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DEMATEL METHOD IN ERP SYSTEMS FOR TSL BRANCH

Summary. The article introduces issues concerning the implementation of key performance indicators (KPIs) dedicated to the TSL (Transport-Shipping-Logistics) branch. The KPIs are used in different modules of the ERP (Enterprise resource planning) information systems, which support strategic decision making. Selected indicators have been used to create four perspectives of Balanced Scorecard in accordance with Balanced Scorecard methodology. Using the multi-factor method of DEMATEL (Decision Making Trial and Evaluation Laboratory) analysis, the evaluation of indicators and Balanced Scorecard's perspectives has been performed. This article can be useful to persons interested in the implementation of modern solutions in ERP applications dedicated to the TSL branch. Presented article can be useful to persons from upper management of TSL companies who are interested in modern methods of supporting strategic management and for IT system developers who are considering expanding modules of ERP software solutions dedicated to TSL industry which support strategic management and decision making.

1. INTRODUCTION

Most companies use key performance indicators (KPI) to analyse current operations. They are often included in the modules of ERP systems, which support managerial staff in strategic decision-making processes. In companies, data used to determine the values of selected indicators are automatically loaded directly from the information systems. This allows to conduct practical and effective analysis of the company's situation based on real-time data and to measure the degree of fulfillment of company's goals. KPI indicators are commonly used to create Balanced Scorecards according to the Balanced Scorecard methodology [1-14]. As a result, companies can make real data analyses of the degree of their development and fulfillment of adopted operating strategies.

Together with the constant increase in the complexity of logistic processes, there is a need to develop methods which support correct decision making within the scope of monitoring of the condition of the company and management of the companies from the TSL industry. A large number of available KPI parameters and their differentiated importance on the proper course of transport-shipping-logistic processes impose on upper management the dilemma of making decisions while considering a series of variable factors. Thus, problems arise in companies regarding which factors and to what degree should they be taken into consideration. One of the methods that support solving this subject is the multi-factor analysis DEMATEL method [15-21], which allows effective analysis of relations between the indicators, which were used to build the Balanced Scorecard.

Increased interest of researchers in DEMATEL methodology could be observed since the early 1990s, when the method was first recognized as an expert tool for multi-attribute analysis of complex problems. In that period, the yearly number of publications dedicated to this subject matter amounted to about 30 titles, whereas in 2008 the number came close to 100 a year, and in 2014 it reached over 650 a year [22]. BSC [1-14] and DEMATEL [15-21] methodologies are relatively numerous in literature. Most of the elaborations do not, however, concern simultaneous implementations of both of

these methods. Descriptions of comprehensive solutions, which include both methods and their practical implementation in TSL industry, are even more seldom.

An example relating to this last group is the elaboration by Apak S. et al. [23], who analysed BSC perspectives in connection with DEMATEL methodology with respect to logistic companies. Within the scope of a methodology closely related to BSC methodology, He and Cheng [24] performed the analysis of key influence factors in city logistics using fuzzy DEMATEL. Similar approach was also presented by Mavi et al. [25]. There are research papers [2] in which indicators used to evaluate different areas of a company (for example with the use of BSC) have a descriptive character. It is difficult, however, to use a mathematical model in such a case, and thus it is not possible, in ERP systems, to automatically assign values to these parameters based on operational data contained in IT systems.

A comprehensive approach to integrating the three, BSC and DEMATEL methodologies as well as KPI assessment, and their application in IT systems represents a gap in the research in the area of practical use of KPI indicators, which are fed directly from ERP class systems dedicated to the TSL industry.

The value of this study comes from the fact that there are too few number of research examples in the literature which consider integrating BSC, DEMATEL in connection with ERP class systems for the TSL industry.

To this effect, a chain of methods and measures are applied and presented in this article, which include the determination of KPI, creation of the Balanced Scorecard and Balanced Scorecard perspectives, performance of analysis with the use of DEMATEL technology, and the use of databases contained in ERP systems, that supply companies with a powerful support mechanism in their strategic decision-making processes.

