidity ratio	Liquidity
X6	Return on assets (ROA)	Profitability
X7	Return on equity (ROE)	
X14	Receivables turnover [days]	Efficiency
X17	Financial leverage	Leverage
X18	Debt leverage to total assets	Debts

For the first and the second factor there was a need of additional correlation analysis because they contained the four variables. The most representative feature for the first factor was the current ratio (X_1) – the high value of the correlation coefficient with all variables and for the second the debt leverage to total assets (X_{18}). From the third factor the financial leverage (X_{17}) and from the sixth the return on equity – ROE (X_7). The final set of diagnostic variables has the form presented in Table 4.

For the selected diagnostic variables the basic descriptive statistics were calculated, with the division of the country in which the surveyed companies operate (table 5).

Table 5. Basic descriptive statistics of selected diagnostic variables

P – Poland, S – Slovakia	Mean	Min	Max	Standard deviation	Coefficient of Variation (V_z)	Kurtosis
X1 - Current liquidity ratio (P)	310,8	0,0	20828,6	942,0	303,1	185,1
X1 - Current liquidity ratio (S) +	191,5	12,2	1400,0	218,5	114,1	22,7
X6 - Return on assets (ROA) (P) +	2,4	-900,0	1050,0	48,3	1984,6	185,2
X6 - Return on assets (ROA) (S)	2,3	-37,3	33,3	12,2	533,4	4,2
X7 - Return on equity (ROE) (P) +	24,2	-7963,6	6900,0	404,1	1666,6	212,0
X7 - Return on equity (ROE) (S)	10,3	-100	133,3	38,9	378,9	3,8
X14 - Receivables turnover [days] (P) +	122,9	0,0	28461,2	803,5	653,7	788,2
X14 - Receivables turnover [days] (S)	57,9	0,0	129,6	26,3	45,4	0,4
X17- Financial leverage (P)	419,8	-52790	53589,0	3456,0	823,2	146,7
X17- Financial leverage (S) +	339,1	-544,1	1505,8	319,4	94,2	5,9
X18 - Debt leverage to total assets (P)	75,4	0,5	6250,0	169,3	224,7	794,6
X18 - Debt leverage to total assets (S) +	59,8	2,0	100,0	24,0	40,1	-0,1

Current Ratio – states how many times the current assets cover the current liabilities. The optimum value of the ratio is in the range of 150% - 220%.[5] The high value which is greater than 2 may indicate an excessive freezing of capital in current assets. If the ratio is too low, it may indicate some problems connected with the repayment of current liabilities. For Polish companies the average value of this ratio was very high, (approximately about 311 %), which indicates an excessive freezing of capital in current assets. For Slovak companies, the ratio has the optimal size (191%). The situation improves median which for both Polish and Slovak companies is at the level of about 133%. Larger differences in the size of current ratio is observed in Polish companies as it is evidenced by the larger standard deviation (942%) and the coefficient of variation (303%).

Return on assets ROA which is the rate of return on assets, is a measure of profit attributable to total assets. It informs about the possibility to achieve profits and efficiency as far as the management of property is concerned. The higher the rate, the better for the company because it indicates a higher level of financial condition of a company. It also presents the return of all assets of the company in relation to the earned profits. The rate indicates how many cents of net profit is generated by a single penny of invested assets. For the companies operating in Poland ROE assumes higher values. The higher are both the average (2,4) as well as the median (3,9). However, as to the Slovak companies we can observe a greater uniformity of profitability, lower values are in the case of the standard deviation (12) and the coefficient of variation (533).

Return on equity ROE – the return on equity – meaning how much of the profit the company was able to save from the contributed equity. The higher the rate, the more favorable the situation of the company is. The higher efficiency of equity implies the possibility of gaining a higher financial surplus (higher dividends). This indicates to what extent the company multiplies the resources entrusted by the owners which is a measure of shareholders profits. The rate shows how much profit was obtained from contributed equity.[6] Companies operating in Poland have on average a higher return on equity (24), the higher is also the median (14). The differentiation in the size of the surveyed rate is also higher.

Efficiency – receivables turnover [days] - informs about the efficiency of receivables to generate revenue. It shows how many times over the year the company reconstructed its receivables, or how many turnover cycles of receivables took place during the financial year. There is no reference value of this rate but its size should be as large as possible. The increase in the number of cycles (the rate) from year to year provides a better management of receivables. The decrease in the value of the rate (the decrease in rotation cycle) reduces the company's ability to settle its liabilities on time because its liquidity falls as well. The rate obtains larger values for companies operating in Poland (about 123 days), however the medians both for Polish and Slovak companies are at a similar level (about 58 days). In the case of companies operating in Slovakia, there is a less variation in the turnover rate, as the standard deviation (130 days) and the coefficient of variation (45%) are less than in Poland.

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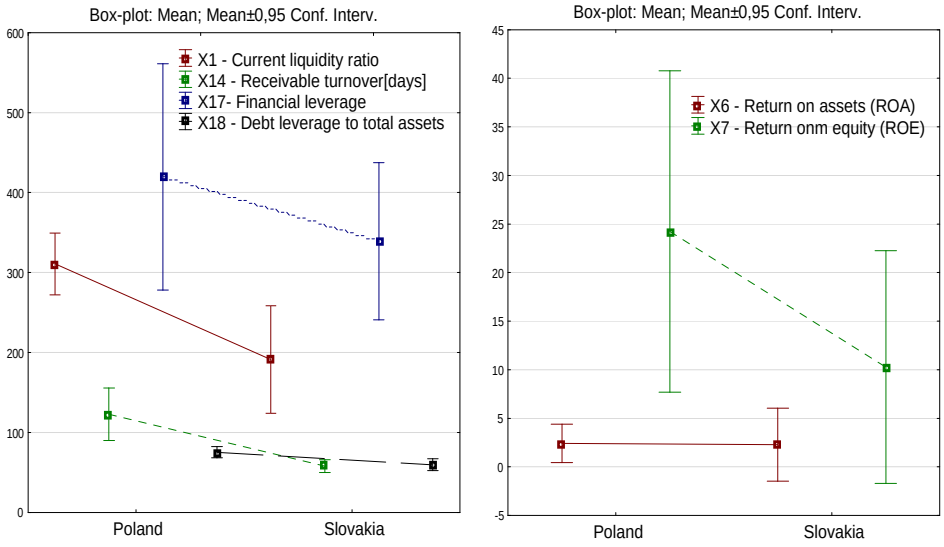
[5] M. Sierpińska, D. Wędzki, *Zarządzanie płynnością finansową w przedsiębiorstwie*, Wydawnictwo PWN, Warszawa 1997.

[6] J. C., Ritchie, *Analiza fundamentalna*, WIG PRESS, Warszawa 1997, p. 214 -215.

The rate of financial leverage – the higher its value, the greater degree of making use of foreign capital and the greater risk of burdening the activity. The average value of financial leverage indicates that Polish companies are more often make use of the foreign capital (420 to 339), but taking into account the value of the median, it turns out that more companies in Slovakia have a higher level of financial leverage (277 to 200). Much greater diversity of financial leverage is observed within the operating area of Polish companies.

Debt leverage to total assets i.e., the rate of debt – it shows in the easiest way the degree of financing the companies from the foreign sources without the distinction of their origin. It can be assumed that the proper level of this rate should be between 0,57 a 0,67.[7] On the basis of the average value, the optimal level takes the rates of the companies operating in Slovakia. The medians of the two rates take the optimal values, but the greater variation had been observed in companies operating in Poland.

Fig. 6. Chart of medium-sized diagnostic features adopted to study the condition of the companies operating in the TSL sector in Poland and Slovakia



4. THE COMPARATIVE ANALYSIS OF THE CONDITION OF THE COMPANIES OPERATING IN THE TSL SECTOR IN POLAND AND SLOVAKIA

It had been examined whether there are the differences in the level of selected rates in the division on the country in which the companies operate, the type of business they run

[7] M. Sierpińska, T. Jachna, *Ocena przedsiębiorstwa według standardów światowych*, Wydawnictwo PWN, Warszawa 2004.

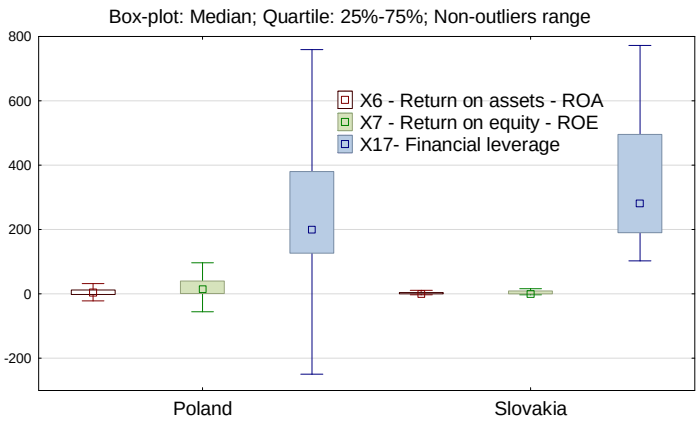
and the size of the individual companies from TSL sector[8]. To identify the differences nonparametric tests of U Mann – Whitney and ANOVA Kruskal – Wallis had been used. The tests were conducted at a significance level α=0,05.

Table 6. Results of the U-Mann-Whitney and ANOVA Kruskal–Wallis tests, selected indicators by country of establishment, type of activity and the size of the company

Variables	Financial ratios	Country	Type of activity	Company size
X1	Current liquidity ratio	0,7060	0,0000***	0,6300
X6	Return on assets (ROA)	0,0144*	0,0000***	0,1879
X7	Return on equity (ROE)	0,0004***	0,0000***	0,0008***
X14	Receivables turnover [days]	0,6372	0,0000***	0,6750
X17	Financial leverage	0,0348*	0,0016**	0,1328
X18	Debt leverage to total assets	0,8639	0,0001*	0,0000***

Analyses show that the country, in which the surveyed companies operate, differentiate the level of ROA (p<α) p=0,0144, ROE p<α (p=0,0004), and the financial leverage p<α (p=0,0348). The differences in these rates had been statistically significant. The median of ROA rate in Poland was higher and amounted about 4, whereas in Slovakia it was at the level of 0. The higher the rate, the better financial condition of the company. The ROE rate also assumes higher values in the case of companies operating in Poland (Me_P=14,3, Me_S=0,0). The median of financial leverage is higher among the companies operating in Slovakia. In Poland there is a wide variation in the level of financial leverage in the surveyed companies.

Fig. 7. Box-plot of indicators which significant differentiate surveyed companies

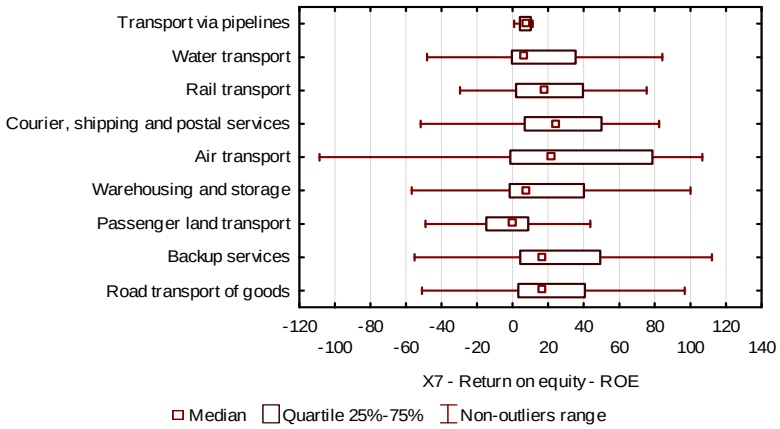


The branch in which the individual companies of the TSL sector operate has a significant impact on the level of all surveyed rates. The current ratio assumes the optimal values in the courier, shipping and postal services, and the smallest is in the passenger

[8] R. Szostek, *Metodologia badań statystycznych*, Zeszyty Naukowe Politechniki Rzeszowskiej nr 272, Zarządzanie i Marketing, z. 17(4), Rzeszów 2010, pp. 149-157.

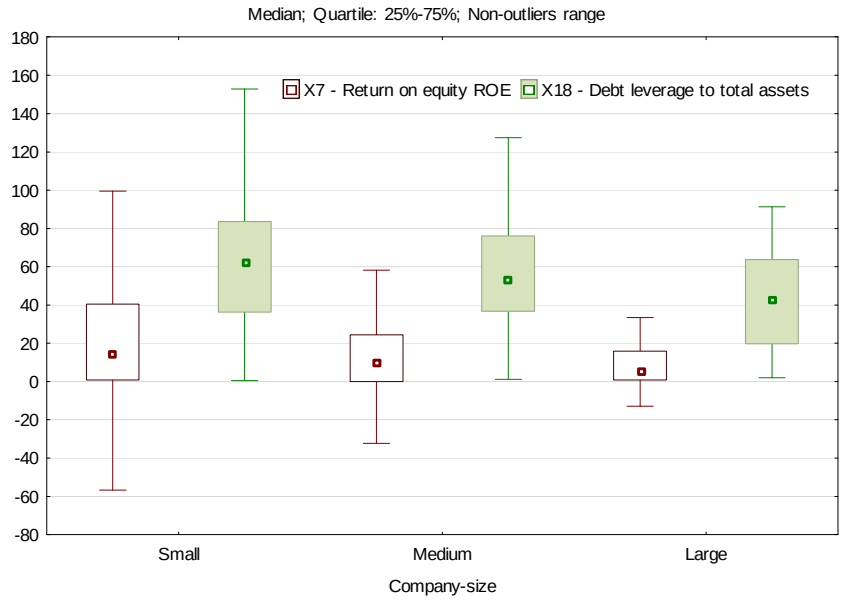
land transport. The return on assets, equity and the efficiency receivables turnover are the highest in the courier, shipping and postal services and the smallest in the passenger land transport.

Fig. 8. Return on equity by type of business in the TSL sector companies



The most frequently the foreign capital is used by the companies operating in the road transport of goods and the least frequently the ones operating in air transport. The size of the company varies the results of two rates: the return on equity and the debt leverage to total assets.

Fig. 9. Return on equity and leverage ratio of debt to assets by company size



The rates behave similarly in both cases. The greatest difference in the two rates is present in small companies and the largest companies are the most uniform. It had been

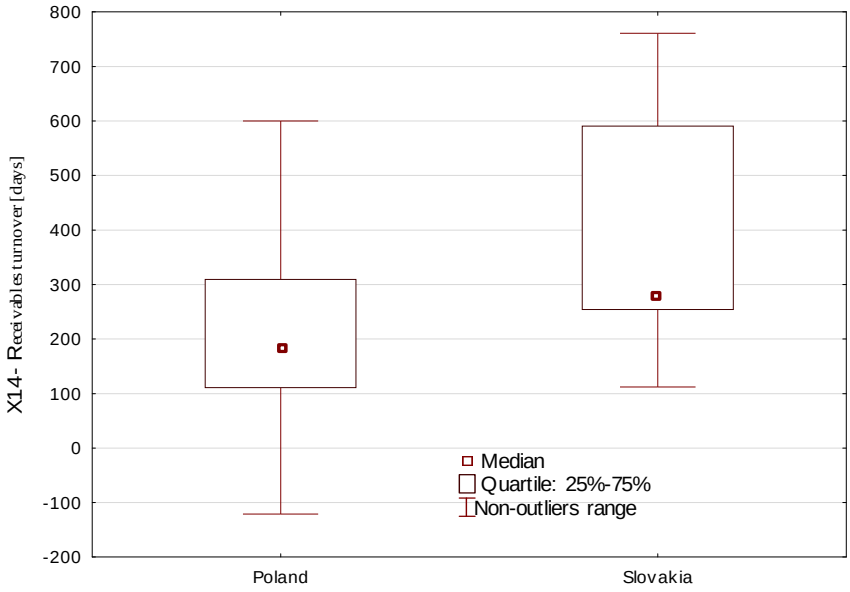
examined whether there are some statistically significant differences in the size of the achieved rates in Polish and Slovak companies in various branches. The test showed three statistically important differences.

Table 7. Results of the U Mann - Whitney test. Comparison of indicators in Poland and Slovakia in particular sectors of activity

	X1	X6	X7	X14	X17	X18
Road transport of goods	0,1889	0,0508	0,0157*	0,3183	0,1431	0,6816
Warehousing and storage	0,7544	0,9878	0,8907	0,9331	0,0176*	0,2555
Passenger land transport	0,1968	0,4942	0,9572	0,0097**	0,1385	0,1604
Courier, shipping and postal services	0,9793	0,551	0,7755	0,6223	0,5169	0,7361
Rail transport	0,6676	0,2157	0,1498	0,1976	0,9798	0,8596

In the group of companies operating in road transport of goods there had been noted the differences in the level of ROE $p<\alpha$ ($p=0,0157$). For companies operating in Poland the median is about 17 and for Slovak companies at the level of 0. In the branch of warehousing and storage the differences occurred in the financial leverage $p<\alpha$ ($p=0,0176$). The median adopted higher values for the companies operating in Slovakia (280) – in Poland (186). The final difference appeared in the passenger land transport branch $p<\alpha$ ($p=0,0097$) in the level of efficiency - receivable turnover [days]. In this case, the median takes greater values for the companies operating in Slovakia. Other rates were at the similar levels in the surveyed branches in Poland and Slovakia.

Fig. 10. Box-plot. Efficiency ratio-receivables turnover of companies operating in land passenger transport in Poland and Slovakia in 2011



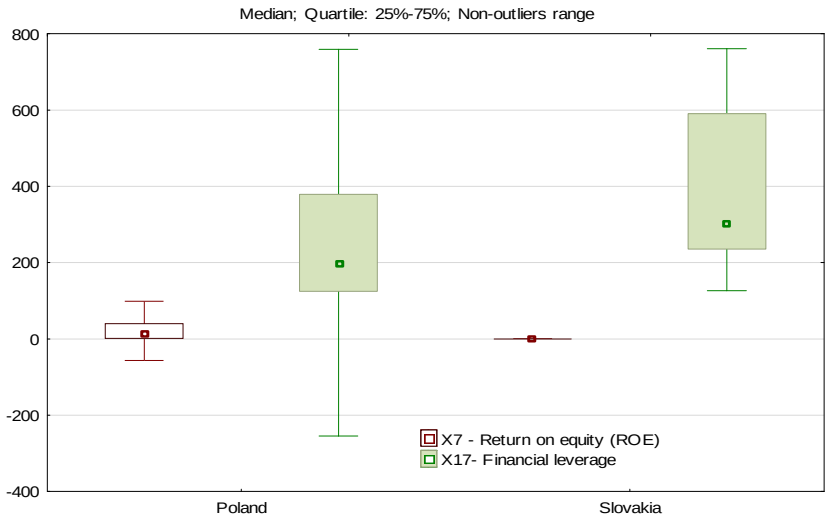
It had been examined whether the size of the company affects the level of received rates in Poland and Slovakia. The most varied are the rates in small companies. The differences were observed in the case of X_7 – the return on equity ROE $p<\alpha$ (p=0,0287) and X_{17} – the financial leverage $p<\alpha$ (p=0,0116).

Table 8. Test Results of U Mann – Whitney. Comparison of indicators in Poland and Slovakia by the size of the company

	X1	**X6**	**X7**	**X14**	**X17**	**X18**
small	0,1675	0,0886	0,0287*	0,7363	0,0116*	0,2054
medium	0,7899	0,1527	0,0612	0,4707	0,1528	0,1350
large	0,2368	0,7948	0,3347	0,4968	0,0950	0,3021

In small companies, the return on equity ROE assumes higher values in Poland (23) to 13 and the median is also higher in Poland (15) to 0. The financial leverage reaches the higher values in Slovak companies on average 419 to 408 and in the case of median 305 to 200.

Fig. 11. Box-plot of indicators showing differences in small companies operating in Poland and Slovakia



Medium and large companies operating in Poland and Slovakia do not show significant differences in the levels of surveyed rates. It had been examined whether there are the differences in the levels of the rates for companies operating in Poland and Slovakia in terms of the type of activity and the size of the company.

Table 9. The results of ANOVA Kruskal – Wallis test, selected indexes by type of activity and the size of the company calculated separately for companies operating in Poland and Slovakia

Variables	Financial ratios	Poland		Slovakia	
		Type of activity[1)]	Company size	Type of activity[2)]	Company size
X1	Current liquidity ratio	0,0000***	0,4450	0,3155	0,2811
X6	Return on assets (ROA)	0,0000***	0,3462	0,0320*	0,7416
X7	Return on equity (ROE)	0,0000***	0,0067**	0,0542	0,7607
X14	Receivables turnover	0,0000***	0,5830	0,1321	0,7909
X17	Financial leverage	0,0016**	0,1875	0,2173	0,0122*
X18	Debt leverage to total assets	0,0007***	0,0000***	0,1833	0,0026**

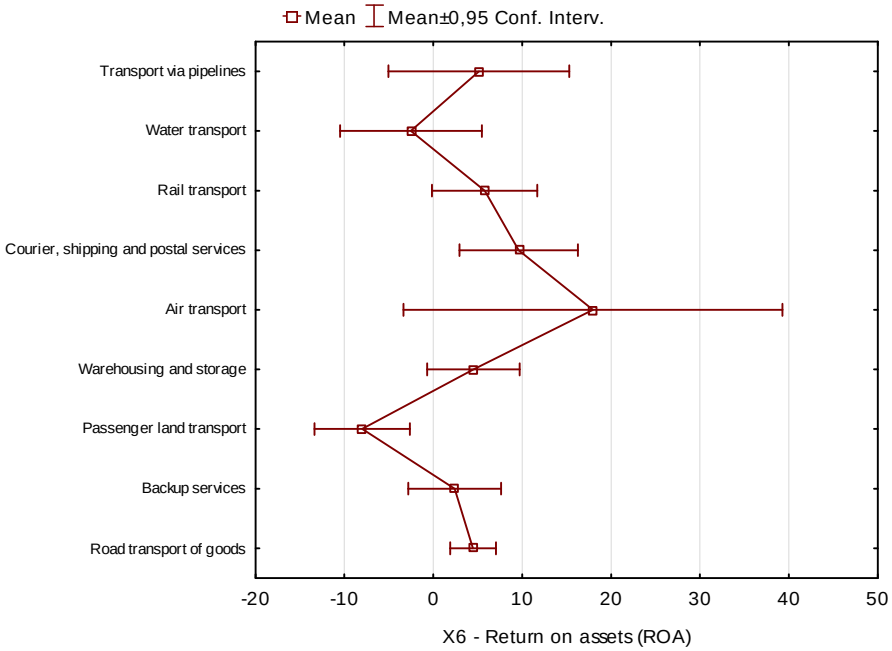
1) *In the group of Polish companies in the analysis the companies in the group transport via pipelines (3 companies) were omitted*
2) *In Slovakia there were omitted companies in the group of pipeline transport, water transport and transportation support services (no companies in the industry or only one company in the group)*

In the group of companies doing the business activity in **Poland**, the branch has a significant influence on the level of all surveyed rates so on the overall financial condition of the companies operating in TSL sector.

The current ratio assumes the highest values in the companies operating in air transport (1379) and the lowest in the case of companies operating in the passenger land transport (210) where there is the highest diversity of results (σ=3018). The highest median is in the transport via pipelines (526) and the smallest in the passenger land transport (99).

The return on assets reaches the highest values in the air transport (18) and the smallest concerns the passenger land transport (-8). The differentiation is the highest in the branch of backup services (61) and the most similar results of ROA rate are in the branch of the transport via pipelines (4). The highest values of median are observed in the courier, shipping and postal services (10) and the smallest in the passenger land transport (-0,6).

Fig. 12. Graph of average values of ROA of companies operating in the sector TSL by activity in Poland



The return on equity ROE on average, had the higher level in the air transport (214) and the smallest was observed in the passenger land transport (-39). The most diversified branch as far as the return on equity is concerned, is the air transport (σ=1025) and the most uniform one is the transport via pipelines (σ=7). The median reaches the highest values in the courier, shipping and postal services (25) and the lowest in the passenger land transport (0,5).

The efficiency – receivable turnover [days] rate is the highest in the warehousing and storage branch (193) and the lowest in the transport via pipeline (31). The greatest diversity presents the companies from the road transport of goods branch (976) and the lowest the transport via pipeline (10). The greatest values of median concern the companies from the branch of the courier, shipping and postal services (64) and the smallest ones are in the passenger land transport (21).

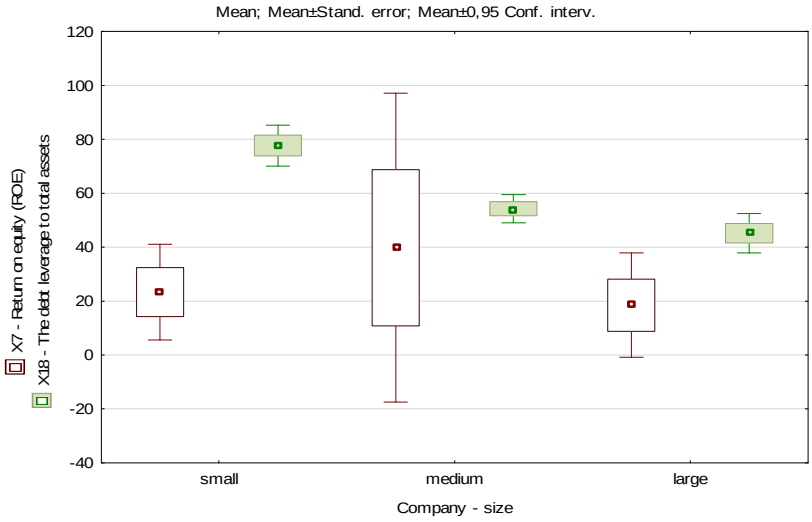
As to the financial leverage rate, its values are the greatest in the branch of warehousing and storage (705) and these companies represent the highest diversity in the level of rates (4454). The lowest values of the financial leverage rate are in the air transport (-353) and the most uniform group is the branch of the transport via pipelines (11). The median of the financial leverage has the highest values in the case of road transport of goods (215) and the lowest in the air transport (115).

Air transport is characterized by the highest average of the debt leverage to total assets (130) and it this branch there is also the highest diversity of results (273). The lowest values of debt leverage to total assets was recorded in the transport via pipeline branch (16) where there is also the smallest diversity in the level of debt leverage to total assets

(12). The median is the highest in the air transport (65) and the smallest level was recorded for the transport via pipeline (15).

The size of the company in Poland has an influence on the level of two rates: X_7 – the return on equity (p=0,0076), and X_{18} – the debt leverage to total assets (p=0,0000).

Fig. 13. Level of profitability and leverage ratio of debt to assets by company size among companies operating in Poland

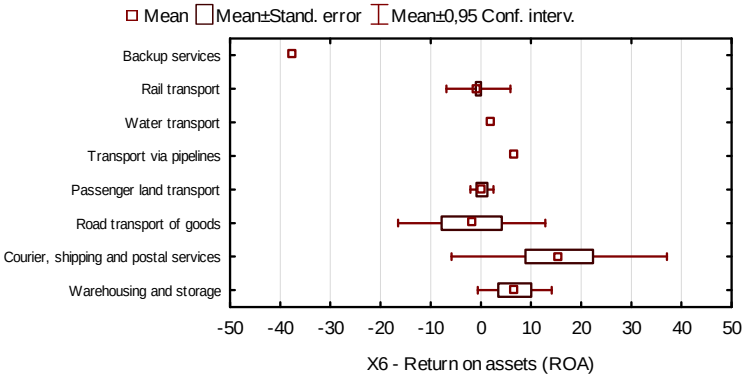


The greatest return on equity rate is characteristic for the companies of the medium size. In this group there is also the greatest diversity in the level of profitability. The smallest level of the return on equity rate is observed in large companies.

As far as Polish companies are concerned, the larger the company, the smallest value of debt leverage to total assets.

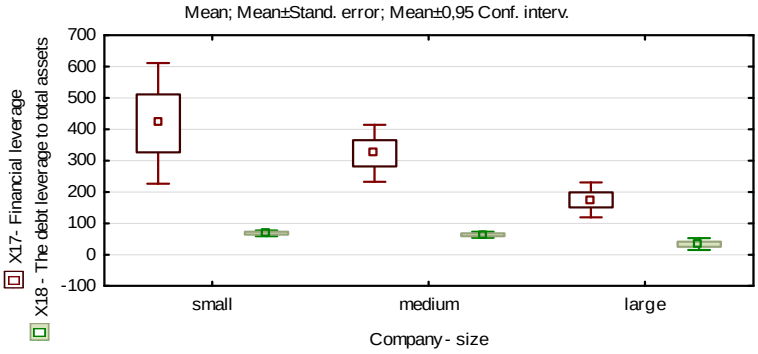
For companies operating in Slovakia only one difference concerning the level of surveyed rates had been identified, in terms of the type of branch in which they operate. It is the return on assets ROA, $p<\alpha$ (p=0,0320). In Slovakia, the highest profitability concerns the companies operating in the branch of the courier, shipping and postal services (16%) and the smallest one is observed in the backup services (-37%). (Both the median and the average were at the same level).

Fig. 14. Average value of ROA by the branch in which the companies operate in Slovakia



The company size in Slovakia differentiates the level of two rates: X_{17} – the financial leverage $p<\alpha$ ($p=0,0122$) and X_{18} – the debt leverage to total assets, $p<\alpha$ ($p=0,0026$). The larger the company, the smaller values of the financial leverage and the debt leverage to total assets.

Fig. 15. The values of leverage and the leverage of debt to assets by company sizes enterprises in Slovakia



5. THE TAXONOMIC ANALYSIS OF THE COMPANIES OF THE TSL SECTOR IN SLOVAKIA

To make a detailed analysis of the companies operating in the TSL sector selected methods of Multidimensional Comparative Analysis were used. They allow to carry out the grouping of the surveyed companies in terms of selected economic – financial rates. Presentation of the idea of such analysis is possible thanks to the small number of companies operating in Slovakia, which published their financial results for the year 2011. A similar analysis can be made for the companies operating in Poland although the presentation of the results would be difficult.

One of the advantages of the classification being made thanks to the procedures of taxonomic methods is first of all the ability to achieve the homogeneous objects of the analysis, in which it is easier to extract the systematical factors and the cause and effect

relationships are clearly outlined. Secondly, an important advantage is associated with the classification of the cognitive presumptions (reducing the large amount of information into a few main categories, which significantly simplifies the application process) and economic presumptions (limiting discussion to analyzing typical trend phenomena or facts with a relatively small deformation of test results)[9]. To extract the accumulation of companies operating in the TSL sector and achieving similar financial results Ward method had been used.

The results of taxonomic analysis were compared with the results of ranking prepared using the generalized distance measure GDM[10]. The analyses had been made for 43 companies operating in the TSL sector in Slovakia in 2011. The companies had been characterized with the use of six rates which had been selected at the beginning of the study.

For the purposes of the ranking the following characteristics of diagnostic variables had been established: the rate X_1 – current ratio, interpreted as a nominant (the nominal value 120%) and measured on a quotient scale, the rate X_6 – return on assets ROA, interpreted as a stimulant and measured on an interval scale, the rate X_7 – return on equity ROE, interpreted as a stimulant and measured on an interval scale, the rate X_{14} – efficiency – receivable turnover [in days], interpreted as a destimulant and measured on a quotient scale, the rate X_{17} – financial leverage, interpreted as a nominant (the nominal value 100%) and measured on an interval scale, the rate X_{18} – debt leverage to total assets, interpreted as a destimulant and measured on a quotient scale.

Nominants measured on a quotient scale were converted to stimulants according to quotient formula: $x_{ij} = \frac{\min\left\{nom_j; x_{ij}^N\right\}}{\max\left\{nom_j; x_{ij}^N\right\}}$, where: x_{ij}^N - the value of the j - nominant observed in the i - object, nom_j - the nominal level of j - variable. Nominants measured on an ordinal scale were transformed according to the differential formula: $x_{ij} = -\left|x_{ij}^N - nom_j\right|$. The standardization had been used as a method of normalization of diagnostic variables. The pattern object was always the object in the form of the upper pole development of the best values of diagnostic variables (maximum for stimulant and minimum for destimulant). Two variants of ranking had been used, the first with the equal weights for the variables ($w_j = 1$) and the second with the variable weights calculated depending on the value of the coefficient of variation: $w_j = m \cdot \frac{V_j}{\sum_{j=1}^{m} V_j}$, where: m – the

[9] T. Grabiński., *Metody aksonometrii*, Wydawnictwo Akademii Ekonomicznej w Krakowie, Kraków 1992, p.11-12

[10] M. Walesiak, *Uogólniona miara odległości GDM w statystycznej analizie wielowymiarowej z wykorzystaniem programu R*, Wydawnictwo UE we Wrocławiu, Wrocław 2011, p. 73-78.

number of variables, V_j - the values of the coefficient of variation for the j - variable, $w_j \in [0;m]; \sum_{j=1}^{m} w_j = m$.

The distance of particular objects from the model had been determined according to the formula[11]:

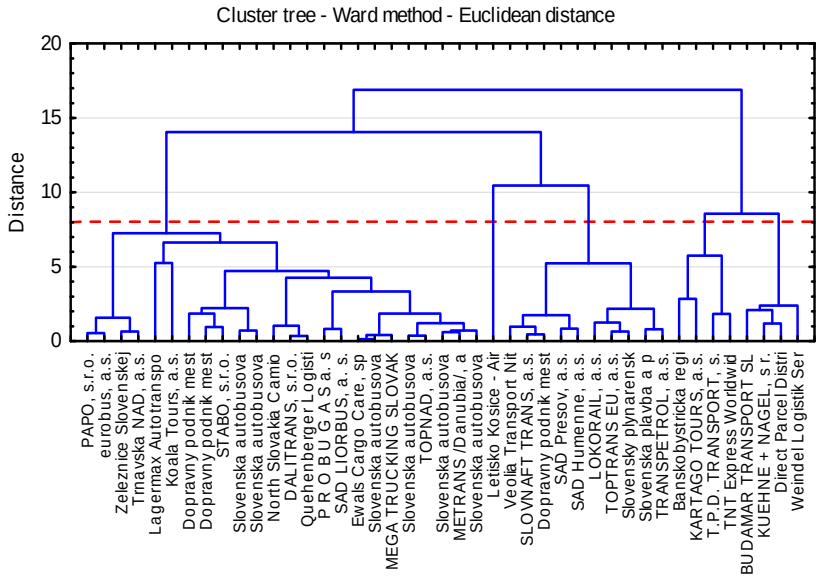
$$d_{iw} = \frac{1}{2} - \frac{\sum_{j=1}^{m} w_j a_{iwj} b_{wij} + \sum_{j=1}^{m} \sum_{\substack{l=1 \\ l \neq i,k}}^{n} w_j a_{ilj} b_{wlj}}{2\left[\sum_{j=1}^{m} \sum_{l=1}^{n} w_j a_{ilj}^2 \cdot \sum_{j=1}^{m} \sum_{l=1}^{n} w_j b_{wlj}^2\right]^{\frac{1}{2}}} \quad (1)$$

where:
d_{iw} - a measure of the distance GDM of the i – object of the pattern w, $p=w,l$; $r=i,l$; $i,l=1,...,n$ – number of the object, w – number of the object pattern $j=1,...,m$ – the number of variable, w_j – weight of j - variable,

$$a_{ipj} = x_{ij} - x_{pj} \quad \text{for} \quad p = w,l; \quad (2)$$
$$b_{wrj} = x_{wj} - x_{rj} \quad \text{for} \quad r = i,l;$$

$x_{ij}(x_{lj})$ - i (l) observation of j - variable.

Fig. 16. Cluster Tree - Euclidean distance - the method of Ward



[11] op.cit. p.78

The companies had been ordered in accordance with increasing values of the distance measurement, the smaller the distance value of GDM from the ideal object (pattern) the surveyed company has, the better it was considered to be (at a higher position) in the ranking. The final ranking of companies was calculated as the average of the rankings assigned in both variants (for similar and different weights of diagnostic variables).
The results of taxonomic grouping of the TSL companies from Slovakia are shown in Figure 16 and the results of the ranking in Table 10.

Table 10. Ranking results and the grouping of companies operating in the TSL in Slovakia

	Company size	Average ranking	Grouping
Weindel Logistik Service SR, spol. s.r.o.	small	1	a
Direct Parcel Distribution SK, s.r.o.	small	2	a
KUEHNE + NAGEL, s r.o.	small	3	a
BUDAMAR TRANSPORT SLOVAKIA, a.s.	medium	4	a
TRANSPETROL, a.s.	**large**	**5**	**c**
Slovensky plynarensky priemysel, a.s.	**large**	**6**	**c**
Slovenska autobusova doprava Michalovce, akciova spolocnost	medium	7	e
SAD Humenne, a.s.	**small**	**8**	**c**
TNT Express Worldwide, spol. s.r.o.	medium	9	b
Slovenska autobusova doprava Zilina , akciova spolocnost	large	10	e
SAD Presov, a.s.	**medium**	**11**	**c**
TOPTRANS EU, a.s.	**large**	**12**	**c**
METRANS /Danubia/, a.s.	large	13	e
T.P.D. TRANSPORT, s.r.o.	small	14	b
Slovenska plavba a pristavy, a.s.	**large**	**15**	**c**
Dopravny podnik mesta Presov, akciova spolocnost	**medium**	**16**	**c**
KARTAGO TOURS, a.s.	small	17	b
Veolia Transport Nitra, a.s.	**medium**	**18**	**c**
SLOVNAFT TRANS, a.s.	**small**	**19**	**c**
Slovenska autobusova doprava Dunajska Streda, akciova spolocnost	medium	20	e
Slovenska autobusova doprava Nove Zamky, akciova spolocnost	medium	21	e
TOPNAD, a.s.	small	22	e
MEGA TRUCKING SLOVAKIA, s.r.o.	small	23	e
LOKORAIL, a.s.	**small**	**24**	**c**
STABO, s.r.o.	small	25	e
Slovenska autobusova doprava Lucenec, akciova spolocnost	medium	26	e
Slovenska autobusova doprava Trnava, akciova spolocnost;	medium	27	e
Ewals Cargo Care, spol. s.r.o.	small	28	e

Koala Tours, a.s.	small	29	e
Trnavska NAD, a.s.	small	30	e
Zeleznice Slovenskej republiky, Bratislava v skratenej forme ZSR	large	31	e
SAD LIORBUS, a. s.	medium	32	e
eurobus, a.s.	large	33	e
P R O B U G A S a. s.	medium	34	e
Quehenberger Logistics SVK, a.s.	small	35	e
PAPO, s.r.o.	small	36	e
DALITRANS, s.r.o.	small	37	e
Dopravny podnik mesta Kosice, akciova spolocnost	medium	38	e
North Slovakia Camion, s.r.o.	small	39	e
Dopravny podnik mesta Ziliny, s.r.o.	small	40	e
Banskobystricka regionalna sprava ciest, a.s.	small	41	b
Letisko Kosice - Airport Kosice, a.s.	**large**	**42**	**d**
Lagermax Autotransport Slovakia, spol. s.r.o.	small	43	e

As a result of examination, five clusters were established bringing the companies similar to each other together in terms of the level of the performance of six rates. The accumulation was labeled as a, b, c, d, e (see tab. 10). To identify which group of companies is characterized by high profitability and has good results and general condition, the group mean method had been used. It aims to identify diagnostic features dominant in the group. For a matrix of the figures, the arithmetic mean of the surveyed rates were calculated marked by $\overline{W_i}$. Then, there was the calculation of arithmetic mean of the surveyed rates in the achieved accumulation which were marked as $\overline{w_i}$ The rate of the structure of each accumulation is the quotient $\frac{\overline{w_i}}{\overline{W_i}}$. The maximum value of the structure rate indicates the dominance of a given feature in the achieved group. The average level of phenomenon has the value of 1. The values more than 1 are the rates of the values larger than the average and less than 1 are the rates for which the level in particular groups is smaller than the average.[12]

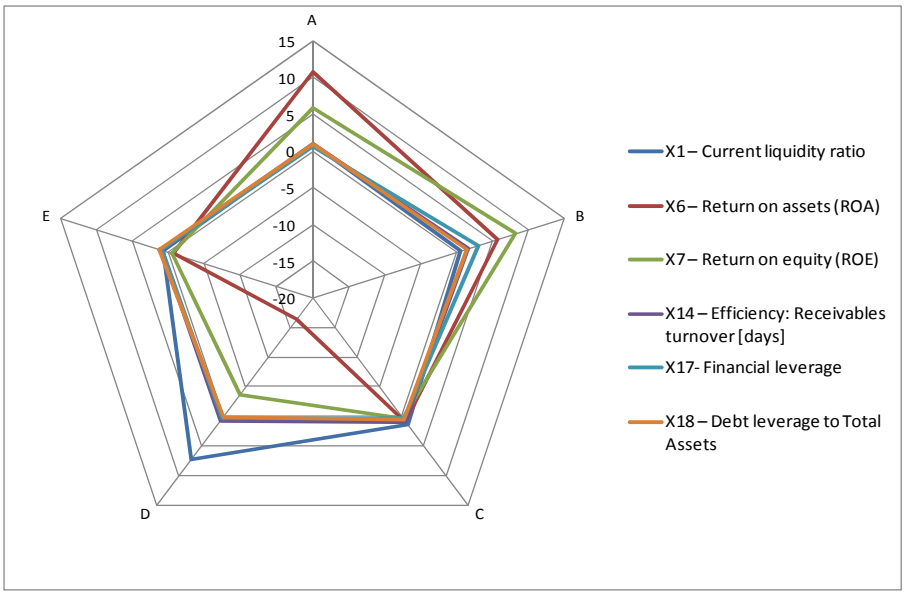
Figure 17 presents the levels of the six surveyed rates in the achieved accumulations.

The graph shows that the highest rates of profitability is characteristic for the **accumulation (a).** This is the group consisting of four companies, two of them operate in the branch of warehousing and storage. The majority of them were the small companies operating around Bratislava. The rates of the financial leverage and the debt leverage to total assets take small values which means that companies from his accumulation are not

[12] K. Chudy – Laskowska., M. Wierzbińska, *Zróżnicowanie województw pod względem infrastruktury transportowej w Polsce – wyniki badań,* Zeszyty Naukowe Wydziału Zarządzania. Ekonomia i Nauki Humanistyczne, z. 18, Rzeszów 2011

exposed to the high risk in their business. In the ranking, the companies from the first accumulation are at the top of the list.

Fig. 17. Radar chart - the average values of diagnostic variables in the clusters



The second **accumulation (b)** are the further four companies. The profitability of the companies is at a high level but the current ratio reaches a very low level and the financial leverage and the debt leverage to total assets are vey high, which may indicate a low stability of the surveyed companies. The majority of them are the small companies operating in the branch of warehousing and storage. Three of them are in the top half of the ranking while one of them takes the third place from the end.

The third **accumulation (c)** is the second one in terms of the size and includes 10 companies. The rates are moderate, profitability is small but positive, it is characterized by the correct liquidity and low values of leverage rates, which may indicate the established position in the market and can prove the stability in the conduct of activities and a good condition. In this group there were in majority the medium and large companies usually operating in the passenger land transport.

The fourth **accumulation (d)** is one company. From the graph can be read that the rates ROA and ROE are at a very low level and their values are negative. The company made loss in running a business. The current ratio has a high value which reflects the excessive freezing in capital in current assets. It is a big company and in the ranking takes the next to last position.

The last **accumulation (e)** is the most numerous and it includes 24 objects. The liquidity rate in this group is very low, the return on assets is negative as well the return on equity (the companies make loss), moreover, the financial leverage and the debt leverage to total assets are at a quite high level and therefore the companies are at risk in their business. The majority of these companies are the small and the medium ones operating in the passenger land transport and the road transport of goods. They take place in the second half of the ranking.

6. CONCLUSIONS

The analysis of the TSL sector companies operating in Poland and Slovakia allows to provide a number of important conclusions.

The largest proportion of the companies from the TSL sector have their legal addresses in the metropolitan regions.

- TSL sector companies show a great diversity in terms of:
  - **running a business –** the largest percentage are the companies operating in the branch of the road transport of goods (Poland 54%, Slovakia 35%),
  - **the legal form –** the most companies operate as Limited Liability Company (in Poland 76%, in Slovakia 64%), a significant difference appears in other forms. Every third company in Slovakia operates as Public Limited Company, whereas in Polish conditions there is only 5% of such companies,
  - **the size –** the largest percentage of companies are the small ones however, in Slovakia there are more medium and large companies.

The comparative analysis showed that:

- Polish companies have better return on assets ROA, return on equity ROE and efficiency measured by the rotation of liabilities,
- Slovak companies have better current ratio and values of the financial leverage and the debt leverage to total assets rates.

Taking into account all the surveyed companies it was also stated that:

- **The country** in which the TSL sector operate has an influence on: the return on assets and the return on equity as well as the financial leverage. In Polish companies, the profitability is higher and the companies are less risky in their actions.
- **The type of activity** has an influence on the level of all surveyed rates. The best results obtain the companies operating in the courier, shipping and postal services. The worst results are achieved by the companies operating in the passenger land transport and the road transport of goods.
- **The size of the company** has an influence on the two rates: ROE and the debt leverage to total assets. The larger the company, the lower profitability and smaller values of the debt leverage to total assets.

It had been examined whether there are the differences in the size of the achieved values of rates in particular **branches** in the division of the companies operating in Poland and in Slovakia. The differences appeared in the rate of ROE between the companies in the group of the road transport of goods. The higher profitability is observed in the case of Polish companies. In the branch of warehousing and storage the differences appeared in the financial leverage. Slovak companies quite often make use of the foreign capital. In the passenger land transport the differences were present in the level of efficiency rate, the companies in Slovakia are more effective.

In small companies the differences occurred in the two rates: the profitability ROE and the financial leverage. The larger the company, the lower return on equity and lower value of the debt leverage to total assets.

The comparison of the financial condition of Polish and Slovak companies gave the following results.

In terms of **the branch**

- The differences were observed in the group of companies operating in the road transport of goods and concerns the rate of ROE – Polish companies have higher profitability.
- The companies operating in the branch of warehousing and storage have a different financial leverage – Slovak companies more often make use of the foreign capital.
- The companies operating in the branch of the passenger land transport have a different rate of the efficiency – receivables turnover – in this respect Slovak companies are much better.

In terms of **the size of the company**

- The differences in the rates were observed only in small companies. The medium and large ones achieve similar levels of the surveyed rates. In small companies the differences were identified in the case of ROE rate (Polish companies have a better condition) and the financial leverage (Slovak companies more often make use of the foreign capital).

For **Polish** companies

- All the rates differ in terms of the business activity (belonging to the branch).
- The size of the company has an influence on the return on assets ROE and the debt leverage to total assets.

For **Slovak** companies

- The differences in the surveyed rates appeared only in the case of the return on assets ROA.
- The size of the company has an influence on the financial leverage rate as well as the debt leverage to total assets.

The taxonomic analysis made for the companies operating in Slovakia showed that they can be divided into five accumulations (clusters). The best results are achieved in the case of four companies from the accumulation *„a”*. These are also the companies that occupy the highest position in the ranking. They have a high profitability and do not show a high risk of default of repayment of their financial liabilities.

The worst rates presents the accumulation „d”, it is one big company characterized by a negative profitability and high risk in action.

There was also created the most numerous group including 24 companies, which represent the average level of condition mainly consisting of small and medium companies.

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ANALIZA PORÓWNAWCZA FIRM Z SEKTORA TSL DZIAŁAJĄCYCH W POLSCE I NA SŁOWACJI

W artykule przedstawiono analizę porównawczą firm działających w sektorze Transport – Spedycja – Logistyka w Polsce i na Słowacji. Przeprowadzone analizy statystyczne obejmowały badanie firm logistycznych ze względu na wielkość przedsiębiorstwa, rodzaj prowadzonej działalności oraz jej charakter. W szczególności scharakteryzowano strukturę firm logistycznych w Polsce i na Słowacji ze względu na region prowadzonej działalności, branżę prowadzonej działalności, formę prawną prowadzonej działalności oraz wielkość przedsiębiorstwa. Z wykorzystaniem metod statystycznych, na podstawie wybranych wskaźników finansowych porównano kondycję finansową firm sektora TSL w Polsce i na Słowacji w latach 2009-2012.

Dla firm działających na Słowacji, za pomocą metod taksonomicznych przeprowadzono badania porównawcze mające na celu wyodrębnienie skupień firm podobnych do siebie pod względem wybranych wskaźników opisujących ich kondycję ekonomiczno – finansową. Wskaźniki charakteryzujące kondycję finansową przedsiębiorstw obejmowały następujące grupy wskaźników: płynności (opisujące płynność finansową przedsiębiorstw), zadłużenia (skłonność przedsiębiorstw do spłaty swoich zobowiązań), zyskowności (opisujące skłonność przedsiębiorstw do generowania zysków), sprawności działania (opisujące sprawność i efektywność zarządzania firmą) oraz pozostałe wskaźniki opisujące strukturę kapitałową przedsiębiorstw oraz efekt dźwigni finansowej.

Na podstawie wybranych wskaźników wykorzystując metody wielowymiarowej statystyki porównawczej (metodę rankingu – porządkowania liniowego) z wykorzystaniem uogólnionej miary odległości GDM przeprowadzono badanie rankingu firm sektora TSL działających na terenie Słowacji w 2011 roku. Analiza wyznaczonych rankingów umożliwiła wyodrębnienie firm najlepszych pod względem ich kondycji finansowej oraz potencjalnych firm zagrożonych ryzykiem upadłości. Wyniki rankingu do firm Słowackich odniesiono do wyznaczonych metodami taksonomicznymi klastrów firm o podobnej kondycji finansowej. Porównanie rankingów w obrębie klastrów zbadano w zależności od wielkości analizowanych przedsiębiorstw. Uzyskane wyniki przedstawiono w formie wniosków praktycznych.

Słowa kluczowe: sektor TSL, analiza porównawcza, analiza statystyczna, metody taksonomiczne.

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MODERN LOGISTICS IN HEALTH SERVICE

The primary task of all hospitals is to improve the health of patients. In a typical hospital a large number of people perform logistics operations often without being aware of it. The aging of the population, particularly evident in Europe, contributes to the increase in the workload of the healthcare system. To ensure the desired level of healthcare services some services such as logistics must be effectively coordinated to ensure the quality and continuity of care.

Logistics in medical activities is a field that is not visible to the patient, but directly affects the quality of health services, which is an important area of interest for the healthcare organization. In most cases, hospital logistics has relied so far on the selection of appropriate suppliers in different areas of activity, starting from the supply of drugs, equipment, laundry, through transportation to the transplant ending up with the food catering. Such an approach in a self- management in most cases had various effects very often totally inefficient.

In the recent period it has been observed the development of logistics services in the medical activity which applies the most advanced technological achievements among them information technologies supported by management, maintenance-free means of transport, automated transport, technologies of automatic identification.

