Some Suggestions on the Organization of a Simulation System for Determining the Planned Volume of Cargo-carrying Realized by Motor Transport

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Some Suggestions on the Organisation of a Simulation System for Determining the Planned Volume of Cargo-carring Realized by Motor Transport: *The paper presents a suggestion about the improvement of the management organisation of goods supply to a chain of hypermarkets using company-owned means of transport. The approach, it offers, involves developing a dialogue simulation system in which the expert, who communicates with it, makes decisions about carrying out the plans for goods supply and he also assesses them.*

The system has to ensure the investigation of all possible variants for calculating the volume of goods to be transported, considering, at the same time, the productivity of an average number of cargo vehicles. Different variants of the plan have to be examined in dynamic conditions, each time taking a fixed set of factors and keeping to the formed volume of transported goods.The implementation of this system can be achieved through the RAO (Resources-Actions-Operations) method of simulative modelling.

The system which the paper presents can be considered as a planning instrument designed to calculate the volume of cargo-carrying transportation. It uses the expert-computer dialogue mode to achieve the best task solution.

Key words: *ooptimization, management, planning, correlation-regression analysis, simulation modelling, ttransport*

INTRODUCTION

The development of the plan for motor transport is an iterative process. As a result of the calculations and co-ordinations made, you get a balanced version of the needs and transport resources of the company's motor transport [5].

The transportation process has to be studied in detail in order to create a system of statistical models which can adequately describe it [4, 7]. The transportation capacity has to be the main factor in these models [2, 9]. In order to achieve its economic objectives the company has to manage quite flexibly the transportation process by exchanging information between the expert and the statistical model, realised as a computer program.

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DESCRIPTION OF THE STRUCTURE OF THE SYSTEM AND ITS FUNCTIONALITY

The paper describes the general structure of the simulation system (fig.1). In dialogue mode between the system and the expert, different variants of determining the main factors for the development of the company's motor transport can be examined, such as the volume of the transported goods and the productivity of the used vehicles. With this functioning system it is necessary to re-create all stages of the planning (on a weekly and on a long-term basis) of the examined process. It is also necessary to use the values of the quantities, which describe the state of this process in a past interval of time, as well as the reasons for the expert's decisions.

Our suggestion is to include eight units in the simulation system. With the real system some units will be realised as separate program modules.

The main part of the system is the operation control unit. The dialogue between the expert and the system will take place in this unit. The separate parts of the system are:

1. Terminal – the expert's work station;
2. Input information unit;

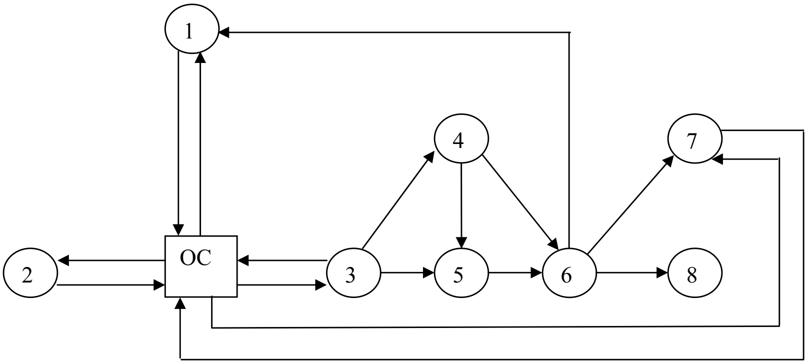

Fig.1. Structure of the simulation system

3. Scenario formalization unit;
4. Unit for simulation of the changes of the technical and economic factors of the system;
5. Unit in which the simulation process is carried out;
6. Unit for interpretation of the results;
7. Archive unit;
8. Unit for printing the calculated results.

The information exchange control, the task control and the archive control will be carried out in the operation control unit. The operation control unit will perform enquiries to the other units and at the same time it will monitor the current values of each variable and the results of the corresponding calculations. The conversion of information has to be done in this unit, too.

The expert's instructions go from the keyboard into the operation control unit where they will be checked, compiled and distributed to the other units following the order in which they are carried out. The simulation system should work either under the direct commands of the expert at the keyboard, or under commands coming from other units. It is recommended that the units work with special commands, which come from the keyboard and through the operation control unit.

