CONCEPTUAL BASES OF THE METHODOLOGY OF SETTING AND ACCOUNTING TIME NORMS FOR CARGO PROCESSING OF ROLLING-STOCK IN TRANSPORT NODAL POINTS

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Abstract: Setting time norms for the cargo processing of vehicles is, undoubtedly, urgent for all participants of not only transshipment, but also cargo delivery in the logistic chain "from door to door".

At the stage of consent in managing transshipment the key role is paid by the task, connected with setting compromise time norms for vehicles processing.

The interpretation of time norms for vehicles processing as the most important parameter of the coordinated management of transshipment is conditioned by the fact that just this parameter influences other transshipment indicators. So, the determination of time norms for vehicles processing must be based on the idea of determining the duration of loading-unloading ships (carriages) as a function of transmission capacity of cargo fronts.

Today the problem is to determine the technological line's productivity, because it is interpreted as a determined value in the transport science. At the same time under conditions of real production it is observed that the technological line's productivity varies in a certain diapason, so, time intervals for loading-unloading ships and carriages must be identified with factual realization of time norms for vehicles processing and interpreted as random variables.

Certain values of time norms for vehicles processing are considered as a base for consent between interested subjects of transport nodal points that act as partners and market competitors at the same time at organizing and realizing transshipment.

Keywords: transshipment process, transport nodal point, technological line, transshipment operations, logistic chain, cargo front, time norm, cargo delivery "from door to door", vehicle.

1. Introduction

Technological integration and future structurization of transshipment in transport nodal points must be based on distinct regulation of time parameters of this process, determined by time norms for transshipment operations [1, 2]. Let's turn to the problem of setting time norms for carriages processing, assuming that this kind of norms is, undoubtedly, most urgent for all participants of not only transshipment, but also cargo delivery in the logistic chain "from door to door". Let's note that the transport literature presents different variants of the methodology of solving this problem. They all are based on the idea of determining the processing duration of giving carriages as a function of transmission capacity of cargo fronts under condition of preliminary setting quantitative and qualitative parameters of their technical equipment, connected with a number of technological lines on cargo fronts. At that the aforesaid number of technological lines on cargo fronts provides loading-unloading of giving carriages during a certain time interval that in fact corresponds to factual realization of time norms for carriages cargo processing [3, 4].

In the general case the carriage processing duration in real production conditions usually varies within certain limits. This circumstance allows to interpret the value of this parameter as a random variable and to associate its minimal and maximal values according to pessimistic and optimistic assessments. It must be noted that the average value of this parameter is approximated to the most reliable assessment [5, 6].

The aim of the study it to elaborate the methodology of setting time norms for the cargo processing of railroad cars at fronts of loading-unloading at transport nodal points.

2. Methods

The following methods were used in this study:

– at the theoretical substantiation and elaboration of the methodology of calculating time norms for the processing of vehicles there were used the methods of: analysis and synthesis, induction and deduction ("compression" of an interval of time norm values and formation of subintervals);

– at forming the sample, there were used methods of mathematical statistics, namely one of groups, average values ("three sigma" rule).

3. Results

The guaranteed intensity of transshipment can be expressed through the parameter of time norms for ships processing, named lay time, found from the ratio:

$$T = \frac{Q}{P}, \qquad (1)$$

where T – lay time; Q – ship loading; P – transshipment intensity.

Taking into account (1), we'll further consider the parameter of norms of time for processing both ships and group (giving) of carriages as a main parameter of transshipment at the general name of these objects of vehicles management.

From (1) we can see that at Q=const the index of time norms for vehicles processing depends on one of transshipment intensity that, in its turn, depends on the number of technological lines at a cargo front (N) and their productivity.

Based on the aforesaid, there is conditioned the appropriateness of setting a question about the expedience of the specific "compression" of the interval of values of time norms for excluding values, characterized by the extremely low, practically inadmissible reliability of occurrence as events. Let's note that we talk about values of time norms, concentrated in subintervals, gravitating to the minimal and maximal norm levels. Excluding these values from the consideration is, obviously, equal to raising the reliability of pessimistic and optimistic assessments of elaborated time norms [8].

The set question may be solved differently, mainly by realizing the approach, as it is shown in [9, 10], based on the idea of dividing the change interval of an observed value in subintervals using "three sigma" rule.

The solution of the corresponding problem may be demonstrated of an example of a separate cargo front of a port, where loading-unloading of giving carriages is realized based on observing a certain time norm for their cargo processing. At that we'll interpret each factually reached value of the realization level of a time norm as a possible variant with the code $j\ (j=\overline{1,n})$ and level G_j. The search for a solution will be realized by an algorithm, providing realization of actions, characterized below.