2. DEMATEL METHODOLOGY

Below described are the main stages of DEMATEL methodology. At the start, a list of parameters, which will undergo the analysis, must be made. Indicators in the form of analytical formulas are preferred to descriptive forms. The analytical form of an indicator allows direct use of data collected from ERP systems. In the next step, with the use of any arbitrary method, the level of influence (for example on a 0-4 scale) of each criterion on all other criteria separately must be determined resulting in the creation of initial direct influence matrix $\boldsymbol{Z}$. In the next step, with the use of any method, the level of mutual influence of all criteria pairs must be determined, and the initial direct influence matrix $\boldsymbol{Z}$ must be created. It is assumed that each criterion may directly influence other criteria, but it cannot influence itself. In fact, based on expert suggestions, expert systems or numerical methods, a cluster of initial direct influence matrices is derived. Each individual matrix is created as an end effect of work assessment of a single expert or a numerical method. In effect, superposition of matrices creates the final form of the initial direct influence matrix $\boldsymbol{Z}$.

The initial direct influence matrix $\boldsymbol{Z}$ is derived according to the following formula:

$$\boldsymbol{Z} = \begin{bmatrix} z_{11} & \cdots & z_{1j} & \cdots & z_{1n} \\ \vdots & & \vdots & & \vdots \\ z_{i1} & \cdots & z_{ij} & \cdots & z_{in} \\ \vdots & & \vdots & & \vdots \\ z_{n1} & \cdots & z_{nj} & \cdots & z_{nn} \end{bmatrix} . \tag{1}$$

In the next step, a normalized direct influence matrix X is determined, in which, all parameters assume a value within range [0,1].

$$\boldsymbol{X} = s\boldsymbol{Z} \quad , \tag{2}$$

where

$$s = \min(1/\max\sum_{i=1,n} z_{ij}, 1/\max\sum_{j=1,n} z_{ij}) \quad (3)$$

In the next step, a matrix of total relations $\boldsymbol{T}$ is derived:

$$\boldsymbol{T} = \lim_{k\to\infty}(\boldsymbol{X} + \boldsymbol{X}^2 + \cdots + \boldsymbol{X}^k) = \boldsymbol{X}(\boldsymbol{I} - \boldsymbol{X})^{-1} \quad , \quad (4)$$

where $\boldsymbol{I}$ is the identity matrix. In $\boldsymbol{T} = [t_{ij}]$ matrix, sums of individual rows are calculated (R_i) – which mirror the sum of indirect and direct i influences criteria on other criteria (equation 5) and sums of all (D_j) columns – which show the sum of direct and indirect influences the j criterion receives from other criteria (equation 6).

$$\boldsymbol{R} = (R_i)_{n\times 1} = (\sum_{i=1,n} t_{ij})_{n\times 1} \quad (5)$$

$$\boldsymbol{D} = (D_j)_{1\times n} = (\sum_{j=1,n} t_{ij})_{1\times n} \quad (6)$$

Next a R_i-D_i – relation indicator – is determined, which is also called a net influence and a R_i+D_i – position indicator – which is also called an overall influence.

If $i=j$ then the value R_i+D_i indicates the sum of criteria values, which both, influence the other criteria, and are under the influence of other criteria. Value R_i-D_i > 0 means that the i criterion, influences other criteria and the entire system as well. Value R_i-D_i < 0 means that other criteria influence the i criterion, hence the i criterion, is not a source of influence on remaining criteria in the system. Taking into consideration above position and relation indicators, a casual diagram can be created in a (R_i+D_i, R_i-D_i) layout. When analyzing the values of R_i+D_i and R_i-D_i indicators, the DEMATEL technique identifies the degree of interdependence of criteria on one hand, and on the other hand, it determines these criteria which influence other criteria, as well as criteria, which depend more on other criteria, and which are the recipients of influence of other criteria.

