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The standing and forecast for the transportation enterprises involving the logical probability simulation method

Stan obecny i prognozowany dla przedsiębiorstw transportowych z wykorzystaniem logicznej metody symulacji prawdopodobieństwa

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Abstract
The economic-mathematical model of the sustainability and predictability of the transportation system and the sea ports was considered as a single model encompassing those related to the financial sustainability and predictability of the enterprises. The author substantiated the expediency of creating the models by way of the logical probability simulation. 10 indexes were suggested for the evaluation of the financial standing of individual enterprises and the entire transportation system, with the method of golden section to be applied for the determination of the appropriate regulatory value thereof. The scenario-based tentative calculations were made and the results analyzed. The author proved that the logical probability simulation makes it possible to create an economic mechanism of striking a balance between the volume of traffic and the Budget payments with no administrative control.

Słowa kluczowe: stabilność finansowa, symulacja, prognozowanie

Abstrakt
Ekonomiczno-matematyczny model trwałości i przewidywalności systemu transportowego i portów morskich został uznany za jeden model obejmujący także ich stabilność finansową i przewidywalność. Autor uzasadnia celowość stworzenia modelu w drodze logicznej symulacji prawdopodobieństwa. Do oceny sytuacji finansowej poszczególnych przedsiębiorstw i całego systemu transportowego wykorzystano 10 indeksów zgodnie z metodą złotej sekcji, umożliwiającą określenie odpowiednich regulacji wartości. Dokonano kalkulacji zawartych w scenariuszu, a rezultaty przeanalizowano. Autor udowodnił, że logiczna symulacja prawdopodobieństwa umożliwia stworzenie mechanizmu ekonomicznego i utrzymanie równowagi między intensywnością ruchu a płatnościami budżetowymi bez kontroli administracyjnej.

Introduction

A transportation enterprise is an economic unit of the entire transportation system and the ports, with its financial sustainability affecting the standing of the transportation network and the national economy as such. Therefore, evaluation and forecasting of the financial sustainability of a transportation enterprise is a hot issue.

Facilities management and administration consists of a number of inter-related components, with the stability of the entire system depending on a streamlined operation thereof. Likelihood of the operation of the system in an unforeseen environment and virtual impossibility to accurately evaluate possible affect thereof complicate the task. What we can do, is to weight up the probability of the operation in the said environment. The administration of the transportation network and the sea ports provides an instance of facilities management and administration. The transportation system encompasses a number of related enterprises. The

objective of the study is the evaluation and forecast of the financial sustainability of the enterprises and the entire system.

The designers of the original technical systems are unable to predict the suitability thereof on the grounds of the statistical data related to the design and operation of the analogous systems. The same holds true for the evaluation and forecasting of the financial status of the transportation network and the sea ports. What is available are numerous, interrelated transportation enterprises and certain hypotheses concerning stable operation of the individual enterprises. The two – the links among the elements of the system and the probability of their operation underlie the terms of economic sustainability of the transportation system. Those also make it possible to reveal the adverse factors to be taken into account in term of a certain situation or an innovation.

A hypothesis applied in the creation of a transportation system should be based on the links among the individual enterprises and a probability of their stable operation, which means that the simulated operation of the system is scenario-based and can be verified as long as the situation develops according to the scenario.

We consider the transportation system as the ERP. The efficacy of the transportation system depends on the stability of an individual transportation enterprise. The depreciation of the vehicles and force-major circumstances should be taken into account in planning the efficient administration thereof.

The economic processes are essentially relative and the links among them may be described by means of certain logical functions. The application of the logical probability simulation methods in the evaluation of the financial sustainability of an enterprise makes it possible to:

- adequately describe logical links among the financial indexes of an enterprise and understand the relative nature of the current economic processes, as well as create the risk evaluation and scenario-based analysis of the sensitive areas;
- based on the expert hypotheses, verify the accuracy of the description of the financial standing of an enterprise relying on the economic indicators suggested by an expert and forecast the financial status thereof.

The creation of a model by applying the logical probability method, the techniques and technology, algorithms and the automation are detailed in 2–3.

The formula $Z = \{K_i / i \in [1,n]\}$ consists of "n" components. The specific value of the $\forall K_i$ index makes it possible to consider the financial standing of an enterprise.