In the paper the modern forms of logistics used in healthcare were presented. The benefits of these solutions were shown. These benefits may be of two types. On the one hand they reduce the costs associated with the operation of the hospital, on the other one they increase security, reliability and availability at any time. A significant share of attention in the article is devoted to the supply chains based on modern means of transport. These measures are used to transport people and materials.

Keywords: health service, health protection, logistics in medical activity, logistics services.

1. INTRODUCTION

The aging of the population particularly evident in Europe contributes to the increase in the workload of the healthcare system. To ensure the desired level of healthcare services some services such as logistics must be effectively coordinated to ensure the quality and continuity of care. Statistics show that the number of patients in the hospital is growing very rapidly especially in Western countries [8]. It greatly increases the load of logistics functions.

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Logistics in medical activities is a field that is not visible to the patient, but directly affects the quality of health services, which is important for the healthcare area. Most hospital logistics has consisted so far in the selection of appropriate suppliers in different areas of activity, ranging from the supply of drugs, equipment suppliers, laundry, transportation to the transplant until the food catering. Such an approach in a self-management in most cases vary widely, often downright inept.

In the recent period the development of logistics services in medical activities, especially in the so-called hospital logistics has been observed. In the case of Poland this development is a consequence of the privatization of hospitals. Private entities in the era of high competition must ensure cost optimization and help them in the logistics operators. The examples of hospital logistics in countries where such services are provided show that hospitals using the services provider specializing in the handling can expect a reduction of logistics costs by up to 25 percent.

Of course, an independent logistics in some units works perfectly, but in the case of larger hospitals with successful optimization of logistics processes it could be more efficient and bring much greater cost savings through cooperation with logistics operator.

The complexity of the areas of the hospital needs clarification of many ranges of services. The basis is a logistics consulting and building a good relationship with the client.

The operator must be well- versed on fulfilling future requirements of the hospital. For this purpose, it should explore the possibility of standardization of products and suppliers for the entire hospital and customize workflows. Additionally, the needs of technical and human resources need to be assessed as well as the necessary changes formulated, the implementation of which is necessary to introduce efficient logistics processes.

The operator may also be responsible for the transportation of tools for sterilization in special heated vehicles, as well as support for the so-called cold chain (medications transported in special cold rooms). All these activities also support the logistics of hospitalization involving the sourcing various departments of the hospital, collecting and delivering the products and the implementation of specific solutions in cooperation with hospital service.

The paper presents the modern forms of logistics used in healthcare. The identification of the effects occurring as a result of the introduction of modern forms of logistics in healthcare was also carried out. A significant share of attention in the article is devoted to the supply chains based on modern means of transport.

2. LOGISTICS TASKS IN HEALTHCARE

The primary task of all hospitals is to improve the health of patients. In a typical hospital, a large number of people lead logistics operations often without being aware of it. And in most cases they are not appropriate people. For example, it is estimated that the nursing staff is dedicating an average of 10 % of the time for logistical activities instead of looking after the sick. This affects not only the cost but also the effects of such care. Moreover, in countries where there is a shortage of health workers and social care it also affects the growth of stress-related illnesses among this group of workers.

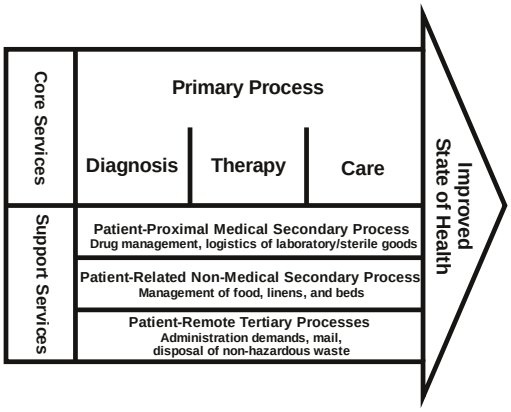
Provision of medical services and patient care are essential processes in the hospital, which create a demand for support services related to patients (background processes). These secondary processes can be medical or non-medical. In addition, there were also

identified services which are referred to as service processes. These processes are not directly related to the patients, but they are necessary for the proper operation of the healthcare facility.

Hospital logistics coordinates inter-ward movement of goods and information as well as part of the care of the patient. The examples of hospital logistics can be found in the supporting processes and services:

- logistic tasks related to patient through medical secondary processes supporting logistics patients: management of medicines, laboratory logistics management, medical products, sterile products, logistics, information and documentation, disposal of hazardous waste.
- tasks related to logistics processes, supporting non-medical secondary processes: management of food, bedding and bed management.
- logistics tasks associated with service processes: administrative management, mail handling, disposal of non-hazardous waste.

Fig. 1 Logistics processes in a hospital



In many processes of hospital logistics material transport plays a decisive role. As required the hospital transportation of materials is either planned or the process is carried out on demand. Compared to industrial applications, the quality of the transport of materials in healthcare must be the highest. Incorrect or inaccurate deliveries can have fatal consequences for patients, hospital staff and visitors. An important roles in logistics plays also a hospital medicines management process. Conventional management of medicines in hospitals is usually a manual process. Daily preparation of drugs for the individual patient is performed by nurses on the wards. Therefore, in hospitals there are numerous drug storages located on the respective wards. Moreover, the manufacturing processes in the hospital pharmacy are characterized by manual handling. Automatic management of medicines in hospital pharmacies and hospital wards support and enhances patient safety.

It is estimated that as many as 46% of the total operating budget of the hospital is spent on activities related to logistics. Of this number, 27% is for materials and equipment, and 19% on labor. Labor costs include not only the staff associated with professional logistics but also health professionals.

3. MEANS OF HOSPITAL TRANSPORT

In hospitals a number of different forms of transport is used. This can be integrated or not integrated transport, in many cases the individual one. Due to the technology used it can be distinguished air transport in the respective tubes, overhead rail transport, manual transport involving personal handling of the selected materials and transportation by using all kinds of wheeled carts. The first three transport technologies are used to transport light materials. Plastic tube used in pneumatic transport can transfer downloaded content to analyze and fine documentation. Overhead rails are designed for carrying small loads such as patient records, test results, laboratory testing or a blood sample. In many cases they are also used to carry heavier loads and more delicate components, such as glass containers. Also, it allows the circulation of several containers at the same time in several directions. Compared to a pneumatic transport this one is slower. Transportation of goods from one end of hospital to the other one takes about 15 minutes. In the case of pneumatic tubes this time is counted in seconds. In the transport where wheeled vehicles are used the more common are automatic guided vehicles to transport the AGV and mobile robots. AGV is intended in most cases for the transportation of materials and weight of up to 1000 kg. Using the automatically guided vehicles transport one can reduce the load on the hospital staff, as well as improve the performance, availability and reliability of the transport system. AGVs also contribute to a reduction in operating costs of transport.

AGVs currently used in hospitals use laser or magnetic navigation. They are so intelligent and flexible that reach the individual branches using both horizontal distributions (corridors) and vertical (lift). If necessary, they may communicate with the control center at any time. In addition, they are equipped with sensors for detection and identification of cargo. AGV carry supplies and waste to and from different areas of the hospital complex, often at different levels. AGVs support hospital wards, kitchen, pharmacy, laundry, research departments, cafeteria and other areas.

In case of automatic means of transport the main applications of the AGVs are:

- Transportation of meals and return dirty dishes to the kitchen, Transport of sterile operating equipment and the return of dirty carts for decontamination,
- Provision of general materials (by weight) from the loading dock to the center of the supply and distribution when needed for the floors to patients or deliveries of linen, uniforms and medical supplies directly from the dock,
- Disposal of waste - handling waste streams (general, recyclable, medical) from all areas of the hospital to the recycling center,
- Provision of clean sheets and return to laundry or dock. The use of exchange carts allows to maximize the efficiency of the transport of both clean and dirty materials. Transport of drugs relies on the safe delivery of drugs from the dock to the center of the supply, or daily medications to nursing levels using a secure access for cars. Washing the carts consisting in the use of automatic dishwashers and dryers.
- Automatic landing - increasing automation of AGV with optional automatic unloading of garbage or soiled bedding. [9]

The first AGV vehicle which was used in a hospital environment was HelpMate. It was used in 1991 in Danbury Hospital, where it was used to transport objects of small sizes. The vehicle used dead reckoning (odometry) and natural landmarks (walls of the corridor). HelpMate was one of the first robots (vehicles) which was used for

transportation in a populated environment and is considered a pioneer in the field of hospital management. HelpMate is currently a registered trademark of Cardinal Health, Inc.

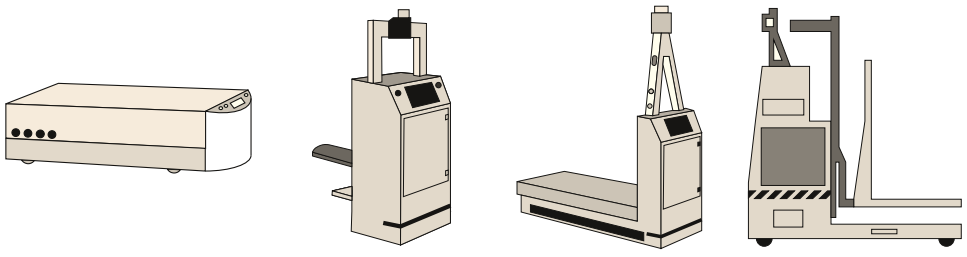
Subsequent vehicles operating on a similar principle as the HelpMate was I- Merc which specialized in the transport of food and Care- O- Bot which was designed to assist the elderly and requiring special assistance [1]. In recent years, many companies took up production of commercial vehicles for the hospital transport. The most well-known European manufacturer of such systems is Swisslog. It features, among others, TransCar system, which consists of AGVs which use the laser navigation and are able to carry loads of up to 450kg. The vehicles carry cargo in specially designed containers under which the vehicle enters. During transport, the container is raised. The disadvantage of this system is that it can carry simple elements such as documentation, medication, food. Swisslog also produces a small autonomous vehicles designed to transport inter-ward cargo weighing about 25kg - RoboCourier. Another vehicle used in hospitals is TUG by Aethon company. It is a vehicle very similar to RoboCourier .

It was designed for the transport of various materials such as trays for meals, medications, linens, blood samples, medical records. It is able to carry cargo weighing up to 250kg. Another vehicle of the Aethon is Homer. Homer moves within the hospital and uses RFID technology and checks whether the equipment in the form of beds, wheelchairs and baskets are in the right place. Homer works with the TUG vehicles. If the equipment is recognized in the wrong place the information is sent to the TUG, which transports the item to its destination. The disadvantage of this system is the use of a special carriage baskets which increases the cost of installation and require a much larger number of changes in logistics hospital compared to the Swisslog [4].

Another company specializing in the production of the AGVs is FMC Technologies which offers ATLIS vehicle. It is a system very similar to Transcar but intended to transport much heavier loads. The system is used to collect, transport and deliver materials from the distribution center to individual areas of users, and vice versa back of baskets from different areas of the distribution center.

At present, the aforementioned companies are only a part of the existing commercial suppliers. Depending on the provided transport for work, there is a whole range of vehicles of various structures used to implement the transport tasks. The examples of these types of vehicles are shown in Figure 2.

Fig.2. Types of AGV vehicles



Individual systems supplied by companies operating on the market but differ with properties and functionalities which is shown in the following tables. Some of the vehicle do not have all the before mentioned functionalities and they were described as a/n.

Tab. 1 Transportation functionalities
Own study based upon [4]

	HelpMate	Swisslog	Hospi	Aethon	SpeciMinder	RobCab
specific goods transportation	-	-	+	-	-	-
varied goods transportation	+	-	+	-	+	+
carry carts on its body	-	+	-	+	-	-
tow the carts	-	-	-	-	-	+

Tab.2 Functionalities of logistic systems
Own study based upon [4]

	HelpMate	Swisslog	Hospi	Aethon	SpeciMinder	RobCab
group of robots cooperation	+	+	+	+	-	+
supervisory system	-	+	+	n/a	-	+
ordering on robots platform	+	-	n/a	-	+	-
ordering through logistic system	-	+	+	n/a	-	+
task scheduling	-	n/a	n/a	n/a	-	+
automatic elevator service	+	+	n/a	+	+	+
artificial landmarks	-	-	-	n/a	-	-
system installed in hospital	+	+	+	+	+	-

Hospital transport processes can be planned or spontaneous. For example, the transport of drugs, specimens and blood products, or sterile goods requires an immediate response. And the planned transportation of materials is usually for larger amounts of materials in special containers. Typical logistics processes with regular transport of concern include transport of food, bedding or waste. Currently, manufacturers of transportation systems intended for hospitals to offer automated material handling systems for both on-demand and scheduled for transportation. These systems are designed for hospital environment , where sterility and transport of highly sensitive products must be taken into account.

Most hospitals in the world, by introducing new technologies for the transport of hospital, decide to implement transportation systems which include AGVs as well as other

technologies that, compared to the AGV are designed for transporting lighter materials (overhead rail systems, pneumatic tubes and small vehicles (mobile robots)).

4. EXAMPLES OF APPLICATIONS

Automatic transport systems are used in most developed countries with high labor costs. In French hospitals, an example of which is the François Quesnay hospital, the presence of automatic guided vehicles (AGV) for the transport of heavy loads can be observed. AGVs transport integrate medical and pharmaceutical agents, meals, bedding and waste. These vehicles move through dedicated corridors located in the basement and elevator. Their plan is programmed in accordance with the schedules of distribution of individual units. Each basket that is carried, has a unique identifier and destiny. The sample François Quesnay Hospital (20 wards, 400 beds) has on its equipment 6 AGV wheelchairs which carry per day 25 baskets of waste, 25 with medical and pharmaceutical, 25 with sheets and 17 with cold meals. For transporting smaller loads, the mobile robots are used. The area of their application is the transport of acts of patients, the results of tests and pharmaceuticals and they are the addition to the regular distribution (hospital CHU de Montpellier). An example of their use is the transfer between pharmacies and offices in the evenings and at the weekends. Robots have different routes to be programmed (source –target). They are equipped with sensors that allow them to choose the appropriate corridors and elevators.

However, the AGV vehicles are of the greatest interest of hospitals as the examples in the later part of the chapter are shown.

The first of these examples is the FN Motol Hospital in Prague. While designing the hospital, an effective solution for internal transport had already been sought. It had been decided to use the AGV vehicles as they provide to achieve full automation and flexibility. A ten-storey building has a special elevator for transport purposes. The hospital is equipped with 28 AGV vehicles that carry beds, laundry, medication, etc. Generally speaking, they support large flow to and from the wards. The transport system comprises a total of 16 points of distribution (among others, laundry, kitchens, sheets storage, pharmacy and distribution of stocks). Goods are collected and stored in 400 locations. They are also transported to and from the adjacent children's hospital by an underground tunnel. The system provides a transportation route corresponding to about 500km per day. Goods are transported in three types of containers and the beds are also transported. For return transport from the wards it is not necessary to give the destination. AGV vehicle identifies transported goods itself and determines its destination. An integrated computer system for hospital management supervises the work of vehicles and provides an optimal flow. For example, the priority is to transport food when it takes place at mealtime. Priority is also considered in the case of movement at high and low top. AGV vehicles are collected when they no longer perform any task and they have not been allocated to another. [3]

Another hospital in which the system of AGV was introduced is Forth Valley Hospital in Scotland. This is a new hospital with new installations and has 860 beds. The AGV system of ATLIS was implemented there and it consists of 12 AGV vehicles capable of transporting carts and baskets. In case of these vehicles, a laser navigation was used. The transport system includes distribution points such as: kitchen, laundry, materials and waste center. The hospital has 9 lift shafts. AGV vehicles of ATLIS have also been

implemented in new hospitals in Castile and Leon (Spain). For example, a newly built hospital in this region featuring 600 beds was equipped with 6 vehicles using laser navigation. These vehicles carry 300 transport tasks a day. The transport system includes distribution points such as: kitchen, laundry room, sterilization center, waste center and pharmacy. The hospital has four lift shafts.

AGV systems are also used in German hospitals. As an example of it can be the University Clinic Friedrich-Schiller-Universität in Jena/Germany. The Gmbh system of MLR was used there. It is used to transport supplies and waste to and from different areas of the clinic often located on different levels. The system supports hospital wards, kitchen, pharmacy, laundry, research units, canteen and other areas. The system uses 26 vehicles fitted with a platform lift trucks and 400 containers transporting food, medicine, laundry, sterile materials, medical devices and waste. Each container has a bar code that is then read by the AGV vehicle so that the control system, that manages not only vehicles but also can track the location of each container. A specific feature of the system is that it also works in the neighboring buildings, providing and taking the appropriate materials.

One of the largest hospital complexes using AGV vehicles is the Cleveland Clinic in USA. The clinic includes 26 institutes of health, 1300 beds, 3.3 million of patient visits and more than 50000 admissions per year. Internal transport system using AGV vehicles was implemented in 2008. The system provides materials for five wards. These are: drugs, surgical kits, meals, linens, materials and supplies for nurses. They are delivered in total to 14000 employees located in the area of 168 acre campus.

The clinic introducing new solutions in hospital logistics has set several goals:

- Centralizing of materials management: which means that the materials necessary for the different units and different applications (medications, sheet, food and waste) are managed by one central point of management. Central warehouse is located in the basement of the hospital connected with the rest of the complex numerous underground passages.
- The study of a system that can handle both vertical and horizontal movement. Since the warehouse is underground, the system must manage the supply of materials to the warehouse or central areas of the warehouse level (horizontal movement) and then must keep track of the flow of materials to specific wards and/or individual floors (vertical movements).
- Ensuring rapid response capability. The clinic aims to provide several days of inventory for most products and fast replenishment if needed.
- Scaling up and down depending on the number of patients. It is difficult to predict in which period and for which number of patients the system should be oriented. Therefore, it is necessary to introduce the possibility of scaling both up and down. The primary objective was to create a system of support for materials handling 1300 beds in the main campus. The initial plan provided downloading about 30000 materials per day. Currently, the system supports an average 70000 downloads of materials per day raising to 150000 downloads a day on the peak days.
- Implementation without switching off. The clinic operates 24 hours a day 7 days a week. Implementation of a system must take place without interfering and interrupting its work.

The heart of the system is a fleet of AGV vehicles, capable to carry 1000 kg of materials each. No matter which ward the goods are to be carried they are packaged to the baskets in a central warehouse which are then transported by AGV vehicles through

underground tunnels to the relevant points where the appropriate clinic staff responsible for the transport of materials is taking them and delivers to the right floor and wards. AGV vehicles are equipped with RFID readers that scan tags in the bottom of each basket. Using the scanning AGV vehicle checks if it has an appropriate basket to carry. RFID tags allow to keep track of AGV when travelling through the underground tunnel. The clinic has also installed RFID readers at the entrance to the landfill. RFID tags are also used for small valuables. If any of these items will be thrown into the waste bin or the dirty linen, RFID reader identifies it before being thrown away. The clinic also installed battery charging stations throughout the system of underground channels and the area of the warehouse.

5. THE EFFECTS OF TRANSPORT AUTOMATION

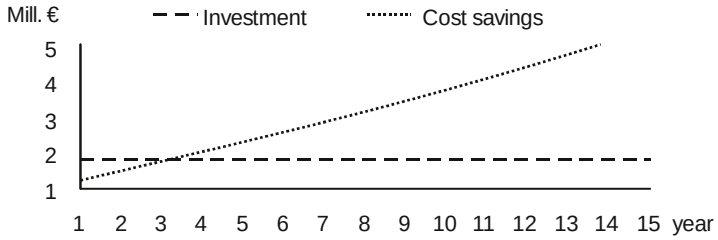
Automatic transport systems applied in hospitals have been used for at least a dozen years. Thus, there is data in various sources concerning the operation of these systems [2,5]. These data however, are incomplete and usually focus on selected areas of working. They mainly relate to economic and sanitary-epidemiological aspects of studies. The introduction of automated transport systems reduced the risk of infection. Traditional hospital transport equipment (hand carts), elevators or the doors are a potential source of infection. The introduction of AGV vehicles that are easy to clean, automatic doors and elevators reduced the risk. When considering economic factors, a good example is the work [6,7] analyzing on the simulation models, benefits from the introduction of automated transport system in University Hospital of Virginia. In [6] work, three scenarios had been established. The first one assumed that robots only serve the clinical laboratory. In the second scenario only hospital pharmacy was assumed to be served. The third scenario assumed the service of laboratory and pharmacy. In each of them the reduction of the human factor in logistics service achieved favorable economic effects. The greatest benefits however, reached the third scenario assuming laboratory and pharmacy services. For the purposes of the stimulation, a model of transport system was developed, consisting of six robots transporting pharmaceuticals and clinical laboratory samples. In this model, six connections were created, one in each floor. In each transport cycle, the vehicle visited clinical laboratory and pharmacy. In the first stage of the study, it had been established to replace all 22 employees by a fleet of six vehicles. The conducted simulations showed that the use of a fleet of 6 vehicles for both laboratory and pharmaceutical supplies causes 63% reduction in costs and 34% decrease in the duration of the entire cycle. The next step assumed the liquidation of 14 day jobs and keep one for a change. Obtained results caused 45% decrease in costs.

The work has also defined the necessary level of operating personnel reduction for which the automation of transport system is becoming profitable. The analysis showed that satisfactory results can be obtained when reducing the number of employees in a number of at least 9 people. The resulting return of investment with a reduction of at least 9 workers was 12%.

Data concerning the operation of the automatic transport system in Leipzig Hospital in Germany are also very interesting. The hospital uses Swisslog transport system. The expected stability of the transport system used in the hospital is at least 15 years. The system is characterized by low operating costs per year at the level of about 2 - 4% of investments. Thanks to introduction of the system, the costs of repairs of damages caused

during the transport were also reduced. In such conditions a very favorable period of return of investments was achieved. The sample graph of return of investments for German hospital was shown in figure 3.

Fig.3 The return of investment for transport system
Own study based upon [9]



As in German hospital, the situation in American Memorial Hermann Southwest Hospital is the same. The payback period of the investment is very similar here. In most of the cases described in the literature, depending on factors such as human labor costs, the costs of investment, labor reduction scale, the payback period is in the range from 1,5 to 3 years.

Apart from purely economic reasons, in many cases the implementation of such a system has brought several additional benefits:

- AGV never get sick, do not need leave and also work at weekends,
- AGV are predictable and do not make human mistakes,
- AGV system can operate 24 hours a day 7 days a week,
- Hospital staff can concentrate on patients,
- Transport tasks can be scheduled and done on the night shift.

CONCLUSIONS

Hospitals are one of the most important organs in a modern society. Demographic factors such as the increase in the elderly population, need to verify the causes of heath care services in order to improve the operation of hospital, their effectiveness and efficiency.

The basic service provided by hospital is the patent care. To provide this service, there are a number of ancillary services that must be taken into account in hospitals. Although most of these services are invisible for the patient, they have a significant impact on the way patients experience a visit to hospital.

One of the main and usually underrated ancillary services in hospital is logistics. The main task of logical support for the hospital is to organize and maintain the flow of materials in the hospital. Hospitals require a huge variety of materials which often causes the formation of complex transport systems and complex material flow. New materials and devices have been developed for disposable use only and are more common. As a result, the transport volume expands significantly. More materials must be more often transported.

Transport capacity can be improved by the introduction of automation. Implementation of transport tasks using people is usually limited by the physical capabilities of the staff. Automated transport systems may subject to much more flexible transport plans. Routes can be optimized and more frequent deliveries can be planned both at day and night. The speed of response to queries can also be improved if inventory tracking systems and transport systems are tightly integrated. To sum up, effectiveness of everyday processes in hospitals can be improved. The staff can save considerable amount of time which may be in turn given to patients. Therefore the quality of services provided to patients can be greatly improved.

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NOWOCZESNA LOGISTYKA W SŁUŻBIE ZDROWIA

Podstawowym zadaniem wszystkich szpitali jest poprawa stanu zdrowia pacjentów. W typowym szpitalu ogromna liczba ludzi prowadzi działania logistyczne często nie będąc tego świadomym. Proces starzenia się społeczeństwa szczególnie widoczny w Europie przyczynia się do wzrostu obciążenia systemu ochrony zdrowia. Aby zapewnić żądany poziom usługi opieki zdrowotnej, kilka usług pomocniczych, takich jak logistyka, musi być skutecznie koordynowanych, aby zapewnić jakość i ciągłość opieki zdrowotnej.

Logistyka w działalności medycznej jest dziedziną, która nie jest widoczna dla pacjenta, ale bezpośrednio wpływa na jakość usługi zdrowotnej, przez co stanowi ważny dla organizacji ochrony zdrowia obszar zainteresowania. W większości przypadków logistyka szpitalna polegała do tej pory na doborze odpowiednich dostawców w poszczególnych obszarach działalności, począwszy od zaopatrzenia w leki, dostawców sprzętu, pralni, transportu do transplantologii aż na cateringu żywności kończąc. Takie podejście w samodzielnym zarządzaniu w większości przypadków przynosiło różne efekty, często wręcz nieudolne.

W ostatnim okresie czasu obserwowany jest rozwój usług logistycznych w działalności medycznej wykorzystujący zdobycze najnowocześniejszej techniki, zaliczyć tu można

technologie informacyjne wspomagane zarządzaniem, bezobsługowe środki transportu, zautomatyzowany transport, technologie automatycznej identyfikacji.

W artykule przedstawiono nowoczesne formy logistyki stosowane w ochronie zdrowia. Wykazano korzyści wynikające ze stosowania tych rozwiązań. Korzyści te mogą być dwojakiego rodzaju. Z jednej strony obniżają koszty związane z funkcjonowaniem szpitala, z drugiej strony zapewniają wzrost bezpieczeństwa, niezawodności i dostępności o każdej porze. Znaczna część uwagi w artykule poświęcona została łańcuchom dostaw bazujących na nowoczesnych środkach transportu. Środki te wykorzystywane są do transportu osób i materiałów.

Słowa kluczowe: służba zdrowia, ochrona zdrowia, logistyka w działalności medycznej, usługi logistyczne.

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NATURAL VALUES AS A BASIS FOR POSITIONING OF POLISH CITIES AND REGIONS

Increasingly nowadays the image of brand is more important than the product's actual characteristics. Therefore, one of the most challenging tasks for contemporary brands is to become deeply embedded in the awareness of the marketing activities recipients. This situation takes also place in the case of the cities and regions that compete with each other in order to attract tourists, new citizens, students and investors. Territorial units may choose, among other things, from such distinctive characteristics (so-called unique selling proposition) as ecology and place-specific natural values. With regard to the above, the aim of this paper is to analyse the extent to which such attributes have been used in positioning of Polish territorial units. For that reason, the paper mentions symbols and promotional slogans of selected cities and all provinces (because for destinations the most essential positioning elements are: the place names, symbols and slogans). Furthermore, it refers also to the nature of positioning, as well as to the features and determinants of its efficiency. Another issue discussed in the paper concerns a group of people, which is susceptible to referring to ecology and natural values in promotional activities. Finally, the paper identifies the factors that decide whether the positioning based on the natural values of territorial units is effective or not.

Keywords: natural values, ecotourism, territorial marketing, an image of territorial unit, the positioning of cities and regions

1. INTRODUCTION

In the age of growing competition, territorial units seek unique features that would let them become distinctive in the minds of marketing activities recipients (including in particular tourists). Local authorities of some cities and the majority of provinces believe that the area in which the unique features of places can be found are their natural values. However, in order to make the positioning based on the elements of natural environment effective and consequently, to achieve intended marketing results, one has to adhere to specified principles. Therefore, the aim of this article is to identify the premises of creating effectively an "environmental" image of territorial units. What is more, the author's intention was to analyse graphic signs and promotional slogans of selected Polish cities and all provinces, taking into consideration direct references to the nature used in the signs and slogans. Such approach is concurrent with the belief that for destinations the most important positioning elements are the place name, a symbol, and a positioning slogan[2].

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2. THE NATURE AND COMPLEXITY OF TERRITORIAL UNIT POSITIONING

The concept of positioning is an important element of marketing strategies applied by all organisations, which, to a large extent, determines the ability to gain a competitive advantage. It also concerns those cities and regions which compete with each other in order to draw interest of the representatives of diverse groups that exist in the vicinity of the discussed cities and regions.

The literature on the subject, both foreign and domestic, offers many definitions of the notion in question. When attempting to generalise the definitions that have been proposed so far, the positioning is a strategic marketing operation which regards a particular sphere of partners, decision-makers – clients of various types of organisations, mental sphere. Performing specified marketing communication tasks – with regard to transmitting properly created marketing messages and monitoring their effects – helps organisations compete in order to make their own features and the benefits to the clients, which result from these features, to be perceived as unique in comparison to the competitors[3].

Completing the positioning process in an appropriate manner entails taking complex actions and requires a lot of time. The most important positioning features can be specified as follows[4]:

- it includes the level of organisation activity which aims at making its own product more distinctive than the competitive offers,
- it takes place in the awareness of purchasers and is a mental process,
- it is an activity related not only to the product, but also to the perception area of the recipients of marketing activities,
- it is a process of place identification in the purchasers' perception area, which ensures that a particular product has the strongest position as compared with market competitors,
- it is a part of product identity.

The positioning of products widely uses USP, i.e. unique selling proposition. Finding such an attribute contributes to the creation of a clear and positive image of an offer in the marketing activity recipients' minds. In the context of searching for a unique feature for a territorial unit, it is worth emphasising the fact that the brand of such unit may and should meet the rational (functional or utilitarian) and emotional needs. It should therefore offer something unique, which can become the reason of a strong emotional relationship with the recipient of the message. Hence the problem and the real challenge is to create such added value, which would be noticeable, accessible and simultaneously, in accordance with the reality[5].

In the world of brands, the product image and positioning may be much more important than the place's actual characteristics[6]. This remark indicates the importance of a proper, strategic attitude of local authorities towards the positioning of cities and regions.

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3. A GROUP OF RECIPIENTS OF MARKETING ACTIVITIES, SENSITIVE TO REFERRING TO NATURAL VALUES IN PROMOTIONAL SLOGANS

Tourism is inextricably linked with the natural environment and depends on its quality. It is an area of activity, which is extremely flexible about the changes in the needs of people and in their way of thinking. Nowadays one can observe the development of new motifs relating to travelling by the tourists who are tired of everyday life in haste, noise and polluted environment, as well as who are more and more aware of the fact that it is necessary to protect the nature, whose resources run out each day. It is estimated that this phenomenon refers to one third of all travellers throughout the world – people who make a trip particularly for tourist purposes, in order to have a holiday, to enjoy heritage tourism, etc.[7]

People who are extremely sensitive to the positioning based on natural values are especially those who are orientated towards cognitive tourism (including landscape tourism) and so-called ecotourism. The latter is also referred to as green tourism or nature tourism.

Ecotourism is a segment of sustainable tourism that offers experiences that enable visitors to discover natural areas while preserving their integrity, and to understand, through interpretation and education, the natural and cultural sense of place[8]. Ecotourism is usually typical of the areas which possess the highest natural and landscape values, and it directly contributes to the environment protection. People who participate in this form of travelling have strong ecological awareness and are very sensitive to the nature[9]. At the end of last century, the literature on the subject defined such people as green tourists or ecotourists. However, it is worth mentioning that the group described in this manner is not internally uniform (homogeneous). On the one hand, someone who belongs to it can be, for example, a staunch proponent of ecotourism, but on the other hand, a person who makes a long journey during which he or she is occasionally involved in the nature-based tourism could be also considered as a representative of the above-mentioned group[10].

In order to determine the dominant motif for the territorial unit positioning, one has to specify target groups on which marketing activities will focus. In the case of the cities and regions that decide to highlight their natural attributes, the most significant group should therefore include the tourists who are extremely interested in the nature and ecology.

4. AN EVALUATION OF THE USAGE OF NATURAL ENVIRONMENT ATTRIBUTES IN THE PROMOTIONAL ACTIVITIES OF POLISH CITIES AND REGIONS

Polish cities attempt to position themselves using diversified attributes. The analysis of logotypes and slogans of several dozens of cities has revealed that very few of them refer to the areas which are directly related to the natural environment. Among the cities which use promotional slogans indicating places that are tourist attractions, one should enumerate the following: Karpacz (*Karpacz – a city under the Śnieżka Mountain*, "Karpacz – miasto pod Śnieżką"), Międzyzdroje (*Międzyzdroje – the pearl of the Baltic Sea*,

[7] D. Zaręba, *Ekoturystyka*, Wydawnictwo Naukowe PWN, Warszawa 2006, p. 34.

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[10] D.A. Fennell, *Ecotourism Programme Planning*. CABI Publishing, Trowbridge 2002, pp. 16-17.

"Międzyzdroje – perła Bałtyku"), Zakopane (*Zakopane – the Tatras can't be any closer*, „Zakopane – najbliżej Tatr"), Wisła (*Wisła – the pearl of the Beskids*, "Wisła – perła Beskidów"), Głuszyca (*Głuszyca. The heart of the Sudetes nature*, "Gmina Głuszyca. Serce sudeckiej natury"), Nidzica (*Nidzica – the gate to Warmia-Masuria*, "Nidzica – brama na Warmię i Mazury"), Bytów (*Bytów. The city in Kashubia* „Bytów. Miasto na Kaszubach"). There are also cities which allude to their unique location – for example Świnoujście (*Świnoujście. The land of 44 islands*, "Świnoujście. Kraina 44 wysp") and Szczecin (*Floating garden*, "Pływający ogród"), and cities which – in regard to their distinctive features – consider climatic conditions to be relevant, like for instance Tarnów (Tarnów – *the Polish pole of warmth*, "Tarnów – polski biegun ciepła") and Gdynia (*Gdynia – a sunny city with temperament*, "Gdynia – słoneczne miasto z temperamentem").

There are very few examples of territorial units that, in connection with the idea of positioning, refer directly to the nature, such as Olsztyn (*Natural garden*, "O!gród z natury") and Krasnystaw (*Naturally!*, "Naturalnie!"). Similarly, only few urban settlements endeavour to relate its image to the ecology. Such examples include Otwock (with a slogan *Otwock – a green city*, "Otwock – zielone miasto") and Racibórz. And although the latter does not use any promotional slogan, the graphic sign of the city emphasises the natural values of the territorial unit. There is a green leaf with an "ISO 14001" mark, which is located next to one of the letters that form the logotype. It informs that Racibórz – as the first city in Europe – was awarded the Certificate in Environmental Management according to the ISO 14001 standard.

In contrast with the above, many Polish provinces refer in the elements of their brands to the natural values. This fact is supported by advertising slogans and graphic signs created for the purpose of promotional activities that are taken by the provinces (table 1).

Table 1. Advertising slogans and symbols of Polish provinces

Province	Advertising slogan	Slogan - original version	Symbol
Lower Silesia Province	*Lower Silesia. Difficult to talk about – easy to see around*	„Dolny Śląsk. Nie do opowiedzenia. Do zobaczenia"	DOLNY ŚLĄSK
Kujawy-Pomerania Province	*Our Kujawy-Pomerania*	„Nasze kujawsko-pomorskie"	
Lublin Province	*Lubelskie. Taste life!*	„Lubelskie. Smakuj życie!"	lubelskie Smakuj życie!
Lubuskie Province	*Lubuskie – worth your while*	„Lubuskie – warte zachodu"	Lubuskie Warte zachodu
Łódź Province	*Łódzkie speeds up*	„Łódzkie nabiera prędkości"	Łódzkie nabiera prędkości
Lesser Poland Province	–	–	Małopolska
Mazovia Province	*Mazovia – the heart of Poland*	„Mazowsze – serce Polski"	Mazowsze. serce Polski

Opole Province	–	–	
Podkarpackie Province	*Podkarpackie. The open space*	„Podkarpackie. Przestrzeń otwarta”	
Podlasie Province	*Podlasie. Wealth of diversity*	„Podlaskie. Bogactwo różnorodności”	
Pomerania Province	*Pomorskie – a good course*	„Pomorskie – dobry kurs”	
Silesia Province	*Silesia. Positive energy*	„Śląskie. Pozytywna energia”	
Świętokrzyskie Province	*Świętokrzyskie enchants. Come on weekend*[11]	„Świętokrzyskie czaruje. Poleć na weekend”	
Warmia-Masuria Province	*Masuria – The wonder of nature*	„Mazury cud natury”	
Wielkopolska Province	*Wielkopolska. Fascinating history. Exciting adventure.*	„Wielkopolska. Wielka historia. Wielka przygoda”	
West Pomerania Province	*Zachodniopomorskie. Sea of adventure*	„Zachodniopomorskie. Morze przygody”	

Source: own elaboration (promotional slogans and graphic signs have been taken from the websites of province offices or other websites related to them).

The most overt reference to the nature can be found in the slogan which promotes Warmia-Masuria Province (*Masuria – The wonder of nature*, “Mazury cud natury”). Additionally, elements and colours presented in the graphic sign of this region refer to the natural resources (according to the authors of the logotype, its colours symbolise as follows: yellow – the sun, green – forests, and light blue – lakes). Slogans and graphic signs of other provinces also refer to the natural environment, yet these references are not so explicit. For example, the slogan of West Pomerania Province (*Zachodniopomorskie. Sea of adventure*, “Zachodniopomorskie. Morze przygody”) directly refers to sea, an attribute

[11] Polish slogan „Świętokrzyskie czaruje. Poleć na weekend” is a pun, in which one can easily decipher the hidden meaning – *czaruje* (enchants) may indicate that the province either enchants with its natural beauty or, figuratively, uses magic on tourists (the association with witches, for which the province was famous in the past – even its logotype represents a witch on a broomstick).

of the province. The slogan implies also the multiplicity of attractions and events which the region offers, and a symbol, which represents an outline of the coastline and seagulls, complements the slogan. A logotype of Lower Silesia Province comprises three squares with motifs that allude to various kinds of tourism – cultural, mountain and health-resort. Their basis are, among other things, natural attractions of the region. A sign, which identifies Lesser Poland Province, is composed of an orange square in the background and a light blue object in the foreground, which represents the summit of the Tatra Mountains. Below the summit one can notice a ribbon – a representation of the Vistula River – that goes to the bottom of the sign. According to the authors of a Lubuskie Province logotype, its colours have associations with forests, fields, rivers and lakes. The nature and fresh air have been attributed to this sign, as they are typical of the western border region of Poland. A concept paper relating to promotional activities of Podkarpackie Province indicates that the strongest brand of this region are Bieszczady Mountains [Strategia kreacji i promocji… 2010]. This fact has been reflected in a logotype and promotional slogan of the region. The same elements of the brand have to evoke association with aviation industry, which is second – economic – distinctive feature of Podkarpackie Province. An element of the symbol, which is green, refers to the nature of Bieszczady mountain pastures, and the blue one symbolises a trace left on the sky by aeroplanes. Furthermore, the slogan *Podkarpackie. The open space* ("Podkarpackie. Przestrzen otwarta") connotes Bieszczady Mountains, as well as the aviation.

In the context of the analysed problems, Lubuskie Province is distinguished by its subbrand *naturally Lubuskie* („naturalnie Lubuskie"), which occurs next to other components of the territorial brand of the region: *young Lubuskie* („młode Lubuskie"), *WE create Lubuskie* („tworzyMY Lubuskie"), *wholesome Lubuskie* („zdrowe Lubuskie"). The subbrand, which refers to the nature, is intended to create the awareness of natural resources of the province among its inhabitants.

It must be mentioned that the analysed graphic signs and slogans have been adopted by the authorities of the provinces (frequently in concept papers, called brand books, visual identity guides, etc.) for a longer period of time. However, there are still undertaken single promotional campaigns which refer strongly to the natural attributes of individual Polish regions. A four-month campaign, *The eternal need for nature – Podlaskie* ("Odwieczna potrzeba natury – Podlaskie"), which was initiated in April 2012, is such an example. One of its elements was to broadcast an advertising film on *Discovery* channels, in which the multicultural nature of the region and unique natural values of the province were highlighted.

5. CONCLUSIONS

Polish cities and regions, to a small extent, endeavour to base the positioning concept on the natural values. It must be noticed that the references to the attributes of natural environment are more often conspicuous in long-term image-related actions taken by the regions, rather than in the case of urban settlements. This situation results from the fact that the provinces, covering vast areas, are much more diverse – and therefore there are more distinctive features (including also those related to the natural environment), to which one can refer in the marketing actions.

Only very few urban settlements manage to evoke nature-related associations using their own images. However, also for those urban settlements which decided to search for

unique characteristics in other areas (which are different to the natural ones) it is difficult to become distinctive compared to the competitors. The most frequently committed error is a lack of the original positioning concept, which results in expressing the essence of brand in a similar manner. Consequently, the cities face difficulties in becoming deeply embedded in the awareness of the recipients of marketing activities. For example, there are urban settlements that attempt to position themselves as "the capitals" in diversified contexts – like Rzeszów (*Rzeszów. The capital of innovation*, "Rzeszów. Stolica innowacji"), Opole (*Opole – the capital of Polish song*, "Opole – stolica polskiej piosenki"), Stalowa Wola (*Stalowa Wola – the bilberry capital of Poland*, "Stalowa Wola – jagodowa stolica Polski"), Złotoryja (*Złotoryja – the capital of Polish gold*, "Złotoryja – stolica polskiego złota"), Sulęcin (*Sulęcin – the bicycle capital of Lubuskie Province*, "Sulęcin – rowerowa stolica ziemi lubuskiej"). A similar behaviour can be observed in the case of the cities which refer to the opportunities that they offer – for instance: Zabrze (*Zabrze – a mine of possibilities*, "Zabrze – kopalnia możliwości"), Gubin (*Gubin. A mosaic of opportunities*, "Gubin. Mozaika możliwości"), Kędzierzyn-Koźle (*Kędzierzyn-Koźle. A city of opportunities*, "Kędzierzyn-Koźle. Miasto możliwości"). There are, however, also positive examples of positioning slogans, which can be regarded as the quintessence of distinctiveness, creativity and pun – like *Toruń. Get Gothic* ("Toruń. Gotyk na dotyk")[12], *Cieszyn – Enjoy the city* ("*Cieszyn – Ciesz się Cieszynem*")[13], *Rybnik. A city with spirit* ("Rybnik. Miasto z ikrą")[14].

In the light of the analyses that have been conducted, one can indicate the factors which have an impact upon the effectiveness of territorial unit positioning based on natural values. Regarding such determinants, one should take into account the following:

- ensuring that marketing personnel of city halls and province offices has knowledge of place positioning or using the services of an outside entity that specialise in providing strategic solutions in respect of territorial marketing,
- perceiving the positioning as an activity that involves great commitment – including both financial outlays and labour amount,
- emphasising natural unique features of a region consistently and coherently, in respect of all marketing activities,
- basing the idea of positioning on marketing research results that refer to a current and intended image of a territorial unit,
- orienting oneself to a specified target audience (recipients of marketing activities who are sensitive to referencing to natural attributes),
- looking for one's own, unique idea for making a place distinctive – deciding not to copy solutions used by other territorial units,
- creating a unique selling proposition (USP) according to real (and not imaginary) attributes of a city or region,
- generating citizens' support for the idea of positioning which has been chosen.

[12] Polish slogan "*Toruń. Gotyk na dotyk"* contains words – *gotyk* (gothic) and *dotyk* (a touch), which rhyme with each other.

[13] Polish slogan "Cieszyn – Ciesz się Cieszynem" represents a play on words, in which *Cieszyn* (a proper name, the city in southern Poland) sounds similarly to the words *Ciesz się* (enjoy) and *Cieszynem* (the instrumental case of the noun).

[14] Polish slogan "Rybnik. Miasto z ikrą" is a pun, since *Rybnik* (a city in Silesia Province), whose name connotes *ryba* (a fish), creates an amusing relationship with the word *ikra* (spawn = the eggs of fish). Additionally, the Polish phrase "Miasto z ikrą" means *A city with spirit*.

A proper positioning is a relevant element of effective city or region brand management. As the market practice proves – the positioning can be based on natural attributes. However, in order to make this action effective, it must be implemented in a well-thought-out manner, regarding the above-mentioned determinants of territorial brand positioning.

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WALORY PRZYRODNICZE JAKO PODSTAWA POZYCJONOWANIA POLSKICH MIAST I REGIONÓW

Obecnie coraz częściej wizerunek marki jest ważniejszy od rzeczywistych cech produktu. Zajęcie wyrazistego miejsca w świadomości adresatów działań marketingowych staje się zatem jednym z głównych wyzwań dla współczesnych marek. Taka sytuacja ma miejsce również w przypadku miast i regionów, rywalizujących między sobą o przyciągnięcie turystów, nowych mieszkańców, studentów lub inwestorów. Dla jednostek terytorialnych jednym z możliwych obszarów poszukiwania wyróżników (tzw. unikalnej propozycji sprzedaży) jest ekologia oraz wyjątkowe walory przyrodnicze. W związku z tym w artykule poddano analizie zakres wykorzystania tych atrybutów przy pozycjonowaniu polskich jednostek terytorialnych. W tym celu przywołano symbole oraz hasła promocyjne wybranych miast oraz wszystkich województw (dla nich bowiem najważniejszymi elementami pozycjonowania są: nazwy, symbole i slogany). Odniesiono się także do istoty samego pozycjonowania oraz cech i determinant jego skuteczności. Scharakteryzowano grupę osób, która jest podatna na odwoływanie się w działaniach promocyjnych do ekologii i walorów przyrodniczych W podsumowaniu zidentyfikowano czynniki decydujące o skuteczności pozycjonowania, opartego na wykorzystywaniu przyrodniczych atrybutów jednostek terytorialnych.

Słowa kluczowe: walory przyrodnicze, ekoturystyka, marketing terytorialny, wizerunek jednostki terytorialnej, pozycjonowanie miast i regionów

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THE USE OF FUZZY COGNITIVE MODELS FOR DIAGNOSTICS OF PROBABILITY OF ENTERPRISES' BANKRUPTCY

The article researches theoretical and methodical foundations of cognitive analysis and semistructured economic systems' modeling, problems of improving of existing methodical approaches to diagnostics of probability of enterprises' bankruptcy through the use of fuzzy cognitive model. Cognitive diagnostic of probability of bankruptcy is aimed to obtaining knowledge of processes of business entity's activities based on a study of quantitative and qualitative indicators with a purpose to assess both current and future state of an enterprise base on accounting and reporting data as well as expert appraisal.

The result of cognitive diagnosis is to determine the probability of enterprises' bankruptcy based on integral indicator of probability of bankruptcy, which reflects the management level in five directions, namely: the management level of fixed and circulating assets, personnel, financial resources and level of culture of enterprise. Is proposed to conduct cognitive diagnostics of probability of enterprises' bankruptcy in two directions, namely: Q-diagnostics, based on an assessment of financial performance, and V-diagnostics, based on the research of non-financial verbal indicators.

Cognitive modeling makes it possible to solve problems of a conceptual nature, to make managerial decisions that will provide the business entity with competitive advantages in future. A characteristic feature of the model of cognitive diagnostics of probability of enterprises' bankruptcy is that it is based on anticipative management concept, it can help to not only to determine the probability of bankruptcy of a business entity, but also to investigate the main factor of bankruptcy in the perspective and identify ways to improve the level of this factor. Using this model, enterprises will not only assess the probability of bankruptcy today, but also to prevent the bankruptcy of economic entities in the future.
Keywords: fuzzy cognitive models, bankruptcy, an enterprise, diagnostics of probability

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1. INTRODUCTION

The current stage of development of Ukraine's economy is characterized by a crisis phenomena in the economic system at its different levels. The largest number of crisis situations observed precisely at the microeconomic level. Today particularly noticeable significant deterioration in financial condition of enterprises, increase in the number of loss-making business entities. In Ukraine crisis state of many enterprises due to the mismatch of their financial and economic parameters of the current situation, which, in turn, is caused by the wrong strategy, inadequate organization of business and, as a consequence, a weak adaptation to the demands of the market.

Under such conditions the problem of developing methodical bases of diagnostics probability of bankruptcy of economic entities acquires nationwide character. This is due to fact that bankruptcy of the enterprise has negative consequences not only for its owners, but also for business partners, employees and the state as a whole in connection with a further imbalance of macroeconomic system. In addition, from the objective assessment of the probability of bankruptcy depends the cost of the enterprise, its investment attractiveness, effectiveness of sanation or restructuring.

Given that the occurrence of crisis phenomena in the enterprise is a threat to the very existence the enterprise and is associated with tangible capital losses of its owners, the probability of occurrence of crisis situations should be diagnosed at the earliest stages with a view to timely opportunities to neutralize them. Therefore the development of methodical approaches to the early diagnostics and overcome the crisis phenomena in the enterprise deserves of great attention both for the purpose the theoretical research and the practical use. Awareness of crisis situation on the earliest stages of its development will enable timely and purposefully to respond to threats by appropriate measures.

Today for Ukraine the problem of sustainable development of enterprises in a global economic crisis continues to be extremely urgent, because in terms of the economic crisis generally majority enterprises running at a loss, as well as there is a large part of the companies that are on the edge of bankruptcy or on the stage of initiation of bankruptcy cases [1]. Namely accurate and timely identification of negative factors of influence on the financial and economic activities using the tools of crisis management the enterprise is a guarantee emerge from the financial crisis. In foreign practice has developed various techniques of management the crisis phenomena at the microeconomic level, but they cannot be completely transferred to the national scientific and practical activities, as thus not taken into account sectoral specification functioning of domestic enterprises, conditions of the economic and the tax legislation, the development trend of the economy of Ukraine as a whole.

2. THE RESEARCH METHODICAL BASES OF COGNITIVE DIAGNOSTICS OF PROBABILITY OF ENTERPRISES' BANKRUPTCY

In order to diagnose the probability of enterprise's bankruptcy, mainly financial indicators are used nowadays. However, this information is not always unbiased and sufficient for effective diagnostics. In the process of managerial decision making there often appears a requirement in obtaining non-financial information, importance of which is increasing in competitive environment. Beside profit making and capitalization increasing today it is important, in particular, to conquest the market and to obtain competitive advantages.

Therefore, along with financial indicators, non-financial indicators of probability of enterprise's bankruptcy shall be considered in diagnostics.

Financial indicators taking source in the accounting system show only the results of previous financial activity of an enterprise and can not be used for appraisal of its future financial opportunities. Making focus on the financial indicators often results into the fact that business processes, development processes and staff training area of an enterprise are not being studied. There emerged a necessity of development of more complete and effective methods to diagnose the probability of enterprise's bankruptcy.

Due to the need for comprehensive study of enterprise's activities, it would be substantiate to consider the diagnostics of probability of the enterprise's bankruptcy as cognitive diagnostics. Cognitive diagnostic of probability of bankruptcy is aimed to obtaining knowledge of processes of business entity's activities base on a study of quantitative and qualitative indicators with a purpose to assess both current and future state of an enterprise base on accounting and reporting data as well as expert appraisal. The system of cognitive diagnostics of probability of enterprise's bankruptcy is based on the cognitive structuring of knowledge about the object; it is used in case of incomplete statistical information, and widely applies to expert polls [2].