3. BALANCED SCORECARD FOR THE TSL BRANCH

The Balanced Scorecard concept was created by Robert S. Kaplan and David P. Norton [7-10]. This methodology is often used in companies in the area of management processes. When correctly implemented in ERP class systems, it brings measurable financial profits. BSC allows to transform an abstract vision of company development into real strategies as well as with the use of several KPI indicators to measure the effectiveness of their implementation. BSC methodology can contain any number of indicators, both current and forecasting. They are always grouped in four, connected with each other BSC perspectives (financial, processes, customers and growth).

The financial perspective analyses the state of finances of an entire company. Processes' perspective suggests most effective actions. Customers' perspective determines the sources of current market standing and analyses the level of clients' satisfaction. Growth perspective determines the readiness of the company to introduce innovative changes.

Traditional methods of strategic management are based on the analysis of current and historical data. BSC concentrates on achieving established objectives in the future and allows measuring of „non-material" activities in the company, in order to plan its development. From the perspective of BSC, it is important to develop a set of KPI indicators which match company's individual situation. When developing suggested [26] set of 12 indicators for the logistics industry, 16 criteria presented in Table 1 have been adopted for further analysis. Clearly, in case of each individual company, both the number of indicators in four perspectives, as well as the form indicators, can be modified and adjusted to individual specification of each company.

Analysis of each of the 16 KPI indicators allows to analyse the state of selected, narrow area of company's activities, which is described by a given parameter. In turn, the analysis of four BSC perspectives allows upper management a quick and comprehensive analysis of both the current situation of the company as well as determination if the development of the company tends towards the right direction. Data presented in Table 5 have been obtained through the integration of BSC (with 16 exemplary KPI parameters and 4 constant BSC perspectives) and DEMATEL methodologies. The process of connecting these two methodologies has been started by the initial direct influence matrix **Z**.

Table 1

Scorecard perspectives and adopted KPI criteria

Perspectives	Indicators
(*F*) Financial	(*F1*) Clients profitability factor (*F2*) Cost of medium order service (*F3*) Goods profitability factor (*F4*) Cash flow and company accounting profit
(*P*) Processes	(*P1*) Indicators of goods' circulation in warehouse in correlation with needs for goods generated by customers (*P2*) Awaiting time for realization of particular production stages (*P3*) The value of deviation from confirmed prices and delivery deadlines (*P4*) Indicators allowing for drawing up of logistic limits
(*C*) Customers	(*C1*) Number and value of lost orders analysed in a time periods and customer groups (*C2*) Amount of customers that was win over in a time periods (*C3*) Total and detailed orders value of individual customers in defined report periods (*C4*) Factor of customer value
(*G*) Growth	(*G1*) Costs of goods import (*G2*) Volume of new foreign customers in a defined time periods (*G3*) Differences of department's work consumption, processes, operations of new technologies and devices implementation; (*G4)* Standardized company position with reference to competition

4. THE IMPLEMENTATION OF BALANCED SCORECARD AND DEMATEL METHOD TO ASSESS KPI PARAMETERS

In order to apply the integration of BSC and DEMATEL methodologies in practice, a group of experts from TSL industry with applicable knowledge and experience in the subject of analysis has been selected. For the purpose of this article, a group of 20 companies from a group of leading enterprises in the TSL industry has been selected, based on industry rankings. Next, data entry sheets with 16 KPI parameters presented in Table 1 have been forwarded to the companies. The parameters were divided into 4 BSC perspectives. Experts have been asked to determine for each criterion, its influence on each of the remaining criteria individually. It has been assumed that each criterion may directly influence other criteria, but it cannot influence itself. A scale of 0-4 has been adopted, where 0 means no influence, and 4 means extremely high influence. It has been assumed that each of the criteria may directly influence other criteria, but it cannot influence itself. Data entry sheets have been filled out by upper management only and departments dealing strictly with TSL subject matter. Nineteen completed data entry forms have been received from 12 companies. Based on received answers, 19 (nineteen) initial direct influence matrices have been created. Superposition of these matrices leads in effect to the calculation of the final form of initial direct influence matrix ***Z***, according to the equation (1). This matrix represents a medium value of opinions of all experts (Tab. 2).