Unit 6 should contain a formal description of the conditions characterising the separate special features; a description of the possible reasons and some recommendations for eliminating the negative effect of some results. It is in this unit that all previously set conditions should be checked. This way the expert is free from the task to handle a huge amount of information and is able to direct his attention to the most significant moments of the transport optimisation process which he supervises.

Unit 7 contains the most important results, which are kept in it until they are needed again.

Unit 3 is intended for checking and observing the limitations imposed by independent variables defining the volume of the transported goods.

The simulation unit 5 should consist of a set of multifactor models of the volume of transported goods.

In this simulation system we should study the dependence of the volume of transportation ***O*** on the factors x_i which form it; separate programme modules should be developed based on these factors. Calculations with different programme modules can give several results as the given variable x_i will be determined by several dependencies.

Different variants of the transported volumes of goods will be calculated. Each variant will correspond to a group of factors. Thus, programme modules which implement different dependencies of the transportation volumes, will have to be designed.

Unit 4 should contain several multifactor models for each of the coefficients for use of the vehicles α, for the distance covered β, for the load capacity γ, for the average speed V_m. The models can be derived through correlation-regression analysis [1]. They could be made more precise and could be improved dynamically by measuring the change of regression coefficients over time.

The first models can be developed following an analysis and processing of files of information that determines the retrospective development of the economic factors, which are studied. The process of building up the system of statistic models [8] is an iterative process and the transition from one iteration to another is performed in a dialogue mode between the expert and the programme.

During the process of communication between the expert and the system the screen will display the meaningful regression coefficients and the regression equations for the dependent variable (the volume of transported goods, the coefficients α, β, γ, etc.) will be composed.

Unit 5 should complete its task only after the unit which simulates the changes of the main technical and economic factors has finished its work and it should interact with them. At the same time a number of other issues are dealt with – the number of drivers needed for the process, the use of maintenance facilities, etc.

The initial calculation of the volume of transported goods can be done on the basis of the technical and economic factors using the well-known formula [8]:

$$O = \frac{\alpha.\beta.\gamma.T_n.V_m.A_к.D.q}{t + V_m.\beta.T_{m-p}}, \tag{1}$$

where $\alpha, \beta, \gamma, V_m$ have been already described; T_n is the working time of the vehicle; $A_к$ is the number of vehicles at the end of the previous month; D is the number of workdays in a week; q - the average load capacity; t - the average duration of the load transportation; T_{m-p} - time allowed to load and unload the vehicles.

The following dependence is used to calculate the time during which the vehicle is working:

$$T_н = \kappa_c.t_c + \varepsilon_c, \tag{2}$$

where κ_c is the shifting coefficient; t_c is the shift duration; ε_c is the average time of zero run (waiting, paperwork, etc.). This detailed calculation of the volume of cargo-carrying transportation in the process of the plans' development and their adjustment is only justified in short-term planning (weekly planning).

With long-term planning, in order to prognosticate, it is necessary to use the modules, based on the corresponding equations of regression about the volume of the transported goods. In a dialogue mode the most suitable of these modules are selected depending on the particular economic conditions when the motor transport is used.

At the start of the simulation system the initial values of the separate factors should be entered by the expert or considering the results from the period under survey. On calculating each of the values α, β, γ, V_m, O the values of the results may be hardly acceptable for the expert who communicates with the system. It is necessary to supply information about the values of the factors and choose values that can improve the factors. The values of the factors should satisfy certain constraints which have economic implications.

The decrease in the volume of transported goods results in an increase in the number of staff and the amount of their salary, as well as an increase in the cost of goods' transportation.

The final decision has to be made by the expert after an analysis and comparison of results based on all formal and informal criteria.

SPECIAL FEATURES FOR REALIZATION OF THE PROGRAMMING SYSTEM

The increase in the amount of transportation should be realized bearing in mind the limitations of salaries, and it can be carried out by the expert who is in charge of the examined system. When the productivity of the vehicles is calculated and when the variants with the complete set of factors are considered, a variant with high cargo-carrying capacity of the vehicles can be found. Following the algorithms and instructions the expert takes into account the influence of each separate factor for determining the productivity. The expert chooses the most acceptable solution.