Given the above, it is proposed to use cognitive diagnostics of probability of enterprise's bankruptcy in two ways, namely:

– quantitative diagnostics (Q-diagnostics) of the probability of bankruptcy basing on an appraisal of financial indicators;

– qualitative diagnosis (V-diagnostics) of the probability of bankruptcy basing on the study of non-financial verbal indicators.

Today it is important to work out the issue of financial and non-financial indicators' combination in the bankruptcy diagnostics of enterprises, taking into account cause-and-effect relations between performance indicators and key factors. Indicators that measure the goals achieved, and indicators showing processes required to achieve these goals shall be consistent, because in order to achieve the goals, for example, increase net income from product sales, it is necessary to implement the indicators describing ways to reach these goals, i.e. to achieve greater loyalty from the existing customers and to increase their number.

For countries with transitional economy there is a common situation where business records show that a company with such level of performance cannot perform its activities at all, though the enterprise has been effectively functioned and developed for years. Sometimes it is the opposite situation, when a business entity has standard performance indicators, but after a short period of time it is eliminated.

Thus, in Ukraine it is substantiated to perform diagnostic analysis of the probability of enterprise bankruptcy in combination with economic and financial indicators with a number of subsidiary factors, e.g. along with the quantitative indicators and qualitative information it is important to consider financial indicators and indicators describing the level of management in the enterprise as well.

Moreover, the process of managerial decisions making at micro level shall be based on the results of modeling of complex systems using the methods of program-oriented, cognitive, systemic approaches, methods of situations modeling and decision-making, as well as cognitive information technologies. Today, the system analysis is quite effective in the study of social and economic systems.

3. THE USE OF COGNITIVE APPROACH FOR SEMISTRUCTURED ECONOMIC SYSTEMS MODELING

Complexity and interrelatedness of problem situations in enterprises necessitates the development of complex, multi-level models, development of which is quite time-consuming process. The effective method of overcoming these difficulties is using cognitive models.

Thus, the pre-condition to apply the cognitive approach in enterprise management is the complexity of analysis of processes and managerial decisions' making [3]. In management performance it is required to use the methodology considering the variability of the environment and enabling forecasts of problem situation's occurrence, taking measures to reduce the level of risk and uncertainty. In cognitive analysis and modeling technologies' basis there are methods of cognitive (cognitive task) structuring of knowledge about the subject.

The analysis of the complex social and economic systems' functioning, development of strategies for their sustainable improvement and assessment of the impact of managerial decisions it is reasonable to perform using methods, models and mechanisms of economic diagnostics such as cognitive technology, which involves modern technologies of system analysis enabling experts' knowledge structuring, formalizing the processes of qualitative and quantitative modeling of complex systems' (e. g. social and economic system) behavior. Cognitive modeling's technology is a modern informational technology of system analysis including methods of expert assessment, methods of set-theoretic and statistical description of the object, methods of graph theory, decision making theory, stability theory and methods of scenario modeling on cognitive charts [4].

It should be noted that most of the social and economic systems are semistructured. This system type includes systems, which parameters and laws of behavior are described mainly on a qualitative level, and changes of system parameters may result into unpredictable changes in its structure. Thus, modeling of such systems and their management using traditional approaches based on analytical description or statistical surveying of dependencies between the input and output parameters is complicated and often impossible. Therefore it is necessary to access the subjective models based on information obtained from experts and processed base on thinking, intuition and heuristics.

It shall be noted that the economic system are featured with a large number of elements, relations between them and the external environment, presence of various uncertainties including the deficit of complete information on the mechanism of their functioning, inaccuracy of quantitative and qualitative appraisals, uneven development. Therefore, considering the problem of forecasting of complex systems' development and their management these systems are usually defined as semistructured. Simultaneously the need to study processes in complex systems requires clear scientific and research methodology. Integration processes in science and up-to date tendency of interdisciplinary approach determine necessity of integral methodological system's development. In recent years there appeared a number of theoretical and practical studies based on the cognitive approach [5].

Both cognitive approach to subjects of study and cognitive technologies are promising for the development of managerial decisions development in the area of ensuring the economic security of a complex system. Cognitive analysis and modeling are essentially new elements in the structure of systems supporting decision making. Today there is sufficient

number of projects developed in different operating areas based on cognitive technologies. Using cognitive technologies in the economic area enables prompt development and justifying of economic development strategy for a company considering changes of the external environment. Using cognitive modeling technology allows feed-forward control, preventing potentially dangerous situations' transformation into threatening and conflict, and when they occur, to make substantiated decisions.

For semistructured economic systems modeling it is appropriate to apply to the cognitive approach aimed to enhance the intellectual processes of a person, who makes decisions, and support him/her in fixing his/her vision of the problem situation in a formal model. Cognitive chart of situation is such a formal model. Multifaceted process, their interrelationship disabling detailed study of certain issues and requiring their analysis in the aggregate, lack of sufficient quantitative information about the dynamics of processes resulting in switching to qualitative analysis, and variability of the processes' nature in the course of time are the preconditions for cognitive approach application to complex economic systems.

In the study of semistructured systems it is complicated to apply traditional econometric approach to analysis of processes supporting development of integrated management solutions. Reasonable alternative to the traditional approach in this situation may be cognitive modeling as a set of methods for obtaining, analyzing subjective expert judgments of the processes of semistructured situations' functioning and methods of management strategies for such situations [6].

Technology of cognitive analysis of economic systems enables direct including of cognitive theory models and methods into the process of development and decision making on system's management; it provides new opportunities for studying the processes in the given system in case of uncertainty and risk inhering in the system's functioning. Using the technology of cognitive modeling in the study of economic systems requires the following conditions:

– ensure the collection of data necessary and sufficient for development of the structure of cognitive model, with experts involved;

– selection of key concepts (parameters), both quantitatively and qualitatively specifying the subject of a study in the subject area;

– definition of relations and connections between the defined key concepts, as well as vectors of parameters specifying the subject of a study;

– ensuring the development of the structure of the cognitive model based on one of the formal (informal) data and knowledge specifying models;

– analysis of relations and correlation dependencies between the selected concepts (parameters);

– sets of parameters should not be contradictory, and the resulting structure of the cognitive model shall meet the purposes, requirements and restrictions developed with respect to the subject of a study;

– implementation of the practical use of the cognitive model, filling the resulting structure with the parameter values;

– accumulation of information about the subject of research as an integrated system and its elements, the analysis of the adequacy and interaction parameters describing dynamics of the subject's functioning;

– processing of aposterior statistical data of modeling and developing conclusions about the effectiveness of the subject of a study generally and particularly;

– formulation of objective conclusions based on data obtained from various subject areas' perspective;

– definition of tasks on cognitive model's structure improvement considering the results of subject interpretation and study of dynamics of researched situation.

In the process of the cognitive model's structuring it is necessary to identify a set of properties specifying the subject of a study from the prospect of particular aspect; represent each feature type as a set of elementary features and each elementary feature of the subject of a study to be defined as a vector of parameters. Thereafter elementary parameters constituent the basis of each vector of parameters are defined.

4. DEVELOPMENT OF THE MODEL OF COGNITIVE DIAGNOSTICS OF PROBABILITY OF ENTERPRISES' BANKRUPTCY

Considering semistructured, multidimensional and interrelationed nature, deficit of sufficient quantitative information on a process dynamics typical for managerial decisions making in enterprises, the most appropriate method of a study and decision making would be the method of cognitive charts and methods of cognitive modeling. Cognitive structuring of information is a useful tool for semistructured problems studying, providing their better understanding, and supporting in identification of contradictions and qualitative analysis of economic systems. The main advantage of the cognitive approach is the possibility of cognitive modeling methods improvement with other methods on any stage of a study of the social and economic systems.

Cognitive model of information analysis enables studying the interrelations of quantitative (measurable) and qualitative (immeasurable) factors that influence the stable development of enterprise. This analysis is based on the graphic and the set-theoretic description of economic systems by means of cognitive structuring of the subject and its external environment, when the subject and the external environment are not clearly differentiated.

The source concept of the cognitive modeling of complex situations is the concept of cognitive chart of the situation. Cognitive chart of the situation is a weighted directed graph; nodes of the graph stand for the basic factors of the situation, in the terms of which the situation processes are described; the graph includes definition of direct relations between the factors through the review of cause-and-effects chains describing the influence spread of one factor upon the other factors.

Cognitive chart represents only the fact of the influence of factors upon each other. It does not provide neither detailed description of its nature, nor the influence dynamics depending on the situation changing, or the temporal changes of the factors. In order to consider all the circumstances above, it is required to apply the lower detail level of structuring of the information presented in the cognitive chart, i.e. the cognitive model. On this level each relation between the cognitive chart factors is described in respective formula, which may include both quantitative and qualitative variables. Whereby the quantitative variables are presented as numeric values. Each qualitative variable is assigned to a set of linguistic variables reflecting various states of the qualitative variable, and each linguistic variable corresponds to a specific numerical equivalent in the scale [0, 1]. Accumulation of knowledge about the processes occurring in the given situation enables further detailed studying of the nature of relationships between factors. Technically, cognitive model of the situation may be, as well as a cognitive chart, represented by a graph, but each arc in

this graph represents particular functional relationship between the basic factors, i.e. the cognitive model of the situation is described with a functional graph.

The following sequence is used to develop a cognitive model of the problem situation:

– selection of the factors defying the problem situation: definition of the basic factors describing the nature of a problem; identification of factors influencing the target factors and definition of factors-indicators describing the process development in a problem situation;

– by blocks grouping of factors: selection of integral indicators in the block, changing of which enables conclusion making on general trends in this area; identification of factors within the block providing detailed description of trends and processes in this area;

– determination of relationships between the factors: identification of links between blocks of factors, definition of the direct links within a block of factors;

– checking of the adequacy of the model, i.e. comparing obtained results with the system characteristics defined in the past with similar initial conditions.

Thus, the main stages of development of a cognitive model for problem situations are the following: identifying the most essential factors that provide sufficient description of a problem situation, definition of cause-and-effect relations between identified factors; base on expert conclusion of development of weight matrix for relations' definition; direct development of studied situation's cognitive model as a relations' weighted directed graph [7].

The basis of cognitive analysis and cognitive modeling is a cognitive structuring of knowledge about the subject and its external environment, where the subject and the external environment are not clearly differentiated. The purpose of this structuring is to identify the most significant (baseline) factors and to define qualitative (cause-and-effect) relations between them. Interrelations between the factors is presented as cognitive chart (model), which is a sign (weighted) directed graph [8]. Thus, the cognitive chart is a tool of structuring and supporting of managerial decision making in case of the absence of sufficient statistical information requiring expert appraisal to use standard methods, and it is a group of directed factors showing and explaining the development of processes in the studied area and their influence on the various elements of the cognitive chart.

Analysis of different mathematical models proves that in order to develop a model, it is reasonable to use the apparatus of directed graphs (digraph) to utilize the expert knowledge. Directed graph $G = \{X, U\}$ is an ordered pair (X, U), where X is – an empty set of objects – nodes (concepts) of the graph with the most essential factors assigned as the graph's nodes; U is a set of ordered pairs of elements of X, $U = \{x, y\} \subseteq X \times X$ called the arcs of the digraph, i.e. an arch is lined from the node X_i to the node X_j, if changing of X_i directly influences X_j. One of the most important aspects of the modeling process is to identify relations between subjects, their direction and influence. Digraphs' visuality and simplicity make it appropriate to use this type of modeling for multicomponent systems. Moreover, this apparatus enables manipulating both qualitative and quantitative types of data.

Using cognitive analysis for diagnostics of a probability of bankruptcy is substantiated due to the large number of interrelated factors affecting the financial state of an enterprise to be considered, as well as the insufficiency of complete information about these factors, or relations between them. Cognitive modeling enables detailed high-quality prompt evaluation of a problem situation; analysis of the mutual influence of operating factors that determine possible scenarios of development of a given situation; identification of trends

of its development; definition of possible methods of business entities' cooperation in the economic system for its directed improvement; developing and proving of problem situation's management direction; select available ways of influence upon the situation considering the results of managerial decision making. Cognitive modeling is performed on a stage basis. Initial stages require approval of a concepts' list, causality relation between them and causality relation's values. In order to develop a cognitive model of a subject, expert methods, statistical analysis methods, provisions of economic theory can be used. Upon development of a cognitive model there is a model analysis stage involving its structure research and scenario analysis. Research of a structure consists of definition of routs, ways and cycles of a graph model enabling analysis of cause-and-effect relations. It shall be mentioned that semistructured nature of the economic systems results into the complexity of cause and effect chains' analysis.

The advantage of the cognitive model is the fact that using graphs enables combining various indicators into a whole, and the indicators can be both quantitative and qualitative. It is possible to analyze the system improvement trends in any direction and to select the most efficient method. It shall be also noticed that digraphs' apparatus is the most effective for hardly formalizing factors [9].

Classic cognitive models are developed into fuzzy cognitive models considering the fact that interinfluences between the factors resulted from the cause-and-effect relations may be of different intensity, while the intensity of any influence may change in the course of time. Thus, the concept of fuzzy cognitive chart is put in, which can be represented as a weighted directed graph. The nodes of the graph correspond to the factors, and the arcs are the cause and effect relations between them, while the weight of each arc corresponds with the intensity of respective influence.

Given the availability the urgent need for an adequate assessment of the subjects of business activity, model of cognitive diagnostics of probability of enterprises' bankruptcy was developed, which is presented in a general form in Fig. 1. According to this model, the process Q-diagnostics of probability of bankruptcy of economic entities comprises the following three successive stages:

I. Determination of the probability bankruptcy of the enterprise.

II. The research by experts of the main factor of bankruptcy in perspective.

III. Identifying ways to improve the level of the main factor of bankruptcy in perspective.

V-diagnosis performed on the basis evaluation of integral indicator the probability bankruptcy of the enterprise, which includes the formation of nonfinancial verbal indicators, computation of aggregated indicators, the calculation of integral indicator, implementation the procedure for its recognition, and building a fuzzy cognitive model of diagnostics of probability of bankruptcy based on the identified cause-and-effect relationships between factors of bankruptcy and a certain intensity of the impact of these factors, which is served compiled as a weighted directed graph (Fig. 2) [10, 11].

In order to develop a fuzzy cognitive model experts use methods of analytical processing directed to the system's structure studying and obtaining forecasts of its development considering various influences with the purpose of effective management strategies' synthesis. At the stage of constructing fuzzy cognitive model is necessary to specify the interconnections and mutual influences of extracted factors of the problem situation. Interconnections of factors that are not supported by objective reasons, are concretized with the involvement of experts on the subject area. Using fuzzy cognitive models enables re-

solving of a range of hardly formalizing tasks emerging on various stages of managerial decision preparing and making process currently solved on a qualitative level using intuition and vague judgments.

Cognitive approach to the modeling in process of enterprise management is used, when there is deficit of statistical information, or it is impossible to describe problem situation features using metric scales, which reduces the effectiveness of, or disables the application of statistical analysis methods for the activities of business entities. At the same time the fuzzy cognitive modeling even in case of availability of statistical estimation of enterprise activities enables visualization of all the elements of a problem situation and relations between them, which certainly provides better understanding of the internal and external processes in the enterprise. In addition, cognitive modeling makes it possible to solve problems of a conceptual nature, to make managerial decisions that will provide the business entity with competitive advantages in future.

In order to obtain non-financial information in the process of cognitive diagnostics of the probability of enterprise bankruptcy, it is sustained to use the expert poll method, which is one of the expert appraisal's stages. The purpose of the expert poll is to obtain the expertise and encode it into the proper shape interpreted using the developed mathematical apparatus. It is believed that the opinion of the expert group is more reliable than the opinion of an individual, which explains the popularity of group interviewing techniques. The main advantage of these methods is the possibility of comprehensive analysis of quantitative and qualitative aspects of the problem, and the disadvantage is that even opinions of experts of similar area may differ. Data obtained within the poll is no always available in written form or opened for the direct observing. Verbal information obtained through this method is much richer than the non-verbal one; it is more sufficient for the quantify processing and analysis enabling using of computer technologies for these purposes.

It should be noted that the advantage of fuzzy cognitive model is the fact that using graphs enables combining various indicators into a whole, and the indicators can be estimated both quantitative and qualitative. Digraphs' apparatus is the most effective for hardly formalizing factors. Specific feature of fuzzy cognitive models is their visibility; in addition, fuzzy cognitive models contain a small number of basic factors and the relations between them showing main rules and laws of the situation development. Fuzzy cognitive models including a large number of factors lose their visibility that result into decreasing of the efficiency of this analysis. In a broad sense, fuzzy cognitive model is a problem model describing its main factors.

A characteristic feature of the model of cognitive diagnostics of probability of enterprises' bankruptcy is that it is based on anticipative management concept, it can help to not only to determine the probability of bankruptcy of a business entity, but also to investigate the main factor of bankruptcy in the perspective and identify ways to improve the level of this factor [12]. Using this model, enterprises will not only assess the probability of bankruptcy today, but also to prevent the bankruptcy of economic entities in the future.

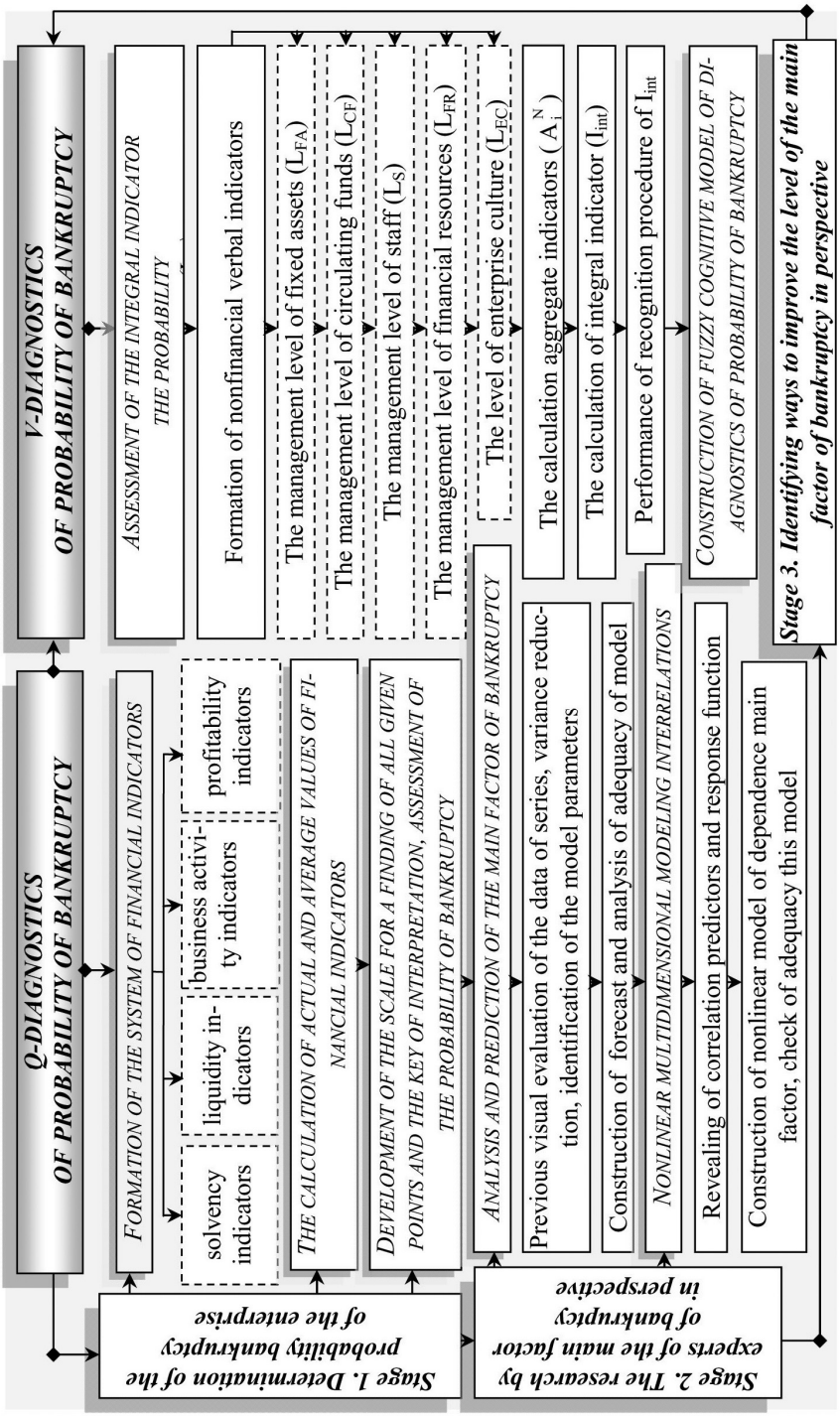

Fig. 1. Model of cognitive diagnostics of probability of enterprises' bankruptcy

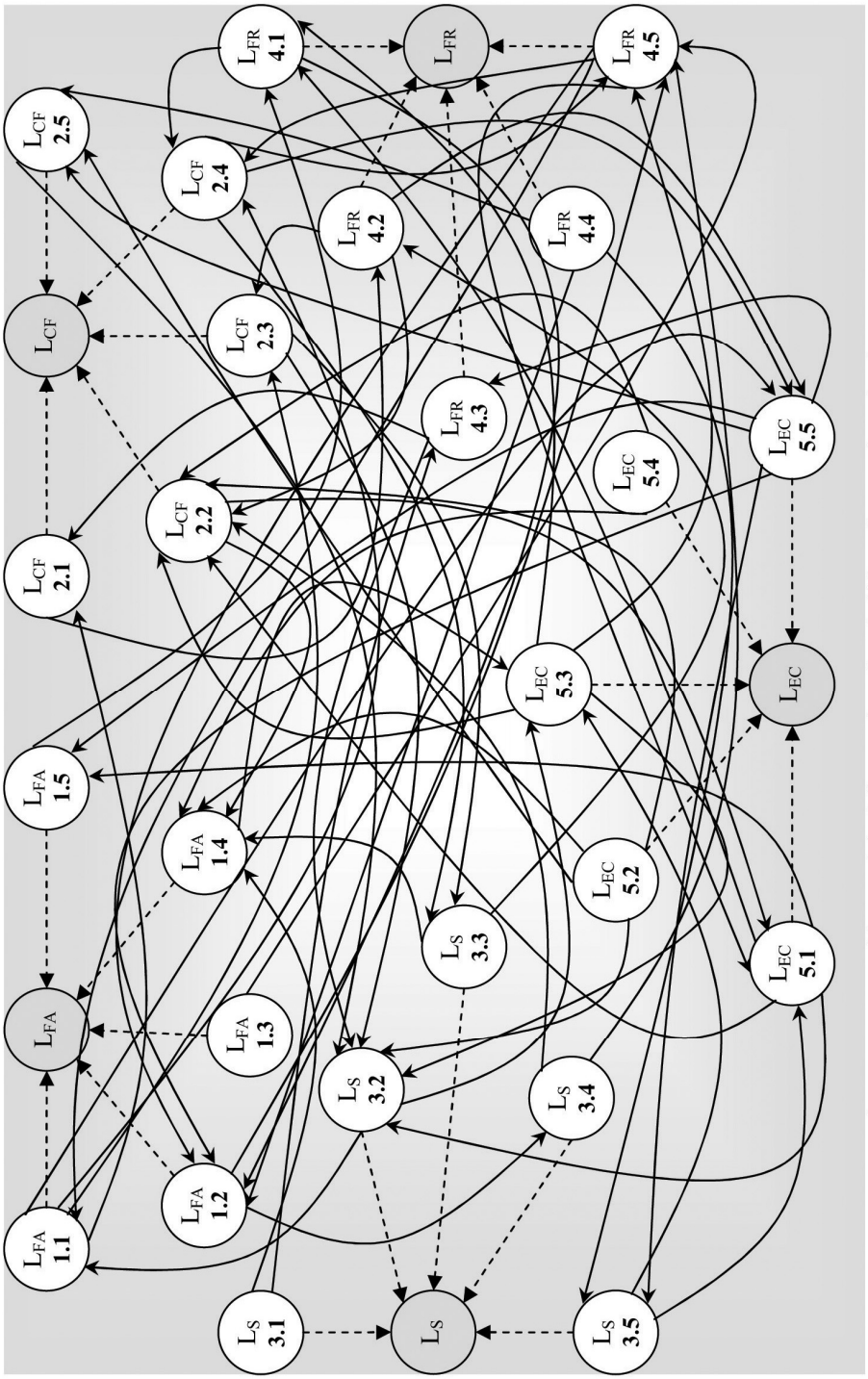

Fig. 2. Fuzzy cognitive model of diagnostics of probability of enterprises' bankruptcy

5. CONCLUSIONS

Thus, for hard formulating processes, their forecasting and support of decision making it is advisable to use fuzzy cognitive model. Its undeniable advantage over other methods is the formalization of quantitatively immeasurable factors, ability to operate with incomplete, unclear and even contradictory information. The apparatus of fuzzy cognitive model that is based on a combination of cognitive modeling and fuzzy set theory can adequately analyze the systems and processes, taking into account uncertainties, inaccuracies and incompleteness of the source data. Application of the theory of fuzzy sets in the diagnostics of the probability of bankruptcy enables involvement the statistical uncertainty, as well as ones of linguistic nature, to make scientific conclusion in the language of mathematics base on obtained unclear descriptions.

It should be noted that the application of the proposed model of cognitive diagnostics of probability of enterprises' bankruptcy will allow for the effective evaluation of the internal environment of the company, will contribute to the timely identification of actual and potential threats in the process of developing an economic strategy, prevention of the emergence crisis phenomena, support the sustainable enterprise financial condition, stable operation and development in the future.

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ZASTOSOWANIE ROZMYTYCH MODELI KOGNITYWNYCH DO DIAGNOSTYKI PRAWDOPODOBIEŃSTWA UPADŁOŚCI PRZEDSIĘBIORSTW

Artykuł analizuje teoretyczne i metodyczne podstawy poznawczej analizy i modelowanie systemów ekonomicznych, problem poprawy istniejących podejść metodycznych do diagnostyki prawdopodobieństwa upadłości przedsiębiorstw na podstawie rozmytych modeli kognitywnych. Diagnostyka ta ma na celu uzyskanie wiedzy o działalności przedsiębiorstwa opartej na badaniach wskaźników ilościowych i jakościowych oraz danych ze sprawozdawczości oraz oceny ekspertów. Wynikiem poznawczej diagnostyki jest określenie prawdopodobieństwa upadłości przedsiębiorstw, który opiera się na wskaźniku prawdopodobieństwa upadłości, który odzwierciedla poziom zarządzania w pięciu obszarach, a mianowicie: poziom kierownictwo środki trwałe i kapitał obrotowy, zasoby ludzkie, zasoby finansowe i poziom kultury przedsiębiorczości. W artykule zaproponowano przeprowadzenie poznawczej diagnostyki prawdopodobieństwa upadłości przedsiębiorstw w dwóch kierunek, a mianowicie: Q-diagnostykę w oparciu o ocenę wyników finansowych i V-diagnostykę w oparciu o badania wskaźników niefinansowych werbalnych. Modelowanie poznawcze pozwala na rozwiązanie problemów o charakterze konceptualnym, służy do podejmowania decyzji zarządczych, które zapewnią podmiotowi gospodarczemu przewagę konkurencyjną w przyszłości. Charakterystyczną cechą modelu diagnostyki prawdopodobieństwa upadłości przedsiębiorstw jest to, że opiera się ona na antycypacyjnej koncepcji zarządzania, może pomóc nie tylko w celu określenia prawdopodobieństwa upadłości jednostki gospodarczej, ale także w celu zbadania głównego czynnika upadłości w perspektywie i identyfikacji sposobów poprawy poziomu tego czynnika. Wykorzystując ten model przedsiębiorstwa będą oceniać nie tylko prawdopodobieństwo bankructwa dziś, ale także aby zapobiec upadłości podmiotów gospodarczych w przyszłości.

Słowa kluczowe: rozmyte modele kognitywne, upadłość, przedsiębiorstwo, diagnostyka prawdopodobieństwa

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THE PECULIARITIES OF KNOWLEDGE MANAGEMENT IN ENVIRONMENTAL PROJECTS

The paper presents investigations on the application of projects and programs on management methods to solve the problems of nature conservation. The analysis of the types of knowledge required for environmental projects implementation showed the necessity of the basic knowledge in ecology and project management. The realization of the project can be successful if this knowledge is integrated. Thus, in order to achieve long-term ecological targets the processes of project management (PM) must be developed on the basis of environmental management (EM) approaches. The integrated model PM+EM gives the opportunity both to administer the project itself and to determine the potential influences on the environment in managerial decision making processes. In order to increase the efficiency of such projects and programs management it is reasonable to use the universal methods of knowledge and knowledge areas management determined by PMI (Project Management Institute). This approach allowed to determine the peculiarities of knowledge management in environmental projects. As a result the features of different types of knowledge for environmental projects realization have been analyzed, the processes of knowledge management as specific resources of environmental projects management have been described and the extended model of knowledge management in environmental projects has been formed. Such a model gives the opportunity to create and introduce the efficient project management system for achieving strategic and operational targets of the project, to increase its success, to reduce the expenses and negative environmental impacts and to acquire new knowledge for efficient environmental project management.

Keywords: environmental projects, management of knowledge, ecology, system of project management

1. INTRODUCTION

As the environmental impact caused by technology increases, more and more investigations are devoted to the application of projects and programmes management methods to solve the problems of nature conservation. Most projects dealing with the development of industry, infrastructure and agriculture are potential sources of pollution which have a negative impact on the environment. In order to achieve long-term

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environmental targets project management (PM) processes should be developed on the basis of environmental management (EM) approaches.

The successful introduction of environmental management techniques allows to determine the potential negative impact on the environment. The impact can be evaluated so that it can be avoided or reduced due to the changes in the project plan. The overall environmental impact is specified, all resulting benefits and expenses are evaluated, and the value of revenues and expenses is determined.

The combination of project management techniques and environmental management techniques allows to realize project management processes based on Deming cycle of continuous improvement [1]. In this case, the project can be defined as the environmental one, namely as a unique activity that has its beginning and its end in time. And it is aimed at achieving previously determined environmental effects, creating a certain unique product or service that will cause the reduction of negative environmental impacts. The given resources, terms, environmental indicators, quality requirements and the acceptable risk level, including the ecological one are limited [2]. The result of environmental project is the change in the state of the environment which can be expressed in specific values of ecosystem parameters. They include: the reduction of harmful substances in the air, water, and soil; the reduction of generated waste; the rise of public environmental awareness, etc. The integrated model will allow to administer the project and also to determine the potential environmental impacts at separate stages of project life cycle.

One of the problems that significantly reduces the efficiency of such projects and programmes management is the lack of universal techniques of knowledge management and knowledge areas management, defined by PMI (Project Management Institute), taking into account environmental changes. Such methods allow to select the projects and their management with minimal environmental damage.

2. THE ANALYSIS OF CHARACTERISTICS OF KNOWLEDGE TYPES FOR ENVIRONMENTAL PROJECTS REALIZATION

Philosophy sources define knowledge as the result of reality cognition, its adequate representation in the form of ideas, concepts, opinions, and theories.

In philosophical dictionary “knowledge” is defined as “a representation of objective attributes and relations of the world” [3].

Knowledge is the informative basis of intelligent systems as they always compare the external situation with their knowledge and follow it while making decisions. Equally important is the fact that knowledge is the systematized information that can be somehow enlarged and based on which you can get new information, i.e. new knowledge.

Environmental project is aimed at solving a definite ecological problem. Management of such a project, therefore, needs a set of environmental knowledge.

Matviychuk A.V. [4] believes that environmental knowledge is the result of human cognitive activity as a reaction to the environment. Environmental knowledge can be regarded as the ability of the purposeful interaction of a human with the environment. And in the aggregate of these two aspects it can be considered as a certain pattern of behavior in the environment.

Environmental knowledge is formed by a complex system of different structured sets of facts, patterns, theoretical constructs, images that contribute to overall impression about the environment and man's place in nature. They include specialized knowledge of

Environmental legislation, Environmental management and Nature conservation; knowledge about the processes occurring in the atmosphere, water, soil under the action of harmful and hazardous substances. The knowledge of Environmental safety, Environmental Audit, etc. is also important. The peculiarity of environmental knowledge is an unscientific component which has a low level of conceptual and theoretical organization, but to a large extent is determined by a level of social organization.

Unscientific components of environmental knowledge are:

- practical experience, mythological ideas and traditions; this knowledge can be regarded as the necessary basis of logical forms of environmental knowledge;
- pre-environmental knowledge which embodies the output "self-evident" picture of the reality; it denotes nature with the help of some "metaphysical" (basically socio-cultural) images; this knowledge gives certain perception, interpretation of the environment and one's place in it;
- personal environmental knowledge which can be regarded as a result of intellectual dedication in the process of mastering the natural world; it is based on active principle which relies on the surroundings, environment, and nature;
- emotional environmental knowledge acquired by individual mental reality within which understanding and experience have no cognitive limitations and complement each other; the cognition process, which includes emotional environmental knowledge, is characterized by implicating irrational and romantic attitudes in epistemological search.

It can be concluded that a person's awareness and assimilation of environmental knowledge means understanding its importance for studying and protecting the environment and its internal connections. It also means the ability to analyze and compare, to prove and generalize, to evaluate and explain. Modern environmental knowledge is thinking which is based on a definite worldview. And ecological worldview is the idea about the structure and functions of nature, about the world which exists and operates regardless of whether a person is a part of it or not, the interaction with which leads to objective knowledge. One of the functions of environmental knowledge is the ability to determine effective methods of solving problems related to environmental changes. In our opinion, the most effective method of solving the problems concerning environmental improvement is to apply projects and programs management techniques.

It is known that PMBoK (A Guide to the Project Management Body of Knowledge) describes project life cycle and organizational structures found in companies carrying out the project [5]. The Guide determines process groups - initiating, planning, executing, monitoring and controlling, closing and their interaction with each other. Knowledge environment (both project management knowledge and environmental knowledge) should be created at each stage. Its aim is to promote knowledge exchange between the participants of the environment thereby increasing the efficiency of the project management. PMBoK identifies nine areas of project management and it defines basic and additional processes. The guide recognizes nine knowledge areas – project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communications management, project risk management, project procurement management. The standard is process-based. Inputs, outputs, tools and techniques for changing inputs into outputs are defined for each knowledge area. The interaction between all the processes, which are included in knowledge areas of project management, is determined.

The knowledge area of project integration management includes processes and operations necessary to ensure that various elements of the plan are properly coordinated and integrated into all knowledge areas and at all stages of project life cycle to guarantee its success.

3. THE DESCRIPTION OF KNOWLEDGE MANAGEMENT PROCESSES AS A SPECIFIC RESOURCE OF ENVIRONMENTAL PROJECTS MANAGEMENT

A great variety of definitions of knowledge management can be found in the literature. According to W.R. Bukowitz and R.L. Williams, "knowledge management is a process through which an organization generates its wealth basing on its intellectual capital or knowledge-based organizational assets" [6]. Intellectual capital or knowledge-based assets in this definition mean something that is closely related to people or arising from organizational processes, systems and culture. And it is relevant to corporate image, employees' individual knowledge, intellectual property, licenses, and such structures associated with knowledge as databases and technologies used both inside and outside the organization. According to D. Zh. Skyrme, knowledge management is a "clear and systematic management of knowledge important for an organization and related processes of management, collection, organizing, diffusion, use and exploitation in order to achieve organizational goals" [7]. R. Ruggles argued that "knowledge management can be defined as an approach to increase or create value through the active support of experience related to know-how and knowledge of what and how to do that are equally existing both inside and outside the organization" [8]. Hence, knowledge management covers a wide range of activities related to wisdom or intellect of individuals and to diverse information used in project activities.

Thus, knowledge management is the management approach that emerged because of the need to take into account the peculiarities of knowledge as a resource. Approaches applied to manage the other types of resources (physical, material, financial) are not used to manage knowledge because it has fundamental differences. For example:

1. A person transferring knowledge remains its owner - knowledge can be transferred unlimited number of times, and being transferred it gets one more owner.
2. Knowledge does not wear out, rather the opposite - being constantly used it develops and becomes more valuable.
3. The possession is virtual and can be formalized (explicit) and personalized (tacit); other resources exist objectively.

There are explicit knowledge that can be put down on paper, the other media, expressed verbally; and implicit (tacit) knowledge that is personalized, for example, intuition, subjective insights, ideals, values and even individual's emotions.

Explicit and implicit knowledge is an essential component of the development of knowledge management strategy. The purpose of knowledge management is to build a bridge between those who need knowledge and those who have it. It is the interaction between people (sharing ideas, decisions, relevant information) that facilitates decision making and effective management of increasing volumes of information within the project.

Knowledge management, therefore, can be defined as a process aimed at creation, accumulation and application of knowledge in the project. The criterion of its efficiency is the ability of each project participant to gain required knowledge in time.

There are two main approaches based on the division of knowledge into explicit and implicit:

1. Formalized knowledge management
2. Personalized knowledge management.

When creating new knowledge explicit and implicit knowledge interact due to the processes of knowledge conversion. This model is called knowledge spiral [9].

The basic process of new knowledge creation is an aggregation of individual knowledge with organizational knowledge, i.e. the "socialization of knowledge". For environmental projects individual environmental knowledge integrates into project management procedures. Thus, it takes some form, i.e. it is converted into concepts – the process of "externalization". In classification ("combination") process it is important to build a model, archetype of organizational knowledge use. It is also important for this organizational knowledge in the form of, for example, project product, service, or environmental change to reach the consumer – the process of "internalization".

The specification of the spiral can lead to the formation and development of technologies for knowledge accumulation in environmental project. This process is the basis for achieving the project success.

4. AN EXTENDED MODEL OF KNOWLEDGE MANAGEMENT IN ENVIRONMENTAL PROJECTS

The purpose of forming the extended model of knowledge management in environmental projects is to develop and implement an effective project management system. Hence, it will help achieve strategic and operational goals of the project, improve its performance, reduce costs, and reduce negative environmental impact.

The systems model of knowledge management in environmental projects, including inputs and outputs, model restrictions, controlling and uncontrollable parameters, is shown in Table 1.

Knowledge management in environmental project has to solve the following problems:

1. Assessment of sufficient knowledge for tactical tasks performance.
2. Assessment of necessary knowledge for strategic decision making.

The first task brings to formalized knowledge management. And it requires project workflow system to be constructed to manage individual processes (cost management, risk management, quality management, etc.). For the project of environmental management system implementation this is the 3rd and the 4th level documentation. These are special procedures, lists, instructions and other primary documents and documentation of monitoring and control.

Table 1. Systems model of knowledge management in environmental projects

Input parameters	$X = \{x_1, x_2\}$, where x_1 is a set of environmental knowledge, x_2 is a set of project management knowledge
Output parameters	$Y = f\{x_1 \cup x_2\}$, where Y is new knowledge as an integration of project management methods and environmental management methods
Restrictions	$U = \{u_1, u_2, u_3, u_4, u_5\}$, where u_1 is legal indicators, u_2 is social and political indicators, u_3 is financial and economic indicators, u_4 is organizational indicators and u_5 is environmental safety indicators
Controlling parameters	$G = \{g_1, g_2\}$, where g_1 is formalized knowledge management, g_2 is personalized knowledge management
Uncontrollable parameters	$V = \{v_1, v_2, v_3, v_4\}$, where v_1 is subjective indicators of separate knowledge carriers; v_2 is social factors caused by a low level of administrative discipline; v_3 is financial risks of knowledge management system introduction caused by external and state factors; v_4 is force-majeure situations.

The second task is strategic management of environmental project, its integration and scope. The example of knowledge management at the strategic level for the project of EMS implementation is the development of environmental policy of a company, its goals, objectives, EMS Manual and other documents established and controlled by top managers.

The formation of new knowledge is based on the integration of environmental knowledge with project management knowledge. Table 2 shows the model for the formation of new knowledge for effective management of environmental projects at the strategic level.

The peculiarities of environmental knowledge integration for other knowledge areas of project management at the **organizational level**. For the development of project management criteria it is necessary to use environmental knowledge and to decompose the problem to the local level as well as to choose problem solving method. With the application of project management knowledge project product and result can be determined and a project from the project portfolio can be chosen.

Project cost management takes place using environmental knowledge of costs relating to environmental influences (permissions, quotas, fines) and project management knowledge of financial aspects of project realization, budgeting and cost control. It is applied to resource expenses necessary for finishing the project. As a result it can be determined that the peculiarities of investment attraction lie in applying clean development mechanism and joint implementation mechanism under the Kyoto Protocol concerning the restrictions on greenhouse gas emissions.

Project quality management implies that environmental aspects are considered and the compliance with the requirements of environmental legislation, standards, nature conservation regulations is taken into account. Project management knowledge allows to ascertain whether project quality and project product quality are up to quality standards and whether preventative approach is used to guarantee quality assurance. The integration of this knowledge facilitates the determination of accordance with ISO 9000 and ISO 21500 standards.

Table 2. The model of integration of environmental knowledge with project management knowledge at the strategic level

	Environmental knowledge	**Integrated knowledge**	**Project management knowledge**
Tasks	Understanding the heart of the problem.	The development of programme mission, project strategy, and performance indicators.	The determination of project product and result.
	Understanding the consequences of activity or inactivity.		The development of project or programme realization indicators.
	Understanding the ways of problem solving.		Projects and programmes portfolio formation.
Processes			
Project integration management	Monitoring and control of the state of the environment, the analysis of impact on the other processes.	The integrated environmental changes control. The influences on all processes of project management are taken into account in decision making. The environment is an aspect that is included in every process of decision making.	All the processes of project management are combined and the interaction of different aspects of the project is identified.
Project scope management	The environment is assessed with every change and is broken down into components in every process of decision making.	The environmental changes, affecting project scope, are assessed, analyzed, and taken into account in decision making.	Management is concentrated on project boundaries, the control of project activities necessary for finishing the project.

Based on knowledge of environmental safety and project uncertainty and risk management *project risk management* occurs. Identification, analysis, planning of prevention or risk response measures are carried out for this purpose.

As for *project procurement management* it is necessary to use environmental knowledge and to choose the suppliers with the highest level of environmental safety. As the suppliers are demanded to satisfy the requirements of environmental standards and environmental aspects in their project activity are identified. Knowledge of resources, products or services procurement management; the conclusion of necessary contracts is used for this knowledge area management.

Thus, the model of knowledge integration allows to determine project strategic and operational aims, the direction of their achievement, and to acquire new knowledge for efficient environmental project management.

5. CONCLUSIONS

The analysis of the types of knowledge required for environmental projects implementation showed the necessity of the basic knowledge of Ecology and Project management. The realization of the project can be successful if this knowledge is integrated. Current knowledge management in project realization is its specific resource the study of which requires a systems approach. The model of knowledge management allowed to form the systems model of knowledge management in environmental projects. The model includes inputs and outputs, model restrictions, controlling and uncontrollable parameters. The peculiarities of creating new knowledge for efficient environmental project management at the strategic and organizational levels were determined.

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CECHY ZARZĄDZANIA WIEDZĄ W PROJEKTACH ŚRODOWISKOWYCH

W pracy przedstawiono badania nad zastosowaniem projektów i programów dotyczących metod zarządzania w celu rozwiązywania problemów związanych z ochroną przyrody. Przeanalizowano cechy rodzajów wiedzy do realizacji projektów ekologicznych, opisano procesy zarządzania wiedzą oraz zarządzania zasobami środowiska, utworzono uogólniony model zarządzania wiedzą w projektach środowiskowych. Taka analiza wykazała konieczność podstawowej znajomości ekologii i zarządzania projektami. Realizacja projektu może być skuteczna jeśli wiedza ta jest zintegrowana. Tak więc, w celu osiągnięcia długoterminowych celów ekologicznych należy opracować procesy zarządzania projektami, które to powinny opierać się na podejściu zarządzania środowiskowego. Tak zintegrowany model daje możliwość administrowania zarówno samego projektu, jak i określenia potencjalnych wpływów na środowisko w procesie podejmowania decyzji menedżerskich. Aby zwiększyć skuteczność takich projektów oraz zarządzania programami rozsądnym jest korzystanie z powszechnych metod zarządzania wiedzą i obszarów wiedzy określone przez PMI (Project Management Institute). Takie podejście pozwola na określenie specyfiki zarządzania wiedzą w projektach środowiskowych . W rezultacie cechy różnych rodzajów wiedzy o realizacji projektów na środowisko mogą zostać przeanalizowane. Taki model daje możliwość stworzenia i wprowadzenia skutecznego systemu zarządzania projektami do realizacji strategicznych i operacyjnych celów projektu w celu zwiększenia jego sukcesu, w celu zmniejszenia kosztów i negatywnego wpływu na środowisko oraz w celu zdobycia nowej wiedzy do skutecznego zarządzania projektami ochrony środowiska.

Słowa kluczowe: projekty środowiskowe, zarządzanie wiedzą, ekologia, system zarządzanie projektami.

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THE ANALYSIS OF CHANGES IN MORTALITY IN TRAFFIC IN THE EUROPEAN UNION COUNTRIES IN THE PERIOD 1991-2011

The article presents the results of time-space analysis of selected aspects of road safety in the European Union countries. The study horizon covered years 1991-2011. Data for the analysis were obtained from the databases of Eurostat and related to the number of accidents and the number of people killed and injured in road accidents. The raw values of these attributes were converted into intensity rates against the number of inhabitants. The rest of the work presents in a graphical form the rankings of EU countries according to road safety in 2011 based on the rate of accidents, injuries and the killed in terms of the number of inhabitants. Since the rankings were characterized by a very low similarity of results, it was made a critical assessment of the reliability of data on the number of accidents and the number of people injured published by EUROSTAT. In particular, it was shown that these data are not comparable and cannot be the subject of thorough international analysis. The reason for this fact are significant differences in the definition of persons injured and hence the accident. We can draw an important conclusion that all international comparisons must be based on the index number of people killed in road accidents. Taking into account the temporal aspect of the studied phenomenon, for each country it was determined the direction and rate of change indicator of the killed in accidents in the years 1991-2011 using the linear trend models. In a more detail way it was analyzed the level of road safety in Poland and neighboring countries - Germany, Slovakia , the Czech Republic and Lithuania.

Keywords: road safety, time-space analysis, ratings.

1. INTRODUCTION

Road accidents are the major cause of deaths of young people in most European countries. Apart from the direct social and economic effects road accidents also have indirect effects on many negative phenomena – such as escalation of demographic crisis in the European Union countries. In 2011, in 27 Member States of the European Union nearly 31 thousand of people were killed on the road. In the study period of this work so in the years 1991-2011, more than 1,1 million people were killed on the EU roads.

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The country in which the most people were killed in road accidents in 2011, was Poland (in total number it was 4189 people, while the rate of road fatalities per 1 million of inhabitants was 109, which placed Poland in second place among the European Union countries). For the meantime, the analysis of variability in the number and effects of road accidents in Poland leads to some optimistic conclusions – every year they are becoming less and less [Sobolewski 2012]. To explain these pieces of seemingly conflicting information, it is necessary to carry out a comparative analysis of the diversity of road safety in Poland and other European countries, taking into account the time factor.

The basic test, the results of which are presented in this work, is the analysis of spatial differentiation of road accidents risk in the particular countries of the European Union. For this purpose, the relative rate of fatalities, in which the reference point was the number of inhabitants, was used. European Union countries are very much different in terms of the level of this rate. In 2011, it was the highest in Greece (111 fatalities per million inhabitants), and the lowest in Great Britain (statistically 31 people on million inhabitants died in road accidents, which is almost four times less than in Greece!). Because of the fact that the risk of road accidents in the European Union countries is so much varied, the issue of variability of such phenomenon over time naturally arises. The following work also contains the answer to such a question, by making a detailed analysis of the dynamic rate of people killed in road accidents in the period 1991-2011 at the level of each country.

In the subsections two and three basic information about the definitions of road accidents in the European Union countries as well as the social and economic costs of these occurrences have been shown. Next, there have been presented the data source from which the material for statistical analysis was used. Subsection four deals with an interesting issue concerning data of number of accidents, injured and those who died in those accidents being linked together. Here what is particularly important is the issue of comparability of international data because without such a condition, any spatial analysis has no practical sense. The fifth part of the work presents a detailed analysis of the variability rate of those killed in road accidents in the years 1991-2011 in each European Union country. The work ends with a conclusion in which the directions for further researches have been outlined.

2. DEFINITIONS OF 'ACCIDENT' IN POLAND AND IN THE EUROPEAN UNION

Definitions of security incidents on the roads in various countries of the European Union are varied. Thus, in order to obtain comparability of statistics concerning road safety, an extensive discussion, which involves experts profession, the European Commission and the European Parliament[4] have been conducted. The European Union, in order to harmonize the statistics from different countries, in the years 2012-2013 has taken several steps towards the adoption of a consistent system for defining the circumstances and occurrences related to road accidents[5]. Thus, from 2014 a new consistent definition, which will allow to use common statistics, will be used. In addition, the objective of

[4] http://www.krbrd.gov.pl/aktualnosci/Parlament_Europejski_o_brd.htm http://edroga.pl/inzynieria-ruchu/brd/8110-ke-strategia-w-zakresie-zapobiegania-powaznym-obrazeniom-odniesionym-w-wypadkach-drogowych-cz-i

[5] http://ec.europa.eu/transport/road_safety/topics/serious_injuries/index_pl.htm

reducing the number of serious injuries and the strategy enabling its fulfilling has been taken. As far as gathering statistical data is concerned, it has been recommended that in the European Union countries there is a need to use one of these methods:

- combining data from hospital documents with the ones from the police;
- using only data from hospital;
- using police data with the margin of error, as the result of which the statistics of number of fatalities are underestimated.

The announcement of European Commission concerning road safety for the years 2011-2020 has obtained the support of the European Parliament in the form of a resolution from 27 September 2011[6], which supported the objective of reducing the number of fatalities by 50 % by 2020. In addition, the social costs of road accidents in the EU amounting to 130 billion Euro per year were stated and determining the following objectives had been suggested:

- 60% reduction in fatalities among children under the age of 14;
- 50% reduction in causalities among pedestrians and cyclists;
- 40% reduction in the number of seriously injured people with the regard of adoption of a consistent definition of an injured person in the European Union countries. [7]

According to the Central Statistical Office *"a road accident is an occurrence associated with the movement of vehicles on public road, which resulted in the death or injury of people's body. A road accident fatality is a person who died as a result of his injuries on the spot or within 30 days. A wounded casualty of road accident is a person who has suffered body injuries and received medical help"*[8].

However, in the Eurostat documents[9] the following definition of road accident has been presented: „An accident with the victims is the accident which involves at least one road vehicle in movement on public road or the private one with the right of access for the general population, as a result of which at least one person is injured or killed. Suicide or its attempt is not an accident but the incident caused by a deliberate act aimed at personal injury resulting in death. However, if as a result of suicide or its attempt some other road user suffers, then such an incident is considered to be an accident with casualties. Here, there can be included: road vehicles collisions, collisions with pedestrians and road vehicles with the participation of road vehicles and animals or fixed obstacles and with the participation of only one road vehicle. Collisions involving road and rail vehicles are also taken into consideration. Collisions involving many vehicles are considered as only one accident if further collisions take place in a very short period of time. Accidents with victims do not include accidents that end only with material loss. Terrorist attacks are precluded. As to „the fatality", it is a road accident in which there is a fatality. The casualty of accident is a person killed or injured as a result of road accident".