According to the equation (2), the normalized direct influence matrix ***X*** has been calculated (Tab. 3).

Table 2

The initial direct influence matrix $\boldsymbol{Z}$

$\boldsymbol{Z}$	*F1*	*F2*	*F3*	*F4*	*P1*	*P2*	*P3*	*P4*	*C1*	*C2*	*C3*	*C4*	*G1*	*G2*	*G3*	*G4*
F1	0.000	1.345	3.123	2.345	2.675	1.234	1.345	2.123	2.342	1.234	1.321	1.231	2.112	0.678	0.543	0.345
F2	1.202	0.000	3.914	3.601	2.023	1.865	1.723	3.723	0.765	3.234	2.523	2.511	1.324	1.487	1.454	3.236
F3	1.654	1.978	0.000	3.732	1.432	2.432	1.245	3.302	1.543	3.632	3.476	2.698	2.432	1.465	1.434	2.143
F4	1.765	0.875	1.254	0.000	2.543	2.412	1.712	2.176	1.654	2.710	2.486	2.901	0.654	1.634	1.532	1.512
P1	0.345	2.512	1.487	2.872	0.000	1.628	1.682	1.856	0.543	1.581	1.627	1.856	2.245	1.827	1.923	0.761
P2	0.654	0.521	0.720	1.753	0.348	0.000	2.845	2.745	0.562	1.276	2.123	2.893	2.543	1.876	1.732	0.476
P3	1.345	0.735	1.141	1.854	3.120	3.703	0.000	1.581	0.678	1.354	1.534	2.423	0.567	2.232	1.776	0.854
P4	3.234	0.632	0.582	1.201	2.320	2.854	2.576	0.000	0.265	3.487	3.598	3.654	1.432	2.556	2.554	2.776
C1	0.765	1.452	1.682	1.856	1.543	2.548	1.954	0.672	0.000	0.723	0.945	1.582	1.352	1.679	1.895	1.892
C2	2.435	0.725	1.126	1.565	0.489	2.832	2.431	2.534	1.345	0.000	2.723	3.013	1.623	2.576	2.123	2.398
C3	3.236	0.864	1.154	2.254	0.234	3.123	3.903	2.865	1.789	0.861	0.000	2.943	0.547	3.812	3.554	2.523
C4	3.234	0.482	0.492	0.965	1.287	2.554	2.498	1.634	2.543	1.501	1.456	0.000	0.876	2.254	2.776	1.723
G1	1.092	2.794	3.628	3.158	2.654	3.268	2.736	3.651	2.102	0.627	3.721	2.623	0.000	1.727	1.837	2.527
G2	0.876	0.643	0.562	0.332	2.856	2.578	3.089	1.754	3.234	1.206	1.598	1.565	2.435	0.000	3.112	3.843
G3	2.213	0.423	0.292	0.335	0.543	3.802	3.121	1.504	0.562	0.905	1.134	1.223	1.673	2.554	0.000	3.632
G4	2.432	1.292	1.153	2.135	0.756	1.902	2.176	1.623	2.654	1.306	1.292	1.243	1.768	2.123	3.765	0.000