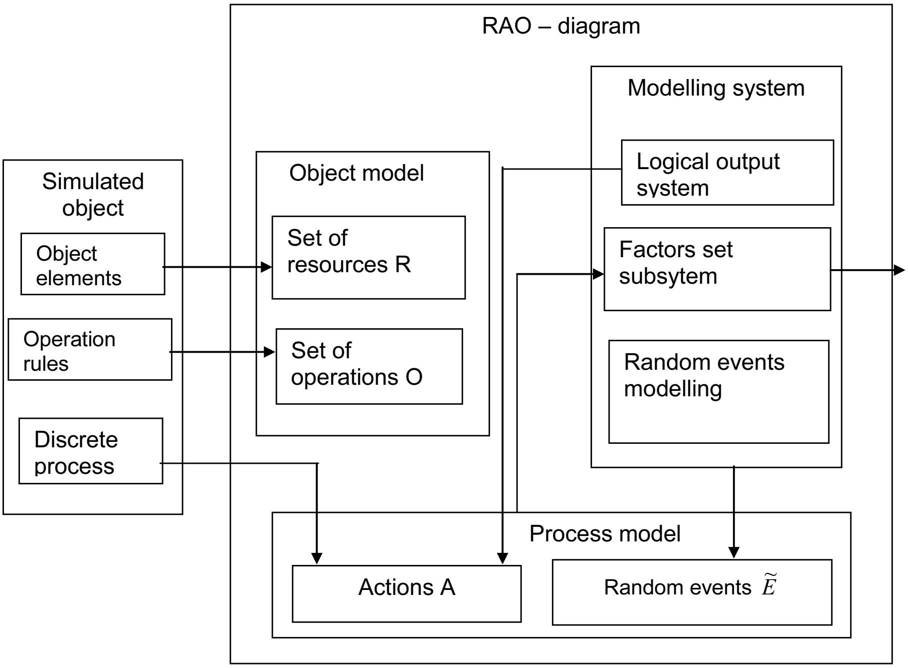

Fig.2. Diagram of the complex system in the RAO method

USAGE OF THE RAO METHOD

The RAO (Resources – Action – Operations) method – described in [3], can be used to develop the examined simulation system. In this case the complex system has to be presented as shown in fig.2.

Main states of the RAO method:

-All elements of the complex system are represented as resources, described by some parameters. The resources are divided in several types. Every resource from a specific type is described by the same parameters.

-The resource states are defined by a vector of values of all of its parameters. The state of the complex system is defined by the values of all parameters of all the resources.

-The process, running in complex system, is described as a sequence of purposeful actions and uncontrollable events, changing the resources' states. The actions are time constrained by two events: start and end.

-The uncontrollable events describe the change of the complex system's states, which are unpredictable within the system model (influence of external for the system factors or factors, which are internal to the system's resources). The occurrences of uncontrollable events are random.

-The actions are described by operations, which are modified rules, measuring the temporal links.

-The set of resources R and the set of operations O form the complex system model.

The complex system model in the RAO method is a dynamic system. The database of this system contains a set of resources R, while the knowledge database contains the set of operations O.

To perform the simulation of the system based on the RAO method, it is necessary to include a module for simulation of uncontrolled events and tools for simulation models.

CONCLUSIONS

The implementation of economic and statistical models for determining the volume of deliveries is of utmost importance, because the models describe different aspects of the examined economic phenomena. These models also make it possible to come to conclusions about the process' suitability. As the regressive models are models which assess the possible variants of behaviour of the examined system, they can be used as simulation models [6].

The influence of the external control effects on the examined objects can be simulated with the following variables: the specific weight of the maintenance station in the fixed production capital; coefficient of the vehicle's drivers work load: the ratio of the wages to the number of staff employed in the production process; the coefficients of the vehicles' availability for service; the load run coefficients, the load capacity coefficient, the average operational speed, etc.

The expert's impact in the course of calculations is realized through external variables included in the model (i.e. with the help of the necessary change of the input information). The best decision is chosen through results analysis, while the simulation system is running.

The system which the paper presents can be considered as a planning tool, designed to calculate the volume of cargo-carrying transportation. It uses the expert – computer dialogue mode to achieve the best possible solution.

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Докладът е рецензиран.

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