[6] http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P7-TA-2011-0408+0+DOC+XML+V0//EN&language=EN

[7] http://edroga.pl/inzynieria-ruchu/brd/8110-ke-strategia-w-zakresie-zapobiegania-powaznym-obrazeniom-odniesionym-w-wypadkach-drogowych-cz-i

[8] http://www.stat.gov.pl/gus/definicje_PLK_HTML.htm?id=POJ-3289.htm

[9] http://ec.europa.eu/eurostat/ramon/coded_files/transport_glossary_4_ed_PL.pdf

3. SOCIOECONOMIC COSTS OF ROAD ACCIDENTS

According to one of the earliest European Commission's guidelines on the subject of evaluation in the category of the costs of transport, the following main categories of unit costs of road accidents are being recognized:

- medical costs;
- the costs of lost productive capacity (lost production);
- the assessment of the lost quality of life (the loss of goods due to accidents);
- the costs of the property damage;
- the administrative costs.

With the development of research in this direction, the issue of the costs of road accidents has been expanded with new elements, including road collisions. Therefore, in terms of the valuation of the social consequences of road traffic, the valuation of the costs of road accidents according to the following formula have been recommended [Jaździk-Osmólska 2012]:

$$K_{zdr} = K_{bps} + K_{bpr} + K_{psr} + K_{kol} + K_{dod}$$

where:

K_{zdr} – the costs of road accidents,
K_{bps} – the security costs per se,
K_{bpr} – the direct costs of accidents (direct economic costs),
K_{psr} – the indirect costs of accidents (indirect economic costs),
K_{kol} – the costs of collision,
K_{dod} – additional costs.

The major direct costs of accidents are:

- medical and rehabilitation costs are the ones associated with the period of the patient's working disability;
- the administrative costs of the accident which include: the costs of police investigation concerning the accident, legal costs and administrative costs of insurance;
- the costs of emergency services concerning emergency assistance;
- the costs of damage to property which include damage to the vehicle and the equipment of the road.

The indirect economic costs can be defined as the lost Gross Domestic Products as a result of premature death and disability to work of the injured due to an accident.

All the costs which were mentioned are not able to convey and balance the tragedy of the casualty, aggrieved and their families. In Poland (as well as in many other countries) apart from the overall statistics, we know practically nothing about the casualties of road accidents. What happens with people who lose their jobs as a result of accident or have to change it for much worse? What happens with the families of fatalities deprived of the main breadwinner as a result of accident?

The losses generated by road incidents have definitely a negative impact on the quality of life of a society. Not only are they the causes of many tragedies but also have a certain economic dimension reflecting adversely on the financial possibilities of the country. As far as Poland is concerned, these losses can be estimated in tens of billions (zloty),

slowing the economic opportunities and at the same time increasing the financial encumbrance of citizens [Popiel 2012][10].

The calculation of accidents costs in case of economy should be an impetus for the authorities to take further steps to increase safety on the roads. According to the recommendation of the WHO, in order to increase road safety in Poland, it is necessary to enforce regulations concerning speed limits in much efficient way. On the other hand, the organization highlights good enforcement of regulations concerning prohibition of driving under the influence of alcohol.

4. DATA SOURCES AND THE METHODS OF MEASUREMENT OF POTENTIAL ACCIDENTS

The analysis was based on data concerning 27 Member States of the European Union (according to the state from the beginning of 2013) about the number of injured and killed in road accidents, which were obtained from the Eurostat sites. This data was supplemented by information on the number of accidents which are available on the UNO. The time horizon of the analysis covered the period of 1991-2011.

In order to enable the comparison of data for countries of different size, rough values for the number of accidents, people injured and killed had been related to the population, defining thereby three rates:

- the rate of the number of accidents per million inhabitants;
- the rate of the number of injured per million inhabitants;
- the rate of the number of fatalities per million inhabitants.

The rate of the number of people killed in accidents seems to be the best to describe a complex phenomenon known as „the level of road safety". This rate cumulates information about the number of accidents and their severity, the effectiveness of life-saving system, etc. On the other hand, considering benefits from the economic point of view, the number of people being injured is strongly associated with the financial consequences of accidents because not only fatal accidents generate such costs. In the next section information about the spatial distribution of the values of all three rates in 2003 defined below will be provided. Correlations between these rates will be also explored and the issues of accordance in case of definitions being analyzed in this work will be mentioned.

The basic variables describing the level of road safety are: the number of accidents, the number of people injured and the number of fatalities. Of course, the analysis of international data require bringing rough values to comparability, which were obtained by converting them into a million inhabitants. The next sections present the spatial distribution of rates obtained in this way in the European Union countries in 2011.

First, however, it was decided to check the accordance of the information about the level of road safety in the individual rates. For this purpose, the values of Spearman's rank correlation coefficients, by which we can assess the accordance of the country's orderliness of each rate, was calculated (Table 1).

[10] Estimated losses caused by the number of road fatalities in Poland, according to the World Bank in 2009 amounted to 12.8 billion zloty, in 2010 – 10.9 billion zloty, while in 2011 increased to 11.7 billion zloty.

The results are surprising. It turns out that there is a very high correlation between the intensity rates for the number of accidents and injuries, but none of them is related to the rate of the number of killed in road accidents.

Table 1. Correlations between the values of the rates of number of accidents, injuries and killed (2011)

The results of correlation analysis	The rate of accidents	The rate of injured	The rate of killed
The rate of accidents	×	R = 0,90 (p = 0,0000***)	R = -0,03 (p = 0,8990)
The rate of injured	R = 0,90 (p = 0,0000***)	×	R = -0,16 (p = 0,4184)
The rate of killed	R = -0,03 (p = 0,8990)	R = -0,16 (p = 0,4184)	×

R – Spearman's rank correlation coefficient, p – test probability

Source: own study

Figure 1 shows the spatial distribution of the rate of the number of road accidents whereas Figure 2 and 3 present analogical rates concerning the number of injured and killed in accidents. Comparison of the values of number of accidents and injured rates with the values of killed leads to surprising conclusions, which could be expected after the recognition of the complete lack of correlation between these values.

For example, the number of injured per million inhabitants is the highest in Belgium, and Austria. It is also high in Germany, Luxemburg and Italy (Fig. 2). The presented territorial distribution of this rate is different from the spatial differentiation rate of road casualties (Fig. 3). These discrepancies are so large that it is difficult to explain them in a rational way. Indeed, the level of road life-saving and health services remain at a much lower level in the Eastern European countries which may result in the fact that the rate of the number of people being killed to the ones being injured is higher in these countries. However, it does not explain such huge differences, especially as they also relate to the Western European countries (in the Netherlands the rate of the number of injured is almost ten times lower than in neighboring Belgium!).

Figure 1. The differentiation of the rate of the number of road accidents in the EU countries in 2011

Source: own study

Figure 2. The differentiation of the rate of the number of injured in road accidents in the EU countries in 2011

Source: own study

It seems that there are two issues of the real reason for such a huge differentiation in the rate level of the people injured in road accidents – firstly, the differences in the definition of a person injured in the road accident, secondly, the tendency of not reporting to the police parts of the road incidents in some countries. The second factor is, however, probably of marginal importance, so it is worth to look closer at the definitional differences that occur in the European Union countries[11]. At this point we will stop for acknowledgment of the fact that the substantive value of the data concerning the number of injured and the number of accidents is very small and, therefore, all further analysis will be based only on the rate of the number of fatalities[12].

Figure 3. The differentiation of the rate of the number of casualties in road accidents in the EU countries in 2011

Source: own study

[11] The issue will be thoroughly presented in the monograph on road safety in an international aspect which is planned to be released by the authors in 2014.

[12] It is worth mentioning that the European Union has taken a number of measures to harmonize statistics from different countries in 2012-2013, which would be possible after the adoption of consistent system for defining the circumstances and incidents related to road accidents.

5. CHANGES IN THE NUMBER OF ROAD CASUALTIES IN THE EUROPEAN UNION COUNTRIES 1991-2011

In this part of the work, the analysis of the risk of road accidents will be extended for the time dimension. The rate of the number of road accidents casualties per million inhabitants will be the subject of the analysis. Below, (Table 2) there have been placed the information concerning the minimum and maximum value of this rate in the European Union countries in particular years, and the mean value as well as median and classical coefficient of variation have been given. The complement of information about the distribution of the rate of the number of killed in individual countries is the total number of road casualties in the whole European Union.

Table 2. The characteristics of the distribution of the number of road fatalities rate in the EU countries for the years covered by the analysis

Year	The total number of casualties in the EU	The number of killed per million inhabitants				
		$\bar{x}$	Me	min	max	V
1991	75 426	178,5	166,3	44,1	385,6	46,7%
1992	70 731	163,8	166,0	30,3	309,4	39,7%
1993	65 441	156,3	161,9	38,6	280,0	40,2%
1994	63 903	154,5	156,7	16,4	304,6	42,5%
1995	63 155	149,4	150,0	37,9	270,6	38,9%
1996	59 409	138,9	132,7	51,2	271,8	38,4%
1997	60 267	140,1	138,7	48,1	250,3	37,1%
1998	58 982	138,4	133,4	45,2	279,7	40,3%
1999	57 691	132,7	135,2	10,6	271,8	40,4%
2000	56 427	130,1	124,0	39,5	266,6	37,3%
2001	54 302	124,0	124,6	40,9	236,0	35,3%
2002	53 342	121,9	124,6	40,5	238,3	35,6%
2003	50 351	115,0	118,2	40,3	228,2	36,4%
2004	47 290	112,2	112,1	32,5	222,5	40,4%
2005	45 346	107,6	104,3	42,2	225,7	39,6%
2006	43 104	102,5	96,5	27,2	223,3	42,9%
2007	42 540	104,0	96,6	34,3	218,6	42,1%
2008	38 941	90,3	83,4	36,6	148,2	38,5%
2009	34 814	78,5	75,8	37,9	130,1	35,5%
2010	31 029	67,6	67,4	28,5	111,3	35,9%
2011	30 751	67,3	63,9	31,4	111,2	33,5%

Source: own study

The following table (Table 3) presents the results of the analysis of linear trends for the accident rate in the period 1991-2011 for each of the analyzed countries. The countries had been ranked in the increasing order against the value of the regression coefficient (B), starting from those where declines in road safety risks were the greatest. About the quality of the linear model matching to the value rate in the years 1991-2011 testifies the value of linear correlation coefficient (r), and the addition of the analysis are the values of

Spearman's correlation coefficient, which should allow to identify the presence of non-linear trends. As we can see, for almost all the EU countries, except for Bulgaria, Romania, Malta and Slovakia we can say about fairly systematic with a huge linear approximation, the decline in the number of killed rate per one million inhabitants. In Portugal, the average annual rate of decline is 12.6 deaths per one million inhabitants, in Germany 4.6 and in Poland 3.8. The profound analysis should, however, rely on the connection of the rate of decline with the average level of the rate provided, therefore, the table contains its highest and lowest value in the whole analyzed period. In this context, the result for Poland is unfortunately one of the worst as no other country has such a low rate of decline with such a high value of the rate of killed.

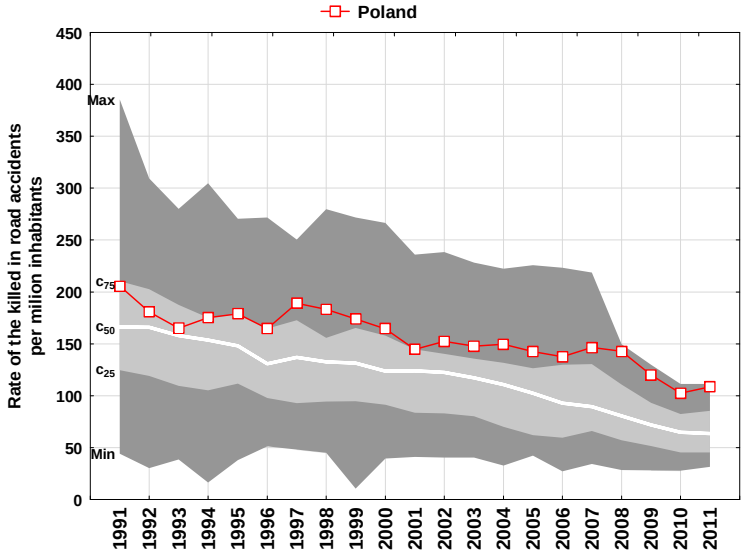
Table 3. The analysis of variability rate of the number of killed in road accidents per million inhabitants in EU

The EU countries	**Min**	**Max**	R_S	r	B
Portugal	79,0	322,5	-0,98*	-0,98*	-12,9
Latvia	86,3	385,6	-0,95*	-0,93*	-11,2
Estonia	58,2	324,2	-0,89*	-0,88*	-9,0
Slovenia	67,4	253,8	-0,94*	-0,95*	-8,6
Spain	44,6	225,8	-0,95*	-0,94*	-7,0
France	61,7	182,7	-0,99*	-0,98*	-6,6
Luxembourg	62,5	210,3	-0,93*	-0,94*	-6,6
Cyprus	73,2	213,2	-0,95*	-0,93*	-6,1
Lithuania	89,8	317,5	-0,55*	-0,71*	-6,0
Austria	62,2	196,8	-0,99*	-0,98*	-5,9
Greece	111,2	227,7	-0,96*	-0,95*	-5,4
Belgium	74,9	186,0	-0,94*	-0,96*	-4,9
Hungary	63,9	204,5	-0,88*	-0,88*	-4,9
Germany	44,6	139,5	-1,00*	-0,99*	-4,6
Ireland	40,7	129,4	-0,91*	-0,91*	-4,0
Poland	**102,4**	**205,7**	**-0,91***	**-0,90***	**-3,8**
The Czech Republic	73,7	158,4	-0,81*	-0,83*	-3,5
Denmark	45,9	117,0	-0,96*	-0,96*	-3,4
Italy	63,7	142,7	-0,92*	-0,92*	-3,4
Finland	50,8	125,0	-0,95*	-0,91*	-2,8
The Netherlands	32,4	86,5	-0,97*	-0,97*	-2,8
Sweden	28,5	87,3	-0,91*	-0,92*	-2,2
Slovakia	65,8	152,0	-0,53*	-0,61*	-2,1
Great Britain	30,7	82,4	-0,97*	-0,93*	-2,0
Bulgaria	89,2	164,3	-0,54*	-0,62*	-1,7
Romania	94,2	142,2	-0,26	-0,31	-0,6
Malta	10,6	51,2	-0,01	0,09	0,2

Min, max – the largest and the smallest values observed in the years 1991-2011
R_S – the value of Spearman's rank correlation coefficient with the assessment of statistical significance
r – the value of linear correlation coefficient with the assessment of statistical significance
B – the coefficient of directional linear trend

Below, there is the „study" of selected cases [13], showing the trajectory of changes in the number of killed per million inhabitants in Poland (Fig. 4) and in the European countries neighboring with Poland or lying nearby (Fig. 5 and 6) on the background of the whole population of EU countries.

Figure 4. The rate of those killed in Poland in the background of the European Union in the period 1991-2011

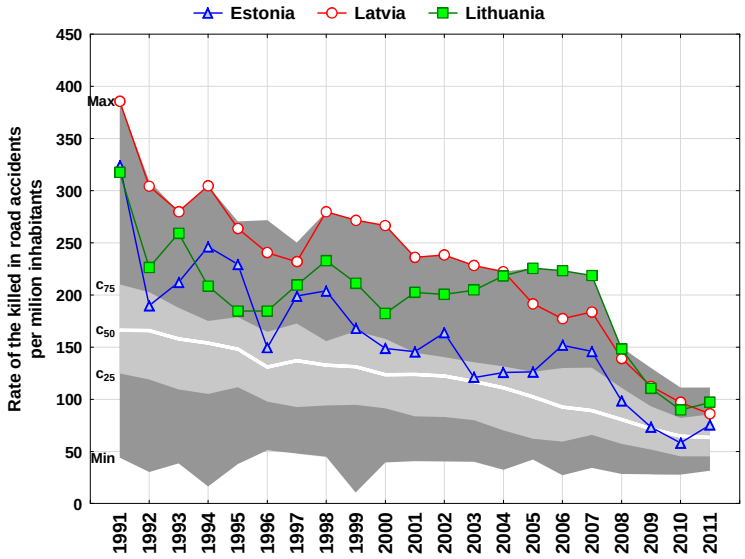


Source: own study

Analyzing the results obtained for both Poland and the EU countries we can observe that there is a downward trend. However, the values for Poland for the vast majority of years slightly exceed the 75th percentile for the EU countries (with the exception of the years 1992-1993 when the rate of killed obtained the values at the level of 50th percentile). For the past four analyzed years (2008-2011) its value was close to the maximum value of the EU countries.

[13] In subsequent publications similar detailed analysis will be carried out not only for all other EU countries but also at the level of EU regions (NUTS-2).

Figure 5. The rate of the killed in the Baltic countries on the background of the EU in the period 1991-2011



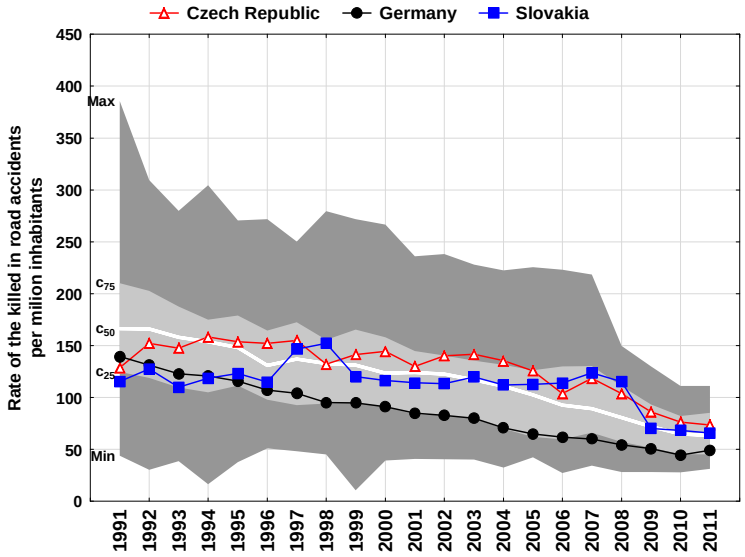
Source: own study

Analyzing data concerning the rate of killed in the Baltic countries it should be noticed that till the year 2004 the highest discussed rate marked Latvia and its value in the period from 1991 to 2004 for almost all the years hovered around the maximum value for the EU. After 2004 there is a strong decrease of these values, however, only in 2011 it reached the level of 75th percentile of values for all EU countries. This country has improved the road safety also in relative terms with respect to changes in the whole European Union.

In the case of Lithuania, the situation was more diverse. Initially the discussed rate had the values between the 75th percentile and maximum value for the European Union countries. In 2004, approached the maximum value and remained until 2008. Then, we can observe the decrease of the rate of killed but it did not reach the value below the 75th percentile for the EU countries. Comparing the values obtained for all three analyzed countries it should be noticed that the values for Lithuania oscillated between the data for Estonia and Latvia (except for the two years 1994-1995 when Lithuania reached the lowest value of the three analyzed countries). In years 2005-2008 the country reached the highest value of the analyzed rate, like in 2011.

The lowest rate of people killed among three analyzed countries is Estonia (except for the two years 1994-1995 when the lowest values had Lithuania) however, the rate had the values of 75th percentile in comparison with the data concerning the EU (except for the years 1991, 1994-1995 and 1997-1998, when its value far exceeded this level). For 2010, the rate fell below the 50^{th} percentile. In 2011, its growth again can be observed.

Figure 6. The rate of the killed in the Czech Republic, Germany and Slovakia on the background of the European Union in the period 1991-2011



Source: own study

Systematic, almost perfectly linear decreasing trend rate of the road fatalities per million inhabitants characterizes Germany (Fig. 6). The pace of improvement in the situation on the road in this country is not in any significant way higher than average in the European countries. In both 1991 and 2011 the country was slightly above 25 percentile rate for all European countries. In Slovakia, life-threatening death in a road accident had increased significantly in 1997 and remained at the level of the center and in some years even at the level of 75 percentile of results for all the EU countries. Only in the last three years covered by the analysis we can observe a significant improvement on Slovak roads. Safety on roads in the Czech Republic started to grow only since 2002, and since then we can observe a slow decline in the rate of road accidents casualties. The pace of these changes in the Czech Republic is similar to most EU countries.

6. CONCLUSIONS

The development of road transport is a very positive and desirable phenomenon but it is associated with the increased risk on the roads which result in socioeconomic losses.

Considering three values describing the dangers of road safety, namely: the number of accidents, the number of injured and fatalities, huge discrepancies in the level of these values within some countries can be noticed. This issue was examined in more detail in subsection 4. The obtained results allow to consider data on the number of accidents and the number of people injured incomparable in the international section, probably for definitional reason. This is an important conclusion which calls into a question the value of quite popular in the media information about the so called rate of severity of road

accidents[14] and its very high value in Poland (allegedly exceeding several times the level for the majority of the EU countries). Meanwhile, the level of this rate is determined mainly by differences in the definition of a road accident, which causes the situation that the road incident classified as an accident in one country does not have to be the same assessed in the other country.

Analyses show that in the most EU countries there is a systematic improvement of road safety. The pace of these changes is not the same in different countries. Unfortunately, one of the countries in which the improvement of the situation on the roads in the years 1991-2011 followed very slowly is Poland.

Presented article is a part of a series of publications which will examine the issues of road safety in international terms. In subsequent work there will be analyzed issues such as:

- searching for factors determining the different results of road accidents in the EU countries among the features describing the level of development of road infrastructure, the level of motorization or natural conditions;
- diversification of road safety at a regional level (NUTS-2) taking into account the spatial correlation;
- linking the threat of accidents with road traffic regulations operating in particular countries.

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ANALIZA ZMIAN W ZAKRESIE ŚMIERTELNOŚCI W RUCHU DROGOWYM W PAŃSTWACH UNII EUROPEJSKIEJ W LATACH 1991-2011

W artykule przedstawiono wyniki czasowo-przestrzennej analizy wybranych aspektów bezpieczeństwa ruchu drogowego w państwach Unii Europejskiej. Horyzont badania obejmował lata 1991-2011. Dane do analiz pozyskane zostały z baz EUROSTAT-u i dotyczyły liczby wypadków oraz liczby osób zabitych i rannych w wypadkach drogowych. Wartości surowe tych cech przekształcono na wskaźniki natężenia względem liczby mieszkańców. W dalszej części pracy przedstawiono, w formie graficznej rankingi państw unijnych według bezpieczeństwa ruchu drogowego w roku 2011 bazując na wskaźniku liczby wypadków, liczby rannych oraz zabitych względem liczby mieszkańców. Ponieważ rankingi te charakteryzowały się bardzo niskim podobieństwem wyników, dokonano krytycznej oceny wiarygodności danych dotyczących liczby wypadków i liczby osób

[14] The rate of severity of road accidents is defined as the number of people killed in 100 road accidents. It is obvious that this rate will be low in countries in which the definition of road accident is wider (e.g. in Germany).

rannych publikowanych przez EUROSTAT. W szczególności wykazano, iż dane te są nieporównywalne i nie mogą być przedmiotem rzetelnej analizy międzynarodowej. Przyczyną tego faktu są znaczące różnice w definicji osoby rannej a co za tym idzie samego wypadku drogowego. Płynie stąd ważny wniosek, iż wszelkie porównania międzynarodowe muszą być oparte na wskaźniku liczby zabitych w wypadkach drogowych. Uwzględniające aspekt czasowy badanego zjawiska, dla każdego państwa oceniono kierunek i tempo zmian wskaźnika zabitych w wypadkach w latach 1991-2011, wykorzystując w tym celu modele trendu liniowego. W bardziej szczegółowy sposób przeanalizowano poziom bezpieczeństwa ruchu drogowego w Polsce i w krajach ościennych – Niemczech, Słowacji, Czechach i na Litwie.

Słowa kluczowe: bezpieczeństwo ruchu drogowego, analiza czasowo-przestrzenna, trendy.

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PREDICTING BANKRUPTCY OF COMPANIES FROM THE LOGISTICS SECTOR OPERATING IN THE PODKARPACIE REGION

Research on effectiveness of various concepts for modelling the bankruptcy of companies from the logistics sector is described in this article. In order to present this issue more completely the above-mentioned prediction of possible negative effects for the conducted business activity was conducted for all companies operating in that sector in the Podkarpacie region. The study was supported by the data from the database EMIS (Emerging Markets Information Service). A wide range of 28 financial indicators was grouped into five groups i.e. liquidity ratios, profitability, debt, performance, and financial respectively. The above mentioned research trial was divided into a group of companies – so-called ill - in relation to which the bankruptcy was declared and healthy ones (of good financial condition).

Such an approach allows for a better and right assessment of the methods in modeling bankruptcy. The purpose of this publication was to find factors (models) describing the risk of bankruptcy of enterprises in terms of their effectiveness prediction in one - and two year- horizon. The logistics regression models, classification trees and two lunatics artificial neural networks were applied. A full evaluation of the models application were made in the validation process. The primary tool used in this case to study the effectiveness of models classification are matrices of correct classification. It was made an estimation of the correct and wrong indications in both the above mentioned models. Finally, an assessment of the method was done as well as the overall condition of the logistics sector in the Podkarpacie region.

Keywords: bankruptcy, logistic sector, modeling, financial indexes.

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1. INTRODUCTION

Insolvency, also called bankruptcy, constitutes a fundamental element of enterprises in the economic sense. Frequency of its appearance has on the one hand a deep influence on the result of economic growth and unemployment and on the other hand on the so-called financial stability, both in relation towards banks and towards broadly defined financial markets. Thus on the micro level insolvency can be perceived as the main credit risk factor, posing primary problem for the mentioned banks and investors, whereas on the macroscale as a negative element of possible recession.

The current period of economic recession on the global markets has lately increased discussions on effective way of predicting the companies' bankruptcy. Emerging solution concepts in that scope do not always allow to predict possible risk of bankruptcy effectively, thus do not always give signal for possible countermeasures. Multitude of solutions in scope of bankruptcy risk modelling does not always goes hand in hand with their „quality".

The content of this publication is the issue of effectiveness evaluation of widely used ways of predicting companies' bankruptcy. In order to present a more comprehensive opinion about commonly used mechanisms in that scope a modelling for one- and two year prediction periods has been conducted. Research sample is made of logistics companies from the Podkarpacie region. Companies have been divided into two groups, i.e. group of the so-called healthy companies, not threatened with bankruptcy and ones that in a given period declared bankruptcy. Such approach was aimed at verification of researched methods in relation to the prediction horizon. Analyzed methods have been divided into three categories, namely models of logistic regression, artificial neural networks and method of classification and regression trees.

2. ANALYSIS OF CHOSEN LITERATURE CONCERNING RESEARCH ON COMPANIES' BANKRUPTCY RISK

An exhaustive analysis of works concerning the issue of predicting companies' bankruptcy risk can be found in the work (Kumar & Ravi, 2007). The authors analyzed 128 publications concerning the issue of predicting companies' bankruptcy risk, which were published in a period from 1968 to 2005. Analysis of publications has been conducted from a perspective of usage of statistical methods and artificial intelligence methods to solve problems related with predicting companies' and banks' bankruptcy risk. Most publications concerned research of bankruptcy risk for companies (both listed and non-listed). Out of 128 analyzed publications only a dozen concerned research on bank bankruptcy risk. In some publications both companies and banks bankruptcy models have been researched.

Volume of research sample used by various authors in their research is very diverse (it ranges from 24 up to even 8977). Similar time periods for used financial data were diversified and included different time periods from 1997 to 2003 with a time horizon from one year up to even a couple of years.

Usage of research techniques by various authors is also very diverse. In research of this type one successfully uses both statistical methods, such as: discriminant analysis, models of logistic regression, decision trees and methods of nearest neighbours, as well as methods based on the optimization algorithms of operational research or methods of

artificial intelligence, such as: neural networks, theory of rough sets, mathematical programming, genetic algorithms, etc.).
The most commonly used statistical techniques to research companies' bankruptcy are based on discriminant analysis, logit models and decision trees. Nowadays they are very rarely used as sole and only research methods. They are used rather as a comparison model, in relation to other non-statistical models, or as component models in hybrid approaches.
One vital issue in regards to application of statistical methods to predict companies' bankruptcy is the work of Altman (Altman & Haldeman & Narayanan, 1977), where for the first time authors introduced a new model of classification of bankrupted companies, which they named „Zeta analysis". Ohlson (Ohlson, 1980) proposed a model of logistic regression to research the risk of companies' bankruptcy, while in 2002 Kolari and others (Kolari & Glennon & Shin & Caputo, 2002) introduced the so-called bankruptcy risk early warning system for large banks in the USA, also based on the logistic regression model. Effectiveness of correct classifications for data collected one year before bankruptcy amounted up to more than 96%, whereas for data two years before bankruptcy up to more than 95%. Among non-statistical methods used in classification of companies bankrupted because of bankruptcy the most often used ones are neural networks models. Tam and Kiang (Tam & Kiang, 1992) compared classifying quality of bankrupted companies for LDA models, logistic regression, k-nearest neighbours with neural networks models. Neural network models estimated by them had the best classifying statistics for prediction horizon of 1 year. In the case of data for 2 years before bankruptcy period the best model turned out to be an LDA model. Fletcher and Goss (Fletcher & Goss, 1993) used neural networks models to predict bankruptcy of a company in relation to logit model. They used a technique of V-times cross-validation to choose the best model and used 3 independent indicators (data was taken for 33 researched enterprises) as potential bankruptcy predictors in created and trained neural networks. Classifying quality of estimated neural network model amounted to 82%, whereas for an alternative logit model only to 77%.
More about usage of different types of artificial neural networks in predicting companies' bankruptcy can be additionally found in works (Lee & Booth & Alam, 2005), (Lam, 2004), (Leshno & Spector, 1996), (Wilson & Sharda, 1994), (Kiviluoto, 1998).

3. CHARACTERISTICS OF FINANCIAL FACTORS AND RESEARCH SAMPLES USED TO PREDICT BANKRUPTCY OF LOGISTICS COMPANIES

Information about bankruptcies of Polish companies were taken from bankruptcy database of Polish companies - Corporate Database EMIS information system (Emerging Markets Information Service).
To predict bankruptcy of logistics sector companies 28 financial indicators characterizing financial condition and managing effectiveness of researched companies have been chosen as bankruptcy predictors. Indicators have been divided into 5 groups: financial liquidity indicators, profitability indicators (return on sales), indebtedness indicators and

financial leverage, operating effectiveness (proficiency) and other indicators of capital-material structure of a company.

Statistical data of financial indicators for Polish companies were taken from financial reports of companies. The following financial indicators were chosen for research:

- *Liquidity indicators (*100%):* X1 - CURRENT LIQUIDITY INDICATOR: Current assets / Short-term liabilities, X2 - FAST LIQUIDITY INDICATOR: (Current assets – Stock) / Short-term liabilities, X3 - LIQUIDITY INDICATOR (KO/SB): Circulating capital (working capital) / Balance sheet total = (Current assets – Short-term prepayments and accruals - Short-term liabilities) / Balance sheet total, X4 - IMMEDIATELY DUE INDICATOR: (Current assets – Stock – Short-term receivables) / Short-term liabilities, X5 – CASH LIQUIDITY INDICATOR: Cash and cash equivalents / Short-term liabilities
- *Profitability indicators (*100%):* X6 - OPERATING PROFIT MARGIN: Operating result (profit-operating loss) / Net sales income, X7 – Profitability: Net profit / (Equity capital – Net profit), X8 - RETURN ON ASSETS (Asset profitability) (ROA): Net profit / Balance sheet total, X9 – RETURN ON EQUITY (profitability of equity capital) (ROE): Net profit / Equity capital, X10 – RETURN ON CAPITAL: Net profit / (Assets in total – Short-term liabilities), X11 – NET SALES PROFITABILITY (ROS): Net profit / Net sales income, X12 – GROSS PROFIT MARGIN: (Net income from sales of goods and products and equal to them – Operating expenses) / Net income from sales of goods and products and equal to them
- *Indebtedness indicators and financial leverage effect (*100%):* X13 – GENERAL DEBT: (Short-term liabilities + Long-term liabilities) / Balance sheet total, X14 - DEBT ON EQUITY: Total liabilities / Equity capital, X15 – DEBT (Equity capital + Long-term liabilities) / Fixed assets, X16 – ASSETS DEBT: Short-term liabilities / Balance sheet total, X17 – DEBT Gross profit / Short-term liabilities, X18 – DEBT (Net profit + Depreciation) / Total liabilities, X19 – LONG-TERM DEBT: Long-term liabilities / Equity capital, X20 – FINANCIAL LEVERAGE: Assets total / Equity capital, X21 – LEVERAGE (DEBT/COMPANMY VALUE): Total liabilities / (Equity capital + Total liabilities – Cash and its equivalents)
- *Operating effectiveness indicators:* X22 – RECEIVABLES TURNOVER [in days]: Average short-term receivables/ Net sales income *360, X23 - OBRÓT AKTYWAMI: Net sales income / Assets *100%, X24 – STOCK TURNOVER [in days]: Stock / Net sales income * 360, X25 – CASH CYCLE: Short-term receivables / Net sales income * 365 + Stock / Operating expenses * 365 – Short-term liabilities (without special funds and other short-term financial liabilities) / Operating expenses (without other operating expenses) * 365
- *Financial indicators – characterizing the companies' capital and material structure (*100%):* X26 – Equity capital / Balance sheet total, X27 – Fixed assets (without long-term prepayments and accruals) / Balance sheet total, X28 – Fixed assets / Current assets

Research samples were created on the basis of collected statistical data. Dependent variable was a qualitative dichotomous dependent variable Y defining whether a company is a company which declared bankruptcy (Y=1 – bankrupt), or a company not threatened with bankruptcy (Y=0 – non-bankrupt). 28 previously characterized financial indicators were chosen as a set of entry variables (bankruptcy predictors).

Two research samples were created. The first one included these bankrupted companies from the logistics sector and healthy companies corresponding to them, for which statistical data for one year before bankruptcy period was available (1-year prediction horizon). The second research sample included these bankrupted and healthy companies for which statistical data for two years before bankruptcy period was available (2-year prediction horizon). For each of research samples one corresponding healthy company not threatened with bankruptcy was chosen for one bankrupted company. Selection of healthy companies was preceded by a thorough indicator analysis and the only chosen companies from logistics sector were the ones which indicators pointed at good financial condition and ability to pay their liabilities.

Research sample for data one year before bankruptcy period included: 33 bankrupted companies and 33 healthy companies (statistical data for one year before bankruptcy was available for only that number of companies), whereas in the case of data for 2 years before bankruptcy period there were 57 healthy companies and 57 bankrupted ones. Research samples were divided randomly into two samples: the learning sample, on the basis of which the prediction model parameters were estimated, and test sample researching the effectiveness of correct classifications. The learning sample for one year prediction horizon included: 47 companies (23 bankrupts and 24 non-bankrupts), whereas the test sample included: 19 companies (10 bankrupts and 9 non-bankrupts). For two year prediction horizon the learning sample included 86 logistic companies (43 bankrupts and non-bankrupts), whereas the test sample included: 28 companies (14 bankrupts and non-bankrupts).

In order to scrutinize influence of chosen variables explanatory variable on explained variable – identifying the companies' bankruptcy a ranking analysis of predictors was conducted. A vital issue when choosing proper predictors is also posed by a necessity to choose only such predictors which have the best prognostic properties in scope of separation, i.e. distinguishing between bankrupt and healthy companies. When preparing a ranking of predictors depending on their classifying power one can use in practice the following factors: Information Value (IV), Gini factor and Cramer's V factor.
IV factor – information value of a predictor is expressed by the formula:

$$IV = \sum_{i=1}^{k} \left(\frac{n_i^{NB}}{n_{NB}} - \frac{n_i^{B}}{n_B} \right) \cdot \ln \left(\frac{n_i^{NB} / n_{NB}}{n_i^{B} / n_B} \right) \tag{1}$$

where: k - the number of attributes (variability intervals) of the examined predictor, n_i^{NB} - the number of healthy companies for i-variability interval of predictor's value, n_i^{B} - the number of bankrupted companies for i-variability interval of predictor's value, n_{NB} - the total number of healthy companies, n_B - the total number of bankrupted companies.

The higher the values of IV factor, the higher the predictive power of the explanatory variable in scope of differentiation between healthy and bankrupted companies. It is assumed that IV values above 0.3 point out to a strong predictive power, while values below 0.02 show complete lack of such predictive power.

Gini factor is based on Lorenz curve factor (for the so-called ROC curve - Receiver Operating Characteristic). It expresses a ratio of fields on the graph of ROC curve (see fig. 1) which is expressed by the formula:

$$Gini = \frac{A}{A+B} = \frac{A}{0.5} = 2 \cdot A = 2 \cdot (0.5 - B) = 1 - 2 \cdot B = 1 - \sum_{i=1}^{k-1} \left(y_{i+1} - y_i \right) \cdot \left(x_{i+1} + x_i \right) \tag{2}$$

where: k - the number of attributes (variability intervals) of the examined diagnostic variable, $y_i = \sum_{j=1}^{i} \frac{n_j^B}{n_B}$ - cumulated percent of bankrupts, for i-attribute value of variable, $x_i = \sum_{j=1}^{i} \frac{n_j^{NB}}{n_{NB}}$ - corresponding cumulated percent of healthy companies.

It is assumed that values of the Gini factor below 0.35 point out that predictor does not have a sufficient classifying ability to correctly distinguish between healthy and bankrupted companies.

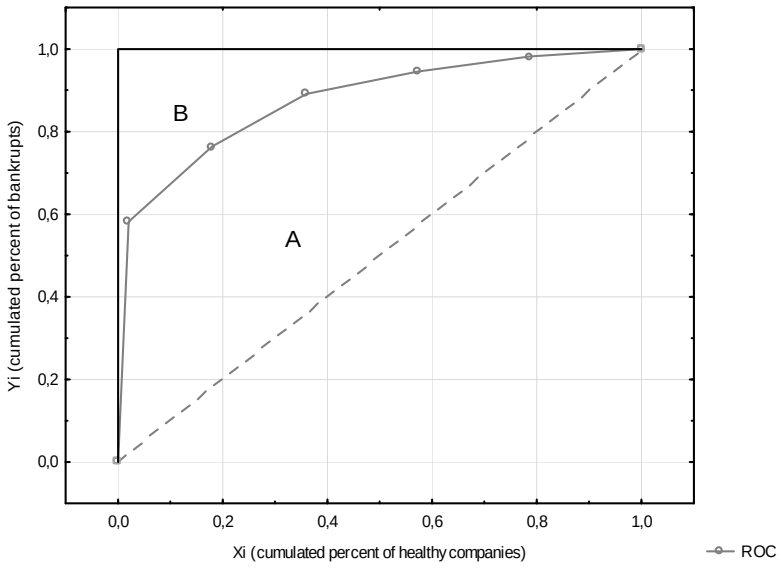

Fig. 1. Example of ROC curve

Source: own study.

Cramer's V factor measures dependence power between values of dichotomous dependent variable 0-1 defining company's bankruptcy and values of the given diagnostic variable. Values of this factor are contained in interval between 0 and 1. It is based on Chi-square independence measure and calculated with the formula:

$$V = \sqrt{\frac{\chi^2}{n}} \tag{3}$$

where: n – the number of statistical observations, and χ^2 - statistic value for Chi-square independence test, between variable 0-1 defining company's bankruptcy and examined indicator (predictor) of bankruptcy.

The higher the V-Cramer's factor values (closer to 1), the better predictive power of the examined indicator in predicting companies' bankruptcy.

3. CHARACTERISTICS OF MODELS USED IN PREDICTING BANKRUPTCY OF LOGISTICS COMPANIES

To predict bankruptcy risk of companies from the logistics sector in this work the following statistical models of bankruptcy classification were used: logistic regression and CRT classification trees. However, from non-statistical methods (using artificial intelligence methods) neural networks models based on multilayer perceptrons (MLP) were used.

Models of logistic regression - Logit

General form of two-state model of logistic regression describing dependence of the possibility of bankruptcy of examined companies depending on a set of factors influencing the occurrence of this event is expressed by function:

$$P(Y=1) = \frac{1}{1+e^{-(\alpha_0+\alpha_1 X_1+...+\alpha_k X_k)}} \tag{4}$$

In order to choose potential variables for a logit model a factor analysis was used as well as values of ranking statistics for importance of predictors (Tab. 1 and Tab. 2). For prediction horizon of 1 year the X_{23} and X_{28} variable were discarded from the list of potential variables, because they had low value of ranking measures, whereas for a model with prediction horizon of 2 years the following variables were discarded: X_{12}, X_{19}, X_{22}, X_{23}, X_{24}, X_{28}.

After implementing factor analysis the following variables were chosen for estimating model for a one year prediction horizon: X_{26}, X_{18}, X_{20}, X_{11}, X_{22}, X_5, X_{10} as well as other variables (weakly correlated with factors and between themselves): X_1, X_2, X_7, X_{15}, X_{24}, X_{25}, X_{27}

A list of potential diagnostic indicators for a model with two year prediction horizon, including variables: X_3, X_5, X_7, X_8, X_9, X_{13}, X_{17}, X_{21}, X_{25} was selected in a similar way.

To estimate parameters of logistic regression model a module of generalized linear and non-linear models was used (generalized logit model).

In the estimated models there were only these diagnostic variables, for which the *Wald* statistics value was statistically relevant on the level of $p<0.05$.

The table below (Tab. 1) presents estimated coefficients and values of *Wald* statistics for both logit models with 1 year and 2 year prediction horizon.

Table 1. Estimation of parameters for logistic regression models.

Predictor	Evaluation of parameter	Estimation error	Wald statistics value	Test probability (*p-value*)
Model of logistic regression – 1 year to bankruptcy				
absolute term	6.16642	2.142386	8.284	0.004
X_1	-0.04938	0.015481	10.174	0.001
X_{11}	-0.11751	0.061335	3,670	0.050
X_{27}	-0.04283	0.021563	3.945	0.047
Model of logistic regression – 2 years to bankruptcy				
absolute term	1,4645	0.569849	6.605	0.0102
X_5	-0.05544	0.023063	5.779	0.0162
X_{11}	-0.0722	0.036052	4.011	0.0452
X_{27}	-0.02084	0.008869	5.522	0.0188

Source: own study.

Classification trees – C&RT

C&RT (Classification and Regression Trees) is a tool for statistical analysis of data used to create classification and regression models. Tree is a kind of a graphic model, created as a result of recurrent division of a set of output observations into numerous subsets. The aim of such division is to gain subsets as homogenous as possible in regards to dependent variable value. Algorithm of recurrent division (so-called Recursive Partitioning) can use different independent variable on each stage of division. All independent variables (predictors) are always taken into account and the chosen variable guarantees the best division of node, namely one receives division into the most homogenous subsets.

Algorithms of decision trees can be divided into 3 basic types:

- CLS (Concept Learning System)
- AID (Automatic Interaction Detection) – an example of this type of algorithms are CHAID type trees
- C&RT (Classification and Regression Trees)

More about methods and trees algorithms in classifying and regression use can be found in (Breiman & Friedman & Olshen & Stone, 1993).

Table 2. Classification trees for bankruptcy models

Node number	Left node branch	Right node branch	Number of nodes	Size of NB class	Size of B class	Chosen class	Division variable	Division constant
Prediction horizon: 1 year to bankruptcy								
Selection rule B: (X_{15}<=75.4 AND X_{21}>63.1) Selection rule NB: (X_{15}>75.4) OR (X_{15}<=75.4 AND X_{21}<=63.1) Effectiveness of correct classification: learning sample = 93.6 [%], test sample=84.2 [%]								
1	2	3	47	24	23	Non-bankrupt	X_{15}	78,4
2	4	5	26	4	22	Bankrupt	X_{21}	63,1
4			2	2	0	Non-bankrupt		
5			24	2	22	Bankrupt		
3			21	20	1	Non-bankrupt		
Prediction horizon: 2 years to bankruptcy								
Selection rule B: (X_{13}>89.4) OR (X_{13}<=89.4 AND X_{24}>13.3) OR (X_{13}<=89.4 AND X_{24}<=13.3 AND X_{7}<=-51.0) Selection rule NB: (X_{13}<=89.4 AND X_{24}<=13.3 AND X_{7}>-51.0) Effectiveness of correct classification: learning sample = 84.9 [%], test sample=71.4 [%]								
1	2	3	86	43	43	Non-bankrupt	X_{13}	89.4
2	4	5	56	39	17	Non-bankrupt	X_{24}	13.3
4	6	7	49	38	11	Non-bankrupt	X_{7}	-51.0
6			3	0	3	Bankrupt		
7			46	38	8	Non-bankrupt		
5			7	1	6	Bankrupt		
3			30	4	26	Bankrupt		

Source: own study.

C&RT trees algorithms were used in this publication to analyze bankruptcy of logistics companies. A Statistica package module – General models of classification and regression trees was used. All 28 financial indicators were chosen as entry variables. Gini measure was used as a method of trees division, whereas to choose the best trunked tree – a V-times cross-validation, as a rule of one standard error. Minimization of average costs of incorrect classification was used as a criterion of optimal tree trunking (the same costs of incorrect classification, equal to 1, were set for bankrupts and non-bankrupts).

Structure of the best classification trees for one year and two year prediction horizon is presented in Table (tab. 2). There are also rules of tree division and node creation, as well

as classification effectiveness of trees given in the table. For a classification tree for a one year prediction the average costs of incorrect classification amounted to 0.106 for a learning sample and 0.162 for a test sample. For a two year prediction these costs amounted to 0.256 and 0.258, respectively.

The figure below (fig. 2) presents a graphic illustration of a classification tree to classify logistics companies threatened with bankruptcy in one year period horizon.

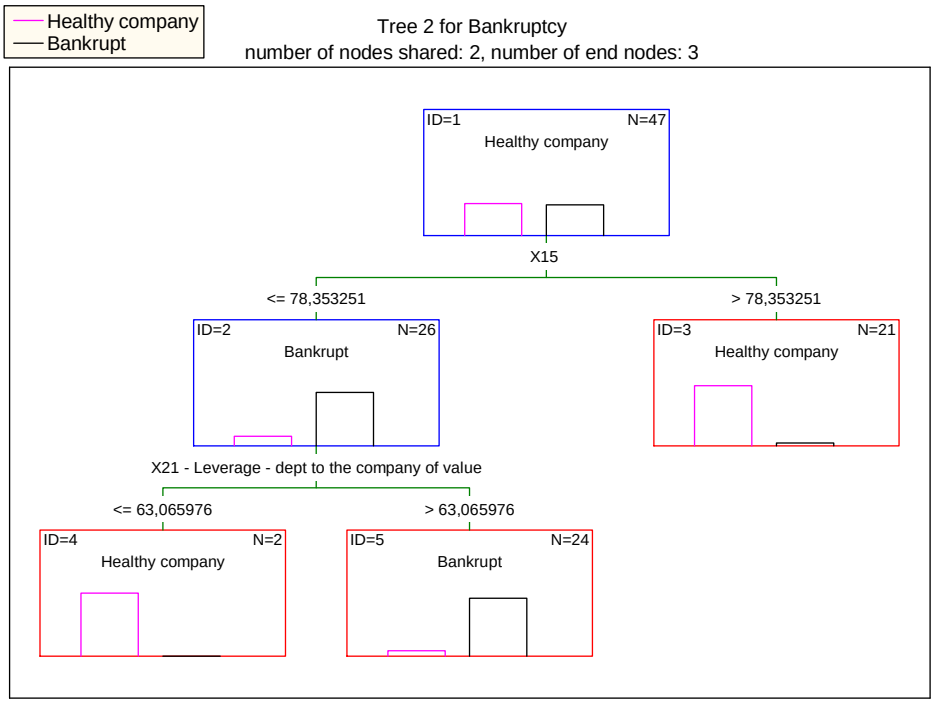

Fig. 2. Graphic illustration of tree structure for classifying logistics companies for a one year period horizon

Source: own study.

Artificial neural networks – MLP

Artificial neural networks are one of the most commonly used techniques to solve problems of correct classification of companies threatened with bankruptcy. The structure of an artificial neural network is modelled after human brain models. Neural networks comprise of many elements processing pieces of information - so-called neurons. Functioning schematic of an artificial network neuron is presented in the figure below (see fig. 3a). Each neuron processes entry signals, marked in figure with x_k $(k = 1, \dots, n)$ into one output signal y. Weights play a very significant role in this model, they are marked by w_k $(k = 1, \dots, n)$, which on the one hand define the importance of information provided

by $i$channel upon entry, on the other hand they record relations occurring between entry signals and output signal. On the basis of data appearing upon entry of a neuron a linear combination of weight vector and entry data is calculated. This combination defines the so-called total neuron stimulation e. Signal occurring at the output of a neuron is a function of neuron activation $y = f(e)$, dependent on the total neuron stimulation.

In practical applications various forms of neuron activation function are assumed. The simplest form is identity function of neuron activation $e = f(e)$. More complex activation functions are also used (Witkowska, 2002), such as: threshold function, linear function, logistic function, exponential function, hyperbolic tangent, sinus function, Gauss function and others.

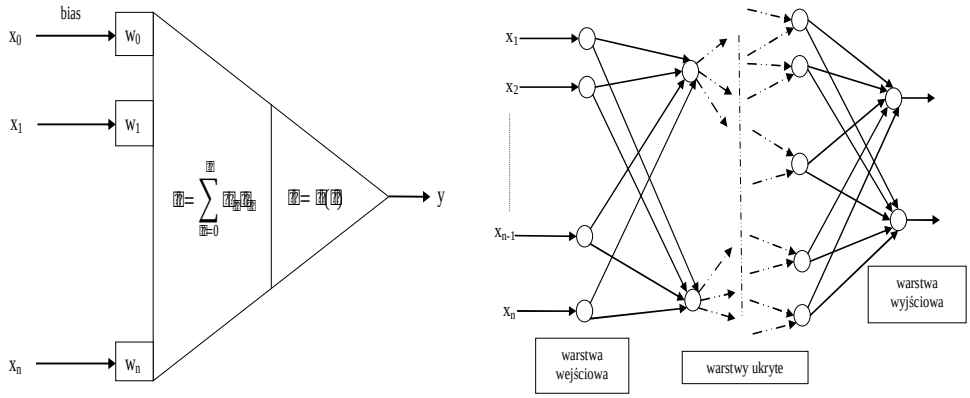

Fig. 3a) Model of an artificial cell

3b) Structure of a one-way multilayer neural network; in a neural network

Source: own study, based on: Witkowska D., *Sztuczne sieci* ..., 2002, pp.4, pp.10.