Table 3

The normalized direct influence matrix $\boldsymbol{X}$

$\boldsymbol{X}$	*F1*	*F2*	*F3*	*F4*	*P1*	*P2*	*P3*	*P4*	*C1*	*C2*	*C3*	*C4*	*G1*	*G2*	*G3*	*G4*
F1	0.000	0.035	0.081	0.061	0.069	0.032	0.035	0.055	0.060	0.032	0.034	0.032	0.055	0.018	0.014	0.009
F2	0.031	0.000	0.101	0.093	0.052	0.048	0.044	0.096	0.020	0.083	0.065	0.065	0.034	0.038	0.038	0.084
F3	0.043	0.051	0.000	0.096	0.037	0.063	0.032	0.085	0.040	0.094	0.090	0.070	0.063	0.038	0.037	0.055
F4	0.046	0.023	0.032	0.000	0.066	0.062	0.044	0.056	0.043	0.070	0.064	0.075	0.017	0.042	0.040	0.039
P1	0.009	0.065	0.038	0.074	0.000	0.042	0.043	0.048	0.014	0.041	0.042	0.048	0.058	0.047	0.050	0.020
P2	0.017	0.013	0.019	0.045	0.009	0.000	0.073	0.071	0.015	0.033	0.055	0.075	0.066	0.048	0.045	0.012
P3	0.035	0.019	0.029	0.048	0.081	0.096	0.000	0.041	0.018	0.035	0.040	0.063	0.015	0.058	0.046	0.022
P4	0.083	0.016	0.015	0.031	0.060	0.074	0.067	0.000	0.007	0.090	0.093	0.094	0.037	0.066	0.066	0.072
C1	0.020	0.037	0.043	0.048	0.040	0.066	0.050	0.017	0.000	0.019	0.024	0.041	0.035	0.043	0.049	0.049
C2	0.063	0.019	0.029	0.040	0.013	0.073	0.063	0.065	0.035	0.000	0.070	0.078	0.042	0.067	0.055	0.062
C3	0.084	0.022	0.030	0.058	0.006	0.081	0.101	0.074	0.046	0.022	0.000	0.076	0.014	0.098	0.092	0.065
C4	0.083	0.012	0.013	0.025	0.033	0.066	0.064	0.042	0.066	0.039	0.038	0.000	0.023	0.058	0.072	0.044
G1	0.028	0.072	0.094	0.082	0.069	0.084	0.071	0.094	0.054	0.016	0.096	0.068	0.000	0.045	0.047	0.065
G2	0.023	0.017	0.015	0.009	0.074	0.067	0.080	0.045	0.083	0.031	0.041	0.040	0.063	0.000	0.080	0.099
G3	0.057	0.011	0.008	0.009	0.014	0.098	0.081	0.039	0.015	0.023	0.029	0.032	0.043	0.066	0.000	0.094
G4	0.063	0.033	0.003	0.055	0.020	0.049	0.056	0.042	0.069	0.034	0.033	0.032	0.046	0.055	0.097	0.000

Next, based on equation (4) the matrix of total relations $\boldsymbol{T}$ has been determined (Table 4).

The matrix of total relations $\boldsymbol{T}$ can be viewed as a $\boldsymbol{T_B}$ submatrix based on Balanced Scorecard perspectives and $\boldsymbol{T_K}$ submatrix based on KPI criteria. Table 5 presents $\boldsymbol{T_B}$ and $\boldsymbol{T_K}$ matrices and respective position and relations indicators.

Next, based on Tab. 5, a causal diagram can be created in R_i+D_i and R_i-D_i layout for four Balanced Scorecard perspectives in TSL branch (Fig. 1).

In Fig. 2, casual diagrams for sixteen examined Balanced Scorecard KPI criteria in TSL branch have been presented.

The analysis performed in this article will result in obtaining answers to two research problems. First, is the *F* Financial perspective strictly related to other BSC perspectives for companies from TSL industry? Second, which of the KPI parameters of the *F* (financial perspective) are most important to the company? The analysis of R_i-D_i relation indicator and R_i+D_i position indicator can be performed

on two levels, global and local. Globally, the maximum and minimum values of these indicators among the four BSC perspectives (Fig. 1) or among 16 KPI parameters (Fig. 2) are analysed. Global analysis allows to answer the first of the two above questions. Local analysis is based on examining the relation and position of KPI parameters within the scope of single BSC perspective (Fig. 2). This level of analysis will allow to reach the answer to the second of the above two questions.

