ANALYSIS OF THE TRANSPORT FLOWS SERVICE TIME OF THE VEHICLES AND ASSESSMENTING OF THE IDETERMINANCY OF EXTERNAL IMPACT

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Basing on the assessment of formulation of the objectives of management of transport flows and on the indeterminacy of external impacts, it is possible to carry out a more detailed analysis of the distributions (according to time) of flows of transport means entering customs, as well as their distribution in to separate customs lanes. It also enables the definition of dependency on the extent of transport flow, as well as allows the calculation of choosing optimum transport amount for the inspection in customs-houses during a certain period of time.

1. Introduction

With the aim to increase the attraction of Lithuania as a transit country it is necessary to identify the main obstacles in the field of border crossing and formalities of customs procedures.

While analysing this situation it is important to explore the incoming and outgoing transit transport flows, to identify their theoretical distribution in proportion to customs and transport pressure on customs as well, to formulate the objectives of management of transport flows and to assess the indeterminacy of external impacts.

Basing on the formulation of estimation of service time for vehicles and on the assessment of indeterminacy of external impacts it will be possible to perform detailed research of flow distribution of incoming transport means according to the time and their distribution in separate customs lanes [1–3]. It will also allow to identify the idle time of transport means and to measure the dependence of carriers' service time in proportion to transport flow.

2. Estimation of service time of vehicles

Basing on experiment, we see that flows of cars entering a customs post is distributed to identify the exponential law. Thus at every moment the average quantity of cars in to platform $\bar{n}$ it would be formulate by average speed of arriving cars by average service time and dispersion of service time:

$$\bar{n} = \frac{\lambda}{\mu} + \frac{\lambda^2 \sigma_{t_s}^2 + (\lambda / \mu)^2}{2\left[1 - (\lambda / \mu)\right]}, \tag{1}$$

there $\sigma_{t_s}^2$ – dispersion of t_s service time. From (1) equation it is that if are senses λ and μ fixed, the average quantity of arriving cars increase by increasing dispersion $\sigma_{t_s}^2$. If λ and μ

are invariable, the average quantity of cars in the platform is according $\sigma_{t_s}^2 = 0$. When the speed λ of arriving cars and service time μ is the same, then:

$$\bar{n} = \frac{\lambda}{\mu} + \frac{(\lambda/\mu)^2}{2\left[1-(\lambda/\mu)\right]}. \tag{2}$$

If service time of arriving cars is distributed along exponential law and if it have negatively sense and average sense μ, then $\sigma_{t_s}^2 = 1/\mu^2$. In this case the equation (1) will be:

$$\bar{n} = \frac{\lambda/\mu}{1-\lambda/\mu},$$

From (1) equation we see, that average quantity of cars are increased when the average quantity service time $(\lambda - \mu)$ existing.

From this equation we see, that along establishing distributing law of service time of cars in the platform would be decreased only decreasing quantity λ/μ. The proportion to decide average quantity of cars in platform. For example if decrease λ/μ quantity $1-(\lambda/\mu)$ increase, but quantity of cars in the platform is decrease [4–6].

3. Assessment of the inderminancy of external impact

Let us analyse the objective of the optimal management of transport flows (3)–(7).

$$J_0(X, U, t) \to \max; \tag{3}$$

$$\Delta X(t) = \varphi(U, t), \quad t = \overline{0, T-2}; \tag{4}$$

$$l(t, \xi) \le U(t) \le f(t, \xi), \quad t = \overline{0, T-1}; \tag{5}$$

$$X(T) \le g(t, \xi), \quad t = \overline{1, T}; \tag{6}$$

$$\left.\begin{matrix} X(t) \ge 0 \\ U(t) \ge 0 \end{matrix}\right\}, \quad t = \overline{0, T}. \tag{7}$$

And the set of initial states $X(0)$ – is put:

$$X(0) = X^0,$$

here (1) – criterion of management efficiency;

(2) – management of the movement of a managed object;

(3) – permissible management range;

(4) – limitations for phasic coordinates;

(5) – non-negativity of phasic variable and managing parameters.

By the stochastic model (3)–(7) it is possible to define a great class of transport flows optimal management objectives.

For the solution of the objective we shall use a two stage scheme of optimisation. Here in the first stage it is stated that $\xi = 0$ and the solution is sought of a determined objective (programme trajectory), but in the second stage it is considered that ξ is a small deviation and a minimisation objective of the occurring deviation from the programme trajectory is solved.

Thus for the search of the programme solution the initial objective will be written as follows:

$$\begin{aligned}
&J_0(X,\ U,\ t) \to \max\ ;\\
&\Delta X(t) = \varphi(U,\ t);\\
&l(t) \le U(t) \le f(t);\\
&X(t) \le g(t).
\end{aligned} \tag{8}$$

The solution of this discrete optimal management objective may be obtained using the discrete maximum principle or traditional methods of network solution which as a rule tend towards the solution of a static objective in a relevant deployed network.