Artificial neural networks are built from many layers of neurons connected with many structural and topological interrelations. Neurons that belong to the first layer create entries to the network and create the so-called network entry layer. The neurons belonging to the last layer are the network exits and create an exit layer of a topological structure of an artificial neural network. Between outer layers of network (entry and exit ones) there are often intermediate layers of neurons creating the so-called hidden layers of network (neurons that create them are called hidden neurons).

Usage of neural networks to predict bankruptcy of logistics companies was conducted by using an *Automatic Neural Networks* module from *Statistica 10.0* package. Artificial neural networks module from Statistica package has embedded algorithms of automatic analysis of neural networks, enabling automatic search for the best neural networks, which have the best classifying properties for a given set of diagnostic variables. Constructed neural networks were *MLP* (multilayer perceptron)-type networks, which had only one layer of hidden neurons. Two versions of entry data were used (both for one year and two

year prediction horizon). In the first version all indicators were used as entry variables, for which values of ranking indicators (Tab. 1 and Tab. 2) were on a properly high level (at least one indicator of ranking measure higher than 0.4), whereas in the second version as entry variables only those were chosen which were chosen as significant for logit and discriminative models. This is why the number of neurons in a hidden layer depended on the number of entry variables in a network and it changed depending on the chosen version in a range between 3 and 21 hidden neurons.

In the process of training (learning) of neural networks a BFGS (Broyden-Fletcher-Goldfarb-Shanno) algorithm was used – it uses quasi Newton's method and two versions of error function were used: sum of squares ERR_{SoS} and cross entropy (*CE – Cross Entropy*) ERR_{CE}.

Usage of Artificial Neural Networks module in the Statistica package allowed for an automatic choice of the best networks for a given set of entry variables and research sample (learning and test ones), for which the total error of classification correctness is the lowest. Table 3 presents a summary of learning results for 4 best networks (one for each version of entry variables and chosen prediction horizon).

Table 3. The best neural networks models obtained for different versions of entry variables and bankruptcy prediction horizon of one year and two years.

Network type (network id)	Function of learning error	Function of hidden neuron activation	Function of output neurons activation	Percent of correct classification learning sample [%]	Percent of correct classification test sample [%]
Prediction horizon - 1 year to bankruptcy					
Version 1: entry variables: X_1-X_{28} with exclusion: X_{23} i X_{28}					
MLP 26-8-2	Cross entropy ERR_{SoS}	Linear	Linear	91.5	94.7
Version 2: entry variables: X_1, X_2, X_6, X_{11}, X_{18}, X_{27}					
MLP 6-3-2	Cross entropy ERR_{CE}	Tanh	Softmax	87.2	89.5
Version horizon - 2 years to bankruptcy					
Version 1: entry variables: X_1-X_{28} wih exclusion: X_{12}, X_{19}, X_{22}, X_{23}, X_{24}, X_{28}					
MLP 22-17-2	Sum of squares ERR_{CE}	Logistic	Softmax	86.1	92.9
Version 2: entry variables: X_2, X_5, X_{13}, X_{26}					
MLP 4-8-2	Cross entropy ERR_{SoS}	Exponential	Tanh	73.3	82.1

Source: own study.

4. VALIDATION OF ESTIMATED BANKRUPTCY MODELS

In order to choose the best models for practical applications, which will be used to predict bankruptcy of logistics companies from the Podkarpacie region, estimated models of bankruptcy prediction were subject to thorough validation analysis. Usefulness of models

in scope of their best classifying properties in correct recognition of companies threatened with bankruptcy and healthy companies, as well as proper model calibration to data from learning samples was examined.

The fundamental tool used to scrutiny classifying effectiveness of classification models are proper classification matrices (see Tab. 4). *TN* (True Negative) number in the table denotes the number of healthy companies properly qualified by the model. Similarly *TP* (True Positive) number denotes the number of bankrupted companies properly qualified by the model. If healthy companies are classified by the model as bankrupts, then such classification error is called I-type error, and *FP* (False Positive) means the number of these incorrect classifications. Much more serious is a II-type classification error, which is made when model qualifies bankrupts as not threatened with bankruptcy, and *FN* denotes the number of such incorrect classifications.

Table 4. Matrix of correct classifications for bankruptcy prediction model.

True affiliation of company	Predicted affiliation of company	
	NB	B
NB	TN (True Negative)	FP (False Positive) I type error
B	FN (False Negative) II type error	TP (True Positive)

Source: own study.

I-type error, namely the percentage of incorrectly qualified healthy companies (also often denoted as: 1-specificity) is expressed with the formula:

$$Err_1 = \frac{FP}{FP+TN} = 1 - \frac{TN}{FP+TN} = 1 - Eff_1 \tag{5}$$

where: Eff_1 (I-type effectiveness or the so-called specificity) – the percentage of correctly qualified companies as not threatened with bankruptcy.

II-type error, namely the percentage of incorrectly qualified bankrupts (often also denoted as: 1-sensitivity) is expressed with the formula:

$$Err_2 = \frac{FN}{FN+TP} = 1 - \frac{TP}{FN+TP} = 1 - Eff_2 \tag{6}$$

where: Eff_2 (II-type effectiveness or the so-called sensitivity) – the percentage of correctly qualified bankrupted companies.

In the process of validation of models for classification of companies threatened with bankruptcy the most commonly used are the following model validation measures: Information Value (IV) factor, Gini factor and Divergence factor, as well as Kolmogorov-Smirnov statistics and Hosmer-Lemeshow statistics.

Information value factor (IV) for model expresses the ability of the model to separate division of results for a population of bankrupts and non-bankrupts. It is calculated according to the formula (1) by previously putting objects from the sample in order, sorting them in decreasing order in relation to estimated values of probability of objects affiliation with negative class on the basis of a model (probability of company's bankruptcy).

Gini factor is used to examine superiority of estimated model over random model – randomly made decisions. It is calculated using the formula (2), however, one should firstly put objects in order in research samples in relation to decreasing values of bankruptcy probability. *k* index present in formulas (1) and (2) means in this case the number of different attributes or categories of variability for values of bankruptcy probability in research samples.

Validation values of IV and Gini factors are interpreted as follows: the higher (closer to 1) the values of these factors, the better the model's ability to correctly classify bankrupts and non-bankrupts. Whereas for models with a strong predictive power they should take values of at least 0.35 or higher.

Kolmogorov-Smirnov statistics value (KS statistics) defines the maximal distance between distribution functions for conditional distributions in population of healthy companies (NB) and bankrupts (B) and is calculated using the formula (Thomas, 2009):

$$KS = \max_x \left| F(\mathrm{x} \mid B) - F(\mathrm{x} \mid NB) \right| \tag{7}$$

Divergence also expresses a unit of measure of distance between the scrutinized conditional distributions of bankruptcy probability for both company classes and it is described with the following formula (Thomas, 2009):

$$D = \frac{1}{2}\left(\frac{1}{\sigma_G{}^2} + \frac{1}{\sigma_B{}^2} \right)\left(\mu_G - \mu_B\right)^2 + \frac{\left(\sigma_G{}^2 - \sigma_B{}^2\right)^2}{2\sigma_G{}^2\sigma_B{}^2} \tag{8}$$

where: $\mu_{NB} = \sum_x x \cdot f(\mathrm{x} \mid NB)$ - the average value of bankruptcy probability in a population of healthy companies (NB), $\mu_B = \sum_x x \cdot f(\mathrm{x} \mid B)$ - the average value of bankruptcy probability in a population of bankrupts (B), $\sigma_{NB}^2 = \sum_x \left(x - \mu_{NB}\right)^2 \cdot f(\mathrm{x} \mid NB)$, $\sigma_B^2 = \sum_x \left(x - \mu_B\right)^2 \cdot f(\mathrm{x} \mid B)$ - variance of bankruptcy probability distribution respectively for the population of healthy companies and bankrupts, $f(\mathrm{x} \mid NB), f(\mathrm{x} \mid B)$ - percentage of healthy and bankrupt companies for a given category of bankruptcy probability.

It is assumed that divergence should take values above 0.5, in order for the scrutinized distributions to lay far enough from each other and the scrutinized model to have

acceptable ability to properly separate bankrupts from companies not threatened with bankruptcy.

Hosmer-Lemeshow statistics is based on Chi-squared statistics and it is calculated using the following formula (Thomas, 2009):

$$HL = \sum_{i=1}^{N} \frac{\left(n_i p_i - NB_i\right)^2}{n_i p_i \left(1 - p_i\right)} \tag{9}$$

where: p_i - average probability of affiliation with non-bankrupt class for the given *i* rating category, NB_i - the number of healthy companies in a given rating category, N - set number of rating categories, into which the range of bankruptcy probability fluctuation has been divided. Hosmer-Lemeshow statistics has a distribution χ^2 with $df = N - 2$ degrees of freedom. The higher the values of H-L statistics, the better the model's ability to differentiate distribution in both populations (B and NB) and better classifying abilities of the model.

ROC concentration curve is a graphic way of presenting classification power of models in correct separation of bankrupted and healthy companies in comparison with the perfect model (having an effectiveness of 100% correct classification) and random model (completely random classification). Measure of conformity with the perfect model is the measure of field under ROC curve $\left(AUROC = 0.5\left(Gini + 1\right)\right)$. The higher (closer to 1) are the values of field under ROC curve, the better predictive ability of the evaluated model.

The previously characterized measures measure the discriminative quality of models. To examine both discriminative quality and calibration precision of models to learning data and test data one uses brier factor (Brier Score) and LL factor (Likelihood of the model).

Brier factor BS is calculated using the following formula (Löffler, Posch, 2007):

$$BS = \frac{1}{n} \sum_{i=1}^{n} \left(d_i - PD_i\right)^2 \tag{10}$$

where: n – the number of observations in sample, d_i - dummy variable with value of 1, when company is considered bankrupt and ones with a value of 0 otherwise, PD_i - bankruptcy probability estimated on the basis of a model.

The lower the Brier factor value, the better calibrated is the model for data and it should have better prediction properties.

LL model reliability factor (LL) is defined with the following formula (Prusak, 2005):

$$LL = \prod_{i=1}^{n} P\left(Y_i \mid X_i\right) = \prod_{i=1}^{n} PD_i(X_i)^{Y_i} \cdot \left(1 - PD_i(X_i)\right)^{1-Y_i} \tag{11}$$

where: n – the number of observations, $PD_i(X_i)$ - estimated bankruptcy probability at given values of entry variables (independent) in a model, Y_i - dummy variable defining (Y=1 – bankrupts) and (Y=1 – non-bankrupts).

The higher the values of classification model reliability for a learning sample, the better it is calibrated on the basis of entry data. High values of reliability indicator for the test sample should point to good classifying value of the model also for new, unknown cases.

The table below (Tab. 5) presents validation statistics for all examined models of predicting bankruptcy of logistics companies

Table 5. Validation parameters of estimated models for a prediction horizon of 1 year

Model	Eff_1 NB	Eff_2 B	IV	K-S	Gini	Divergence	H-L	AUROC	Brier Score	LL (model)
Logit	learning sample									
	88%	96%	3.6	0.83	0.89	8.8	11.2	0.95	0.081	$1{,}8 \cdot 10^{-6}$
	test sample									
	78%	90%	2.8	0.80	0.91	5.7	3,3	0.95	0.108	$3{,}0 \cdot 10^{-3}$
Network MLP 26-8-2	learning sample									
	92%	91%	4.0	0.83	0.89	5.3	17.9	0.95	0.152	$1{,}3 \cdot 10^{-10}$
	test sample									
	89%	100%	2.4	0.89	0.82	2.9	48.2	0.91	0.162	$2{,}1 \cdot 10^{-5}$
Network MLP 6-3-2	learning sample									
	92%	83%	2.6	0.75	0.86	4.2	13.1	0.93	0.135	$1{,}5 \cdot 10^{-9}$
	test sample									
	89%	90%	2.8	0.79	0.91	7.0	3.6	0.96	0.111	$8{,}6 \cdot 10^{-4}$
C&RT Tree	learning sample									
	92%	96%	5.7	0.96	0.93	14.4	7.2	0.97	0.059	$1{,}8 \cdot 10^{-5}$
	test sample									
	78%	90%	1.3	0.68	0.67	4.2	19.0	0.83	0.140	$1{,}1 \cdot 10^{-4}$

Source: own study.

Table 6. Validation parameters of estimated models for a prediction horizon of 2 years

Model	Eff_1 NB	Eff_2 B	IV	K-S	Gini	Divergence	H-L	AUROC	Brier Score	LL (model)
Logit	learning sample									
	74%	81%	1.9	0.58	0.65	2.2	6.0	0.82	0.172	$1{,}1 \cdot 10^{-19}$
	test sample									
	79%	79%	1.8	0.57	0.70	2.9	4.9	0.85	0.153	$2{,}8 \cdot 10^{-6}$
Network MLP 22-17-2	learning sample									
	88%	84%	3.6	0.74	0.87	5.9	9.6	0.94	0.103	$4{,}8 \cdot 10^{-13}$
	test sample									
	100%	86%	3.7	0.86	0.92	10.2	2.4	0.96	0.087	$3{,}7 \cdot 10^{-4}$
Network MLP 4-8-2	learning sample									
	67%	79%	2.4	0.56	0.70	2.4	14.8	0.85	0.184	$1{,}8 \cdot 10^{-21}$
	test sample									
	100%	86%	3.7	0.86	0.94	6.8	11.4	0.97	0.167	$4{,}6 \cdot 10^{-7}$
C&RT tree	learning sample									
	88%	81%	2.8	0.70	0.75	4.2	8.8	0.88	0.127	$2{,}6 \cdot 10^{-16}$
	test sample									
	71%	71%	1.3	0.50	0.56	0.8	19.0	0.78	0.229	0

Source: own study.

5. CONCLUSIONS

When setting predictions of possible bankruptcy with help of examined models it is worth introducing a separation into two groups, like it was done previously. One of them comprises of predictions made by models estimated on the basis of data for the period of one year before bankruptcy, the second one includes predictions for the same group of models, however estimated on the basis of data for two years until the bankruptcy moment (Tab. 7). In the first case we consider a sample of 82 “healthy” logistics entities from the Podkarpacie region. In the second version the total number of companies amounts up to 61.

Table 7. Average value of predictions in section of examined models for Podkarpacie.

estimation based on data from one year before bankruptcy period	
logit model	0.316692
C&RT model	0.234901
MLP 26-8-2 model	0.456908
MLP 6-3-2 model	0.410757
Average one-year prediction	**0.454873**
Average two-year prediction	**0.596491**
Average three-year prediction	**0.683806**
estimation based on data from one year before bankruptcy period	
logit model	0.354433
C&RT model	0.439643
MLP 4-8-2 model	0.407781
MLP 22-17-2 model	0.298116
Average one-year prediction	**0.374993**
Average two-year prediction	**0.562758**
Average three-year prediction	**0.671097**

Source: own study.

Dividing the above bankruptcy probabilities into two categories, namely one up to a value of 0.5 and the other more than 0.5(non-bankrupt or bankrupt), one needs to underline the fact that among operating logistics companies from Podkarpacie there are no negative indicators for the whole sector. the worst negative premises concerning whole groups of companies are given with help of an artificial neural network *MLP* models, because they exceed value of 0.4 and they are much higher than the two others. In the case of estimations on the basis of data for two years before bankruptcy period one can observe improvement in indications of artificial neural network models and deterioration of classification trees' indications.

When evaluating average predictions for a period from one up to three years it can be generally said that only average two year indications show signals of possible bankruptcy. Of course, the longer the prediction horizon, the higher the bankruptcy possibility.

An interesting comparison in case of prediction values in section of four examined models can be the illustration of a number of signs for possible companies' bankruptcy (Tab. 8).

Table 8. Evaluation of bankruptcy threat scale in a survey of models.

	Number of bankruptcies				
	0	1	2	3	4
	estimation based on data from one year before bankruptcy period				
Podkarpacie	38 (46.34%)	17 (20.73%)	5 (6.10%)	9 (10.98%)	13 (15.85%)
	estimation based on data from two years before bankruptcy period				
Podkarpacie	28 (45.90%)	13 (21.31%)	7 (11.48%)	8 (13.11%)	5 (8.20%)
Scale of bankruptcy risk	Small threat		Average threat	High probability	

Source: own study.

Large number of companies was in the group of so-called small threat in regard to possible predictions concerning bankruptcy. Entities for which none or one of the examined models showed a potential danger of bankruptcy can be included in this class. One needs to underline the fact that high number of companies in a survey of estimated methods does not have any negative indications. It may prove a really solid position of these entities. This group makes more than a half of the researched ones.
When comparing estimations on the basis of data for one year and two years before the bankruptcy period, the second group fares better. In this case one can observe a distinct declining trend for a number of companies in relation to the number of possible negative indications.
An interesting juxtaposition can be made of signals for being threatened with bankruptcy for each researched model (Tab. 9). Here one can conduct a real evaluation of the quality of their indications. It seems that the most stable, without regard to the examined version, is the logit model. The most sensitive are models of artificial neural networks.

Table 9. Enumeration of threats for given models.

	Bankruptcy	
	Yes	No
	estimation based on data from one year before bankruptcy period	
logit model	25 (30.5%)	57 (69,5%)
C&RT model	18 (22.0%)	64 (78.0%)
MLP 26-8-2 model	34 (41.5%)	48 (58,5%)
MLP 6-3-2 model	29 (35.4%)	53 (64.6%)
	estimation based on data from two years before bankruptcy period	
logit model	21 (34.4%)	40 (65.6%)
C&RT model	23 (37,7%)	38 (62,3%)
MLP 4-8-2 model	12 (19.7%)	49 (80.3%)
MLP 22-17-2 model	15 (24.6%)	46 (75.4%)

Source: own study.

When performing a general evaluation of the examined group of models one has to implement the previously used division. So for estimations on the basis of data for one year before bankruptcy period of a given entity the best results are produced by a model of the *C&RT* classification trees, mainly for the so-called learning sample and models of artificial neural networks for the test sample. As for the second group, model of artificial neural networks *MLP 22-17-2* for both test and learning groups can be used.

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Notes

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PROGNOZOWANIE UPADŁOŚCI FIRM Z SEKTORA LOGISTYCZNEGO DZIAŁAJĄCYCH W REGIONIE PODKARPACIA

W artykule przeprowadzono badanie skuteczności różnych koncepcji modelowania upadłości przedsiębiorstw z sektora logistycznego. W celu pełniejszego zobrazowania zagadnienia ww. prognozowanie ewentualnych negatywnych skutków prowadzonej działalności przeprowadzono dla wszystkich firm ww. sektora działających w regionie Podkarpacia. Analiza została poparta danymi pochodzącymi z bazy danych *EMIS* (*Emerging Markets Information Service*). Szeroka gama 28 wskaźników finansowych została pogrupowana na pięć grup wskaźników tj. odpowiednio wskaźniki płynności, zyskowności, zadłużenia, sprawności działania oraz finansowe. Wyżej wspomnianą próbę badawczą podzielono na grupę przedsiębiorstw chorych – w stosunku co do których ogłoszono upadłość – oraz grupę tzw. firm zdrowych (sprawie działających, o dobrej kondycji finansowej. Podejście takowe pozwala na lepszą, obiektywną ocenę stosowanych metod w zakresie modelowania upadłości. Celem niniejszej publikacji była zatem chęć znalezienia czynników (modeli) opisujących ryzyko upadłości przedsiębiorstw w kontekście ich skuteczności przewidywań w horyzoncie jedno- i dwu letnim. Zastosowano w tym wypadku modele regresji logistycznej, drzew klasyfikacyjnych oraz dwóch wariatów sztucznych sieci neuronowych. Pełnej oceny zastosowanych modeli dokonano w procesie walidacji. Podstawowym narzędziem stosowanym w tym wypadku do badania efektywności klasyfikacyjnej modeli klasyfikacyjnych są macierze poprawnych klasyfikacji. Dokonano zatem oszacowania poprawnych oraz błędnych odsetków wskazań modeli zarówno w grupie wskazanych wcześniej przedsiębiorstw zdrowych jak i chorych. Ostatecznie przeprowadzono ocenę poruszanych na łamach artykułu metod oraz ogólnej kondycji sektora logistycznego w rejonie Podkarpacia.

Słowa kluczowe: upadłość, sektor logistyczny, modelowanie, wskaźniki finansowe.

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THE STUDY OF THE DYNAMICS OF TRAFFIC ACCIDENTS USING THE CONTROL CHARTS

The aim of this article is an attempt to use the control chart for the average to study the dynamics of traffic accidents in selected European countries. The study covered the three countries: Poland, Ukraine and Sweden for the period 1993-2008. The obtained results were compiled with the European average-annual number of accidents for 42 countries. The analysis confirmed that according to common opinion Sweden has the lowest average of accidents, while Ukraine oscillates around the European canon, which may be surprising, considering the fact that Ukraine is seen by many as a country with low and high culture of driving accidents. The analysis showed that the worst ranks shows Poland, which differs significantly from the European average in spite of the positive trend noticeable since 1997. It was also found that the liberalization of rules and increase the number of cars contributed negatively to the increase in the number of accidents (Ukraine), and exacerbation of traffic regulations had a positive impact on test feature (Poland). It should be emphasized that the website of the European Economic Commission, which the data were collected from has no information for subsequent periods. It is therefore difficult to determine whether the positive trend of Poland development remains at a similar level, and within the next four years, i.e. until 2012 it managed to get closer to the expected level in Europe. In the case of Ukraine the opposite trend can be observed, but again for the same reasons it is hard to determine whether the negative trend was prevented. It is also not possible to examine what impact on the development of the number of accidents in Poland and Ukraine had the organization of mass events such as Euro2012 and related with it multimillion-dollar expenditure on the improvement of road infrastructure.

Keywords: control charts, traffic accidents, dynamics, the average.

1. INTRODUCTION

Monitoring of socioeconomic processes is one of the essential tasks of the Department of Mobility and Transport of the European Commission. It aims at the qualitative improvement of the phenomena being observed, the maintenance of the observed positive trends, as well as counteracting the negative trends in terms of both time and space. Extensive use of econometric methods had been widely used here, in particular those related to the analysis of time series. However, the scientists are constantly looking for the alternative methods for the analysis of dynamic phenomena.

This work places emphasis on the attempt to use the control chart for the average in the study of the dynamics of traffic accidents in the three selected European countries in the period 1993-2008.

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2. CONTROL CHARTS – METHODOLOGY

Waler Shewhart is considered to be the father of control charts, who first adapted it to practical purposes in 1924[2] [1]. The basis for their use is the belief that the internal (natural) variability, characteristic for each process, can be controlled independently of external factors (non-accidental) which negatively affect the investigated phenomenon. Their appearance will force a change process and bring it up to standard.

Depending on the type of tested feature and the underlying process it is possible to choose from many types of control charts such as: the chart of average value and range chart (X and R), the chart for the average value and standard deviation (X and S), the chart for median and range chart (MR) and the special charts with the moving average (MA), cumulative sum (CUSUM), or similar for measurable features and immeasurable ones: the fraction of non-compliant chart (chart p or np) and for the number of non-compliance for one unit (chart z or u). In this work for the analysis, the charts for the average value had been used.

An important added value of his method is simple and clear presentation with diagrams maintenance, which resemble simple line graphs where the x-axis the number is plotted, while the y-axis the value of the collected sample. The scheme is supplemented by the top and bottom control line (*Upper and Lower Control Limit)* and the central line *(Central Line).* Customarily, it is assumed that the value of the control limits are a multiple of the standard deviation, while the central line is desired for a given process size around which the observed values of the sample[3] [2] should oscillate. The result of these annotations is presented below in Figure 1.

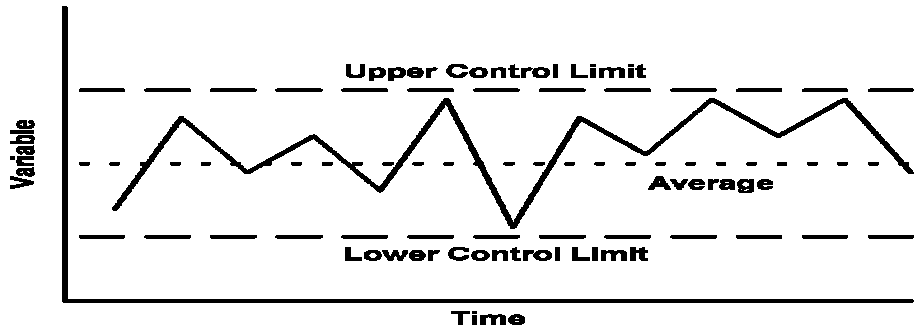


Fig. 1. The graphical presentation of the control chart with inlaying demonstrative control lines [4]

The analysis of control charts focuses on the controlling of the tested process for its stability. It is assumed that the process is under control if the observations do not exceed the control lines.

[2] M. Best i D. Neuhauser, „Walter A Shewhart, 1924, and the Hawthorne factory," *Quality and Saety in Health Care*, vol. 15, no 2, pp. 142-143, 2006

[3] M. L. Berenson, D. M. Levine i T. C. Krehbiel, Basic Business Statistics, Prentice Hall, 2012.

[4] Source: http://www.tangram.co.uk/

3. THE RESULTS OF THE ANALYSIS

Detailed analysis of the dynamics of traffic accidents with the usage of control charts have been conducted in case of two developing countries: Poland, a transit country between the Eastern Europe and the West, which is the member of the European Union; Ukraine, in which the road law is considered a significantly liberal and in contrast one of the Scandinavian countries, Sweden, considered to be highly developed, where the culture of driving and the quality of roads is at a high level, and the penalties for driving offenses are a deterrent high. In this case data derived from the Economic Commission for Europe (ECE)[5] had been used. Individual data had been compared with the average results for Europe.

In the first stage of the analysis the control chart for the average value for all 42 European countries had been used. Data downloaded from ECE were presented for each country on a monthly basis. To be able to adapt them for the purpose of control charts, the average values for each month had been determined and then the monthly average values had been aggregated to the annual average. The central line equals to 3.587 was determined as the average value determined for all subjects of observations. Upper and lower control line were taken as three times the standard deviation and are respectively 3.961,9 and 3.312,1[6].

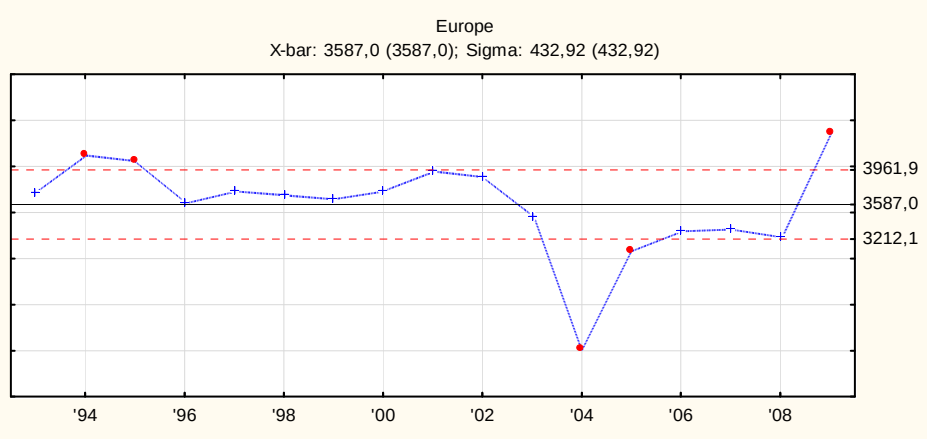
Figure 2 shows the graphical representation of the control chart for the average including all European countries. It is assumed that the process is out of control if the observation exceeds one of the limits, upper or lower. However, because of the nature of the tested features i.e., road accidents the fact that they exceed the top control line is alarming because the value below the lower control line indicates a positive development of the studied phenomenon. It is clear that the warning signal is generated for the years 1994, 1995 and 2009. The average of accidents in these years is more than four thousand. Countries which systematically overestimated the European annual average of accidents are: Poland, Portugal, Russia, Spain, Turkey, Italy, France and England. It is clear that the developed countries dominate on this list, what can be surprising, because in current opinion of many, in the developing countries the proportion of accidents is the highest, the culture of driving is low, the infrastructure is unsatisfactory. This is reflected even in the warnings for tourists who want to come to the territory of that country using their own car, while the developed countries are considered to be safe and friendly for drivers. The presence on the list such countries as England, Italy or France can be explained by a higher proportion of cars per capita which gives statistically a greater probability of the occurrence of an accident or collision than in the case of countries in which the amount of traffic is lower. According to data from the World Bank at the beginning of the 1990s an average on 1.000 residents in developed countries accounted for not less than 300 cars (in most Western European countries this number ranged between 400-500 with the exception of Germany and Italy where the percentage was above 500)[7].

[5] http://w3.unece.org

[6] Details of the techniques of calculation and design of control charts are available in:
[5]Levinson, W. A., 2011. *Statistical Process Control for Real-World Applications.* p.l.:CRC Press.
[6]Zontec, 2010. *The Book of Statistical Process Control.* Second Edition ed. p.l.:The Zontec Press Cincinnati.

[7] http://data.worldbank.org

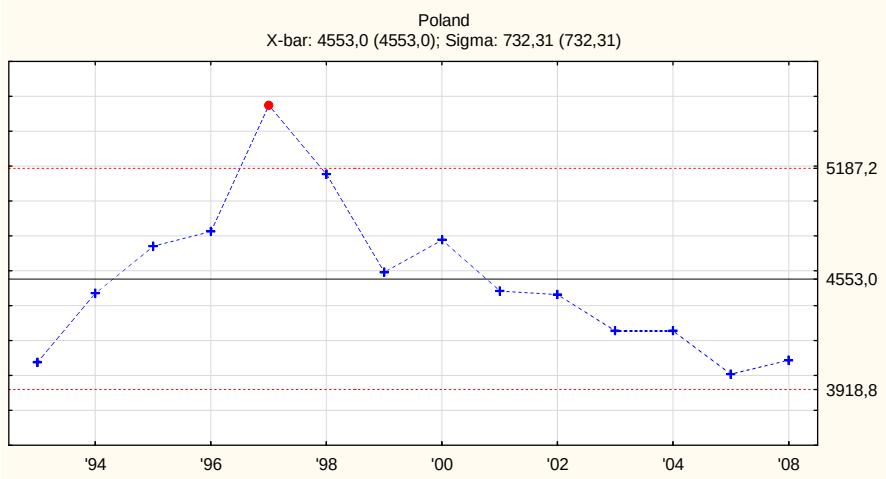
Fig. 2. The graphical presentation of the control chart for the average for Europe



The use of control charts for Poland (Fig. 3.) showed that the year 1997 turned out to be the critical one, where the average annual number of accidents was higher than 5.000. The observations for the remaining years oscillating around the average of 4.553 located in the critical area, also designated as three times the standard deviation – 5.187 and 3.919 respectively. A clear downward trend of the average number of accidents can be observed in the Republic of Poland, starting from the critical year 1997 which continues until the end of analyzed period. The reason for the decreasing trend in Poland may be the Law on Road Traffic passed on 20 June 1997, which among other things provided for the use of lights in autumn and winter, the use of seat belts in cars also in the back seat as well as far more effective fight against driving under the influence of alcohol and the prevention of alcoholism[8] [3].

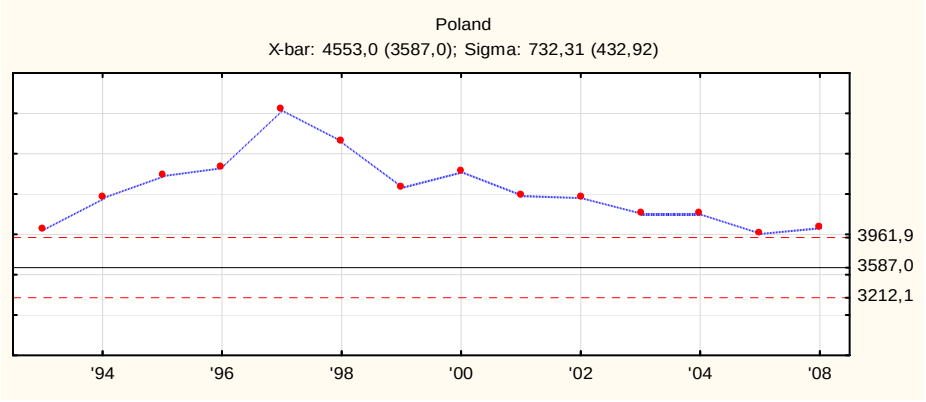
[8] J. Moskalewicz i J. Żulewska-Sak, „Alkohol w latach transformacji ustrojowej w Polsce. Raport z realizacji celu operacyjnego Narodowego Programu Zdrowia."

Rys.3. The graphical presentation of the control chart for the average for Poland



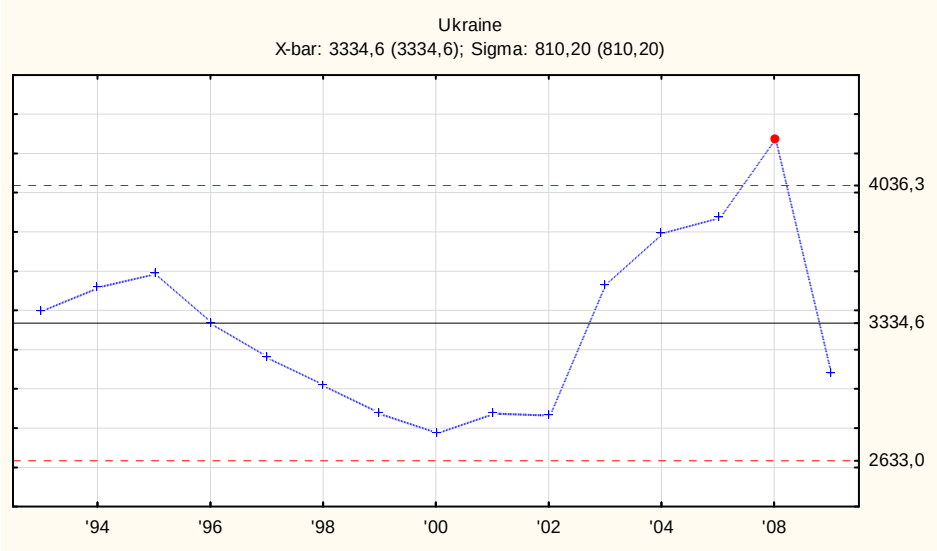
The results of the analysis for Poland May be appealing especially a positive development trend showing a decreasing number of accidents. However, the adoption of the European average equal to 3.587 as the central line and applying it to a control chart for Poland (Fig.4) shows clearly how far Poland from the Europe is. Even in the years where the number of accidents was below 4.000, i.e., in 1993 and 2007 the average number of accidents is not situated below the upper limit of the control set on the European database. The lack of database for subsequent periods does not allow to determine whether the positive downward trend resulted in the achievement of average at the acceptable European level.

Fig. 4. The graphical presentation of the control chart for the average for Poland where the central line is the average for Europe



A similar analysis was conducted for Ukraine (Fig.5 and 6). The results, however, significantly differ from those for Poland. The main difference is the central line (3.335), which is lower than the European average, but with a greater standard deviation. The Report of Ukraine from 2008 prepared by the Oxford Business Group[9] [4] as an important cause of the increase of accidents in Ukraine until 2008, the year in which the number of accidents has increased almost doubled compared with the year 2000, provides a significant increase in the number of cars and the liberalization of road regulations.

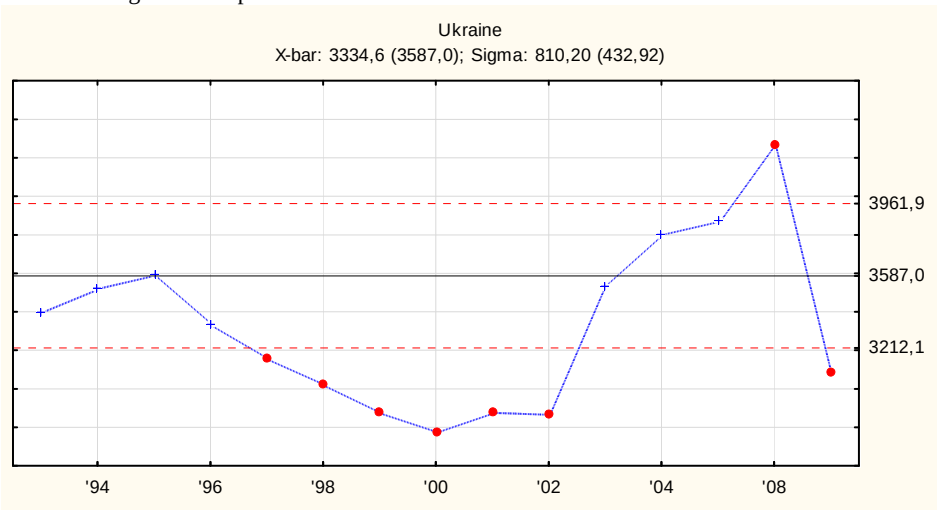
Fig.5. The graphical presentation of the control chart for the average for Ukraine



Comparing Ukrainian results with the European average and taking into account the fact that the annual average for Ukraine was lower than the European, it is not surprising that the modified control chart (Fig.6) is confusingly similar to the original chart and the only year in which there was the upper limit is the year 2008.

[9] „The Report Ukraine 2008," Oxford Business Group

Fig. 6. The graphical presentation of the control chart for Ukraine, where the central line is the average for Europe



In contrast, the control chart for Sweden has been generated (Fig.7), which presents the average annual number of accidents not exceeding the alarm values throughout the period considered. Only a slight increase in the number of accidents between 2001 and 2003 is noticeable. However, it is worth noting that due to the adopted scale (a small value of the standard deviation) the increase in the graph appears to be significant. Nominally, however, this is an increase of approximately 300 units, which nevertheless does not exceed the upper limit of control, defined at the level of 1.562. as can be seen after 2003 the growth was stopped and the average number of accidents remained at a stable level. Remaining at a high level and being continued the improved road safety program, combined with a very good state of the roads and a high driving culture result in this country having one of the lowest accident rates in Europe and in the world. This is reflected in the Figure 8., presenting the average of accidents for Sweden in the background of Europe, where evidently the two averages differ from each other and even the highest average values of accidents for Sweden are far below the critical value for the European average.

Fig. 7. The graphical presentation of the control chart for the average for Sweden

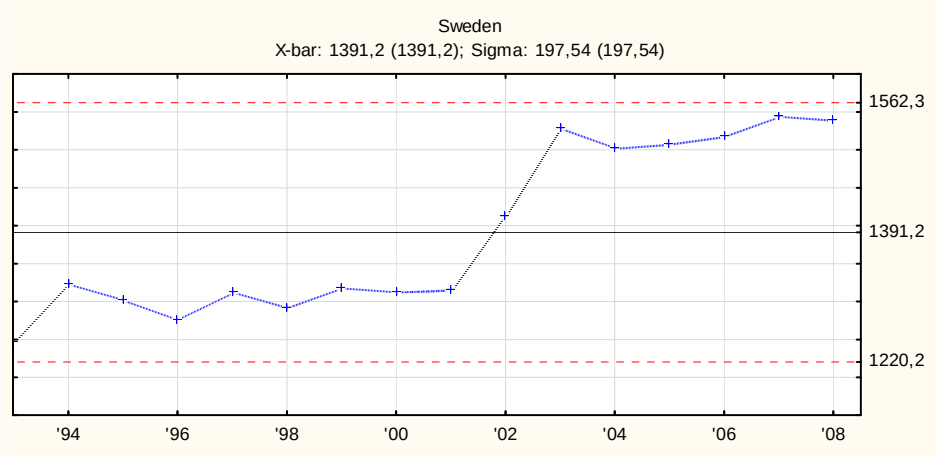
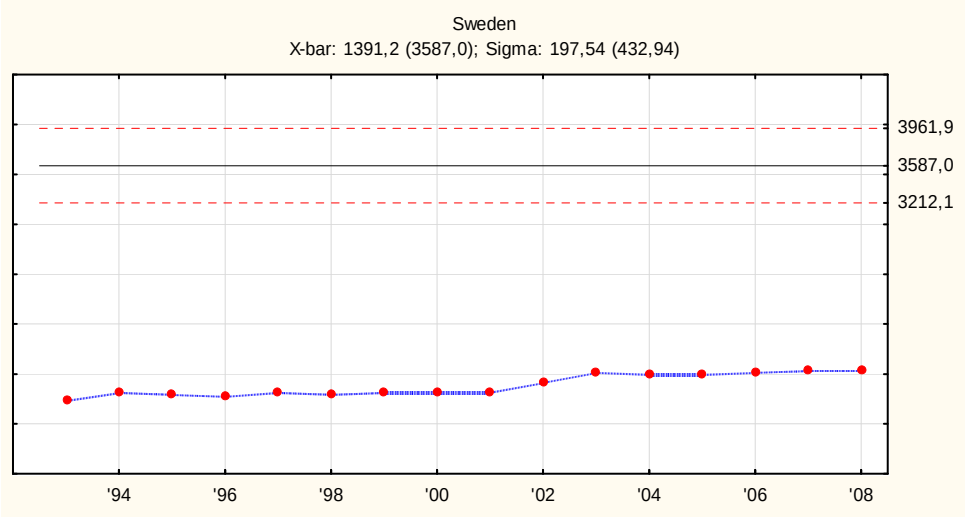


Fig. 8. The graphical presentation of the control chart for the average for Sweden, where the central line is the average for Europe



4. CONCLUSIONS

The aim of the work is an attempt to use the control charts for the average to study the dynamics of traffic accidents in selected European countries. The study covered three countries: Poland, Sweden and Ukraine in the period 1993-2008. The obtained individual results were further combined with a European annual average number of accidents, calculated as the average number of accidents for 42 countries. The analysis confirmed that in accordance with the general opinion that Sweden has the lowest

average of accidents while the Ukraine oscillates around the European Union, which may be surprising considering the fact that Ukraine is seen by many as a country with low driving culture and high rate of accidents. The presented results, however, contradict this thesis. The worst in their rank is Poland, which differs significantly from the European average, despite the positive trend noticeable since 1997. It was also found that the liberalization of regulations and the increase in the number of cars, negatively contributed to the increase in the number of accidents, while tightening the regulations on the roads traffic had a positive impact on the study. It should be emphasized that the website of the European Economic Commission, from which the data for analysis had been downloaded, does not have the data for subsequent periods. Therefore, it is difficult to determine whether the positive trend for the development of Poland remains at a similar level, and within the next four years i.e., until 2012 it managed to get close to the expected European level. In the case of Ukraine, the opposite trend can be observed, but again for the same reasons it is not possible to determine whether the negative trend has been prevented. It is also impossible to examine what impact on the number of accidents in Poland and in Ukraine had the organization of mass event which was Euro 2012, when during the preparations for the championship, both governments put a great emphasis on the development of road infrastructure, however, because of summer months and the organization itself there was heavy traffic on the roads of both countries.

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[3] J. Moskalewicz i J. Żulewska-Sak, „Alkohol w latach transformacji ustrojowej w Polsce. Raport z realizacji celu operacyjnego Narodowego Programu Zdrowia.," *Przegląd Epidemiologiczny,* no 57, pp. 713-23, 2003.

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BADANIE DYNAMIKI WYPADKÓW KOMUNIKACYJNYCH Z ZASTOSOWANIEM KART KONTROLNYCH

Celem pracy jest próba zastosowania kart kontrolnych dla średniej do badania dynamiki wypadków komunikacyjnych w wybranych krajach europejskich. Badaniem objętych zostały trzy kraje: Polska, Ukraina i Szwecja, na przestrzeni 1993-2008 roku. Otrzymane indywidualne wyniki zostały zestawione z europejską średnioroczną ilością wypadków, obliczoną na podstawie średniej dla 42 krajów. Analiza potwierdziła, że zgodnie z powszechną opinią, Szwecja charakteryzuje się najniższą średnią wypadków, natomiast Ukraina oscyluje wokół kanonu europejskiego, co może dziwić, zważywszy na fakt, że Ukraina widziana jest przez wielu jako kraj o niskiej kulturze jazdy i wysokiej wypadkowości. Analiza wykazała, że najgorzej plasuje się Polska, która znacząco odbiega od europejskiej średniej, mimo pozytywnego trendu zauważalnego od 1997 roku.

Stwierdzono dodatkowo, że liberalizacja przepisów oraz wzrost liczby samochodów, negatywnie przyczyniły się do wzrostu liczby wypadków (przypadek Ukrainy), natomiast zaostrzenie przepisów o ruchu drogowym miało pozytywny wpływ na badaną cechę (przypadek Polski). Należy podkreślić, że strona Europejskiej Komisji Gospodarczej, z której pobrano dane, nie dysponuje danymi za kolejne okresy. Trudno zatem stwierdzić, czy pozytywna tendencja rozwojowa Polski utrzymuje się na podobnym poziomie i w przeciągu czterech kolejnych lat, tj. do roku 2012 udało jej się zbliżyć do oczekiwanego poziomu europejskiego. W przypadku Ukrainy obserwować można tendencję odwrotną, jednak znowu z tych samych powodów nie jest możliwym ustalenie, czy negatywny trend został zastopowany. Nie jest również możliwe zbadanie, jaki wpływ na rozwój liczby wypadków w Polsce i na Ukrainie miała organizacja masowej imprezy jaką było Euro2012 i związane z nią wielomilionowe wydatki na poprawę infrastruktury drogowej.

Słowa kluczowe: karty kontrolne, wypadki komunikacyjne, dynamika, średnia.

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Mariola NYCZ[3]

THE SIZE OF PUBLIC PASSENGER TRANSPORT AND THE NUMBER OF PASSENGER CARS IN POLAND AND SLOVAKIA

The increase in wealth of the society leads to an increase in the number of possessions. Nowadays, one of the basic goods is our own vehicle. Starting from the second half of the twentieth century a passenger car has become the own means of transport in Europe. The development of the automotive industry is critical for the changes taking place in the way of satisfying transport needs. The increase in the number of cars in society usually leads to a lower demand for public transport services.

The paper is a comparison of the size of the public transport of passengers and the number of passenger cars in two bordering countries, i.e. in Poland and Slovakia. The available data collected by the statistical offices of both countries were used in the analyses. The data covered the years 2007–11 and related provinces and regions in Poland and Slovakia. In order to compare with each other the studied variables, these data were referred to the size of the population in the regions.

To study the relationship between variables the correlation analysis as well as linear regression were used. The conducted analysis shows that the growth of the automotive industry has contributed to the decline in the number of public passenger transport in both countries. For each country this relationship was described by the linear regression equation. In addition, for both countries there were determined linear trend equations of the studied variables and demonstrated the existence of analogous trends in the regions. Also there were shown some differences between regions and countries, which are expressed mainly in the values of variables, and the pace of change.

Keywords: public passenger transport, a passenger car, province, variables, correlation analysis and linear regression.

1. INTRODUCTION

The increase in wealth of the society leads to an increase in the number of possessions. Nowadays, one of the basic goods is our own means of transport. Having your own personal means of transport results from the need to meet ever increasing individual transportation requirements. Starting from the second half of the twentieth century a car has become a very popular mean of transport in Europe. The increase in the number of cars in society can lead to a reduced demand for public transport.

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In the paper it was analyzed how the size and the number of passenger cars in Poland and Slovakia in the period 2007–11 developed. In order to eliminate the effect of population size of the two countries the following variables: number of passengers per 1000 inhabitants and the number of passenger cars per 1000 inhabitants were applied. There were also studied the differences which exist in various regions of the two countries and between the countries.

The analysis was based on the data collected by the Central Statistical Office in Poland and the Statistical Office of the Slovak Republic. To study the relationship between variables the linear regression and correlation analysis was applied (see: R. R. Wilcox[4]).

2. PUBLIC TRANSPORT

One of the main factors determining the economic development of the country is transportation. Public transport is an area of the economy. Modern transport infrastructure can provide the effect of diffusion of the main centers of economic growth of the country on those parts which – due to the lack of adequate access government – are in a state of stagnation. Properly organized transport and following the innovations transport infrastructure strengthen the competitiveness of the state's economy and its consistency, not only spatial, but also economic and social one. The research on transport in Poland in terms of qualitative and quantitative terms, in relation to the developed European economies, clearly illustrates the disparities which are formed between the two countries.

Without effective functioning transport one cannot talk about full advantage of the potential of the economy and education. Low quality of both these international connections, as well as local ones, adversely affect the mobility of the population and the poor effects of trade and is a very significant barrier to the development of trade and services.

The issue of passenger transport meets with the problem of vague terminology. Such an activity is referred interchangeably as public transport, within the agglomeration, public, local, municipal or passenger. Often as a synonym for the word of transport the term communication is used.[5]

Development of the proper communication system in cities requires large expenditure allocated to infrastructure, including fleet vehicles. In order the system could encourage the use of public mass transport it needs also, in addition to a number of different factors,some kind of encouragement with an attractive price.[6] Properly functioning public mass transport is a vital component of the social infrastructure that enables sustainable development.[7]

Conducting appropriate actions to manageeffectively the flow of people in urban areas is a task for practitioners and theorists dealing with issues of urban logistics. According to

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[4] R. R. Wilcox, *Applying Contemporary Statistical Techniques*, Amsterdam: Academic Press, 2003, s. 173–206.

[5] J. Gadziński, *Ocena dostępności komunikacji przestrzeni miejskiej na przykładzie Poznania*, Bogucki Wydawnictwo Naukowe, Poznań 2010, s. 17-18.

[6] A. Drewnowski, A. Wysocka, *Możliwości rozwoju zintegrowanych systemów kolejowo-drogowych pasażerskiego transportu regionalnego w świetle nowej ustawy o publicznym transporcie zbiorowym*, Zeszyty Naukowe Politechniki Śląskiej, Seria: Transport z. 75, Gliwice 2012, s. 22.

[7] T. Bartosiński, *Cel i zakres ustawy o publicznym transporcie zbiorowym*, [w:] *Materiały konferencji „Plan transportowy w ustawie o publicznym transporcie zbiorowym"*(Warszawa, 25 XI 2009), SITK Oddział w Warszawie, Warszawa 2009, http://siskom.waw.pl/nauka/konferencje/20091125/publikacja_calosc.pdf, s. 1.

the opinion of the European Economic and Social Committeefrom 2007 which shows the proposals for transport in metropolitan areas, the worrying fact is a fast decline of collective public transport and an excessive growth of car traffic in cities. The Committee recommends the need for actions affecting the attractiveness and development of public transport.[8]

The task of the public authorities is a gradual increase of its involvement in the provision of public transport services in urban areas. At the beginning, in the time of application of the omnibus as a means of transport, the market was very competitive and the involvement of local authorities was limited to the issuance of licenses and possible enforcement. Today the situation is completely different. In retrospect, the development of urban public transport market can be divided into three stages:

- Stage I - associated with the creation of the first transport companies characterized by high dynamics and market instability;
- Stage II - associated with the formation of mergers, agreements and consolidation in order to increase profits and achieve stability on the market and the long term functioning. Entrepreneurs were looking forward to create a monopoly on the market;
- Stage III - which is a period of significant involvement of public authorities and high interference.[9]

Undertaken measures,which are used to achieve objectives related to integrated transport policy and land use in cities, are aimed at three groups including:

- development of the city in accordance with the course of the route characterized by the best service by public transport;
- introducing difficulties in the use of private cars in the central parts of cities;
- shortening the length of routes to those which are the most popular destinations among passengers.[10]

Introduction of modern means of transport is primarily associated with the reduction of transport costs of service and ensuring reliabilityand convenience for passengers as well as its safety while traveling. Technological changes are generally associated with the process of diffusion. The process of diffusion of technology means the gradual improvement of inventions and innovations. This process is related tothe development of human skills necessary for the use and application of new techniques to improve the old technology and industry. Some significant market features which are a measure of the rate of adoption of new technologies have a great influence on the diffusion.[11]

3. CHANGES CHARACTERISTICS IN PUBLIC TRANSPORT

Among the currently existing systems of public transport, it is the urban transport which has the most stable position in the transport system. The awareness of the needs of its maintenance and the need for its continuous development is also growing. The rapid

[8] Opinion of the European Economic and Social Committee on transport in urban and metropolitan areas (exploratory opinion), TEN/276-CESE615/2007, Brussels 2007.