Table 4

The matrix of total relations $\boldsymbol{T}$

$\boldsymbol{T}$	*F1*	*F2*	*F3*	*F4*	*P1*	*P2*	*P3*	*P4*	*C1*	*C2*	*C3*	*C4*	*G1*	*G2*	*G3*	*G4*
F1	0.104	0.101	0.159	0.172	0.163	0.181	0.169	0.181	0.144	0.132	0.157	0.166	0.144	0.137	0.138	0.125
F2	0.186	0.091	0.206	0.244	0.184	0.260	0.239	0.272	0.145	0.223	0.236	0.254	0.163	0.210	0.218	0.245
F3	0.196	0.139	0.113	0.246	0.170	0.274	0.229	0.262	0.164	0.228	0.257	0.258	0.188	0.210	0.217	0.219
F4	0.163	0.092	0.118	0.120	0.167	0.226	0.197	0.193	0.139	0.173	0.193	0.219	0.119	0.177	0.180	0.166
P1	0.120	0.128	0.121	0.184	0.100	0.198	0.186	0.180	0.105	0.142	0.167	0.186	0.149	0.171	0.178	0.143
P2	0.122	0.073	0.093	0.145	0.103	0.148	0.205	0.188	0.100	0.124	0.168	0.199	0.147	0.164	0.166	0.126
P3	0.137	0.081	0.104	0.152	0.169	0.238	0.138	0.164	0.104	0.129	0.155	0.191	0.107	0.175	0.169	0.135
P4	0.223	0.100	0119	0.173	0.182	0.271	0.251	0.169	0.128	0.210	0.243	0.264	0.158	0.226	0.234	0.221
C1	0.114	0.095	0.114	0.146	0.125	0.200	0.174	0.133	0.080	0.107	0.132	0.160	0.118	0.151	0.162	0.152
C2	0.190	0.093	0.122	0.167	0.128	0.251	0.228	0.213	0.142	0.114	0.208	0.232	0.150	0.209	0.206	0.198
C3	0.219	0.101	0.129	0.192	0.135	0.275	0.277	0.232	0.162	0.147	0.153	0.243	0.135	0.250	0.253	0.214
C4	0.186	0.077	0.094	0.134	0.131	0.217	0.204	0.167	0.153	0.133	0.155	0.133	0.118	0.179	0.197	0.160
G1	0.193	0.168	0.211	0.249	0.213	0.313	0.281	0.287	0.187	0.172	0.278	0.273	0.141	0.231	0.243	0.242
G2	0.144	0.093	0.107	0.136	0.180	0.241	0.239	0.188	0.181	0.138	0.176	0.191	0.168	0.143	0.226	0.228
G3	0.154	0.071	0.083	0.111	0.106	0.235	0.209	0.157	0.101	0.111	0.140	0.155	0.131	0.177	0.123	0.196
G4	0.175	0.102	0.117	0.170	0.126	0.214	0.206	0.178	0.162	0.137	0.162	0.175	0.145	0.184	0.229	0.130

Table 5

The $\boldsymbol{T_B}$ i $\boldsymbol{T_K}$ submatrices and position and relations indicators

$\boldsymbol{T_B}$	R_i	D_i	R_i+D_i	R_i-D_i	$\boldsymbol{T_K}$	R_i	D_i	R_i+D_i	R_i-D_i
F	0.735	0.561	1.297	0.174	*F1*	2.375	2.625	5.001	-0.25
					F2	3.377	1.604	4.981	1.773
					F3	3.368	2.012	5.380	1.357
					F4	2.642	2.741	5.383	-0.099
P	0.641	0.795	1.436	-0.155	*P1*	2.456	2.383	4.839	0.073
					P2	2.270	3.741	6.011	-1.471
					P3	2.348	3.433	5.781	-1.085
					P4	3.174	3.164	6.338	0.010
C	0.661	0.681	1.342	-0.020	*C1*	2.165	2.196	4.361	-0.031
					C2	2.851	2.421	5.272	0.429
					C3	3.118	2.979	6.097	0.138
					C4	2.437	3.299	5.736	-0.862
G	0.708	0.707	1.416	0.001	*G1*	3.681	2.281	5.962	1.399
					G2	2.780	2.995	5.775	-0.216
					G3	2.261	3.139	5.540	-0.877
					G4	2.612	2.900	5.512	-0.288

When performing global analysis (Fig. 1), one can see that R_i-D_i relation indicator for the financial perspective has the highest value among all BSC perspectives. It means that this perspective has a predominant causative influence on remaining perspectives, and therefore, it is most important of them. From another side, however, it has the lowest R_i+D_i position indicator. This points to the weakest relation of the financial perspective with other perspectives and means, that the financial perspective does not play a significant role in the network of interrelations. It is the answer to the first question formed at the beginning of the analysis. For upper management, it carries the information that

for the good of the company, they should pay close attention and care about correct values of KPI parameters within the scope of financial perspective; on the other hand, any disturbance in the other perspectives should not have a significant influence on the areas covered by the influence of the financial perspective.