Let us presume that the solution of the objective (8) has been obtained and it is of the following shape $\widetilde{X}(t)$ and $\widetilde{U}(t)$. Now, assuming that interferences ξ are sufficiently insignificant, we shall seek for the solution of the objective (3)–(7) in the shape of:

$$\begin{aligned}
&X(t) = \widetilde{X}(t) + y(t);\\
&U(t) = \widetilde{U}(t) + v(t),
\end{aligned} \tag{9}$$

here $y(t)$ and $v(t)$ are small successions as well as in ξ. Having inserted (10)

$$X(t+1) = X(t) + B^{+}U(t) + B^{-}U(t+1),\quad t = \overline{0, T-2}\ ; \tag{10}$$

into the initial issue (3)–(7) and having deployed the functions φ, l and f into the line according to y, v, ξ and leaving only linear members we shall obtain:

$$\begin{aligned}
&\Delta y(t) = a(t)v(t);\\
&y(t) = g(t)\xi + \overline{g}(t);\\
&\bar{l}(t) + \theta(t)\xi \le v(t) \le \delta(t)\xi + \bar{f}(t);\\
&\overline{g}(t) = g(t) - \widetilde{X}(t);\\
&\bar{f}(t) = f(t) - \widetilde{U}(t);\\
&\bar{l}(t) = l(t) - \widetilde{U}(t);\\
&\alpha = \left(\frac{\partial\varphi}{\partial\xi}\right),\quad \theta = \left(\frac{\partial l}{\partial\xi}\right);\\
&\gamma = \left(\frac{\partial g}{\partial\xi}\right),\quad \delta = \left(\frac{\partial f}{\partial\xi}\right).
\end{aligned} \tag{11}$$

Here all the derivative programme trajectories are calculated along the system (i. e. at the zero meanings of ξ, v, y). In the second stage for various objectives the functional, which has to be minimised, may be of different expression. In general shape we shall put it as follows:

$$J_1(y, v, t) \to \min . \tag{12}$$

Further, in the second stage, we shall solve the objective identifying the correcting management $v(x,t)$ and the reaching minimum to functional (12) to the conditions (11). For finding $v(x,t)$ it is necessary to know how to measure present solution diversions from that of the programme, at least at relevant discrete moments and to select correcting impacts according to the results of this measurement. The objective is solved by the mechanism of reversible synthesis. However, in general case, there are no regular methods of making the reversible mechanism. We shall apply the above said general solution sequence for the 1–4 objectives. After restoring (9). into the conditions and after linearization, we shall obtain:

$$\begin{aligned} &y(t+1) = y(t) + B + v(t) + B - v(t+1)\,; y(T) = y(T-1) + B + v(T-1); \\ &y(0) = 0\,; \\ &\bar{l}(t) + \theta(t)\xi \le v(t) \le \delta(t)\xi + \bar{f}(t); \\ &y(t) \le \gamma(t)\xi + \bar{g}(t). \end{aligned} \tag{13}$$

Further we shall state that the quantities $\theta(t)$ and $\delta(t)$ for each t cannot have a meaning with various symbols and the quantities $\theta(t)\xi$, $\delta(t)\xi$ and $\gamma(t)\xi$ may be positive and negative as well.

Let us take the criteria of the second stage for the objectives 1–4.

1 Objective.

$$y_n(T) \to \min. \tag{14}$$

2 Objective.

$$\left| \sum_{t=0}^{T} (R(t),\ v(t)) \right| \to \min . \tag{15}$$

3 Objective.

$$Y_n(T) \to \min . \tag{16}$$

if $\theta(t) = \delta(t)$, for all branches of a lot $\Omega(t)$.

4 Objective.

$$\begin{aligned} &\left| \sum_{t=0}^{T-1} \left[\left(C(t),\ v^2(t)\right) - \left(R(t),\ v©(t)\right) \right] \right| \to \min\,; \\ &v^1(t) + v^2(t) = v(t); \\ &v^1(t) \le \delta^1(t)\xi,\ v^2(t) \le \delta(t)\xi . \end{aligned} \tag{17}$$

Further, basing on theoretical research, it would be possible to make the analysis of the distribution (according to time) of flows of cars entering a customs post as well as the analysis of their distribution in to separate customs lanes. It would also be possible to identify the idle time of transport means caused by customs procedures, to identify the dependence of the time of services given to carriers in proportion to the amount of transport flow, to calculate and to assess the optimal selection of transport amount for inspection in customs during a certain period of time.

4. Practical Assessment of the Theoretical Research of Transport Flows

The theoretical research of freight transport flows allows to make a detailed analysis of freight flows enabling the elaboration of the recommendations for the improvement of customs inspection procedures. Basing on this the analysis of freight structure and distribution according to countries would enable to prepare the most influential forecasts of freight transport by separate customs-houses.

The stochastic management model obtained as a result of the theoretical research of freight transport flows enables the determination of a great group of optimal freight flows management issues, such as the issue on maximum dynamic flow in the network, which would allow to calculate maximum transport rate in a customs post; the objective of minimum cost, defining the extent of transported flow filling in the dynamic set of the pane, the objective the essence of which is the determination of minimum quantity of international transport means allowing efficient scheduling of transport traffic.

5. Conclusions

1. It is important to define and to analyse transit transport flows, to identify their theoretical distribution in proportion to customs-houses and to investigate how busy they are with transport means.
2. Basing on the assessment of formulation of the objectives of management of transport flows and on the indeterminacy of external impacts, it is possible to carry out a more detailed analysis of the distributions (according to time) of flows of transport means entering customs, as well as their distribution in to separate customs lanes. It also enables the definition of dependency on the extent of transport flow, as well as allows the calculation of choosing optimum transport amount for the inspection in customs-houses during a certain period of time.

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