[9] Á. Costa, R. Fernandes, *Urban public transport in Europe: Technology diffusion and market organization*, "Transportation Research" Part A 46 (2012), s. 269–284.

[10] J. Malasek, *Pakiety wdrożeniowe koordynacji miejskiej polityki transportowej z polityką zagospodarowania przestrzennego*, „Transport Miejski i Regionalny", nr 12, 2011, s. 13.

[11] Á. Costa, R. Fernandes, *op. cit.*, s. 269–284.

growth of urban areas, the negative effects of the increasing vehicular traffic are the results of an increased number of accidents, increased air pollution and congestion are the impetus for the construction of a functioning public passenger transport.[12]

In Western European countries already in the 50s of the twentieth century the phenomenon of a steady decline in the size of passengers using public transport, mainly on local railway lines was observed. In Poland, this trend appeared after 1990 as a result of the rapid development of the automotive industry[13]. Over the last two decades the number of passenger transport by bus decreased almost fourfold. Among other reasons for such a drastic decrease in the size of transport there should be distinguished the following:

- competition from other carriers;
- poor quality of services, low level of modernization of means of transport;
- unsuitable offer to the needs of the transport of passengers;
- removal of unprofitable lines, destabilize profitable lines;
- lack of a coherent communication system on a scale of different areas (region, county, or municipality and country);
- low price competitiveness relative to private means of road transport. [14]

According to Eurostat data for 2010, the leading country in the bus transport measured in kilometers is Hungary, where the share of the transport in all transport amounts to 25.1 percent. For the EU the figure is 8.8 percent. Poland is classified into one of the last in this respect, with the result of 6.4 percent.

The level of motorization is one of the statistical measures describing the state of transportation in the country, region or city. Definitely a better measure would be to use the distribution into transport tasks of individual means of transport and an average trip length of inhabitants . Unfortunately, only some local governments collect such data.[15]

The worrying aspect is the dominance of road transport in passenger transport in the United States (85%) and the European Union (83 %). The cost of congestion phenomena is estimated by European Union at 1.5 % of GDP. This phenomenon limits the bandwidth for European routes, and it is often the cause of significant delays on the routes, as well as adversely affects the size of transport costs.[16]

Among European countries, the largest share of car travel in the structure ratio of 91.1% is characterized by Lithuania. This fact is surprising since countries such as Spain and Germany (with the highest motorway networks - the fourthand second in the world), and France (the longest network of public roads in Europe) are not in the forefront of this sheet. Poland is the runner of the classification, the percentage is 88.4%. It should be added that the motorization rate in our country is increasing. Slovakia, in turn, is a country characterized by one of the lowest shares of passenger cars in the structure of travel

[12] A. Drewnowski, A. Wysocka, *op. cit.*, s. 21.

[13] Ibidem.

[14] W. Zdanowski, *Rozwój czy regres przyszłości transportu publicznego w Polsce i na Dolnym Śląsku w perspektywie 2020*, Instytut Rozwoju i Promocji Kolei, Wrocław 2012, s. 26.

[15] M. Beim, *Europejskie trendy w transporcie miejskim i regionalnym*, [w:] *Materiały z konferencji „Przyszłość transportu publicznego – perspektywa regionalna i europejska"* (Wrocław, 5 XII 2012), http://www.wspolnesprawy.pl/uploads/Beim_trendy_w_transporcie.pdf, s. 5-6.

[16] M. Mindur, *Transport pasażerski w Stanach Zjednoczonych i Unii Europejskiej w latach 1990–2010*, „Transport Miejski i Regionalny", nr 7–8, 2011, s. 42–44.

(77.8%). To the following there are classified only Hungary (63.1%) and the Czech Republic (73.7%).[17]

In the next chapters it was checked how the size and the number of passenger cars has developed in Poland and Slovakia in recent years.

4. DATA ANALYSIS FOR SLOVAKIA

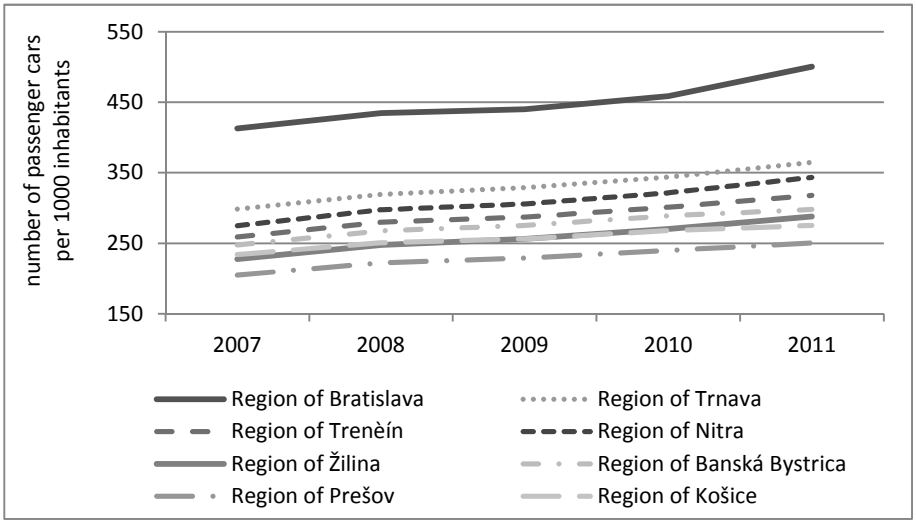
Data on the number of passenger cars per 1000 inhabitants are presented inTable 1.

Table 1. Number of passenger cars per 1000 inhabitants in Slovakia.

Years	2007	2008	2009	2010	2011	Change 2011/2007
Slovakia	**265**	**285**	**293**	**307**	**324**	**21,9%**
Region of Bratislava	413	435	440	458	500	21,2%
Region of Trnava	298	319	329	344	365	22,2%
Region of Trenèín	259	280	287	301	318	22,7%
Region of Nitra	275	298	306	321	344	24,9%
Region of Žilina	228	247	256	270	288	26,4%
Region of Banská Bystrica	247	267	275	289	298	20,4%
Region of Prešov	205	222	229	240	250	22,1%
Region of Košice	234	251	256	268	275	17,7%

Source: own study based on the data of the Statistical Office of the Slovak Republic.

Fig. 1. Number of passenger cars per 1000 inhabitants in the regions of Slovakia in the years 2007–11.



Source: own study.

[17] http://kurierkolejowy.eu/aktualnosci/9875/Trendy-w-transporcie-pasazerskim.html

In the years from 2007 to 2011 the number of passenger cars per 1000 inhabitants in Slovakia was characterized by a constant upward trend. This trend can be described by a linear trend equation of the form:

$$x_t = 253{,}5 + 13{,}8 \cdot t + u_{1t} \quad (1)$$

where:
x_t – the number of passenger cars per 1000 inhabitants,
t – the number of the next period of time (a year), t = 1, 2, ..., 5,
u_{1t} – residual component of the model.

On the basis of equation (1), for which the coefficient of determination is 0.984, it is concluded that the number of passenger cars per 1000 inhabitants increased year on year by an average of 13.8 of the vehicle. During the studied period the increase was almost 22%, which gives an average annual rate of change of 5.1%.

While studying the evolution of the number of passenger cars per 1000 inhabitants in the regions of Slovakia it was stated that:

- during the research period in all regions regular upward trend performed (Fig. 1);
- depending on the region, throughout the period the increases ranged from 17.7% to 26.4%;
- clearly the largest index value was maintained in the region of Bratislava (about 100% more than the value of the smallest – in the Prešov Region).

In turn, the data on the number of passengers per 1000 population were shown in table 2.

Table 2. Number of passengers per 1000 inhabitants in Slovakia.

Years	2007	2008	2009	2010	2011	Change 2011/2007
Slovakia	**71 216**	**67 535**	**59 566**	**57 535**	**55 433**	**-22,2%**
Region of Bratislava	27 984	27 464	25 248	25 049	25 660	-8,3%
Region of Trnava	63 080	59 062	51 693	50 503	49 414	-21,7%
Region of Trenèín	103 864	98 608	88 745	86 013	81 190	-21,8%
Region of Nitra	82 208	85 091	77 447	76 433	72 763	-11,5%
Region of Žilina	90 450	84 692	75 848	72 081	72 136	-20,2%
Region of BanskáBystrica	90 866	82 217	70 455	69 026	64 672	-28,8%
Region of Prešov	61 220	57 055	49 075	47 529	44 582	-27,2%
Region of Košice	52 303	48 571	41 172	37 610	37 000	-29,3%

Source: own study based on the data of the Statistical Office of the Slovak Republic.

In the period from 2007 to 2011 in Slovakia there was a consistent trend of decreasing the number of passengers per 1000 inhabitants. Throughout the period, the decrease was 22.2% (year-on-year average of 6.1%).

This trend can be described by a linear trend equation in the form:

$$y_t = 74727 - 4156 \cdot t + u_{2t} \quad (2)$$

where:
y_t – the number of passengers per 1000 inhabitants,
t – the number of the next period of time (a year), t =1, 2, ..., 5,
u_{2t} – residual component of the model.

Equation (2) shows that the number of passengers per 1000 inhabitants decreased from year to year by average of 4156. This equation describes the variation trend of the

number of passengers per 1000 inhabitants in almost 94% (coefficient of determination R^2 = 0.937).

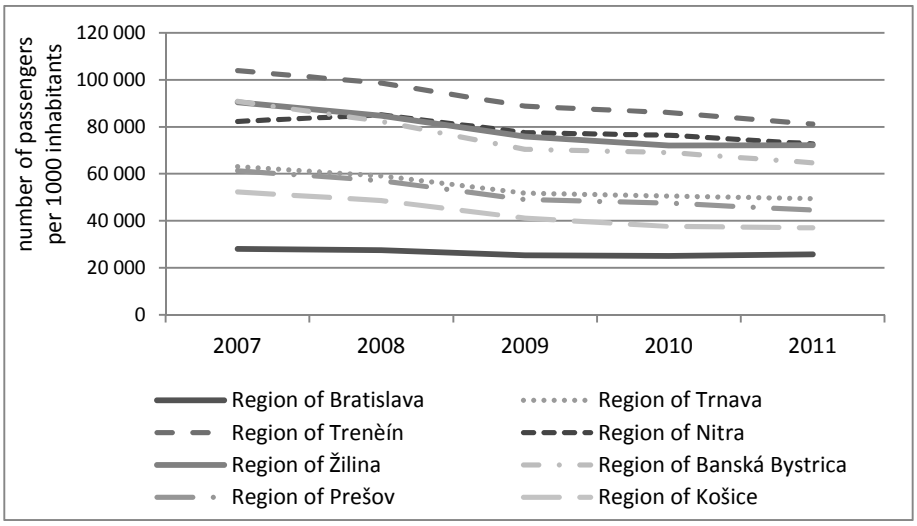
The equation of the trend indicates the trend of development but does not explain its cause. However, this is not difficult to find the cause. Opposing trends in the number of cars and the number of passengers per 1000 inhabitants for Slovakia in the research period can be explained by the existence of a strong linear correlation between these variables (correlation coefficient is equal to -0.94). This relationship can be described by the following linear regression equation:

$$y_t = 147914 - 290{,}4 \cdot x_t + u_{3t} \tag{3}$$

where:
y_t – the number of passengers per 1000 inhabitants,
x_t – the number of passenger cars per 1000 inhabitants,
u_{3t} – residual component of the model.

Equation (3) indicates that the increase in the number of passenger cars per 1000 inhabitants by 10 pieces causes a decrease in the number of transports per 1000 inhabitants by average 2904. Average error of estimate is about 2,647, which is slightly more than 4% of the average number of passengers. This model explains in almost 89% changes in passenger sizes in Slovakia in the years 2007–11.

Fig. 2. Number of passengers per 1000 inhabitants in the regions of Slovakia in the years 2007–2011.



Source: own study

When comparing the regions of Slovakia due to the number of passengers per 1000 inhabitants, one can see that:

- in all regions a regular decreasing trend was observed during the period of time (Fig. 2);
- there are large differences between regions that are systematically reduced; the smallest transport size in the Region of Bratislava, and the largest – in the Region of Trenèín (in 2007 year – 271% more than in the Region of Bratislava, and in 2011 only 216% more);

- there are large differences in the rate of decline between regions, we can distinguish three groups:
  - smallest declines (approximately10%): Region of Bratislava, Nitra Region;
  - medium-sized drops (about 21%): Region of Trnava, Region of Trenèín, Region of Žilina;
  - the largest decreases (approximately 28%): Region of Banská Bystrica, Prešov Region, Region of Košice.

5. DATA ANALYSIS FOR POLAND

The same tests as for Slovakia were performed for Poland. The corresponding data are shown in Tables 3 and 4.

Table 3. Statistical data for Poland.

years	2007	2008	2009	2010	2011	Change 2011/2007
no. of passenger cars per 1000 inhabitants	383	422	432	451	470	22,9 %
no. of passengers per 1000 inhabitants	106 990	106 619	99 011	102 225	100 972	-5,6 %

Source: own study based on CSO data.

In the years 2007–11 the number of passenger cars per 1000 inhabitants in Poland was constantly growing. This trend can be described by a linear trend equation of the form:

$$x_t = 370{,}1 + 20{,}5 \cdot t + u_{4t} \tag{4}$$

where:
x_t – the number of passenger cars per 1000 inhabitants,
t – the number of the next period of time (a year), t =1, 2, ..., 5,
u_{4t} – residual component of the model.

Based on the equation (4) it was concluded that the number of passenger cars per 1000 inhabitants increased year by year by an average of 20.5 of the vehicle. The coefficient of determination is 0.959 which indicates a high consistency with the data model. During all the studied period the increase was almost 23%, which gives an average annual rate of change of 5.3%.

At the same time in Poland there was a decrease in the number of passengers per 1000 inhabitants. Throughout the period, the decline amounted to 5.6% (year-on-year average of 1.4%). This trend was brought closer with the linear trend equation of the form:

$$y_t = 108093 - 1643 \cdot t + u_{5t} \tag{5}$$

where:
y_t – the number of passengers per 1000 inhabitants,
t – the number of the next period of time (a year), t =1, 2, ..., 5,
u_{5t} – residual component of the model.

Model (5) shows that the number of passengers per 1000 inhabitants decreased from year to year by average of 1643. This trend equation describes the variation of the number of passengers per 1000 inhabitants in almost 55% (coefficient of determination R^2 = 0.545).

Like for Slovakia, also for Poland the linear regression equation was determined, which allows to estimate the size of the passenger transport based on the number of cars:

$$y_t = 135389 - 74{,}6 \cdot x_t + u_{6t} \quad (6)$$

where:
y_t – the number of passengers per 1000 inhabitants,
x_t – the number of passenger cars per 1000 inhabitants,
u_{6t} – residual component of the model.

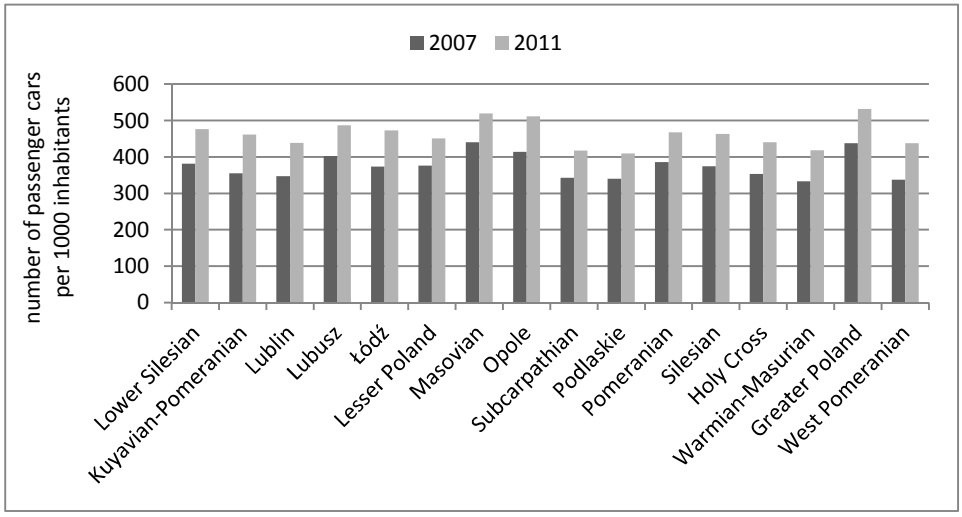
Equation (6) indicates that the increase in the number of passenger cars per 1000 inhabitants by 10 pieces causes a decrease in the number of transports per 1,000 inhabitants by average about 746. The average error of estimate is about 2,890, which represents only 2.8% of the average number of passengers, which proves the high compatibility of the model with the data. This model explains in almost 50% the changes in passenger sizes in Poland in the years 2007–11.

Table 4. Statistical data for provinces in Poland.

	no. of passengers per 1000 inhabitants			no. of passenger cars per 1000 inhabitants		
Provinces	2007	2011	change in %	2007	2011	change in %
Lower Silesian	86 854	74 079	-14,7	381,2	476,4	25,0
Kuyavian-Pomeranian	91 477	82 932	-9,3	355,2	461,5	29,9
Lublin	44 779	45 062	0,6	347,2	438,3	26,3
Lubusz	49 579	41 052	-17,2	402,4	487,0	21,0
Łódź	78 642	85 120	8,2	373,2	473,2	26,8
Lesser Poland	159 805	118 830	-25,6	376,2	451,3	20,0
Masovian	185 796	210 644	13,4	440,4	519,1	17,9
Opole	29 891	27 570	-7,8	414,2	511,6	23,5
Subcarpathian	32 423	25 378	-21,7	343,1	417,6	21,7
Podlaskie	98 097	89 850	-8,4	340,2	409,2	20,3
Pomeranian	149 261	128 554	-13,9	385,8	467,9	21,3
Silesian	135 579	123 110	-9,2	374,0	463,3	23,9
Holy Cross	59 580	36 716	-38,4	353,6	440,0	24,4
Warmian-Masurian	49 783	43 356	-12,9	332,6	418,3	25,8
Greater Poland	86 510	84 051	-2,8	437,9	531,6	21,4
West Pomeranian	109 910	105 624	-3,9	337,2	437,5	29,8

Source: own study based on CSO data.

Fig. 3. Number of passenger cars per 1000 inhabitants in Polish provinces.

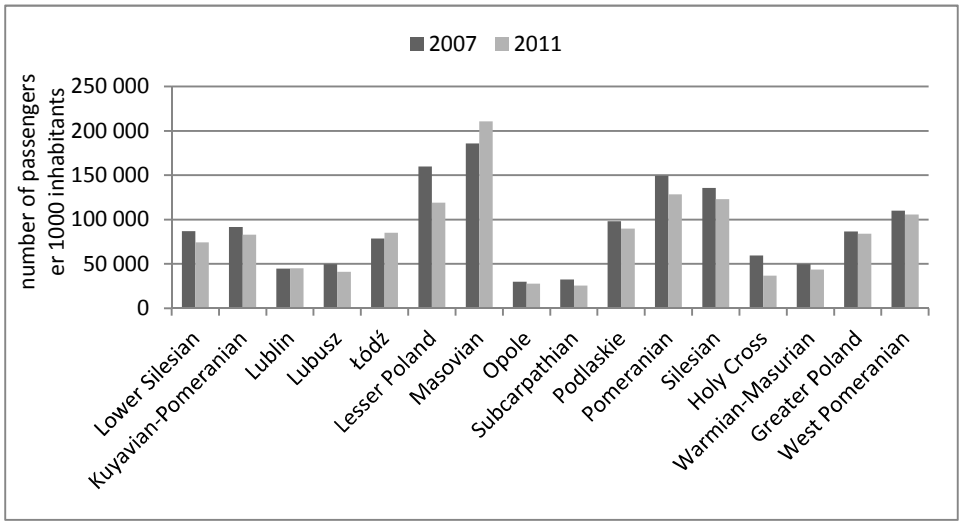


Source: own study

While observing how the number of passenger cars per 1000 inhabitants in Polish provinces shaped (Fig. 3), it was discovered that:

- in all regions a regular upward trend was noticed;
- the highest value of the index is in Masovian and Greater Poland, about 30% higher than the minimum;
- in different regions in the research period the increases ranged from 17.9% to 29.9%.

Fig. 4. Number of passengers per 1000 inhabitants in Polish provinces.



Source: own study

When comparing the various Polish regions due to the number of passengers per 1000 inhabitants it can be observed (Fig. 4) that:

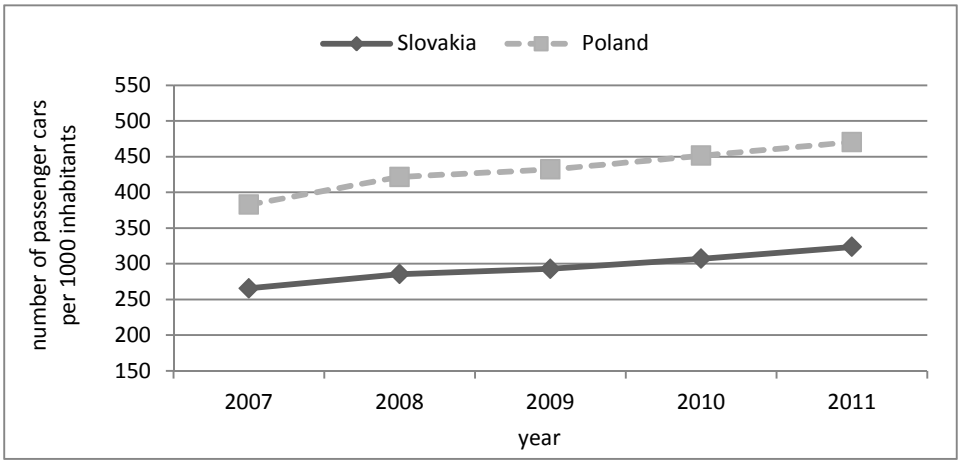
- between regions there are significant differences in the sizes of transport: the smallest value in Opole and Subcarpathian provinces, the largest in Masovian;
- in 13 regions a decline was recorded, while in the three the growth rate, which is dominated by a decreasing trend;
- in the research period the changes in different regions ranged widely, from a decline of 38.4% for the Holy Cross to increase by 13.4% in Masovian province;
- changes are not regular – in many regions the increase in the index in the selected years was recorded.

6. CONCLUSIONS FROM DATA ANALYSIS

In chapters 4 and 5 the analysis of data on public transport and automotive index in Poland and Slovakia was done. In order to determine similarities or differences in the changes taking place on the public transport market the comparison of relations between countries was done. By comparing how the variables shaped in both countries in the years 2007–11, one may conclude that:

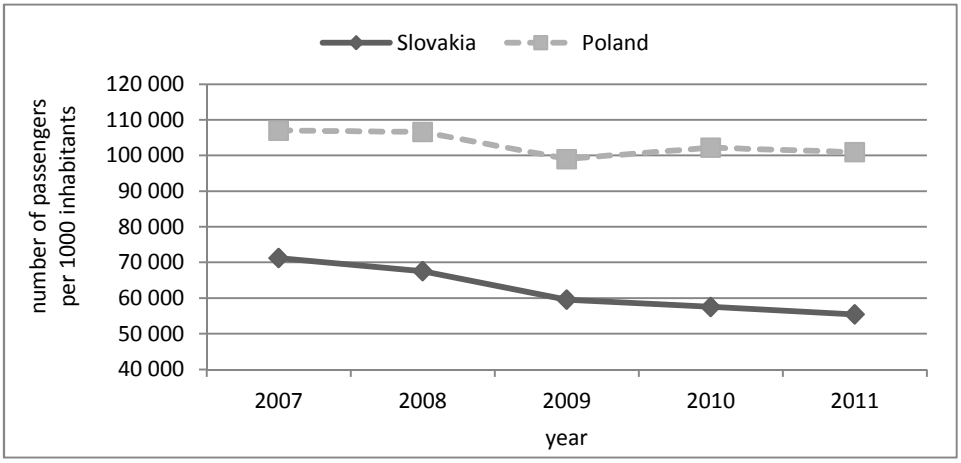
- in all regions of the two countries the number of passenger cars per 1000 inhabitants was characterized by a constant upward trend, resulting in the occurrence of similar trends in the country (Figure 5);
- the annual average growth rate in the two countries remained at a similar level (5.1% in Slovakia and 5.3% in Poland);
- in the analyzed period, the number of passenger cars per 1000 inhabitants in Poland was approximately 46% higher than in Slovakia and this difference did not change;
- the relative differences in the number of cars between regions in Slovakia was much higher than in Poland (coefficient of variation in individual years was approximately 21% for Slovakia and about 8% for Poland);

Fig. 5. Change in the number of passenger cars per 1000 inhabitants in the years 2007–11.



Source: own study.

Fig. 6. Change in the number of passengers per 1000 inhabitants in the years 2007–11.



Source: own study.

- in all regions of Slovakia and in most regions of Poland there was a reduction in the number of passengers per 1000 inhabitants, which resulted in the occurrence of downward trends in both countries (Figure 6), the average annual rate of decline in Poland (1.4%) was significantly lower than in Slovakia (6.1%);
- throughout the period the disparity between the two countries in the number of passengers per 1000 inhabitants increased; in 2007 year 50.2% more passengers were carried than in Slovakia, and in 2011 up to 82.1% more;
- the relative differences in the size of passenger transport between the regions of Slovakia was much lower than in Poland (coefficient of variation in individual years was approximately 33% for Slovakia, while the coefficient for Poland rose from 50% to 57%).

In conclusion, one can say that the statistics in both countries confirm the existence of a link between the number of cars and the size of passenger transport. This relationship for each country can be expressed with high accuracy by the linear regression equation. Moreover, one can notice the presence in the years 2007–11 similar trend of the tested variables in the regions, which translates into analogous trends for the country. In addition to these similarities, one can notice the differences between regions and countries which are expressed mainly in the values of variables, and the pace of change.

The research done and the presented models, except that they illustrate and explain the changes, can be also used for forecasting. The demand for forecasting for urban transport services, however, is a difficult task. In addition to the saturation level of the individual means of transport the communication mobility is also important. Communication mobility of the population[18] depends on the number of inhabitants and their characteristics (occupational structure, place of employment or age), and the degree of industrialization of the city (the specifics of the urban area). The materials available do not include statistical data that would describe current trends occurring in these interesting areas.

[18] K. Hebel, *Potrzeby przewozowe jako determinanty popytu na usługi transportu miejskiego*, „Przegląd Komunikacyjny", nr 12, 2007, s. 26–29.

Changes in both countries are similar to the trends that occurred in the "old" EU countries several decades ago and are therefore inevitable. Knowledge of these relationships may, however, allow faster achievement of the desired target state in the form of re-development of public transport in the new form.

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WIELKOŚĆ PUBLICZNYCH PRZEWOZÓW PASAŻERSKICH A LICZBA SAMOCHODÓW OSOBOWYCH W POLSCE I NA SŁOWACJI

Wzrost zamożności społeczeństwa prowadzi do zwiększania liczby posiadanych dóbr. W obecnych czasach jednym z podstawowych dóbr staje się własny środek transportu. Począwszy od drugiej połowy XX wieku jako własny środek transportu upowszechnił się w Europie samochód osobowy. Rozwój motoryzacji jest czynnikiem decydującym o zachodzących zmianach w sposobie zaspokajania potrzeb transportowych. Wzrost liczby samochodów osobowych w społeczeństwie zwykle prowadzi do zmniejszonego popytu na usługi transportu zbiorowego.

W pracy dokonano porównania wielkości publicznych przewozów pasażerskich oraz liczby samochodów osobowych w dwóch graniczących ze sobą krajach, to jest w Polsce i na Słowacji. W przeprowadzonych analizach wykorzystano dostępne dane zgromadzone przez urzędy statystyczne obu krajów. Dane te obejmowały lata 2007-11 i dotyczyły województw w Polsce i regionów na Słowacji W celu porównania ze sobą badanych zmiennych dane te odniesione zostały do wielkości populacji w poszczególnych regionach.

Do badania związków pomiędzy zmiennymi zastosowano analizę korelacji i regresji liniowej. Przeprowadzona analiza wskazuje, że wzrost wskaźnika motoryzacji przyczynił się do spadku liczby publicznych przewozów pasażerskich w obu krajach. Dla każdego kraju związek ten opisano liniowym równaniem regresji. Ponadto wyznaczono dla obu krajów liniowe równania trendów badanych zmiennych oraz wykazano występowanie analogicznych trendów w regionach. Pokazano również pewne różnice pomiędzy regionami i krajami, które wyrażają się głównie w wartościach zmiennych oraz w tempie zachodzących zmian.

Słowa kluczowe: publiczne przewozy pasażerskie, samochód osobowy, województwo, zmienne, analiza korelacji i regresji liniowej.

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AN EXAMPLE OF OPTIMIZING THE SIZE OF THE QUEUE IN THE NONDETERMINISTIC LOGISTIC SYSTEMS

The work presents the example of nondeterministic model of the operating system and optimizing the size of the queue in such a system. As far as modeling is concerned, Markov models [3][4][13][16][17] have been used. The work also presents a method of determining crucial work parameters of the nondeterministic system.

The first and the second chapter contain some general information connected with modeling, as well as equations from which nondeterministic models of the systems with a countable number of conditions have been constructed. They are also shown the distinctions of discrete models and the ones continuing in time. The third chapter provides the information on geometric distributions. The distribution itself is the model element being presented in the other part of the work. The fourth chapter presents the definitions of essential operating parameters and their implementation. It is particularly important to highlight two major parameters: the average time for operating one notification, as well as the average time of notification in a system. The theorem of the notification time in a system has also been proved. The fifth chapter deals with the sample model of nondeterministic operating system. In such a system operating is shown in a pipelining way. Between two operating nodes in a system there is a queue, the size of which determines the efficiency of a system. The sixth chapter presents the optimal size of a queue for a previously mentioned model. For this purpose the relationship based on the cost of manufacturing system, depending on the size of the queue and the price of a system in its efficiency was adopted.

Keywords: optimizing, size of the queue, nondeterministic logistic systems, Markov models.

1. INTRODUCTION

As far as modeling and system optimization in general technical problems are concerned, three different issues can be distinguished:
1) modeling
2) determining the parameters of the system
3) optimization

The aim of modeling is to provide the actual system in mathematical form (systems of linear equations, differential equations, graphs, etc.)

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Models can be used to simulate the behavior of the system in unusual conditions, as conducting experiments on real systems sometimes is not possible or simply too expensive. In the queuing theory models are generally presented in the form of linear equations of ordinary differential equations (continuous models) or linear difference equations (discrete models). In the given conditions these models are simplified to the linear equations of the systems. For the queuing theory, it is characteristic that in the systems of modeling probabilities of system's existence in provided states are their variables.

The aim of determining the parameters of the system is to obtain information about the system. Sometimes some interesting parameters are included in the model itself. However, they are often hidden and it is necessary to determine them.

In the queuing theory such parameters are, for example: the average time of the node engaging, the average number of notifications in the queues or the average time of the notification's staying in a system.

Optimization aims to find the best solution (control or the structure) in the set of many available solutions.

To talk about the best control or structure it is necessary to define the function of objective. The objective function is the measure of the quality control or the structure of the system. Its arguments are the parameters of the system which were mentioned above. The objective function is the balance of profit and loss connected with the decision about a control or a structure of a system. The objective function very often has an economic interpretation.

In the queuing theory the control can be understood as operating timetable, priorities of transitions, probabilities of transitions or the queues regulations, etc.). As to the structure, it consists of the number of operating nodes, the number of seats in the queue, etc.

Such division is not the only one and in special cases may be different.

The work presents the examples of processes model in multiphase systems of logistics operation. Incoming notifications of these systems are the processed objects. The operating nodes can be units and the systems of loading, packing, selection, etc.

2. THE EQUATIONS DESCRIBING THE SYSTEM

2.1 The discrete case (Markov chain)

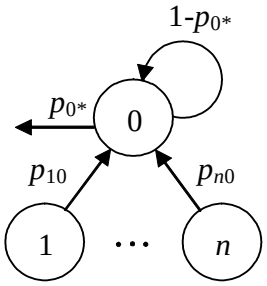

Fig. 1. A state in a discreet system

Let's analyze the graph shown in figure 1. Probability p_{0*} is the total probability of output from the state 0.

For the graph following equations occur.

The probability of state 0 in the next step, $\Delta t = 1$ (total probability):

$$p_0(k+1) = (1 - p_{0*})\, p_0(k) + \sum_{i=1}^{n} p_{i0}\, p_i(k) \tag{1}$$

$$\Updownarrow$$

$$p_0(k+1) = p_0(k) - p_{0*}\, p_0(k) + \sum_{i=1}^{n} p_{i0}\, p_i(k)$$

$$\Updownarrow$$

The change of probability in one step:

$$p_0(k+1) - p_0(k) = -p_{0*}\, p_0(k) + \sum_{i=1}^{n} p_{i0}\, p_i(k) \tag{2}$$

For the state provided the following equations occur.

$$p_0(k+1) - p_0(k) = 0, \qquad p_i(k) = p_i, \qquad i = 0,1,\ldots,n \tag{3}$$

The proposition of a total probability (received from the equation (1) after consulting the equation (3)):

$$p_0 = (1 - p_{0*})\, p_0 + \sum_{i=1}^{n} p_{i0}\, p_i \tag{4}$$

$$\Updownarrow$$

The probability of output equals the probability of input (received from (2) after consulting the equation (3)):

$$p_{0*}\, p_0 = \sum_{i=1}^{n} p_{i0}\, p_i \tag{5}$$

2.2 The continuous case (Markov process)

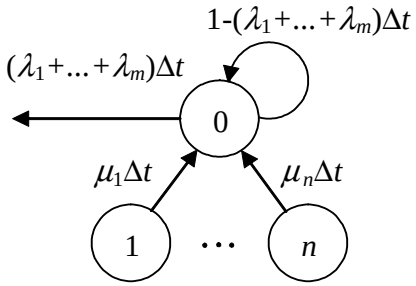

Fig. 2. A state in a continuous system

Let's analyze the graph shown in figure 2. In the state 0 the operation takes place in m nodes which are subjected to exponential distributions with coefficients $\lambda_1,\ldots, \lambda_m$
For the graph presented, the following equations occur.

The probability of state 0 at the next moment (total probability):

$$p_0(t+\Delta t) = (1-\sum_{i=1}^{m}\lambda_i \Delta t)\, p_0(t) + \sum_{i=1}^{n}\mu_i \Delta t\, p_i(t) \tag{6}$$

$$\Updownarrow$$

$$\frac{p_0(t+\Delta t) - p_0(t)}{\Delta t} = -\sum_{i=1}^{m}\lambda_i\, p_0(t) + \sum_{i=1}^{n}\mu_i\, p_i(t)$$

$$\Updownarrow$$

The derivative of probability ($\Delta t \to 0$):

$$p_0'(t) = -\sum_{i=1}^{m}\lambda_i\, p_0(t) + \sum_{i=1}^{n}\mu_i\, p_i(t) \tag{7}$$

For the state provided the following equations occur.

$$p_0'(t) = 0, \qquad p_i(t) = p_i, \qquad i = 0,1,\ldots,n \tag{8}$$

The proposition of a total probability (received from the equation (6) after consulting Δt =1 and the equation (8)):

$$p_0 = (1-\sum_{i=1}^{m}\lambda_i)\, p_0 + \sum_{i=1}^{n}\mu_i\, p_i \tag{9}$$

$$\Updownarrow$$

The probability of output equals the probability of input (received from the equation (7) after consulting the equation (8)):

$$\sum_{i=1}^{m}\lambda_i\, p_0 = \sum_{i=1}^{n}\mu_i\, p_i \tag{10}$$

The equations (1) (6), (2) (7), (4) (9), (5) (10) are their countertypes.

The equations (7) are called Chapman -Kolmogorov equations.

3. GEOMETRIC DISTRIBUTION

In discrete models the operating time will be modeled by discrete distributions.

Let's assume that $F(t) = p(\tau \le t) = 1 - p(\tau > t) = 1 - B(t)$

The discrete distribution has the following form:

$$B(t) = \begin{cases} 1 & 0 \le t < t_1 \\ 1 - \sum_{i=1}^{j} p_i & t_j \le t < t_{j+1}, \quad j = 1,2,...,k-1 \\ 0 & t_k \le t \end{cases} \tag{11}$$

Density function:

$$f(t) = \sum_{i=1}^{k} p_i \delta(t_i - t) \tag{12}$$

where: $t_i < t_j$ for $i < j, \quad i, j = 1,2,...,k$.

The probability of the appearance of notification in time t_i is p_i.

There is also: $\sum_{i=1}^{k} p_i = 1$

If $p_1 = 1$ we get determined distribution.

A special case of a discrete distribution is a geometric distribution for which:

$$f_\pi(t) = (1-\pi)\sum_{i=1}^{\infty} \pi^{i-1} \delta(iT - t) \tag{13}$$

$$B_\pi(t) = \pi^i \qquad iT \le t < (i+1)T, \quad i = 0,1,... \tag{14}$$

where: T geometric distribution period,

π geometric distribution parameter.

For the geometric distribution when we consider the specific moment in which the occurrence is to appear (time multiple T) it will appear with the probability 1-π and will not appear with the probability π. Such probability does not depend on whether a previous notification had appeared or not.

The mean value and the variance of geometric distribution are:

$$m_\pi = \frac{T}{(1-\pi)} \tag{15}$$

$$\sigma_\pi^2 = \frac{T^2}{(1-\pi)^2}\pi = m_\pi^2 \pi \tag{16}$$

If we approximate the distribuer of geometric distribution $B_\pi(t)$ exponential distribution (for the exponential distribution $B(t)=e^{-\lambda t}$) we get

$$e^{-kT\lambda}=\pi^k \quad \Rightarrow \quad \lambda=-\frac{\ln\pi}{T} \tag{17}$$

In borderline case where $\pi\to 1$ and $T\to 0$ so that λ=const geometric distribution aims at exponential distribution with parameter λ.
Geometric distribution is a discrete equivalent of the exponential distribution. For the geometric distribution just like for the exponential one, the distribution of the time to the nearest appearance of occurrence is not dependent on the waiting time (it is without the memory), because

$$P\{\tau>(k+r)T/\tau>kT\}=\frac{P\{\tau>(k+r)T\wedge\tau>kT\}}{P\{\tau>kT\}}=$$

$$=\frac{P\{\tau>(k+r)T\}}{P\{\tau>kT\}}=\frac{\pi^{k+r}}{\pi^k}=\pi^r=P\{\tau>rT\} \tag{18}$$

If we have two geometrical streams with two identical periods and at least one common notification point, so:
- the probability that in the moment kT there will not happen any of them

$$P(\tau>kT)=P(\tau_1>kT)P(\tau_2>kT)=(\pi_1\pi_2)^k \tag{19}$$

where: k = 0,1,2,...
- the probability that they will happen at the same time is

$$f_{\pi 1}(kT)\,f_{\pi 2}(kT)=(1-\pi_1)(1-\pi_2)(\pi_1\pi_2)^{k-1} \tag{20}$$

where: k = 1,2,3,...
what may be different from 0 (for the exponential distributions = 0).

4. THE OPERATING PARAMETERS

Before presenting exemplary models of operating systems, the operating parameters which the researcher may find interesting will be discussed.

First of all, these are the parameters which characterize the efficiency of a system. They include the average time being operated by a single notification system *S* (which means the average time interval between the moments of output from the system of two other notifications). More information can be found in the function of distribution of time intervals between the moments of the output from the system of two other notifications. However, it is not always possible to determine it by analysis. The average length of time of the presence of notification in a system R is also a very important parameter. The time of notification's presence in a system is counted from the moment of notification's input to the system till the moment of finishing operating of such notification by the last phase.

The length of staying and operating one notification in a system may be identical only in trivial case when the operation is not happening at the same time (when there is no

more than one notification in a system at any time). Such an operating variant occurs in simple device.

The structure of the logistics system with the stream of flowing goods may consist of several operating phases. In such a system the next notification does not have to wait until the whole system will be released and can be operated as soon as the first phase of operation was released (so called pipelining).

Let's analyze the system consisting of k operating phases shown in figure 3.

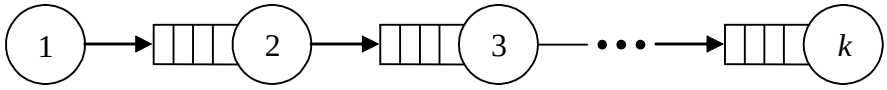

Fig. 3. The system consisting of k operating phases

Let's assume that the average operating time in phase i (i =1,...,k) is m_i.

For such a system with pipelined (P) and non pipelined (N) operating, the following relationships occur:

$$S_P \le S_N = \sum_{i=1}^{k} m_i = R_N \le R_{P\,i} \tag{21}$$

where: S – the average operating time of one notification
R – the average time of notification's presence in a system

and

$$S_P \ge \max_{i=1,2,...,k} m_i \tag{22}$$

$$R_P = t_{\text{wyjś}} - t_{\text{wejś}} = R_N + \Delta R \tag{23}$$

where: ΔR the total average time of notification spent in queues

The parameter S_P is strictly associated with max m_i which is the average time of the slowest operating phase (so called bottleneck of the system).

Both S_P and R_P are dependent on the structure of the system.

In the transition to pipelining operating S decreases because the time of unused appliances decreases as well because the notification is waiting in queues. These two operating parameters allow to expose the reserves of the system's efficiency. So:

$$\Delta S = S - \max m_i \tag{24}$$

shows the possible time of reserve that is lost by inappropriate operating rule at the given stream of notifications.

The time of notification spent in queues determines a reserve by which we can reduce the time of notification spent in a system. This reserve is:

$$\Delta R = R - \sum_{i=1}^{k} m_i \tag{25}$$

Another important parameter is the time r_i which the node i does not use in the operating process. The node cannot use the whole time on operating for two reasons. Firstly, it does not operate the notifications as there are no notifications on its inputs (the node is free). Secondly, it does not operate notifications as there is no place in the queue which accepts notifications being operated by this node (the node is blocked).

The components of time lost by the nodes having the maximum value m_i, are particularly important as their decrease gives the possibility of decreasing the average operating time of one notification. This time can be also decreased by decreasing the maximum value m_i. In each particular case determining the best way of decreasing S depends on the costs.

Other important parameter of system's operating is the probability g_ν that at any moment of time in a system there are ν notifications. The parameter g_ν characterizes so called operating depth.

The characteristic of the efficiency of the queue in a system may be the distribution of a random variable defining the level of saturation of the queue at any point in time.

The conditions of stationarity in the system as well as the impact of engaged rate on the characteristic of the processes within a system are also very important.

Let's discuss the possibilities of determining the operating parameters on the assumption that it is possible to obtain in any way the probability p_i that the system in a stationary state there is at any moment of time in the state i, where i takes the value of the numerable set of possible states.

To determine the average operating time S of one notification, let's choose an operating phase through which all the notifications go once only. In fact, in the queuing systems in which pipelining operation takes place, such phases are always present. Let m^* be the average operating time of notification in this phase. Let D be the set of states in which the system performs the operating notification in the selected phase. The value

$$p_D = \sum_{i \in D} p_i \tag{26}$$

shows the probability that the operation takes place in the selected phase.

For sufficiently large range of the time T with the probability close to 1 the average working time of the selected phase is:

$$T^* = p_D T \tag{27}$$

Then the average number of notifications that have been handled by the system at this time is equal to:

$$N^* = \frac{p_D T}{m^*} \tag{28}$$

and the average operating time of one notification by the system is defined by:

$$S = \frac{T}{N^*} = \frac{m^*}{p_D} \tag{29}$$

the distribution of operating depth is:

$$g_v = \sum_{i \in D_v} p_i \qquad v = 1,2,3,... \tag{30}$$

where: D_v set of states which are in the notification system v
Similarly, there are the distributions of the size of queue's saturation

The average number of notifications in a system

$$\overline{v} = \sum_{v=1}^{\infty} v g_v \tag{31}$$

The average time R of notifications' presence in a system can be defined with the usage of operating depth.

$$R = \overline{v} S \tag{32}$$

Now we will conduct the proof of equality (5.12).

THE PROOF:

There will be given an operating system with one input and one output for which there is a stationary state. Let's consider sufficiently large range of time T. Let M be the total average time of all notifications' presence in a system in time T. This is an analogy of energy, in our case dedicated to operation by the system. M can be determined in two ways.

$$M = \overline{v} T \tag{33}$$

$$M = RT / S \tag{34}$$

T / S is the average number of notifications being operated by the system in time T.

After comparing the last two relationships we get the equation (5.12).

It is worth noticing that any additional assumptions are not needed (e.g. the rules of the queues, the distribution of the input stream, the distributions of operating time, the priorities of entries inside the system). It is even acceptable that some notifications after their input into the system would never leave it (there can be finitely many such notifications due to the assumptions of the existence of a stationary state).

Parameter such as the function of distribution of length of time operating one notification in a system can be found by examining the transitional processes in SK.

5. THE MODEL AND ITS ANALYSIS

Let's consider two-phase operating system. The first node generates the notifications. The generation time is constant and equal 2. The second node operates the notifications. The operating time is random and is subjected to geometric distribution of the period T=1 and the parameter π. After the operation in the second node, the notification leaves the system. Between the phases there is a queue with a capacity of n notifications.

A node of the first phase may represent the generating device. A node of the second phase may represent a device selecting generated objects.

The states of our system will be denoted by threesome $<jt_1t_2>$.

The vector time component of such a system contains two parameters: t_1 the time remaining until the end of operating in the node of the first phase, t_2 the time remaining until the possible end in the node of the second phase. The component t_1 may have three values: 0 when the first node is blocked, 1 and 2 when it is working. The component t_2 may have two values: 0 when the second node is free, and 1 when it is working.

Combinational component of the vector's state has one component j which is the number of notifications in the queue, j=0,1,...,n.

The elements of matrix transitional probabilities will be determined by considering the possible transitions from the state n01 in which the first node is blocked, i.e. t_1=0. From this state with the probability 1-π the system goes to the state n21, when the second node finished notification's operation and took from the queue the next notification to operate, and the first blocked node passed the notification to the vacant place in the queue and started generating the next notification. With the probability π the second node will continue to operate the notification and the system will remain in the same state. From the state n21 the system may go to two states n-111 with the probability 1-π and to n11 with the probability π. Analogical transitions are possible from states i21, i=1,2,...,n so we have

$$\left.\begin{aligned} p[i21 \rightarrow i-111] &= 1-\pi \\ p[i21 \rightarrow i11] &= \pi \end{aligned}\right\} \tag{35}$$

where: i=1,2,...,n

From the state n11 the system with the probability π returns to the state n01 (the second node did not finish notification's operation and the first was blocked because there was no place in the queue), with the probability 1-π the system goes to state n21 (the nodes finished operating at the same time and started to operate other notifications, there was no change in the queue's).

For the state i11, i=0,1,...,n-1 the probability of transitions equals

$$\left.\begin{aligned} p[i11 \rightarrow i21] &= 1-\pi \\ p[i11 \rightarrow i+121] &= \pi \end{aligned}\right\} \tag{36}$$

From the state 021 the system with the probability π goes to the state 011, and with the probability 1-π to the state 010 (the second node is free and is waiting for notification).

Let's notice that the state 020 is not achievable from any state.

The graph of passes of the analyzed system is shown in figure 4.

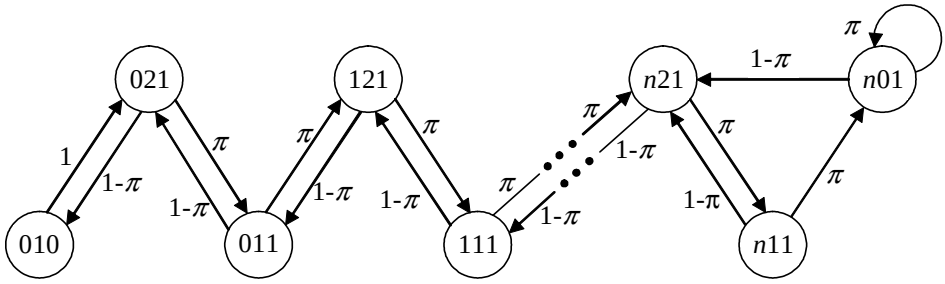

Fig. 4. The graph of a two-phase system. The first phase generates the notifications every two units of time. The second phase is subjected to the geometric distribution

The layout of equations defining the stationary probabilities of the analyzed system is:

$$\left.\begin{aligned}
&p_{010}=(1-\pi)\,p_{021}\\
&p_{021}=p_{010}+(1-\pi)\,p_{011}\\
&p_{i21}=\pi\,p_{i-111}+(1-\pi)\,p_{i11},\quad i=1,2,...,n-1\\
&p_{n21}=\pi\,p_{n-111}+(1-\pi)\,p_{n11}+(1-\pi)\,p_{n01}\\
&p_{i11}=(1-\pi)\,p_{i+121}+\pi\,p_{i21},\quad i=0,1,...,n-1\\
&p_{n11}=\pi\,p_{n21}\\
&p_{n01}=\pi\,p_{n01}+\pi\,p_{n11}
\end{aligned}\right\} \tag{37}$$

Assuming that $\pi\neq 1$ we may predict:

$$p=p_{010},\quad \omega=\pi/(1-\pi) \tag{38}$$

The solution of the layout is as following:

$$\left.\begin{aligned}
&p_{i21}=\frac{\omega^{2i}}{1-\pi}\,p && i=0,1,...,n\\
&p_{i11}=\frac{\omega^{2i+1}}{1-\pi}\,p && i=0,1,...,n-1\\
&p_{n11}=\omega^{2n+1}\,p && p_{n01}=\omega^{2n+2}\,p
\end{aligned}\right\} \tag{39}$$

After taking into account the condition of normalization $\sum p_{ijk}=1$ from (6.26) we get

$$p=[1+\frac{1}{1-\pi}\sum_{i=0}^{2n}\omega^{i}+\omega^{2n+1}+\omega^{2n+2}]^{-1} \tag{40}$$

which results in

$$\left.\begin{aligned}
&p=\frac{1-2\pi}{2(1-\pi)-\omega^{2(n+1)}} && \omega\neq 1\\
&p=\frac{1}{4n+5} && \omega=1
\end{aligned}\right\} \tag{41}$$

The probability that the system is working is 1-p. Because $m_2=T/(1-\pi)= 1/(1-\pi)$ the average time spent by the system to operate one notification is:

$$\left.\begin{aligned} S &= \frac{m_2}{1-p} = \frac{2(1-\pi)-\omega^{2n+2}}{(1-\pi)(1-\omega^{2n+2})} && \omega \neq 1 \\ S &= \frac{4n+5}{2n+2} && \omega = 1 \end{aligned}\right\} \tag{42}$$

6. THE SYSTEM'S OPTIMIZATION

The example of the system's optimization discussed in chapter 5 has been presented below. We consider the special case when $\omega=1$ ($\pi=1/2$).