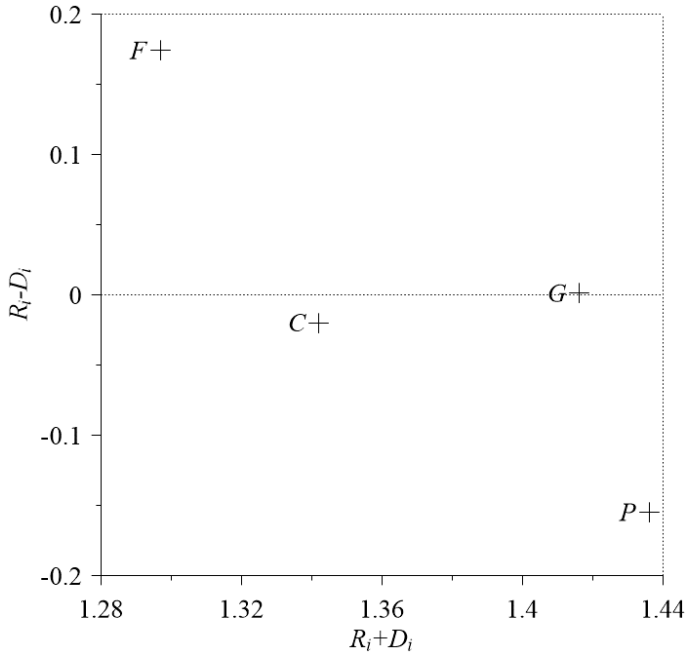

Fig. 1. Casual diagram for four Balanced Scorecard perspectives in TSL branch

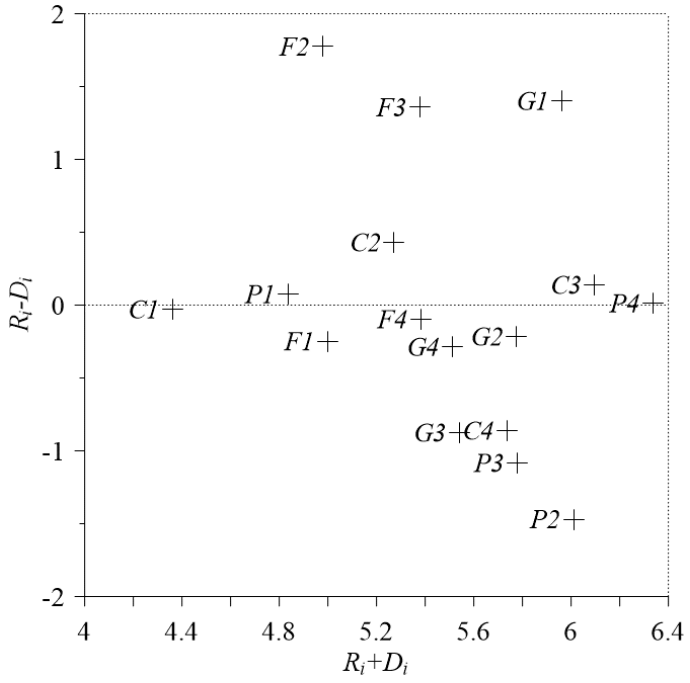

Fig. 2. Casual diagram for sixteen Balanced Scorecard criteria in TSL branch

Global analysis also points out that the *P* (processes perspective) (in Fig. 1) has the highest R_i+D_i position indicator value which means, that it is related in the strongest way with other perspectives, taking a central place in the web of mutual relations. Moreover, in Fig. 2, the highest indicator value of position is assigned to *P4* criterion - indicators allowing for draw up of logistic limits, thereby taking