If presumed that the financial status of an enterprise depends on haulage, then within T period it may find itself in various discrete situation. Any "n" financial index may have two contrary values: "one" when it is less or equals a logically presumable value, e.g. 0.5 and "nil" when the value exceeds the certain one. If the value of "n" component is less or equals its presumable value, it is considered reliable (acceptable) and marked with "R". Otherwise, the value of "n" is unreliable (unacceptable) and is marked with "Q". The probability of the reliability of K_1 elements within "t" period of time was marked with $P_1(R_1)$, respectively unreliability of the K_1 elements was translated into the following formula:

$$P_t(R_i) = 1 - P_t(R_i),\ i = \overline{1-n} \tag{1}$$

Within "t" period of time and economic index acquires both values. In case of the reliability, the number of the states the system may be in is m_1, while in the contrary case $k_i = n - m_i$:

$$C_n^m = \frac{n!}{m_i! k_i!},\quad i = \overline{1-n} \tag{2}$$

The probable reliability of the evaluation indexes of the financial status of an enterprise within "t" period of time will be:

$$P_t(R_i, R_2, \ldots R_n) = \prod_{i=1}^{n} p_t(R_i) \tag{3}$$

Probable unreliability of an index involved in the calculation of the integrated reliability index of the financial standing of an enterprise:

$$P_t(R_i, R_2, \ldots R_{n-1,} Q_n = \prod_{i=1}^{n-1} p_t(R_i) 1 - p_t(R_n)) =$$

$$= \prod_{i=1}^{n-1} p_t(R_i)\, p_t Q_n) \tag{4}$$

The economic-mathematical model related to the simulation of the sustainable transportation system and the sea ports can be presented as a conglomerate of the economic-mathematical models related to the financially sustainable and predictability of the enterprises and the entire system (Fig. 1).

Balance is the basis of a financial analysis of an enterprise. The analysis of the balance data makes it possible to understand the financial standing of the enterprise and making the adequate decision for the improvement thereof.

The indexes applied in the evaluation of the financial status of an individual enterprise and the

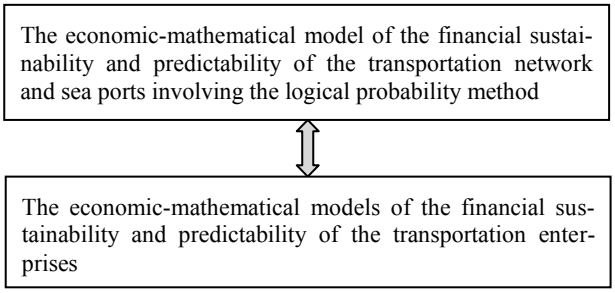

Fig. 1. Models of the financial sustainability and predictability of the transportation system
Rys. 1. Modele stabilności finansowej i przewidywalności systemu transportowego

entire transportation system (Tab. 1). The regulatory values were defined on the grounds of the enterprise competitiveness statistical data.

Table 1. Indexes applied in the evaluation of the financial status
Tabela 1. Wskaźniki stosowane w ocenie sytuacji finansowej

Name	Regulatory value
Solvency ratio	0.5–0.7
Maneuvering ratio	0.05–0.1
Supply sweep ratio	0.1–0.15
Current liquidity ratio	0.1–0.15
Absolute liquidity ratio	1.0–2.0
Rapid liquidity ratio	0.1–0.2
The bills payable and receivable ratio	0.1–1
The ratio of funding the supplies and costs with the own funds	0.6–0.8
Common profitability	0.05–0.15
Turnover profitability ratio	0.05–0.15

The method of golden section /8/ was applied for the evaluation and forecasting of the financial standing of individual enterprises and the entire transportation system, as well as for the determination of the appropriate regulatory value.

As specified above, 10 indexes are applied in the financial evaluation. The system is affected both the endogenous and exogenous factors. Consequently, each financial index may be in various discrete states. Let's say that each financial index equals the value determined by the golden section ratio. If the probability of the reliability of each coefficient is similar and equals $(R_1) = 0.62$, then the probable unreliability coefficient will be $(Q_1) = 0.38$.

The system consists of $n = 10$. Both the positive and negative status will be $N = 3\ 628\ 800$ of which $N - 1 = 3\ 628\ 799$. The system contains at least one "bad" factor. If less than the logically acceptable value, an index may have two contrary values: "one" and "nil". If the value of component "n" equals the acceptable one, it is regarded reliable (acceptable) and marked with "R". Otherwise, the value of "n" will be unreliable (unacceptable) and marked with "Q". If reliable, the number of the states will be m_1 while if unreliable – $k_1 = n - m_1$; $C_n^m = n!/m_i!k_i!)$, $i = \overline{1-n}$ (Tab. 2).