Let's assume that the producer of the system wants to make a decision on how many seats should the queue between the operating phases contain. For this purpose, we assume that we have the following knowledge:

- the dependence indicating the manufacturing costs of the system in the function of the number of seats in the queue

$$K(n) = \frac{1}{300}n + \frac{1}{3} \tag{43}$$

- the dependence indicating the property of the market which is the price of the system in the function of system's efficiency and in the function of number of seats in a queue

$$C(n) = \frac{1}{S} = \frac{2n+2}{4n+5} \tag{44}$$

As the function of aim we will assume the value of the profit which is

$$Z(n) = C(n) - K(n) \tag{45}$$

So we have

$$Z(n) = \frac{2n+2}{4n+5} - \frac{1}{300}n - \frac{1}{3} \tag{46}$$

We will treat n as a continuous variable ($n>0$). The function $Z(n)$ is of class C^1.

$$Z'(n) = \frac{2}{(4n+5)^2} - \frac{1}{300} = 0 \tag{47}$$

The solution of the above equation shows that the function $Z(n)$ has a positive maximum for n=4,87. Since we are only interested in the total n so n=4 or n=5.

Z(4)=0,1295

Z(5)=0,1300

which means that optimal n=5.

7. CONCLUSION

The theory of queues can be successfully applied to the modeling of logistics systems with pipelining. The tools used in the theory allow one to model and optimize complex systems in an effective way. The work presents the examples of such an analysis.

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PRZYKŁAD OPTYMALIZACJI WIELKOŚCI KOLEJKI W NIEDETERMINISTYCZNYM SYSTEMACH LOGISTYCZNYCH

W pracy został przedstawiony przykład niedeterministycznego modelu systemu obsługi oraz optymalizacji wielkości kolejki w takim systemie. Do modelowania wykorzystano

modele Markowa [3][4][13][16][17]. W pracy przedstawiony został także sposób wyznaczania istotnych parametrów pracy systemu niedeterministycznego.

W pierwszym oraz drugim rozdziale pracy przedstawione zostały ogólne informacje na temat modelowania oraz przedstawione zostały równania, z których skonstruowane są niedeterministyczne modele systemów z przeliczalną liczbą stanów. Rozróżnić tu należy modele dyskretne oraz ciągłe w czasie. W rozdziale trzecim przedstawione zostały informacje na temat rozkłady geometrycznego. Rozkład ten jest elementem modelu przedstawionego w dalszej części pracy. W rozdziale czwartym przedstawione zostały definicje istotnych parametrów obsługi oraz wyprowadzone zostały te parametry. Szczególnie istotne są dwa parametry: średni czas obsługi jednego zgłoszenia oraz średni czas przebywania zgłoszenia w systemie. Udowodnione zostało także twierdzenie, na temat czasu przebywania zgłoszeń w systemie. W rozdziale piątym przedstawiony został model przykładowego niedeterministycznego systemu obsługi. W systemie tym obsługa odbywa się w sposób potokowy. W systemie pomiędzy dwoma węzłami obsługi znajduje się kolejka, od której rozmiaru zależy jego sprawność. W rozdziale szóstym dla przedstawionego wcześniej modelu wyznaczony został optymalny rozmiar kolejki. W tym celu przyjęte zostały zależności określające koszty wytworzenia systemu w zależności od wielkości kolejki oraz zależność określająca cenę systemu w funkcji sprawności.

Słowa kluczowe: optymalizacja, wielkość kolejki, niedeterministyczne systemy logistyczne, modele Markowa

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УПРАВЛЕНИЕ КАЧЕСТВОМ В ПРОЕКТАХ ПЕРЕВОЗОК ПАССАЖИРОВ АВТОМОБИЛЬНЫМ ТРАНСПОРТОМ

В статье предложены методические подходы к разработке моделей систем качества услуг по перевозке пассажиров автомобильным транспортом с использованием модульного подхода.

Определено, что актуальность создания системы качества в сфере предоставления транспортных услуг заключается в невозможности разделения процесса предоставления услуги и её результата.

Предложено, что объективная оценка качества услуги возможна при условии оценки технологического процесса предоставления услуги через процедуру сертификации. Это позволяет проводить государственную политику поддержки транспортных предприятий через оценку транспортных услуг и предусматривает два основных подхода: оценку качества готовой продукции и оценку качества транспортного обслуживания населения.

В статье проведено анализ модульной оценки соответствия транспортных услуг на уровне, который соответствовал бы условиям безопасности для жизни, здоровья и имущества граждан, а также внешней среды.

Определено, что оценку соответствия разделяют на модули относительно подготовки процесса предоставления транспортной услуги и непосредственно процесса их предоставления. На пассажирском транспорте имеют место оба эти этапа, поэтому предоставление услуг возможно при условии, что результаты оценки соответствия на обоих этапах позитивны.

Результаты статьи показали, что внедрение оценки соответствия предоставляемых транспортных услуг на основе модульного подхода соответствует действующему законодательству, интересам государства и общества для Украины. Этот подход, на сегодня, является наиболее эффективным направлением реализации механизма государственного регулирования безопасности перевозок пассажиров и способом создания справедливых и равных условий конкуренции.

Ключевые слова: автомобильный пассажирский транспорт, моделировани, системы качества, сертификация

1. ВВЕДЕНИЕ

Обеспечение надлежащего уровня безопасности и качества транспортного обслуживания пассажиров – первоочередная задача. Вместе с тем, о неудовлетворительном их состоянии свидетельствует существенное количество дорожно-транспортных происшествий и нарушений в технологии предоставления транспортных услуг.

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В сфере повышения уровня безопасности и качества транспортного обслуживания пассажиров необходимо предусматривать ряд мероприятий государственного регулирования, которые направлены на стимулирование соответствующей работы перевозчиков, создание целевых направлений, разработку механизмов управления качеством, а также формирование адекватной структурно-функциональной организации системы управления пассажирскими перевозками, что позволит предупредить выход на рынок транспортных услуг недобросовестных перевозчиков и ограничить природные монополии.

2. ОСНОВНАЯ ЧАСТЬ

Пассажирские перевозки влияют на социальную, производственную и экологическую сферы, а также на создание условий справедливой конкуренции. Обострение конкуренции на рынке транспортных услуг в сфере пассажирских перевозок создаёт предпосылки к повышению качества обслуживания, уровень которого сегодня остается достаточно невысоким. Одна из причин – отсутствие эффективного механизма для оценки качества услуг пассажирского транспорта по определенным показателям. Для повышения качества транспортного обслуживания пассажиров предлагается разработка мер, направленных на стимулирование высококачественной и безопасной работы перевозчиков. Данные меры разрабатываются по следующим направлениям:

1) создание целевых направлений влияния на качество через ISO, ГОСТы и т. д., которые определяют основные требования по стандартизации, сертификации и лицензированию на транспорте;

2) создание механизмов управления качеством через сертификацию транспортных средств, систем качества, технического обслуживания и текущего ремонта и услуг пассажирского транспорта;

3) создание адекватной структуры функциональной организации системы управления на транспорте;

4) предупреждение выхода на рынок перевозок недобросовестных перевозчиков через использование процедуры лицензирования и сертификации транспортных услуг;

5) создание действующего механизма государственного регулирования природных монополий на рынке транспортных услуг.

Проведенное исследование позволяет определиться в дальнейшем с основными показателями интегральной оценки перевозчика для обеспечения соответствующего уровня качества и безопасности транспортных услуг, что в перспективе должно быть формализовано для создания равных условий для хозяйственной деятельности, ограничения монополизма и развития конкуренции на рынке транспортных услуг.

Требованиями международных и государственных нормативных актов определено, что право на безопасность определяет право на защиту от продуктов, производственных процессов и услуг, вредных для здоровья и жизни граждан.

Актуальность создания системы качества в сфере предоставления транспортных услуг заключается в невозможности разделения процесса предоставления услуги и её результата. Объективно оценить качество услуги возможно при условии оценки технологического процесса предоставления услуги через процедуру сертификации,

что позволяет проводить государственную политику поддержки транспортных предприятий через оценку транспортных услуг и предусматривает два основных подхода:

– оценка качества готовой продукции, использование данного подхода не позволяет предусмотреть отклонения в дефиците;
– оценка качества транспортного обслуживания населения, использование данного подхода позволяет создать гарантии стабильности качества предоставления транспортных услуг.

Отсутствие гарантий стабильности технологического процесса предоставления услуги нарушает права пассажира. Такие нарушения трудно зафиксировать, а потому некачественные услуги потребитель получает практически «беспрепятственно», в отличии от товаров, контроль которых предполагается службой технического контроля предприятий. Предлагаемая система качества позволяет минимизировать брак в техническом процессе предоставления транспортных услуг. Можно отметить, что Госстандарт, совместно с Министерством инфраструктуры, Украины проводит комплекс работ по созданию нормативно-технологической базы формирования системы качества при предоставлении услуг по перевозке пассажиров автомобильным транспортом, который разрабатывается путем рассмотрения всех возможных вариантов, предусмотренных международными стандартами ISO на основе системного анализа следующих факторов:

– сложность процесса проектирования транспортной услуги;
– обоснование проекта с помощью проведения испытаний его эксплуатационных характеристик или на основе накопленного практического опыта
– сложность технологического процесса, с учетом влияния на эксплуатационные характеристики услуги;
– безопасность предоставления транспортной услуги;
– затраты на предупреждение «непредоставления» соответствующего уровня качества транспортного обслуживания.

Принимая во внимание интеграционные процессы на транспорте и вышеуказанные факторы, наиболее приемлемым для создания модели системы качества услуг по перевозки пассажиров автомобильным транспортом представляется модульный подход при оценке соответствия (МПОС). Основные требования МПОС можно определить следующим образом:

– внедрение МПОС с учетом директив ЕС дает возможность обеспечивать качество предоставления услуг по перевозке пассажиров автомобильным транспортом соответственно требованиям действующего законодательства и нормативным документам, требованиям безопасности жизни, здоровья граждан и внешней среды;
– оценка соответствия состоит из модулей разработки услуги и ее предоставления;
– работы по оценке соответствия осуществляются органами добровольной сертификации или органами сертификации, аккредитованными в государственной системе сертификации;
– перечень органов сертификации ежегодно публикуется в официальном бюллетене.

Следуя вышеизложенному, оценку соответствия предлагается проводить с помощью модулей, приведенных далее.

Модуль А – внутренний контроль предоставления услуг, который определяет процедуру, по которой предприятия, которые предоставляют услуги по перевозки пассажиров автомобильным транспортом, декларируют, что предоставляемые ими услуги соответствуют требованиям нормативных документов, действие которых распространяется на них (конкурентные требования к претендентам и т.д.).

Модуль В – определяет, что техническая документация предприятия соответствует требованиям нормативных документов, действие которых распространяется на них (технологические карты проведения технического обслуживания и текущего ремонта и т.д.).

Модуль С – обеспечение качества предоставления услуг относительно соответствия информации о данной услуги (информация на остановках, автостанциях, автовокзалах, в транспортных средствах и т.д.).

Сертификат соответствия предоставляется при условии, что типовая услуга соответствует действующим требованиям. В этом случае процедура сертификации систем качества предоставления услуг осуществляется соответственно следующим этапам:

а) предварительная оценка, анализ анкет опроса и исходных материалов, представленных перевозчиком;

б) окончательная проверка и оценка результатов;

в) оформление результатов проверки;

г) техническое сопровождение (наблюдение) сертификованой системы качества.

Модуль D – обеспечение качества услуг. Для того, чтобы убедится в соответствующем исполнении предприятием своих обязательств, которые регламентированы системой качества, проводятся периодические проверки.

Наиболее важной задачей является разработка алгоритма практического внедрения систем качества на транспортном предприятии. Предлагается постановка задачи, по которой предприятия-перевозчики создают у себя системы качества услуг по перевозки пассажиров. Разработка такой системы заключается в формировании стандартов предприятия (СТП). Разработка на конкретных предприятиях СТП проводится с использованием требований типовых СТП. При необходимости предприятия включают в комплект своих стандартов документы, которые не имеют аналогов. Таким образом, сертификат соответствия предоставления транспортных услуг предоставляется перевозчику при выполнении требований нормативных документов, которые удостоверяют:

- уровень квалификации и знаний перевозчика, водителей, особ, деятельность которых связана с предоставлением транспортных услуг;
- наличие контроля состояния здоровья водителей и следование ими требованиям, установленным режимами труда и отдыха;
- безопасность технического состояния транспортных средств.

В перспективе можно ожидать, что реализация модульного подхода при оценке соответствия предоставления услуг по перевозки пассажиров автомобильным транспортом позволит:

- повысить квалификационный уровень работников предприятий транспорта;
- повысить уровень обеспечения безопасности перевозок;

- повысить уровень качества транспортного обслуживания, обеспечивая своевременность, комфортность предоставляемой услуги;
- улучшить экономические показатели деятельности перевозчиков.

3. ВЫВОДЫ

Проведено анализ модульной оценки соответствия транспортных услуг на уровне, который соответствовал бы условиям безопасности для жизни, здоровья и имущества граждан, а также внешней среды. Подтверждение соответствия предоставления услуг осуществляется на базе требований действующего законодательства Украины и нормативных документов, действие которых распространяется на вышеупомянутые услуги.

Таким образом, оценку соответствия разделяют на модули относительно подготовки процесса предоставления транспортной услуги и непосредственно процесса их предоставления. На пассажирском транспорте имеют место оба эти этапа, поэтому предоставление услуг возможно при условии, что результаты оценки соответствия на обоих этапах позитивны.

Внедрение оценки соответствия предоставляемых транспортных услуг на основе модульного подхода соответствует действующему законодательству, интересам государства, общества и для Украины, на сегодня, является наиболее эффективным направлением реализации механизма государственного регулирования безопасности перевозок пассажиров и способом создания справедливых и равных условий конкуренции.

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QUALITY MANAGEMENT IN THE PROJECT ON PASSENGERS ROAD TRANSPORT

In the article methodical approaches to the modeling of systems of quality services for the transportation of passengers by road using a modular approach is proposed.

It has been determined the importance of establishing a quality system for the provision of transport services is the impossibility of separating the process of providing services and its result. The objective assessment of the quality of service possible while process evaluation of the service through the certification procedure is proposed. This allows for public policy support of transport enterprises through the assessment of transport services and provides two basic approaches: assessing the quality of the finished product and assessment of the quality of transport service.

In the article the analysis of modular conformity assessment of transport services at a level that would be consistent with the conditions for safety of life, health and property of citizens, as well as the environment is carried out.

The conformity assessment modules are divided into the preparation process of providing transport services and their delivery process itself is determined. In passenger transport, both of these stages, so the provision of services is possible provided that the results of conformity assessment in both stages positive.

The result of the article showed that the implementation of conformity assessment of transport services based on a modular approach corresponds to the current legislation, the interests of the state and society in Ukraine. This approach today is the most effective direction for the implementation of the mechanism of state regulation of safety of the transport of passengers and way to create a fair and equal condition of competition.

Keywords: passenger road transport, modeling, quality system, certification.

ZARZĄDZANIE JAKOŚCIĄ W PROJEKCIE DOTYCZĄCYM PASAŻERKIEGO TRANSPORTU DROGOWEGO

W artykule omówiono metodyczne podejście do modelowania systemów jakości usług w zakresie pasażerskiego transportu drogowego przy wykorzystaniu podejścia modułowego.

Stwierdzono potrzebę wprowadzenia systemu jakości w zakresie świadczenia usług transportowych oraz niemożność oddzielenia procesu świadczenia usługi od jej wyniku. Zaproponowano obiektywną ocenę jakości usług możliwą podczas oceny procesu usługi w ramach procedury certyfikacji. Pozwala to na wsparcie polityki publicznej przedsiębiorstw transportowych poprzez ocenę usług transportu i zapewnia dwa podstawowe podejścia: ocenę jakości produktu końcowego i ocenę jakości usług transportowych.

W artykule przeprowadzono analizę modułowej oceny zgodności usług transportowych na poziomie, który byłby zgodny z warunkami bezpieczeństwa życia, zdrowia i mienia obywateli, a także środowiska.

Moduły oceny zgodności zostały podzielone na proces przygotowania do świadczenia usług transportowych, jak również został określony sam proces dostawy. W transporcie pasażerskim świadczenie takich usług jest możliwe pod warunkiem, że wyniki oceny zgodności w obu etapach pozytywne.

W rezultatach wykazano, że wdrożenie oceny zgodności usług transportowych w oparciu o podejście modułowe odpowiada obecnym prawodawstwu, interesom państwa i społeczeństwa na Ukrainie. To podejście jest obecnie najskuteczniejszym kierunek dla realizacji mechanizmu regulacji stanu bezpieczeństwa przewozu pasażerów i jest to sposób na tworzenie sprawiedliwych i równych warunków konkurencji.

Słowa kluczowe: pasażerski transport drogowy, modelowanie, systemy jakości, certyfikacja.

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Tina VUKASOVIČ[1]

SOCIAL MEDIA AND ITS IMPLICATIONS FOR BUILDING BRAND RELATIONSHIP

Innovation in social networking media has revolutionized the world in 21st Century. Social networking media presents potential opportunities for new forms of communication and commerce between marketers and consumers. The objective of the study in this paper is to analyze the effective communication strategy through social networking media. Survey was conducted, by sending questionnaire by e-mail to collect the individual opinion from the respondents. The total population is social networking user community, but to collect the effective data the sampling is constrained to the target population like young adults, between the ages of 18 years to 45 years. The sample size is seven hundred. The paper presents research results including internet marketing activities that have contributed to building a relationship with the brand. It is necessary to study the effectiveness of brand communication strategy carried out/conducted in social networking media which are mainly accessed by users. In recent trend of marketing in social networking sites, various brand communications are widely used to attract targeted leads. So, this study would help to assess the effectiveness of communication and strategy done through social networking media which encourages the target audience to participate in this kind of advertising.

Keywords: Internet, Social networking media, Fast Moving Consumer Goods, Brand, European Union

1. INTRODUCTION

The Internet is transforming the business environment, creating new challenges and opportunities. This chapter provides an overview of the Internet and its defining characteristics, highlighting the key developments that have contributed to its explosive growth and its impact on the business environment. In its current form, internet is primarily a source of communication, information and entertainment, but increasingly, it also acts as a vehicle for commercial transactions. Since the explosion of the web as a business medium, one of its primary uses has been for marketing. Soon, the web could become a critical distribution channel for the majority of successful enterprises. One among them is marketing and spreading brand communication through Social networking sites (Thompson, 2002). Among other methods, using online brand communities is a good way to listen to customers and engage them in a co-production process while employing the Internet (Brandt et al., 2010).

The Internet provides the opportunity for companies to reach a wider audience and create compelling value propositions never before possible (e.g. Amazon.com's range of 4.5 million book titles), while providing new tools for promotion, interaction and relationship

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building. It is empowering customers with more options and more information to make informed decisions. The Internet also represents a fundamental shift in how buyers and sellers interact, as they face each other through an electronic connection, and its interactivity provides the opportunity for brands to establish a dialogue with customers in a one-to-one setting. As such, the Internet is changing fundamentals about customers, relationships, service and brands, and is triggering the need for new brand-building strategies and tools (Cleland, 2000).

The Internet became a visual and audio multimedia attractive of communication in the business world and in everyday life-

The distinctive characteristics of the Internet can be summarised in three key points (Cleland 2000, 35):

- *It Dramatically Reduces Information Costs* - the cost of searching for information and the cost of the information itself is significantly reduced (and in many cases is free).
- *It Allows for Two-way Communication and Interactivity* - this radically alters the process of interaction between communicating parties, allowing both parties to identify each other and build one-to-one relationships - not previously available with mass medium forms of communication.
- *It Overcomes the Barriers of Time and Space* - The Internet is a global network and can be reached from everywhere, regardless of where the computer or Internet access device is physically located. The Internet can also be accessed at any time - 24 hours a day, 7 days a week. These qualities eliminate the barriers of time and space that exist in the physical world.

These characteristics combine to create a very powerful medium. By allowing for direct, ubiquitous links to anyone, anywhere, the Internet lets individuals and companies build interactive relationships with customers and suppliers, and deliver new products and services at low cost. These defining characteristics have fuelled its explosive growth (Cleland 2000, 35).

1.1 Building successfull brand on the Internet

The Internet is changing the brand environment or ″brandscape″. This chapter explores new strategies and tools for building brands on the Internet, including the interactive approach to attracting customers and building loyalty. Building a strong brand is a complex task. The brand building process starts with the development of a strong value proposition. Once this has been established, the next step is to get customers to try the brand. If the offering is developed properly, it should provide a satisfactory experience and lead to a willingness to buy again. To entice trial and repeat purchase requires triggering mechanisms, which are created through advertising, promotion, selling, public relations, and direct marketing. The company needs to communicate the values of the brand and then reinforce brand associations to start the wheel of usage and experience, and keep it turning. Through the combination of the stimulus of consistent communications and satisfactory usage and experience, brand awareness, confidence and brand equity are built (Vukasovič, 2013).

Traditionally, in addition to providing added value, brands were a substitute for information - a way for customers to simplify the time-consuming process of search and comparison before deciding what to buy. However, the Internet makes search and

comparison much easier. This threatens to undermine the value of brands. On the other hand, the logic of the Internet cuts another way. Transactions on the Internet require customers to provide detailed personal information - names, addresses, credit card numbers, etc. Generally, people have concerns about sharing personal information. In addition, the intangible nature of the Internet, and the fact that customers are buying goods that, in most cases, they have never handled or seen (except on-screen), has placed greater importance on trust and security. People only tend to transact with sites they know and trust - sites that provide a wealth of information and make comparison shopping easy, where the user feels a part of, and sites that understand the user's needs and preferences. This highlights the surfacing of information and relationships as key sources of added value in the Internet economy. Customers derive added value through the provision of information on the products or services they buy, as well as on topics of interest related to the brand and product characteristics. Traditionally, brands have been developed in an environment whereby a company creates a brand, and projects it onto a third party intermediary (the media). In response, many unnamed customers develop a ″relationship″ with the brand. The Internet, on the other hand, offers interactivity, whereby the company can establish a dialogue and interact with individual customers on a one-to-one basis. In doing so, a company can listen, learn, understand and relate to customers, rather than simply speaking at customers. This creates the opportunity for companies to build stronger relationships than previously attainable. However, this also poses a challenge as these relationships may take on a life and character of their own (Cleland, 2000). The differences between the traditional approach and the one-to-one approach are outlined in Table 1.

Table 1. The emerging brand building environment

TRADITIONAL APPROACH	ONE – TO – ONE APPROACH
Monologue	Dialogue
Public	Private
Mass	Individual
Anonymous	Named
Adversarial	Collaborative
Focused primarily on one –off transactions	Focused on relationship over time
Remote Research	Intimate learning
Manipulative, ″stimulus-response″ approach	Genuine need driven, service approach
Standardised	Customised

Source: Cleland, 2000, 46.

The Internet gives companies control over all their interactions with customers and therefore, brand-building must focus on the end-to-end customer experience - from the promises made in the value proposition, to its delivery to the customer. In maximising the customer experience, companies have to find innovative ways of leveraging the information and relationship building characteristics of the Internet.

1.2 The Social Media

Not long ago, social media were viewed as a phase. Not anymore. The world is being transformed by these new collaborative technologies, which have created a participatory

society and new business models on an unimaginable scale. Over the last decade, social networks have changed communications, shifting the way we consume, produce and interact with information, based on explosive migration to the web (Carlsson, 2010). Social media websites like Facebook, Twitter etc. have created huge impetus on the communication platform with the end customers of different products and services that was lacking in the traditional medium. Social networking sites are used as marketing tool by marketers in creating brand relationship (Nigam, 2012). Huge growth of customer base enables marketers to explore social media networking sites as new medium of promoting products and services and resulting in reduction in clutter of traditional medium advertising of reaching the mass customers and not realizing the actual return on investment (ROI).

Social media advertising is a paid form of brand, service or business promotion and requires a proper and planned communicative message and budget. Advertising is customer centric in nature. Customers play an important role in any major or minor communication because they are the one who are going to decide the fate of the advertising communication. Some benefits of social network advertising include (Jothi et al., 2011):

1. Popularizing your brand, idea or service to the target group.
2. Informing target audience about your brand or service's presence in the market.
3. Encouraging healthy competition in the market.
4. Providing social benefits for the brand.
5. Making the audience to interact and keep them intact with the brand.

Advertising on internet provides a major contribution to brand competition in the market. Advertising here not only provides information about a product or service but also promotes innovation. Besides it also facilitates customer satisfaction. Big and small companies, individuals of all walks of life, major and minor events, concepts, etc., nowadays lay their base on social network advertising to get recognized in the market (Zarrella, 2010).

Social media foster communities where people tend to gather around a common goal or shared interest and interact regularly. Join the conversation, but remember that as a member of the community, you need to do a fair share of listening. Engage in conversations with community members, share ideas and actively participate. Recruiters should be transparent about their connection to the employment brand because creating an authentic brand is one of the most crucial pieces to online success (Leary, 2009).

1.3 Social networking sites

Social networking is the classifying and expanding of individuals into specific groups or communities creating connections through individuals, groups or organizations (Boyd and Ellison, 2008; Constantinides and Fountain, 2008; Trusov et al., 2009). The word "social" refers to a people-to-people interaction and may consist of a set of customers, employees or organizations which have a relationship that holds them together (Haythornthwaite, 2005). Examples of famous global Social networking sites are Facebook with over 500 million active users and LinkedIn with over 90 million users worldwide in 2011. Social networking sites facilitate meeting people, finding like minds, sharing content (Boyd and Ellison, 2008; Constantinides and Fountain, 2008; Trusov et al., 2009).

A social networking site creates network communication among the user community. Though social networking site serves for communication purposes among special interest groups, the marketing strategy has also entered this medium for its reach. People get exposed to various kinds of brand communication through this media. They tend to interact with the brand and also get awareness about the brand and its service in an interesting way (Nicole, 2007). In recent trend of marketing in social networking sites, various brand communications are widely used to attract targeted leads (Jothi et al., 2011). Social networking sites are more collaborative and interactive in comparison to traditional media followed by marketers.

1.4 Brand pages on Social Networking Sites

Social networking sites, like Facebook, Twitter or Netlog, provide the opportunity for brands to create their own online profile. They are called "brand pages", "fan pages", "groups" or "profile pages" depending on the network. According to Lee (2007), "brands become members of the social network like other users". Network users have then the opportunity to associate with a brand. The communication on these pages can go in four different directions: brand to member, member to brand, member to member, member to outsider (Godin, 2008). Unfortunately, most advertisers still use these social network tools to push product information rather than to invite people to interact. Brand pages, are, when used properly, "a priceless medium to gauge what your marketplace is saying about you and/or your company" (Holzner, 2009). Practitioners should understand that they share control of the brand with consumers who want to engage with them in a rich online dialogue. Brand pages on Social networking sites qualify on all the characteristics of online communities: they are online, not limited to business transactions and allow information exchanges and influence games between members (Kim et al., 2008). Trusov et al. (2009) even freely use Social networking sites and online communities interchangeably. The appearance of Social networking sites features has introduced a new organizational framework for online communities and a vibrant new research context. (Brandt et al., 2010).

Facebook, Twitter etc. have become a personal, product and corporate branding hub in the world. Every brand that exists on social networking sites has the same core features and benefits, such as the ability to create a page, share resources, add multimedia and much more (Eric, 2008). The effective brand communication strategies are analyzed to find the impact among the users.

1.5 Brand Management via Social Networking Media

Today hundreds of millions of internet users are using thousands of social web sites to stay connected with their friends, discover new ''friends,'' and to share user-created contents, such as photos, videos, social bookmarks, and blogs. Social networking sites, such as Youtube, Hi5 and My space, are equivalent in many ways to the giant to draw mass audiences. Users spend 2.6 billion minutes daily on Facebook, where advertising can gain some part of their online attention. The online social graph offers four distinct advertising methods, as summarized below by Nigam, 2012.

Targeted ads

These ads offer content directed to specific audiences. With "hypertargeting" or "microtargeting," you can place your ads in front of the consumers can be identified by

such filters as “location, gender, age, education, workplace, relationship status, relationship interests and interest keywords.” People post these traits on their individual profile pages on social network Web sites.

Application Advertising

Use fresh kinds of advertising “platform applications,” such as “games, slideshows and polls,” to increase users’ engagement with your messages.

Social actions

Marketer can place their advertisement on sites where people discuss related social activities, for instance, advertise eatery on pages where diners post restaurant critiques.

“Engagement'' ads

Facebook uses this word for advertisement that enables companies to grap “opportunities to integrate into other aspects” of the site without being “disruptive.”

1.6 Advantages of Social networking Sites

The use of social networking sites have many advantages for marketers. Here are some important, summarized by Nigam, 2012.

Cost Effective

The unique inherent advantage of social networking sites is that the that it is cost effective and more focused.

Networking Applications

The major reason behind increase in usage of social networking websites is its unique application features. These applications include profile viewing, downloading, gaming and chatting. Such kinds of features are not found in other website engines like Yahoo or Goggle. Thus, teenagers are increasingly opening their account on social media websites since they offer variety of fun applications to the user that not only gives them sense of enjoyment but also merges their gaming pleasures with their peer groups and other social media communities. In order to get visibility for brand profile, the marketers need to develop relationship network. This means, get out there and connect with the other users. Send them messages, add them as friends and leave comments on their user profiles. Marketers can also initiate to join and start groups that are related to topics that connected back to brand to participate in forums and chats, as well as special activities a social site may have. This allows you to reach other users on a personal level.

Staying Connected

Another important reason for joining theses websites is to stay updated in relation with getting knowledge on different arenas on the website. These websites help the user to stay in connection with their long distance friends and relatives. Through these social networking, the user also gets in touch with the business and professional associates which helps them to build their career. They are not only useful in delivering messages, but these messages can be shared to the millions of people if the user is active on social media account.

Regularly Refresh the Content.

As in any relationship, the same dinner topics grow stale quickly. Marketers should have a plan for how they will engage their most ardent fans — what interactions, content, and features will keep users coming back over and over again Marketers can should give updates about their brand, and adding interesting content such as photos and videos. Marketers can create a widget with content that’s directly related to brand, and this widget

is exportable directly from the marketer's profile, It encourages others to place the widget on their own profile, letting them work for you while still expanding the recognition of your brand. If the widget itself can't be linked back directly to the profile, the caption can be added to images slide show or video that displays brand and public URL.

Creating Analytical Databases For Brand Marketers

The activity of users over networking sites create a lot of data to consumers which can be leveraged in places where they make the decision creating impact regarding different brands.

1.7 Emerging trends in social media in European Union

Today Internet is widely spreading as a communication media in European Union. Emergence of the information super highway has revolutionized the way media is created and consumed. Previously media used to be created by media firms who are the content generators as well as the content owners. And the content used to broadcast to the consumers by the media. This concept has undergone an elementary change, now anyone can create content best known as User Generated content and share it with others using platforms like Blogging, Social Networks, YouTube etc. Now the consumers of the media have converted into media creators and the content also distributed on the internet through social networking and people connect with this content through comments. Social networking has become more popular among everyone. Consumers are getting more connected and communicative with their networks and technology allows them to voice their opinions rapidly.

Today European Union consumers can make use of facilities like E-banking-retailing-shopping etc. with more confidence and trust as never before. Internet has proved to be more than just emails and Google search. With the advent of networking media, broadband and Web 2.0 now many people are joining the social networks like Facebook, Twitter and thus it is easier for the marketers to spread the word about them over the network. To bridge the gap between the consumers, organization, marketing and media planning people there is the need of uniformity and trust in the social media. Social media, community networking, blogging, twitting, etc. were beyond anticipation for large mass of people. E- Shopping and E- bookings, E-learning and online dating have achieved good heights and became popular among European Union consumers.

Another area of opportunity for building brand is Viral marketing. Viral marketing, also known as word-of-mouth (WOM) or "buzz marketing", is the tactic of creating a process where interested people can market to each other. Implementing an effective viral marketing strategy is a good way to get people talking about your business. A successful viral marketing campaign can be developed through social networking media like Twitter, Facebook etc. With the information available on online network the marketers have the knowledge of the needs and wants of different level of customers. Word-of-mouth is a particularly powerful medium, as it carries the implied endorsement from a friend. The Internet, with its e-mail lists, web sites, chat rooms and bulletin boards, makes communication tighter, and word-of-mouth even more effective. As a result, viral marketing is an effective tool in getting a message out fast, with a minimal budget and maximum effect. If a company can provide a strong enough incentive for customers to share their lists of personal contacts, whether for communications or community, they will have a powerful viral opportunity at their disposal. A good virus will look for prolific

hosts (such as students) and tie into their high frequency social interactions (such as e-mail and messaging).
Next chapter provides some information about leading brand in the category of fast moving consumer goods in selected European Union country. Chapter also provides a mix of activities that have been carried out as part of marketing campaign by using social networking media.

2. MATERIALS AND METHODS

The objective of the study in this paper is to analyze the effective communication strategy through social networking media. It is important to study the effective way of communication in branding the product in social networking media and analyze its reach among the consumers. The paper explores the consumer engagement practices adopted by social networking media for building the brand. Dialogue between consumers and the brand is presented in the paper on the case of a leading brand in the category of fast moving consumer goods in selected European Union country.

2.1 Learning from and with young consumers with social media

New products and strong brand play a very important role in the fast moving consumer goods industry. It is large and competitive industry with many active companies (Vukasovič, 2012). The producers of high-volume products are aware that a company's leading role on the market is ensured through strong and established brands and loyal consumers. Today, the labelling with brands is such a strong factor that there are hardly any products without a brand. Various literatures provide tons of advices and rules on how to create or shape a successful brand. On the other hand, decisions regarding the policy of brands are far from being straight-forward and require numerous researches and considerations.
Due to data protection and providing discreet company for analyzed brand we used in this paper instead of brand name label X. Brand X is a synonim for pleasure, emotions and quality. Brand X personality is matching the characteristics of brand X target group – generation Y (witty, funny, dynamic, full of energy), which always needs something new and challenging. Brand name X doesn't bring any negative associations neither regionally, neither by any consumer group. Brand X stands for values like trust, safety, quality and loyalty.
Advertising campaign were designed on irresistable desire for brand X. Basic guideline of the market communication campaign was the orientation towards consumers and their benefits. The next guideline was the creativity as the most powerful marketing tool to create a brand. After defining the marketing and communicative goals and target group to which the message is intended, what followed was the stage of defining the implementation of the creative strategy. Advertising campaign was spread across web site for brand X, internet media with web advertising on Windows Live Messenger, Facebook.com, YouTube.com.

The marketing goals of the campaign were:

1. To retain 46.4% volume and 61.6% value share for brand X on an annual basis in its category in selected European Union country.
2. To achieve high (90%) campaign recognition by the target group.

The communicative goals of the campaign were: to increase the involvement of consumers and their engagement with the brand X.

1. Web site for brand X:
   - to increase the attendance of web site for brand X with basic 3.367 unique visitors and 4.581 visits in the previous three month period to 100.000 different visitors and 200.000 page views.
2. Facebook:
   - Brand X activate in the Facebook environment – to increase the number of Facebook fans: from 5.882 fans before campaign to 20.000 fans after campaign.
   - to increase the level of interaction with the posts (min. 500 comments, min. 1000 likes).
   - to increase the number of female Facebook fan (25+ years) of 100% (key decision makers on daily and weekly purchases).
3. Fun Club for brand X:
   - to acquire at least 10.000 new email contacts for future direct communication.

2.2 Methods of data collection and sample

To analyze and find the effectiveness of communication strategy to building a relationship with the analyzed brand, communication through social networking media was done with the quantitative survey method in the research. Survey was conducted, by sending questionnaire by e-mail to collect the individual opinion from the respondents. Non probability sampling technique is used to collect the opinion from the online respondents. The total population is social networking user community, but to collect the effective data the sampling is constrained to the target population like young adults, between the ages of 18 years to 45 years. The sample size is seven hundred. The sample consisted of 350 women and 350 men. The majority of respondent were between 25 and 45 years old. More than half of them had finished high school (58%), 22% had a higher education, 8% had a primary school and 12% of respondents completed secondary school. 80% of respondents currently living in cities, visit rural areas regularly, at least once a month. The respondents are interested in using internet and social networking sites often or very often, suggest that the survey respondents provide an interesting study group for this issue.

2.3 Data analyses

Analysis of quantitative data provided by mentioned questionnaire used the Statistical Package for Social Sciences (SPSS 17.0). The data obtained from the survey were analysed with univariate analysis in order to check distributions of frequencies and to detect possible errors occurring during the research and/or data entry. Chi-square, Anova and correlation analysis were performed to examine the relations among respondends. The level of comparison was set at, 0.05. Prior to hypotheses testing, factor analysis was conducted to determine the independent variables of the study. Ambigious items were eliminated from the survey by varimax rotation. The data collected from the surveys was put through a validity assessment (KMO = 0.898; Bartlett's Test sign = 0.000) thus revealing that the sample of the study was appropriate for factor analysis and that there is

a strong relationship between the variables. The reliability analysis of the research instrument yielded a Cronbach's Alpha value of 0. 89 and a significance level of 0.000.

2.4 Research Hypotheses

The survey aims to examine a number of research hypotheses formulated based on the literature review. More specifically, the research hypotheses are:
H1: More than 45% of respondents use internet more than 3 hours a day.
H2: Age variable has an effect on the use of the internet.
H3: More than 90% of respondents are aware of social networking sites
H4: More than 95% of respondenst are aware of social networking sites for brand X.
H5: More than 70% of young population (between 18 and 35 years old) have high level of awareness about internet marketing campaign for brand X.
H6: More than 90% of user agreed that the communication strategy used in brand X communication creates impact on brand effectively.
H7: The target group for brand X is young population, between 18 and 35 years old.
H8: An effectiveness of communication and strategy done through social networking media could increase brand relationship with young people.

3. RESULTS

Usage of internet by the user

It has been found that 5% of audience use internet once a week, 13% of the respondents use 2 to 3 days a week. 33% of the respondents use 1 or 2 h a day and the remaining 49% of users are accessing internet more than 3 hour a day. It is understood that the new media and its technology is an emerging trend in communication which attracts almost all the people, if they have knowledge of computers. So this digital media has more snatchers towards its communication and internet is becoming part of necessary communication among young population (Table 2) in selected European Union country. Differences in young population usage of internet with respect to their gender and age level were verified by Chi-square analysis. Chi-square analysis showed that there were differences in population usage of internet with respect to their gender and age level. We found that men tend to use internet more often than woman. More than 55% of men and 45% of woman claimed to use internet very often (more than 3 hours a day) (x^2 = 12.573; df = 2; p = 0.002). Further, our results suggested that 77% of younger population (between 18 and 35 years old) tend to use internet more often than older people (23%) (x^2 = 8.301; df = 2; p = 0.012). Based on the presented results the hypothesis 1 and 2 were confirmed.

Table 2: Usuage of internet

Usuage of internet	%
Once a week	5
2 to 3 days a week	13
1 or 2 hours a day	33
More than 3 hours a day	49

Awareness of social networking sites and internet marketing campaign for brand X

From this result, it is observed that nearly 97% of the internet users are aware of social networking sites and only 3% of them are clueless. Although the concept of computer-

based communities dates back to the early days of computer networks, only some years after the advent of the internet online social networks have met public and commercial in a successive manner. At the most basic level, an online social network is an internet community where individuals interact, often through profiles that represent their selves to others. Social networks have grown rapidly, and some like Facebook, YouTube, have achieved the mass market and penetrated in a few months since their inception, such applications have infringed their users in different strategy to interact with more people (Jothi et al. 2011). Also from this results it is observed that nearly 96% of the internet users are aware of internet marketing campaign for brand X (Table 3). Based on the presented results the hypothesis 3 and 4 were confirmed. More than 72% of young population (between 18 and 35 years old) had high level of awareness about internet marketing campaign for brand X. Based on the presented results the hypothesis 5 was confirmed.

Table 3: Awareness of social networking sites and internet marketing campaign for brand X

Awareness of social networking sites	**%**
YES	97
NO	3
Awareness of internet marketing campaign for brand X	
YES	96
NO	4

Accessibility of ads in internet marketing campaign for brand X

Only 2% of the total samples say that they have never accessed or shown interest to the ads displayed in social networking sites for brand X. 86% of the respondents use to access often and were interested to listen to the advertisements for brand X, 12% of the respondents use to access somethimes and were interested to listen to the advertisements for brand X (Table 4). Today's customers want to be engaged differently than in years past and many traditional marketing tactics simply do not work anymore. Social media marketing is a revolutionary way to build solid relationships with customers long before first contact with fun, attractive messages and interactions (Borges, 2009)

Table 4: Accessibility of ads in internet marketing campaign for brand X

Accessibility of ads in internet marketing campaign for brand X	**%**
Often	86
Sometimes	12
Never	2

Brand communication that attracts the users

Interactive fan page for brand X attracts 55% of users. 20% of users are pulled their interests towards brand X game and 15% of users listened to viral video ads, 10% of users are interested to traditional banner ads. Most of the social networking websites are enabling brands to engage the right people in the right conversation at right time (Shih, 2009). Nowadays communication on branding in social networking sites is more personal, contentious, fascinating and influencing among the user community (Table 5).

Table 5: Communication fro brand X that attracts the users

Communication for brand X that attracts the users	%
Interactive fan FB page for brand X	55
Game "Crazy T-shirts" on web site for brand X	20
VIDEO ads for brand X"	15
Banner ads for brand X	10

Impact on building brand relationship with target group

According to the respondents, 98% of user agreed that the communication strategy used in brand X communication creates impact on brand effectively and also which could help it to recall the same often and interactively. Based on the presented results the hypothesis 6 was confirmed.The remaining respondents almost 2%, says that it does not create much impact on brand relationship but still effective for other communication purpose like sharing and chatting information (Table 6). Based on research results the target group for brand X is young population, between 18 and 35 years old. The hypothesis 7 was confirmed.

Table 6: Impact on building brand relationship with target group

Impact on building brand relationship with target group	%
Agree	98
Disagree	2

Key performance indicators campaign for analyzed brand

The finding of the study states that the internet marketing campaign for brand X was effective and resulted in the process of building a relationship with the brand. Key performance indicators campaign for brand X are:

- after campaign volume market share has been raised to 48,3% and value market share for brand X has been raised to 63,7% in its category in selected country of European Union market (Nielsen, 2012)
- the awareness of internet marketing campaign for brand X was 92%, so the campaign for brand X has been recognized.
- we activated 178.682 unique visitors and reached 377.832 page views (Google Analytics, 2012).
- with the mentioned marketing campaign brand X gained more than 20.000 Facebook fans; at the end of the campaign, brand X had 20.510 Facebook fans (Facebook Insights, 2012).
- we increased the level of interaction with the posts: we had got 938 comments and 2.841 likes (Facebook Insights, 2012).
- the number of female Facebook fans, 25+ years has increased by 431.63% (from 784 to 3.384 Facebook fans) (Facebook Insights, 2012).
- we achieved 12.212 new email contacts for future direct communication

Based on the presented results the hypothesis 8 was confirmed. We can conclude that the marketing and communicative goals of the campaign for brand X were achieved.

4. DISCUSSION

Social media affords us a great opportunity, the ability to build relationships directly with consumers. It's something no amount of media targeting has been able to achieve. We believe in the power of social media to help develop the relationships between a brand and its users. But it has to be real. It has to be done right, with a genuineness of purpose if it is truly to be a two-way communication and not merely another brand monologue. Brand leaders need to listen and respond to our most valuable asset -- our consumers -- on many levels.

Currently, marketers are using social media as a way to promote their brands and build these consumer brand relationships. Social communities such as Facebook, Twitter, Four Square, and LinkedIn are channels of social media focused on relationships, shared interest and identification. These communities feature multi-way communication, conversion and collaboration (Tuten and Solomon 2012).Brands from fast moving consumer goods category like Coca-Cola, Starbucks, Milka, etc. actively use online social communities as forums for consumer engagement. Additionally, the use of online social communities has especially become important in food industry.

Marketers are interested in developing relationships between consumers and brands and have used social media as avenues to achieve such partnerships. This research demonstrated outcomes of relationships that are based on affective commitment. Affective commitment led to greater brand advocacy from consumers. The Internet is an optimal mechanism for developing consumer-brand relationships due to its interactivity. This research contributes to understanding about how such relationships are developed in an online context by using social media and its implications for building brand relationship. This research contributes that appropriate communication strategy used in brand communication creates impact on brand effectively. An effectiveness of communication and strategy done through social networking media could increase brand relationship with consumers. Further, in the online environment, value co- creation also plays an integral role in developing emotionally based brand relationships. As individuals become more actively involved in creating and disseminating information about the brand, they may also exhibit more loyal behavioral intentions and overall advocacy for the brand. This research suggests that marketers might be successful in developing relationships between a consumer and a brand by being proactive in on line communications by using social media.

5. CONCLUSIONS

However, building consumer brand relationships can be a challenging and complex process. Brand relationships with consumers are often associated with different psychological processes and social norms and can take many forms. For example, a consumer brand relationship may be emotionally based and can involve obsessive thought, or it may be cognitively based and simply habitual (MacInnis et al. 2009). Social media are valuable forums for building brand relationships with consumers. Many organizations, products, brands and entertainment professionals have a presence on Facebook because of its ability to facilitate multiplicative exposure and its suitability as a relationship enhancing tool (Oszajca 2012, Thorbjornsen et al. 2002). Cultivating based and committed customer brand relationships requires time and resources to develop.

Facebook, as do other social media, provides a viable platform for the formation of such relationships because of its targeted approach.

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MEDIA SPOŁECZNE I ICH IMPLIKACJE DLA BUDOWANIA RELACJI Z MARKĄ

Innowacje w mediach społecznych zrewolucjonizowały świat w XXI wieku. Media społeczne w sieci przedstawiają potencjalne możliwości dla nowych form komunikacji i handlu między sprzedawcami a konsumentami. Celem badań zamieszczonych w niniejszej pracy jest analiza skutecznej strategii komunikacji poprzez media społeczne. Badanie zostało przeprowadzone za pomocą wysyłanego pocztą e-mail kwestionariusza w celu zebrania indywidualnych opinii respondentów. Cała populacja jest społecznością użytkowników mediów społecznych, ale do zbierania próbek skutecznych danych została ona ograniczona do populacji docelowej ludzi dorosłych w wieku od 18 lat do 45 lat . Wielkość próbki to 700 osób. W pracy przedstawiono wyniki badań, w tym działań marketingu internetowego, które przyczyniły się do budowania relacji z marką. Konieczne było zbadanie skuteczności strategicznej komunikacji marki prowadzonej w mediach społecznych. W najnowszej tendencji marketingu, w serwisach społecznościowych, aby przyciągnąć liczbę klientów stosuje się różne strategie komunikacji marki. Badanie takie pomoże ocenić efektywność komunikacji i strategii społecznej mediów wykonanej w sieci, które zachęca grupę docelową do udziału w tego rodzaju przedsięwzięciu.

Słowa kluczowe: Internet, media społeczne, produkty szybkozbywalne, marka, Unia Europejska

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VORAUSSCHAU UND REGULIERUNG VON INNOVATIONSPROZESSEN IM BEREICH DER UBIQUITÄREN INFORMATIONS- UND KOMMUNIKATIONSTECHNOLOGIE

Technische Innovationen können einerseits neue Märkte eröffnen und Problemlösungen aktueller gesellschaftlicher Herausforderungen liefern, andererseits aber auch bspw. Fragen der Umwelt- und/oder Sozialverträglichkeit auf kurzen, mittleren und langen Zeitskalen aufwerfen. Aufgabe der Technikfolgenabschätzung ist, sowohl die positiven und negativen Folgen und Nebenfolgen wenn möglich schon frühzeitig aufzuzeigen, damit die positiven Folgen und Nebenfolgen gezielt gefördert und die negativen Auswirkungen einer Innovation bewusst gemildert oder gar verhindert werden können. Allerdings setzt dies voraus, dass erstens einigermaßen verlässliche Aussagen über die Zukunft getroffen werden können und zweitens, dass regulatorische Maßnahmen zur Vermeidung negativer und Förderung positiver Folgen auch ihre Adressaten finden. Am Beispiel der ubiquitären Informations- und Kommunikationstechnologie wird jedoch gezeigt, dass diese Voraussetzungen oft gar nicht erfüllt werden können. Dies ergibt sich aus den Innovationstypen, die im Bereich der IuK-Technologie oft vorliegen ebenso wie aus dem Collingridge-Dilemma. Beide Faktoren mindern die Verlässlichkeit von Prognosen. Außerdem finden regulatorische Maßnahmen oft ihre Adressaten nicht, da die gesellschaftlichen Subsysteme, in denen Innovationen stattfinden, immer weniger klar umrissen sind und mit klassischen Regulierungsmaßnahmen wie Gesetzen kaum mehr erreicht werden können.

Schlüsselwörter: Technikfolgenabschätzung, Foresight, Innovationsforschung und –management, Informations- und Kommunikationstechnologien.