the central position in the web of mutual relations with other criteria. The lowest position indicator value is attained by *C1* criteria - number and value of lost orders analysed in a time periods and customer groups. In turn, *P* (processes perspective), having the highest negative value of the relation indicator, is in to the highest degree recipient of the influence extended by other perspectives (Fig. 1). The awaiting time for realization of particular production stages – *P2* criteria, with the highest negative value of R_i-D_i, is among criteria with the largest recipient of influences from other parameters, and it has the lowest priority in the group of 16 adopted criteria for the TSL companies (Fig. 2).

When searching for the answer to the second of the two questions formed at the beginning, it must be determined which of the *F1-F4* parameters has a predominant position within the scope of the financial perspective (Fig. 2). It is assumed that the importance of the parameter, its priority among others, is described by the R_i-D_i relation indicator. From among *F1-F4* indicators, it is the *F2* parameter – cost of medium order service – which has the highest value of relation indicator, and therefore for the companies, it is the most important parameter within the scope of the financial perspective.

BSC methodology shows cause-effect relations between four perspectives, which influence each other and ultimately are connected with the financial perspective of the company. In effect, improvement of results in any of the four perspectives can in the end facilitate achieving the increase in economic results for the company. ERP class systems with BI (Business Intelligence) modules fulfill the support function for the upper management of TSL companies, when making strategic decisions. From this perspective, it is very important to correctly select and monitor KPI parameters in ERP class systems. Moreover, a cyclical process of KPI usefulness verification should be set up, and their constant adjustment to current objectives of the company should be performed. KPI parameters monitored in BI modules should be fed by real data from relevant modules of an integrated ERP system. DEMATEL methodology allows companies to establish which of the KPI parameters and BSC perspectives monitored in the ERP system are most decisive. Concentrating the focus of upper management on these areas simplifies forecasting, definition of business strategies as well as planning actions and analysis of their effect in companies from TSL industry.

5. CONCLUSIONS

Companies from the TSL branch, which in their strategy of building competitive advantage, support themselves with modern information systems, should implement KPI indicators. They are useful in both the evaluation of current operations, as well as in setting future strategies. KPI indicators coupled with real data from the ERP systems support the managerial staff in making strategic decisions.

The article presents the analysis of a set of KPI criteria dedicated for the TSL branch. After determining, in each of the four perspectives of the Balanced Scorecard method, 4 most important criteria, a set of 16 KPI indicators is obtained. Next, with the use of DEMATEL methodology, the matrix of interdependent influences is determined for all criteria pairs. Finally, a matrix of total influence T is created and indicators of position and relation are determined for 4 Balanced Scorecard perspectives, as well as for 16 KPI parameters. Following, both Balanced Scorecard perspectives as well as criteria within these perspectives have been determined, having the highest and least overall and net influence.

It is worth mentioning that in the practical application of DEMATEL methodology, a key role in the assessment of credibility of research results is the appropriate selection of the group of experts. The process of their qualification for the research could be an independent academic study. Among problems which should be resolved in this area is, for example, the selection of experts' assessment criteria and their remarks, the layout of the requirements' list, comparison of often non-measurable professional profiles, as well as minimizing the subjective view when assessing the person. The suggestion on how to resolve the problem of experts' selection will be provided in the subsequent, prepared publications of the author.

Another research problem is related to the subject matter of selecting appropriate experts. DEMATEL methodology performs well in the identification and analysis of cause-effect relations which commonly occur in companies. The requirement for the usefulness of that analysis is the correct determination by each one of the experts, of the initial direct influence matrix *Z*. However, in order to also support upper management in the process of decision making while under uncertain conditions and minimize assessment mistakes made by experts, it is necessary to expand the DEMATEL methodology with elements of fuzzy logic. This subject matter will also be described in subsequent, planned publications of the author.

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