Table 2. Factors
Tabela 2. Faktory

№	m	k	C_n^k	№	m	k	C_n^k
1	10	0	1	7	4	6	40
2	9	1	10	8	3	7	30
3	8	2	20	9	2	8	20
4	7	3	30	10	1	9	10
5	6	4	40	11	0	10	1
6	5	5	50				

Table 3 contains the computation results of the probable reliability of the system, with the standard indicators defined by the method of the golden section and the probable values of the reliability/unreliability of the system, as well as the probable status

Table 3. The computation results of the probable reliability and unreliability of the system
Tabela 3. Wyniki obliczeń prawdopodobnej niezawodności i zawodności systemu

Financial ratio	Value of the ratios according to the method of the golden section	Probable reliability $P(R_i)$ of the X_i – index	Probable unreliability $P(Q_i)$ of the X_i – index	Probable reliability of the system in view of the probable status of each element $P_t(Y_i)$	$C_n^k \times P_t(A)$
Solvency ratio	0.65	0.62	0.38	0.008392994	0.05144093
Maneuvering ratio	0.4	0.62	0.38	0.005144093	0.06305662
Supply sweep ratio	0.38	0.62	0.38	0.003152831	0.0579714
Current liquidity ratio	0.38	0.62	0.38	0.00193238	0.04737448
Absolute liquidity ratio	1.65	0.62	0.38	0.001184362	0.03629495
Rapid liquidity ratio	0.165	0.62	0.38	0.000725899	0.01779624
The bills payable and receivable ratio	0.65	0.62	0.38	0.000444906	0.00818052
The ratio of funding the supplies and costs with the own funds	0.72	0.62	0.38	0.000272684	0.00334258
Common profitability	0.6	0.62	0.38	0.000167129	0.28545772

Table 4. Changes of the probable reliability and unreliability of the financial ratio
Tabela 4. Zmiany w prawdopodobnej niezawodności i zawodności wskaźników finansowych

#	Financial ratio	Ratio values	Probable reliability of the financial ratio $P(R_i)$	Probable unreliability of the financial ratio $P(Q_i)$
1	Solvency ratio	0.62	0.62	0.38
2	Maneuvering ratio	0.05	0.72	0.28
3	Supply sweep ratio	0.1	0.72	0.28
4	Current liquidity ratio	0.1	0.8	0.2
5	Absolute liquidity ratio	1	0.9	0.1
6	Rapid liquidity ratio	0.1	0.62	0.38
7	The bills payable and receivable ratio	0.1	0.9	0.1
8	The ratio of funding the supplies and costs with the own funds	0.6	0.85	0.15
9	Common profitability	0.6	0.62	0.38
10	Turnover profitability ratio	0.6	0.62	0.38

of each element taken into account (in case of a transportation enterprise – the value of the financial ratio, while in case of the transportation system – the integral value of the financial sustainability of an enterprise).

There is little likelihood of all the ratios of the system being less than their respective values, i.e. the probability of all the 10 components is "bad".

$P_t\{A(m = 0,\ k = 10\} =$ 0.000102434, while the likelihood of all the ratios of the system equaling their respective values is $P_t\{A(m = 10,\ k = 0\} =$ 0.008392994.

Even, if the value of a single ratio out of the 10 is less than the acceptable one, the probability of the system will be $P_t\{A(m = 9,\ k = 1\} =$ 0.005144093 etc.

The probability of a common risk affecting the reliability of $\sum P_t\{Y(0 \le m < 10; 0 < k \le 10)\} = 0.28$ system will be 0.28 or 28%.

If presumed, that the financial ratios have different values and only three of those: solvency ratio, common profitability and turnover profitability ratio are defined by the method of the golden section the probable reliability of the other financial ratios will change respectively (Tab. 4).

The probability of a common risk affecting the reliability of $\sum P_t\{Y(0 \le m < 10; 0 < k \le 10)\} = 0.321$ system will be 0.321 or 32.1%.

All the ratios were defined by the method of golden section.

Conclusions

For the purpose of sustainability of the transportation system, the logical probability model should be developed, with the following factors taken into account: depreciation of the vehicles, force-major circumstances, such as terrorism, natural disasters, floods, heavy snowfalls, avalanches etc. and in the seismic regions – earthquakes, tsunami etc.

The transportation-related revenue contributes a lot to a national economy. Therefore, prediction of the financial standing of the transportation enterprises will make it possible to prevent or mitigate the financial problems. Also, the information can be beneficial for controlling tax-related incomes. As is well known administrative measures solely cannot secure the balance between the taxes charged to the economic activities and the volume of the rendered services. It is necessary to create a cyber regulation-based economic mechanism, which would make it possible to balance the haulage and Budget payments without administrative control of the enterprises and that's what the logical probability model is for. The model makes it possible to forecast the financial sustainability of an enterprise and its comparison to the actual situation on the grounds of the minimal economic indexes (10 indexes). The tentative calculations show that as a result of modeling, the profit of an enterprise should diminish or go down to nil, while it pays the taxes in actually equal amounts. The conclusion to be drawn is that the taxes are not adequate with the services. More precisely so the paid taxes are lower than the actual ones. The applied methods of the financial analysis do not secure the regulation of the aforesaid indexes and the detection of the disproportion between them. It is only by the logical probability model that the said disproportion can be detectable.

Supplementary

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