1. NEUE KONZEPTE DER INTERAKTION MIT COMPUTERSYSTEMEN

Innovative Nutzerkonzepte stehen derzeit hoch im Kurs; so geht bei mobilen Geräten der Informations- und Kommunikationstechnologie der Trend zu Bedienungskonzepten, die darauf aufbauen, dass die Nutzer Gesten verwenden, um Aktionen auszulösen. Schon länger wird diskutiert, die Steuerung und Kontrolle von Geräten dadurch natürlicher zu gestalten, dass die unmittelbare Umgebung auf das Verhalten der sich dort befindenden Personen reagiert und so selbst eine allgegenwärtige Nutzerschnittstelle realisiert. Dieses Konzept, das unter Bezeichnungen wie AmbientIntelligence, Ubiquitous Computing oder Pervasive Computing firmiert (vgl. bspw. Beigl, Gellersen& Schmidt 2001), impliziert dabei auch, dass die entsprechende technische Infrastruktur nicht mehr als solche erkennbar sein wird, da die entsprechenden Funktionen nicht von klar identifizierbaren und eng lokalisierten einzelnen Geräten ausgeführt werden, sondern die Umgebung selbst die

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gerade abgefragte Funktionalität bereitstellt, wie Marc Weiser, auf den dieses Konzept zurückgeht, in seinem Aufsatz „The Computer fortheTwenty-First Century“ (1991) bereits betonte. Heute verbirgt sich diese Idee hinter Bezeichnungen wie Anytime, Anywhere Communication and Computing (AACC, vgl. Neitzke et al. 2008); hier wird als Einsatzbereich insbesondere die häusliche Betreuung von betagten oder körperlich gehandicapten Menschen genannt. Smart Home und AmbientAssisted Living (AAL) gehören ebenfalls in dieses Umfeld (vgl. bspw. Park et al. 2003). Die Rede vom Internet der Dinge wiederum verweist darauf, dass angestrebt wird, eine wesentlich stärkere Repräsentation realer Objekte im Netz als bisher zu erreichen (vgl. bspw. die Beiträge in Fleisch& Mattern 2005). Weitere Benennungen sind Ubiquitous Media (vgl. bspw. Drews 2004), Mixed bzw. Augmented Reality (vgl. Kabisch 2008: 227), Computer-Mediated Reality (vgl. Rekimoto&Ayatsuka 2000) oder Tangible Media bzw. Tangible Interfaces (bspw. Brereton 2001; Shaer et al. 2004).

2. INNOVATION IN DER TECHNIKFOLGENFORSCHUNG

Details und Ausgestaltung dieser Technologien ebenso wie deren tatsächliche und potenzielle Anwendungen sind jedoch unerheblich für die Antwort auf die Frage, ob Technikfolgenforschung und -abschätzung (TA) zukünftige Technologiepfade wenigstens mit einiger Verlässlichkeit voraussagen kann, damit von politischer Seite, durch die Zivilgesellschaft oder von Unternehmen regulierend eingegriffen werden kann, um gewünschte Entwicklungspfade zu verstärken und ungewünschte Pfade möglichst zu versperren, sei es durch gesetzliche Regelungen, soziale Normen oder ökonomische Mechanismen. Um die technische Entwicklung zu gestalten, müssen allerdings Adressaten für Regulierungsmaßnahmen identifiziert werden. Traditionelle Konzepte der TA benennen hier an erster Stelle Wissenschaft und Unternehmen als Innovationsakteure bzw. -systeme, die in einem institutionellen Rahmen agieren und so regulatorischen Maßnahmen zugänglich sind. Shang und Fagan (2006) nennen außerdem noch Nichtregierungs- und Non-Profit-Organisationen, betonen jedoch ebenfalls, dass Innovationen institutionelle Zusammenhänge benötigen.

Daher stellt sich die Frage, was passieren könnte, wenn ein entsprechender institutioneller Rahmen nicht mehr existierte. Um dies beantworten zu können, müssen Innovationsprozesse genauer betrachtet werden, denn Technologien können auf sehr verschiedenen Wegen entwickelt und implementiert werden. Im Folgenden wird eine dichotome Unterscheidung genutzt, die für die Beschreibung realer Prozesse meist zu grob wäre, aber für eine grundsätzliche Analyse durchaus hilfreich sein kann: Es wird vorausgesetzt, dass Innovationsprozesse im Wesentlichen entweder top-down oder bottom-up (vgl. Pallas 2009) betrieben werden. In der Innovationsforschung wird meist eine andere Terminologie genutzt (vgl. Fiore 2007); hier wird von „Communities“ als Ort von Top-down-Innovationen und von „Networks“ als Ort von Bottom-up-Innovationen gesprochen.

Top-down-Innovation soll bedeuten, dass Technologie in einem gesteuerten Prozess, angestoßen von einem oder wenigen Akteuren wie z. B. Unternehmen oder staatlichen Institutionen, entwickelt und implementiert wird, um ein konkretes und explizit formuliertes Ziel zu erreichen. Paradigmatisch hierfür ist Großforschung wie z. B. in Deutschland mit Growian (**Gro**ß**wi**nd**an**lage), Hochtemperaturreaktor, Transrapid und ähnlichen Pro-

jekten. Top-down-Innovation muss jedoch nicht diese Dimensionen annehmen, sondern kann sich auch in kleineren Maßstäben bewegen (siehe den folgenden Abschnitt). Sie zeichnen sich dadurch aus, dass es ein vergleichsweise klar definiertes Ziel gibt und dass die zur Erreichung dieses Ziels entwickelte und eingesetzte Technologie (zunächst) nur für dieses Ziel verwendet werden soll.

Bottom-up-Innovation soll im Gegensatz dazu heißen, dass Technologie in einem allenfalls lokal gesteuerten Prozess von einer nicht klar zu benennenden und in vielen Fällen auch nicht deutlich zu erkennenden bzw. zurechenbaren Zahl von Akteuren angestoßen, entwickelt und implementiert wird, um ein wiederum allenfalls lokal definiertes Ziel zu erreichen. Ein Beispiel für eine Bottom-up-Innovation ist Google Maps: Zwar hat das Unternehmen Google als einzelner Akteur diesen Dienst implementiert und es ist davon auszugehen, dass das Unternehmen damit auch einen konkreten Zweck verfolgte, doch die Offenheit und Interoperabilität des Services erlaubt es weiteren Akteuren, andere Dienste darauf aufzusetzen, ohne dass diese von Google mitgeplant gewesen wären.

3. EIN SZENARIO MIT NICHT INTENDIERTEN FOLGEN

In dem folgenden Szenario von Kang und Cuff (2005) wird der Einsatz von Ubiquitous Computing- bzw. Pervasive Computing-Technologie (häufig auch alsUbiComp und PerC abgekürzt) zur Überwachung und Kontrolle der Besucher einer Shopping Mall beschrieben; zudem behandeln die Autoren nicht nur technische oder ökonomische Fragen, sondern machen sich ebenso Gedanken darüber, wie sich die Nutzung des öffentlichen Raums aus soziologischer und politikwissenschaftlicher Perspektive verändern würde, wenn diese massiv durch den Einsatz von Technologie ko-reguliert werden würde. EinedieserKonsequenzenverdeutlicht das folgendeZitat:

„Generally, PerC helps the mall identify ‚undesirables' by examining individuals' immediate attributes for disliked characteristics. A person might fall into a pariah category because of what she is wearing, who she is ‚hanging out' with, or her demographic category" (Kang & Cuff 2005, S. 122).

Entscheidend ist, dass dieses SocialSorting – eine Form der sozialen Exklusion – gewollt, also gezielt angestrebt und durch den Einsatz von Technologie erreicht wird. Doch möglich wird es erst dadurch, dass der Shopping Mall-Betreiber durch rechtlich kodifizierte Verfügungsgewalt die Definitionsmacht darüber besitzt, wer in den Räumen der Mall als unerwünscht („undesirable") eingestuft werden darf. Dies legt den Schluss nahe, dass Top-down-Innovationen nur dann erfolgreich sein können, wenn sie durch juristische Regulierungsmaßnahmen flankiert werden.

Kang und Cuff nehmen eine Top-down-Sichtweise ein, doch gleichzeitig bemerken sie, dass die Technologie, die ursprünglich zur Überwachung und Kontrolle genutzt werden sollte, ganz anderen Zwecken zugeführt werden könnte. Dazu muss man dieses Szenario nur zu Ende denken und Entwicklungen in Rechnung stellen, die bereits heute realisierbar wären: Alle Produkte, die die Lebensmittelläden innerhalb der Shopping Mall verkaufen, sind mit RFID-Chips versehen. Dies könnte man beispielsweise dazu nutzen, eine lokale Häufung von Schnapsflaschen zu detektieren, die ein Indikator dafür wäre, dass Alkohol

von einer Gruppe von Personen konsumiert wird, sodass diese ein potenzielles Unruhe- oder gar Sicherheitsrisiko darstellen.

Genauso aber könnten Hersteller potenziellen Käufern die Möglichkeit bieten, mithilfe eines im Mobiltelefon oder Smartphone integrierten Scanners die RFIDs (**r**adio**f**requency**id**entification) der Produkte auszulesen und Zugriff auf Datenbanken zu gewähren, in denen Informationen über die Herkunft der Inhaltsstoffe, das Produktions-, Verpackungs- und Auslieferungsdatum und vieles mehr gespeichert sind (vgl. Frank et al. 2008). Konsumentscheidungen könnten so besser informiert getroffen werden: Vielleicht möchten die Kunden keine Produkte mit Inhaltsstoffen aus asiatischen Ländern kaufen, weil sie protektionistisch gestimmt sind. Oder aber es sollen keine Produkte aus Ländern sein, in denen kein Mindestlohn gezahlt wird. Eine weitere Möglichkeit wäre, Allergiker automatisch vor bestimmten Inhaltsstoffen zu warnen. Es ist zwar eher unwahrscheinlich, dass Informationen über Mindestlöhne, Menschenrechtsverletzungen oder umweltschädliche Produktionsmethoden in den Datenbanken der Produkthersteller selbst zu finden sein werden, doch NRO wie Attac, Human Rights Watch oder die ILO könnten sie nach dem Muster der Wikipedia bereitstellen.

Solche Mash-ups geben den Hinweis, dass der schöpferische Part einer Bottom-up-Innovation vor allem aus der Neukombination bereits existierender Technologien bestehen wird. Die gerade skizzierten Anwendungen und Services wären technisch sofort realisierbar. Statt auf RFIDs aufzusetzen, könnten die heute auf den Produktverpackungen aufgedruckten Barcodes mit den Kameras marktüblicher Mobiltelefone aufgenommen und dann decodiert werden; grundsätzliche technische Hindernisse, die die Realisierung dieses Szenarios verhindern könnten, existieren nicht. Einer bottom-up verlaufenden Innovation sind in diesem Fall nur sehr niedrige Hürden gesetzt; die denkbaren sozialen und ökonomischen Konsequenzen könnten jedoch sehr umfangreich oder gar disruptiv sein.

4. SUBKULTUREN ALS QUELLE VON INNOVATION

Das zur Umsetzung notwendige Know-how ist beispielsweise in der Open-Source-Gemeinde oder in Subkulturen wie der Hackerszene weit verbreitet. Auch in anderen subkulturellen Zusammenhängen, z. B. in der sogenannten Cyberpunk-Szene, ist entsprechendes Wissen verfügbar, insbesondere auch im Hinblick auf neuartige Weisen der Interface-Gestaltung für Computer. Die Möglichkeit zur (technischen) Modifikation des eigenen Körpers wird dort als Ausdruck personaler Autonomie verstanden (vgl. Pitts 2003). In der Cyberpunk-Szene mischen sich technikaffine Sichtweisen beispielsweise mit feministischen Perspektiven; zentral ist die Idee, dass der menschliche Körper und seine Biologie nichts Unveränderbares und schicksalhaft Gegebenes, sondern der sozialen und technischen Gestaltung zugänglich sind. Dabei spielen neue Zugänge zur Realität durch die Erweiterung bestehender oder das Hinzufügen neuer Sinne eine wichtige Rolle, wie es z. B. Steve Mann oder noch radikaler der Künstler Stelarc in ihren Arbeiten aufzeigen. Neue Nutzungskonzepte und Schnittstellen sind dabei aber nichts dem menschlichen Körper Externes (vgl. Campbell et al. 2010); der Körper, Teile davon oder eben implantierte Technik sollen die Schnittstellen bereitstellen – hierzu sind die Arbeiten von Kevin Warwick sehr instruktiv. Über die möglichen individuellen und sozialen Folgen und Nebenfolgen einer inkorporierten Technologie wissen wir heute allerdings nur sehr wenig.

Für die Frage nach der Steuerbarkeit von technischen Innovationen sind solche Detailfragen aber nicht wichtig. Im Vordergrund steht, dass sich Subkulturen in der Regel explizit vom kulturellen Mainstream abtrennen und sich als subversiv sehen. Solche sozialen Verbände sind in ihrem Handeln und kreativen Potenzial kaum einschätzbar; ebenso ist die Wirkung, die subkulturelle Phänomene auf den kulturellen Mainstream haben, praktisch nicht vorhersehbar. Hinzu kommt, dass gerade Subkulturen, deren Mitglieder sich bezüglich ihrer Stellung in der Mainstream-Kultur marginalisiert sehen, moderne IuK-Technologien nutzen, um sich weltweit zu vernetzen und so die eigene Marginalisierung zu überwinden. Dies schafft kreatives Potenzial und stellt Ressourcen bereit.

5. INKREMENTELLE, RADIKALE UND DISRUPTIVE INNOVATIONEN: DIE GRENZEN DER TA

Daher muss aus der Perspektive der TA die zentrale Frage sein, wie weit voraus und wie präzise zukünftige Technologien und ihre Folgen vorhergesehen werden können. Sofern es sich um netzwerkartig strukturierte Technologien handelt, fällt die Antwort in doppelter Hinsicht negativ aus: Unserer Fähigkeit, Entwicklungen vorherzusehen, sind sowohl in Bezug auf den Zeithorizont als auch der Präzision extrem enge Grenzen gesetzt.

Man kann Innovationen in verschiedene Typen einteilen. Dabei ist insbesondere die Unterscheidung in inkrementelle Innovationen auf der einen und radikale bzw. disruptive Innovationen auf der anderen Seite von Bedeutung (vgl. Latzer 2009). Es wurde oben bereits angedeutet, dass es Orte der Innovation gibt: Communities für Top-down-, Networks für Bottom-up-Innovationen. Gleichzeitig können Top-down-Innovationen mit inkrementellen Innovationen identifiziert werden, Bottom-up-Innovationen wiederum mit radikalen bzw. disruptiven Innovationen.

Inkrementelle Fortentwicklung baut nicht nur auf bestehenden Technologien auf, sondern hat dabei ein bewahrendes Element – es wird deshalb von Sustaining Technologies gesprochen (vgl. Christensen 1997). Statt einen bereits existierenden Technologiepfad komplett zu verlassen, wird eine schrittweise Entwicklung betrieben. Durch inkrementelle Innovationen können auf Anbieter- wie auch Nachfragerseite Kosten vermieden werden. Daher ist es kein Zufall, wenn als Ort solcher Innovationen Communities identifiziert werden: Diese bieten einen institutionellen Rahmen, der radikalen Veränderungen entgegensteht und jenen Innovationen, die an bereits existierende Technologien anknüpfen, ein geeignetes Umfeld. Im Bereich der Nutzerschnittstellen ist dies gut erkennbar: Multitouchscreens beispielsweise implizieren keinen radikalen Bruch mit existierenden Technologien, sondern stellen nahe liegende Fortentwicklungen von breit eingeführten Nutzerschnittstellen dar. Für die Anbieter stellt ihre Produktion keine neue Herausforderung dar, für die Nutzer erfordert ihre Nutzung keine Adaption an eine völlig neue Semantik, sondern es kann auf bestehendes Know-how zurückgegriffen werden. Den Vorteilen inkrementeller Innovationen stehen aber auch Nachteile gegenüber: Da kein radikaler Bruch mit etablierten Nutzungskonzepten vollzogen wird, werden deren Schwächen perpetuiert.

Radikale bzw. disruptive Innovationen bieten nun die Chance, die Nachteile etablierter Technologien komplett zu verwerfen. Solche Umbrüche können als Instanzen der Schumpeter'schen kreativen Destruktion verstanden werden (vgl. Latzer 2009, S. 602 ff.), wenn

auch bedacht werden muss, dass Schumpeter in erster Linie Basistechnologien betrachtet hatte. Allerdings gehen jene, die von einem radikalen bzw. disruptiven Technologiewandel sprechen, in der Regel nach wie vor davon aus, dass dieser letztlich in Form von Top-down-Innovationen stattfindet, also in einem institutionellen Rahmen bzw. in einer Community.

Dem steht das Konzept der Bottom-up-Innovation gegenüber, in dem davon ausgegangen wird, dass die Innovationsakteure eben nicht zu einer Community gehören und damit auch nicht an den entsprechenden institutionellen Rahmen gebunden sind, sondern dass Bottom-up-Innovationen netzwerkartig ablaufen: Lokal werden auf Basis bestehender Infrastrukturen neuartige Mash-ups entwickelt, die zunächst lokalen Erfordernissen und Ansprüchen genügen sollen und dabei auch mit etablierten Nutzungsweisen, Standards, Regeln u. Ä. brechen können. Die Eigenart von IuK-Technologien, durch Vernetzung und (Neu-)Kombination bestehender Dienste und Anwendungen neue Produkte zu ermöglichen, erleichtert Bottom-up-Innovationen erheblich. Zudem lassen sich in Netzwerken produktive Ressourcen erschließen, die klassischen Innovationsakteuren wie staatlichen Institutionen, akademischen Einrichtungen und Firmen (oft) verschlossen sind. Dabei ist auf ein mögliches begriffliches Missverständnis hinzuweisen: Wenn Fiore und andere Autoren von Community sprechen, ist damit etwas anderes gemeint als beispielsweise in der Rede von der Open Source Community – diese müsste aus Sicht der Innovationsforschung eigentlich Open Source Network heißen.

In der Technikfolgenforschung wird häufig das Collingridge-Dilemma (vgl. Collingridge 1980) angeführt, wenn auf ein wesentliches Problem der Vorhersage von Folgen und Nebenfolgen technischer Innovationen sowie auf die Probleme der Regulierung der technischen Entwicklung hingewiesen wird: Das Wissen über die Folgen einer Technologie ist vor deren Innovation und selbst in der frühen Implementierungsphase zu gering, als dass sinnvolle regulatorische Eingriffe möglich wären. Dann aber, wenn dieses Wissen vorhanden ist, können Eingriffe kaum mehr vorgenommen werden, da der eingeschlagene Technologiepfad zu vertretbaren volkswirtschaftlichen Kosten nicht mehr verlassen werden kann. Das Collingridge-Dilemma setzt aber voraus, dass die eigentliche technische Innovation als solche bekannt ist; gerade dieses Wissen ist es aber, das im Zusammenhang mit Bottom-up-Innovationen nicht verfügbar ist, da die entsprechende Technologie in sozialen Kontexten entwickelt wird, die sich einer systematischen Untersuchung oft genug entziehen. Radikale bzw. disruptive Innovationen, die soziale Netzwerke ermöglichen und die durch die Eigenschaften hoch vernetzter Basistechnologien zusätzlich gefördert werden, entziehen sich daher weitgehend der Vorwegnahme durch die Methoden der TA ebenso wie der Steuerung durch partizipative Methoden, da dafür der institutionelle Rahmen fehlt.

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PROGNOZOWANIE I REGULOWANIE PROCESÓW INNOWACYJNYCH W SEKTORZE WSZECHOBECNYCH TECHNOLOGII INFO-KOMUNIKACYJNYCH

Innowacje techniczne z jednej strony mogą otwiera nowe rynki i dostarczać rozwiązań problemów związanych z aktualnymi wyzwaniami społecznymi, z drugiej strony narzucają jednak również pytania dotyczące znośności środowiskowej i/lub socjalnej na krótkich, średnich i długich skalach czasowych. Zadaniem szacowania skutków technologii jest wskazywanie, możliwie z wyprzedzeniem, pozytywnych i negatywnych oraz ubocznych skutków, po to aby można było w sposób celowany wspierać pozytywne następstwa i pozytywne skutki uboczne oraz świadomie łagodzić negatywne oddziaływania danej innowacji, a nawet im zapobiegać. Warunkiem tego jest jednak po pierwsze możliwość formułowania w miarę spolegliwych twierdzeń o przyszłości, a po drugie, aby działania regulacyjne zmie-

rzające do zapobiegania negatywnym skutkom, a wspierania pozytywnych skutków znajdowały swoich adresatów. Na przykładzie wszechobecnej inżynierii informacyjno-komunikacyjnej artykuł ukazuje, że te warunki często nie mogą być spełnione. Wynika to z typów innowacji, które często występują w sektorze ICT, jak również z tzw. dylematu Collingridge`a. Oba te czynniki obniżają spolegliwość (ufność) prognoz. Ponadto często działania regulacyjne nie znajdują swoich adresatów, bowiem podsystemy społeczne, w których dokonują się innowacje, mają coraz mniej wyraźne kontury i są już prawie nieosiągalne dla klasycznych działań regulacyjnych takich jak np. regulacje prawne.

Słowa kluczowe: ocena technologii, wczesne rozpoznanie, badania nad innowacyjnością, zarządzanie procesami innowacyjnymi, technologie infokomunikacyjne, ubiquitous computing

FORECASTING AND CONTROL OF INNOVATION PROCESSES IN THE SECTOR OF UBIQUITOUS INFO-COMMUNICATION TECHNOLOGIES

On the one hand technological innovations can create new markets and can provide for solutions of current social problems; on the other hand the can raise questions concerning environmental and/or social adequacy on short-, middle-, and long-range time scales. In order to strengthen the positive outcomes of innovations and to reduce or even prevent negative effects, the task of technology assessment is to predict the positive as well as the negative effects and repercussions of innovations as early as possible. However, it must be presupposed that first, it must be possible to make to a certain extent reliable predications about the future development and second, that regulatory measurements in order to strengthen the positive outcomes of innovations and to reduce or even prevent negative effects will find their respective addressees. But if one takes, for instance, ubiquitous information and communication technology into account it can be demonstrated that those conditions rarely can be met. This is the result of the types of innovation which take place in case of ICT as well as of the so-called Collingridge dilemma. Both factors reduce the reliability of predictions. Furthermore, regulatory measurements often do not find their addressees since the borders of the societal subsystems in which innovation take place are blurring and therefore, these subsystems often cannot be reached with mainstream regulatory approaches like laws.

Keywords: technology assessment, foresight, innovation research, innovation management, information- and communication technologies, ubiquitous computing

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APPLICATION OF CONSTRAINED COST BENEFIT ANALYSIS TO THE THIRD PARTY RISK CONTROL AROUND AIRPORTS

Public Safety Zones (PSZ) policy at civil airports is recommended by ICAO to protect the population living or performing activities in airports' vicinity from the hazard being killed occasionally by crashing aircraft. Currently it is based on methodology to evaluate the individual risk around airports, called Third Party Risk (TPR), using appropriate historical aircraft accident data and population loss due to them. The paper presents how combination of constrained cost benefit analysis (CBA) with TPR weighs the actuarial value of the number of lives that would be lost in a single incident against the cost of reducing population densities through relocation. The basic assumption has been that risk always exists, cannot be reduced to zero and should be predictable, transparent, and controllable. The economic costs are or the costs of removing of existing activity or a percentage of the value of land-usage development. The benefits in human risk assessment are usually proportional to the monetary value of the human's life engaged in the activity and to the individual risk in the specific location where the activity takes place. The value of statistical life, economical damage and the degree to which the exposure to the risk is voluntary are taken into account. CBA allows to prove the TPR values of PSZ boundaries for airports.

Keywords: Third Party Risk, control, an airport, safety, constrained cost benefit analysis.

1. INTRODUCTION

The safety of aircraft and their occupants, as well as people on the ground, is a very important concern for aviation policy. Aviation accident rates have fallen over the years due to relentless efforts to develop strategies that reduce the occurrence of accidents and to promote technologies, programs, and practices that enhance aviation safety. Aviation accidents are costly to society. Air transport has become the safest way to travel with 0.37 accidents per million flights in 2011 globally (measured in hull losses per million flights of Western-built jets), the equivalent of one accident every 2.7 million flights. This represented a 39% improvement compared to 2010, when the accident rate was 0.61, or one accident for every 1.6 million flights (International Air Transport Association (IATA), 2012, [1]).

Risk criteria are reference levels that are set in order to protect people against natural and man-made hazards. A methodology to assess Third Party Risk (TPR) around airports

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has been developed and recommended by CAEP for usage in grounding of Public Safety Zones (PSZ) around specific runways or airports as a whole [2].

Reason for the discussion can be found in the fact that risk has been customarily considered purely as the probability of the loss of life. Third-party risk implies a risk of an individual on the ground being killed by crashing aircraft. In such a case, the accident is called a "groundling accident" or "groundling crash" and the fatality a "groundling fatality". Since most air traffic accidents (about 70% according to [3]) happen around airports, the concept and assessment of third-party risk has been mainly focused on areas around airports. Population densities at these airports were considered through a constrained cost benefit analysis (CBA). This weighs the actuarial value of the number of lives that would be lost in a single incident (i.e. all those within so called "crash consequence area") against the cost of reducing population densities through relocation. In the given context, the basic assumption has been that risk always exists, cannot be reduced to zero and should be predictable, transparent, and controllable, as well as quantifiable and measurable. Economical damage and the degree to which the exposure to the risk is voluntary must be taken into account.

The third-party risk methods/models have been mainly used for decision-making and policy purposes related to airport development and operations as follows [4]:

a) forecasting risk for an individual in airport vicinity to be killed by a crashing airplane around given airports;

b) zoning around airports (PSZ) by usage of calculated individual risk contours (possible in combination with societal risk values, which also used by current legacy for hazard control) and in this way determining the areas, which should be considered as dangerous for human activities;

c) indicating changes in risk contours arising from airport development (changes of arrival or departure trajectories, aircraft fleet, etc).or changes in using PSZ (type of human activities, vulnerable infrastructure like storages for dangerous substances, etc).

The implementation of PSZ policy at civil airports is based on a model work carried out using appropriate aircraft accident data to determine the level of individual risk to population, living or performing activities in airports' vicinity. By the basis for the policy of new development or removal within PSZ must serve cost-benefit analysis (CBA) [5].

The application of constrained CBA to the determination of PSZ in principle requires the following steps [6]:

1) identify the risk contour corresponding to the individual tolerability limit of a mortality risk of 10^{-4} (or other value of risk) per year;

2) at each point outside the 10^{-4} contour, but inside the contours of other valuable risks (10^{-5}, 10^{-6}, 10^{-7}, etc), compare the benefits from reducing risk, using the appropriate valuation of statistical life for population living/acting at the points/areas of assessment, with the costs of removing or prohibiting activities at that point/area; and

3) designate the PSZ as the area within the contour, defined at step 1) together with the area, in which the benefit, defined at step in 2), exceeds the cost.

Land uses with high population concentration are incompatible with airports activities because they expose them not only to aircraft noise but also to risk of property damage and personal injury (even mortality risk) from aircraft accidents possible to be happened near airports. New developments within the PSZ (human activities, vulnerable infrastructures, etc) will be inhibited in case of prevalence of the inhibition benefits over the relative costs.

For example, effective building restrictions established in Schiphol [16], - "…to reduce the risk for local residents, houses in zones close to the take-off and landing runways (where the risk of an accident is the greatest) have been purchased and demolished. New houses may not be built in a wide area around the airport. Close to the airport, in the area with a safety risk greater than 10^{-6}, no new buildings may be built for companies with large numbers of employees, unless the companies' business is directly related to the airport and their activities are small scale (a maximum of 22 persons per hectare)".

Existing activities should be able to remain within the PSZ if their removal costs are greater than the relative benefits. The economic costs, considered here, are or the costs of removing of existing (if a case) activity or a percentage of the value of land-usage development (if a case of change of its use). The benefits in human risk assessment are usually proportional to the monetary value of the human's life engaged in the activity and to the individual risk in the specific location where the activity takes place.

2. COSTS ESTIMATION

Aviation accidents are costly, because they can result in loss of lives, injuries, property damage, and substantial monetary costs associated with hospitalization, accident investigation and, in certain cases, litigation. Aircraft accidents in the vicinity of airports tend to occur near runway ends (up to 70-80 % of total number of accidents) under the approach and departure flight paths (see white paper on accident location data analysis [7]). The risk of aircraft accidents may increase in case of presence of tall structures, visual obstructions, and land uses that attract wildlife in or near the runway approach and departure areas, because all of them poses flight safety hazards.

People who live in certain areas near the airport face greater risk of exposure to aviation accidents than those who live far away from airports. Usually community opposition to growth in airport operations and expansion of airport capacity arises because people are exposed, first of all, to the adverse environmental impacts of aircraft noise (leading cause of community opposition) and local air quality effects. The constraints placed by incompatible land uses on airport growth indirectly result in unrealized economic benefits to surrounding local and regional jurisdictions.

Incompatible land uses give rise to community opposition and physical constraints to airport development. These have various consequences that ultimately lead to increased aircraft delays, increased passenger travel time, increased development costs, and increased accident risk. Table 1 lists the negative consequences and resulting costs to different stakeholders of the presence of incompatible land uses around airports [7].

To present for the economic analysis of the consequences and costs due to incompatible land uses near airports there are available different analytical tools with their dependence upon the context and purpose of the analysis. The main tools among them are economic valuation and cost-benefit analysis. To assess the economic costs arising from the presence of incompatible land uses around airports, the main tool is economic valuation. By itself, it is useful for increasing awareness of the costs of incompatible land uses and gaining support for efforts to promote airport-compatible land use planning. Economic valuation provides useful information in decision making - for example, in weighing the benefits of reducing or avoiding the costs of incompatible land uses against the costs of proposed public investments and regulatory interventions to mitigate

aviation's environmental effects, prevent the development of incompatible land uses, and promote compatible land use development around airports. This can be done within the framework of CBA.

But economic valuation has also a number of limitations:

1) It requires making numerous assumptions and is therefore subject to a number of uncertainties especially when applied to the environment.

2) Economic analysis is geared toward achieving economic efficiency, and policies maximizing economic efficiency do not necessarily lead to a fair outcome when there are ethical issues to consider.

3) Certain things, including impact on environment, cannot be valuated by money, thus application of economic valuation in these cases is limited [8].

Table 1. Consequences and Costs of Incompatible Land Uses [7]

Consequences	Costs
To the aviation system and its users: – Delays and constraints to airport development, leading to system delays – Restrictions on aircraft operations, leading to system delays and travel time penalties – Constraints to runway approach protection, leading to runway capacity constraints and safety risks – Litigation and related costs – Increased development costs – Increased risk of aviation accident from the presence of tall structures, visual obstructions and wildlife attractants	**To the aviation system and its users:** – Costs of delays – Litigation and related costs – Increased development costs – Costs of aviation accidents
To people who live near airports: – Exposure to noise, air contamination – Exposure to aviation accident risk	**To people who live near airports:** – Costs of noise impacts – Costs of exposure to aviation accidents
To surrounding local and regional jurisdictions: – Unrealized economic impacts due to constraints on airport growth	**To surrounding local and regional jurisdictions:** – Unrealized economic benefits

The CBA of regulatory policies and public investment is an important application of economic valuation. On enhancing airport land use compatibility their examples may include [8]:

• Airport expansion, taking into account the full costs including environmental effects;

• Regulations, policies, and measures to promote compatible land use planning, taking into account the full benefits of removing restrictions on aviation system capacity and development, as well as reducing or avoiding the exposure of third parties to adverse environmental effects.

To promote efficient policy development and use of resources, the CBA needs to take into account the wider social costs and benefits of proposed measures or investments. To

this extent, the estimation of costs for surrounding local and regional jurisdictions is related to the following hypotheses [6]:

• removal of a building of private ownership (first of all residences);
• removal of a public building (first of all schools and other children childcare);
• change of land use (from building site to agricultural, forestry, any unmanned activities).

The concept of economic loss due to these hypotheses is based on opportunity cost, which is the consequential cost from the missed exploitation of a granted opportunity to the economic subject, they are shown in Fig. 1 [6] in form of flow diagram for the valuation of the costs relative to the change of use of land from building site to agricultural land.

The difference between the value of building site and its value after the change of use is called "development value". Development land typically has a value that is very much greater than agricultural land. Therefore inhibiting development on a piece of land greatly reduces its value. However, it does not follow that the social cost of inhibiting development on a specified piece of land is the full development value of the land, because it may depend on what substitute pieces of land are available, or can be made available.It has been assumed that the opportunity cost of inhibiting of new development is a percentage (a representative value is 10%, Fig. 2) of the land's development value.

Figure 1. Opportunity cost related to the removal of private and public building [6]

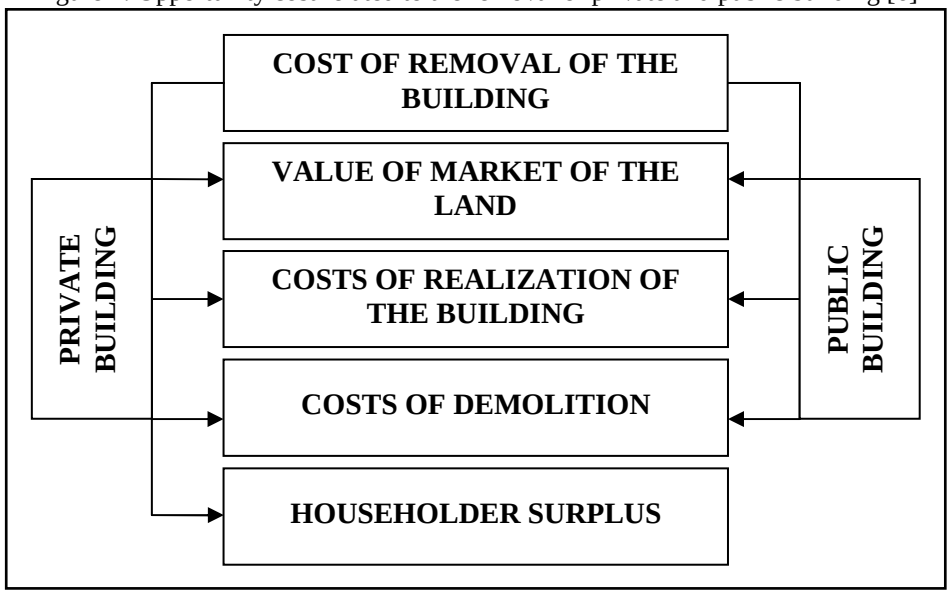


Figure 2 Opportunity cost related at the change of use of land [6]

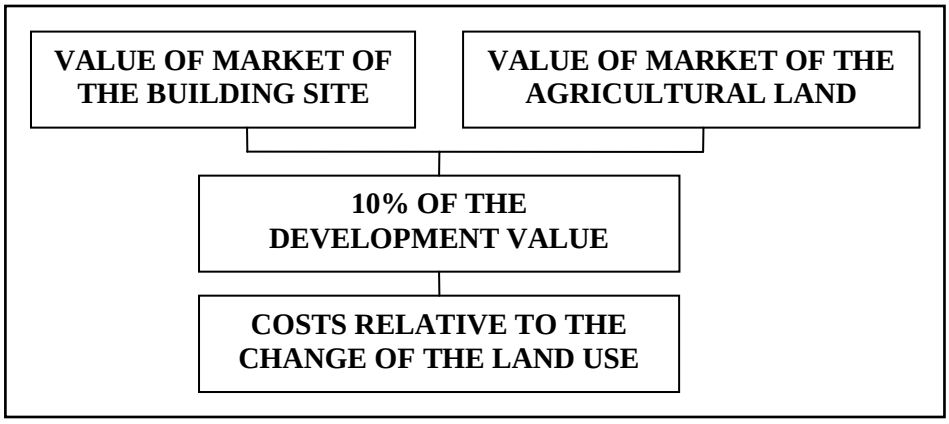


Table 2 shows the contributions to the opportunity costs (the value of what is lost). The value depends crucially on what buildings are already on the land, and, if there are no buildings already on the land, on what buildings would otherwise be permitted (for safety reasons the land may be forgone – it becomes a subject of 'opportunity cost'). The category of land for which it is most difficult to value the opportunity cost of inhibiting development is land on which development would be permitted if it were not for the PSZ (category (c) in Tab. 2).

Table 2. Components of value of forgoing use of land [6]

Development present or permitted	**Value of what would be foregone if use of land ceased, except for agriculture**
(a) Occupied buildings	(1) Value of land and buildings (2) Any "occupiers' surplus"
(b) Unoccupied buildings	Value of land and buildings
(c) No buildings, but development permitted	Opportunity cost of not using land for its permitted purpose
(d) No buildings, and development not permitted	Nothing

3. BENEFITS ESTIMATION

The benefits related to the removal or to the inhibition of a generic activity are considered in relationship to the costs related to the individuals' death involved in the activities and to the value of individual risk in the specific location taken by activity. Then the benefit is expressed as expected value.

Mortality is defined as the fraction of fatalities amongst the exposed population. For some event types, mortality will be well predictable without further extensive modelling: For example for airplane crashes the mortality amongst persons on the ground within the area affected by airplane crash proves to be relatively constant [9]. For other event types, mortality shows larger variation over different single events, due to their dependence on various event-specific variables. In order to estimate loss of life due to a certain event, usually a mortality fraction is determined.

It has been observed that the existing approaches of life estimation in different fields include the following similar steps, which correspond to the elements in the right hand side of Fig. 3 [10]:

1. Assessment of physical effects associated with the critical event and the extent of the area affected by these effects;

2. Determination of the number of exposed persons in the affected area, taking into account possibilities for warning and evacuation;

3. Estimation of the mortality amongst the exposed population as a function of the mentioned effects.

In the context of quantitative risk analysis, consequences are generally expressed in terms of expected economic damage or loss of life [11]. The corresponding framework is proposed in Fig. 4. As a starting point, an undesired event with physical effects (x) is assumed to occur. x is a general vector signifying the event's intensity, which is represented by the physical effects, such as arrival time of effects, concentration, etc.

The number of persons exposed will depend on the number of persons present N_{PAR}(x) (“people at risk” or persons within reach of the physical effects before event) in the affected area and the fraction of persons that will be able to evacuate ($F_E(x)$), both depend on x. Event-specific mortality is generally determined by means of so-called dose-response relations, which determine mortality (F_D) as a function of the physical effects. Then the number of fatalities (N) is now found as follows [12]:

$$N(x) = FD\,(x)(1- F_E\,(x))NPAR\,(x).$$

Figure 3. Evolvement of a critical event and steps in risk analysis [10]

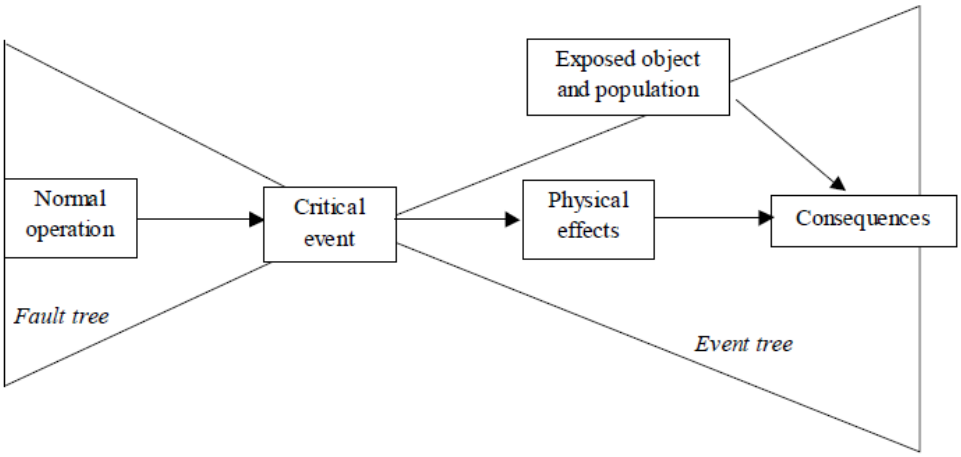
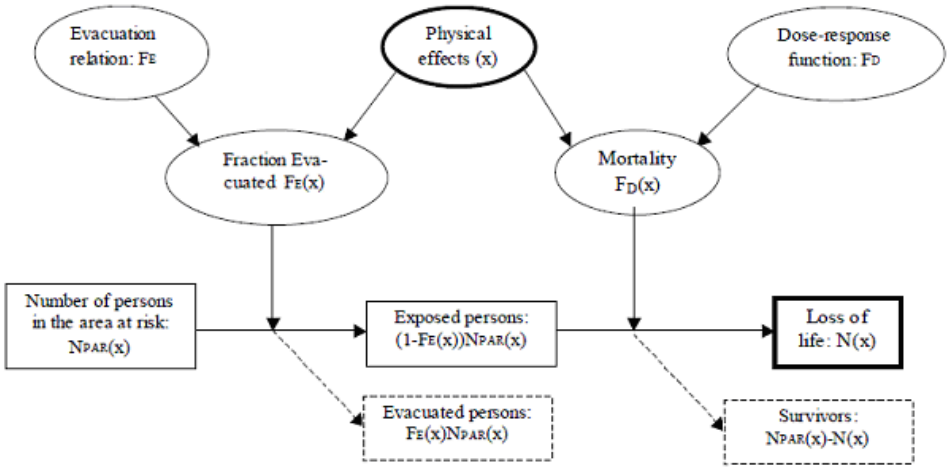


Figure 4. Framework for loss of life estimation [12]



In general case the number of persons exposed to the effects of the particular event (N_{EXP}) may be found by first correcting the population at risk for the number of evacuated persons:

$$N_{EXP} = (1 - F_E(x))N_{PAR}(x).$$

Here, the probability for successful evacuation $F_E(x)$ describes the fraction of people at risk N_{PAR} that are able to leave the affected area, before conditions become potentially harmful [12]. This, however, is not quite appropriate for airport third party risk assessment.

The value of the risk at any location is proportional to the absolute individual risk level, say *r* (If the value of statistical life doesn't vary with the absolute risk). Let the average number of occupants per dwelling be *n*, and let the value of statistical life be *v* (in current investigations taken as 1.000.000 €). Then the value of the statistical lives of the occupants of the average house is *nv*, and if the activity is located on risk contour *r*, the annual value of the risk is *nvr*. If this risk is maintained for *m* years (in current investigations taken as 30 years), and the discount rate for future costs and benefits is *d* (in current investigations taken as 3.5 % per year), the present value of the benefit from the risk is:

$$\text{Risk value}: n \cdot v \cdot r \left(\frac{1 - \frac{1}{(1+d)^m}}{1 - \frac{1}{1+d}} \right) \tag{1}$$

Thus the risk is mostly depends on how much the density with which the people occupy the territory and the hours in one day and the number of days in one year when the presence of the n individuals is verified inside the specific activity.

4. UKRAINIAN AIRPORTS CASE STUDY

The approach, explained in this document, was implemented for the case of PSZ policy in airports of Ukraine. Aircraft accidents might involve sensitive or high-density land-uses, such as schools, hospitals or places of assembly. In Ukraine, for all development and activities outside the 10^{-4} risk contour PSZ policy should be based on the relevant cost-benefit balance.

The average price of agricultural land in Ukraine is 0.014 UAH mln per hectare, and that of housing development land is 2.69 UAH mln (all prices for Ukrainian case study relevant to 2009). If it is assumed that existing houses near Ukrainian airports have a density of 23.4 houses per hectare, and that their average price is 1.85 UAH mln, then the average value of a hectare of land with existing houses is equal to 43.33 UAH mln. The opportunity cost of ceasing to use the houses would be more than the value of the houses, or 50.92 UAH mln. The average value of a piece of agricultural land of the same size as the average house plot is 13,600 UAH divided by the average housing density of 23.4 houses per hectare, or 581 UAH. The average value of a house plot is 115,160 UAH. It is assumed that the social opportunity cost of inhibiting housing for PSZ reasons is 10% of the development value (see Fig. 4.1), then this opportunity cost would be 11,560 UAH. The average value of an unoccupied house is 1.85 UAH mln. The average opportunity cost of ceasing to use an occupied house, including the householders' surplus, would be more than the value of the house, or 2.18 UAH mln. An important conclusion from the cost data is that because the opportunity cost of forgoing the use of developed land is very different from that of undeveloped land, it is reasonable to expect that on cost benefit

grounds a consistent PSZ policy would impose different restrictions on different land categories.

It is assumed that each dwelling near airports contains one household with average densities of human occupation is 2.65 persons. So, the value of statistical life is 9.75 UAH mln, the value of the statistical lives of the people living in the average dwelling in the neighbourhood of airports in Ukraine is 25.83 UAH mln. This is much larger than the average value of the dwelling itself, which is 1.85 UAH mln. So, the principal benefit from the reduction of third party risks near airports takes the form of reductions in casualties rather than reductions in property damage. Correspondingly, if risks were increased, the number of casualties would be increased. The value of avoidance of property damage can be regarded as negligible.

With d = 3.5% and m = 30, the term in large brackets on the right-hand side of equation (3.1) is equal to 19.04. Therefore, with the values of n and v used above, the value of the stream of risks to the occupants of the average house on contour r is 491.76r UAH mln. So, the present value of the risk per house located inside the 10^{-4} contour is 49.176 UAH.

The benefits from inhibiting an activity at a specified location take the form of reduced risk. The value of risk reduction for a single person present for 24 hours per day on risk contour r is given by equation (3.1) with n set to 1. This is evaluated with the parameters v, d, and m (9.75 UAH mln, 3.5% per year, and 30 years respectively) and the value of risk reduction for a single person on risk contour r is 185.57 UAH mln. If the density of persons present at that location, averaged over the 24-hour day, is p persons per hectare, the value of risk reduction per hectare on risk contour r is 185.57 p UAH mln. So, the benefit of inhibiting activity is proportional to p and r.

In the case of housing, the average value *of* p near airports is the product of the number of persons per house and the number of houses per hectare, which was assumed above to be 2.65 x 23.4, or 62.0 persons per hectare. So, the average benefit of inhibiting or removing housing near Ukrainian airports on risk contour r is 11.51 UAH mln per hectare. Inside the 10^{-4} risk contour this is 1.15 UAH mln per hectare; inside the 10^{-5} risk contour it is 115,054 UAH per hectare. The same benefits per hectare would apply to any other land use or activity near airports in Ukraine that had the same average density of persons present as housing (62.0 per hectare), the lower benefits would apply to lower densities, and higher benefits to higher densities.

The cost of inhibiting or removing activities is the opportunity cost of forgoing the use of the land, the components of which were shown. As with housing, this opportunity cost depends crucially on what buildings are already on the land. For any existing activity with a density of occupation of the same order of magnitude as that of housing, such as employment, the value of the buildings and any 'occupiers' surplus' would almost certainly exceed 1.15 UAH mln per hectare. Therefore the opportunity cost of their removal would exceed the benefits, even if they were located inside a risk contour 10^{-4}. For activities with lower densities of occupation the value of the buildings might be reduced somewhat, but then the benefits of their removal would also be lower, so the cost-benefit ratio might be rather similar; the same argument would also apply in reverse to activities with higher densities. Therefore, for all existing development within PSZ should be permitted to remain, with the exception of that within the 10^{-4} contour. Moreover, at most airports the 10^{-4} contours are so close to the runways that new development within these contours should be inhibited. The values of existing buildings located between 10^{-4} and 10^{-5}

contours are much greater than the benefits of their removal. The benefits of inhibiting development as shown above were to be proportional to the average density of occupation, *p*, and therefore inhibiting low density activities would have low safety benefits.

Transport links commonly pass close to airports. For a 40-metre wide, six-lane motorway operating near capacity with 2,000 vehicles per lane per hour, assuming that each vehicle carries an average of 1.5 persons and moves at 80 kilometres per hour, the average density of human occupation is 56 persons per hectare. By chance, this is close to the 62.0 persons per hectare as calculated above for housing. The person-flow on such a motorway is 18,000 persons/hour in both directions combined, which is of the same order of magnitude as that of a high-density passenger railway. It follows that the safety benefits of removing either motorways or railways would be of the same order as those of removing housing that is about 117,900 UAH per hectare inside the 10^{-5} contour, and 1.18 UAH mln per hectare inside the 10^{-4} contour. Transport terminals have higher densities of human occupation than transport links, and therefore the benefits per hectare of reducing risk are higher.

New development within the PSZ should be inhibited. In the context of PSZs, the activities with low average densities of human occupation, such as long-stay car parking and warehouses, and surface transport links should be organized.

5. CONCLUSIONS

The conclusions from the application of constrained CBA to PSZ policy are the following:

1) CBA may be used as a basis of an original methodology in order to define PSZ policy, which must support Third Party Risk (TPR) contour calculations, which are necessary for PSZ boundaries assessment;

2) there is a strong principal requirement for PSZ policy to remove existing housing and other development occupied by third parties for a high proportion during the day within the 10^{-4} individual risk contours. It is estimated that a quite valuable number of properties within this contour are possible in airports with flight intensity close to their operational capacity, but some specific issues on subject of effected by aircraft accident risk airports closely to their runways is possible also;

3) removing existing housing outside the 10^{-4} individual risk contour is still unusual;

4) inhibiting new housing, so as non-housing, development, including transport terminals, as far as the 10^{-5} individual risk contour, but not beyond, may be a principle requirement of the PSZ policy. An exception to that there is a case for allowing new development with a low density of human occupation, averaged over the day, within the 10^{-5} and up to the 10^{-4} individual risk contour. This might include long stay car parking and warehousing;

5) permitting extensions to existing houses within the 10^{-5} individual risk contour, may be a principle requirement of the PSZ policy;

6) removing non-housing existing development outside the 10^{-4} individual risk contour was not proved by any CBA research;

7) there is no case for diverting existing transport links near airports. Low cost measures to prevent vehicles from routinely coming to a stand within the 10^{-5} contour might well be worthwhile, if not already adopted.

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ANALIZA KOSZTÓW I KORZYŚCI W KONTEKŚCIE KONTROLI RYZYKA OSÓB TRZECICH NA TERENIE PORTÓW LOTNICZYCH

Niniejsza publikacja przedstawia metodologię oceny ryzyka osób trzecich przebywających na terenie portów lotniczych, rekomendowaną przez Organizację Międzynarodowego Lotnictwa Cywilnego, dotyczącą zakazu lotów w strefie bezpieczeństwa publicznego w przypadku konkretnych pasów startowych oraz portów lotniczych jako całości. Ryzyko to dotyczy osób indywidualnych, które mogą stracić życie w wyniku wypadku lotniczego. W niniejszej analizie została uwzględniona liczba osób znajdujących się we wspomnianych portach lotniczych. Ukazuje ona wartość aktuarialną (ubezpieczeniową) w przypadku osób, które mogłyby stracić życie w wyniku ewentualnego wypadku lotniczego w odniesieniu do kosztów związanych z przemieszczeniem tych osób

do innego portu. W tym kontekście główne założenie dotyczyło tego, iż ryzyko istnieje zawsze i nie może być zredukowane do zera, ale powinno ono być przewidywalne, przejrzyste i kontrolowane, a także wymierne i możliwe do oszacowania. Zagadnienie to jest istotne zarówno ze względu na bezpieczeństwo statków powietrznych i ich pasażerów, jak również ze względu na ludzi na ziemi. Należy pamiętać, że wypadki lotnicze są kosztowne dla społeczeństwa i konieczne jest podejmowanie wszelkich działań w celu zapobiegania im. W ciągu ostatniego roku liczba wypadków lotniczych spadła, a powodem są opracowywane i wdrażane strategie ograniczające możliwości wystąpienia wypadku, jak również promowanie technologii, programów i praktyk zwiększających bezpieczeństwo.

Słowa kluczowe: ryzyko osób trzecich, kontrola, port lotniczy, bezpieczeństwo, analiza kosztów i korzyści

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