The obtained set of values of time norms $\{G_j\}$ is regularized by increasing (not decreasing) and the succession $G_1 \le G_2 \le \ldots \le G_j \le \ldots \le G_r$, where G_1 and G_r values are accepted as the minimal

(G_{min}) and maximal (G_{max}) values of time norms, respectively, is constructed.

There is found the arithmetic mean of the time norm level $\overline{G}$. Lower time norm values are on the left from it, higher ones – on the right.

The set of time norm variants is divided in two subsets, according to the rule:

$$\left.\begin{aligned} j \in N_1,\ \text{if}\ \ G_j < \overline{G},\ \ j = \overline{1,n}; \\ j \in N_2,\ \text{if}\ \ G_j \geq \overline{G},\ \ j = \overline{n+1,r}; \end{aligned}\right\} \tag{2}$$

It is obvious that the subset N_I includes time norms with the level from the interval [G_{min}, $\overline{G}$), and subset N_{II} is formed by time norms with values from the interval [,G_{max}].

The procedure of time norms differentiation continues farther within the subset N_I, N_{II}. For this aim, arithmetic mean values and mean-square variations of time norm indices are found for the indicated change subintervals of time norm level values [G_{min}, $\overline{G}$), [$\overline{G}$, G_{max}] – $\overline{G}_1$, $\overline{G}_2$, σ_1, σ_2 respectively.

There are fixed the boundary values of the time norm ($G_{min}G_1$, $\overline{G}$ G_2, G_{max}) for forming the sectors – N_I – N_{IV} by the rule:

$$j \in \left\{\begin{aligned} &N_I,\ \text{if}\ \ G_j\ \in\left[\overline{G}+3\sigma_2;\ \sigma_{max}\right]; \\ &N_{II},\ \text{if}\ \ G_j\ \in\left[\overline{G};\ \overline{G}+3\sigma_2\right); \\ &N_{III},\ \text{if}\ \ G_j\ \in\left[\overline{G}-3\sigma_1;\ \overline{G}\right); \\ &N_{IV},\ \text{if}\ \ G_j\ \in\left[\overline{G_{min}};\ \overline{G}-3\sigma_1\right); \end{aligned}\right\}\ \ j = \overline{1,r}. \tag{3}$$

The obtained results are presented on the scale of 0 – G values of the time norm for cargo processing carriages for forming the aforesaid sectors (**Fig. 1**).

After that there takes place the "compression" of the value interval of the time norm by excluding its level from the sectors N_I and N_{IV} and pessimistic (G_{ps}) optimistic (G_{op}) assessments of the time norm level are fixed:

$$\left.\begin{aligned} G_{ps} &= \overline{G} - 3\sigma_1; \\ G_{op} &= \overline{G} + 3\sigma_2. \end{aligned}\right\} \tag{4}$$

The is found the expected (most reliable) value of the required time norm (G), that finally looks as

$$G = \frac{5\overline{G} + 9\sigma_1 - 6\sigma_2}{5}. \tag{5}$$

4. Discussion of results

Questions of forming time norms are elucidated in works [6, 8, 9].

In work [6] time norms for vehicles processing are determined according to working fronts of a terminal and their equipment without taking into account cargo types and labor-intensiveness of its transshipment.

The author of work [8] demonstrated the rather complicated, sometimes ambiguous, methodology of the multi-agent optimization for determining time norms.

As to work [9], it considers a transport nodal point as an institute of net partner relations, and time norms are formed by their coordination.

The results, obtained by the author of this article are maximally approximated to production and "Integral technological process of port and station work" that is proved by checking the elaborated methodology by factual data of the work of Belgorod-Dnestrovsky ports for 2016–2017. The results demonstrated that factual indices of the duration of cargo processing carriages at cordon and rear railway cargo fronts may essentially differ for its calculated values that are time norms for loading-uploading carriages. At that most mismatches were observed in the environment of minimal and maximal considered indices.

The given facts condition the appropriateness and expedience of the "compression" of the interval of time norm values for excluding values, characterized by the extremely low, practically inadmissible reliability of occurrence.

Research results are useful in the work of transport nodal points, because the correct determination of time norms for vehicles processing results in the correct shift-day planning of the complex work that is deviations from plan indices are minimized that, in its turn, results in economy of finances. The elaborated methodology may be used in the composition of the "Integral technological process of ports and stations work" for both existent cargo fronts and ones, implemented to operation, after accumulating correspondent statistic data about reached values of the rolling-stock processing duration.

The offered methodology of setting time norms for the cargo processing of carriages is universal and may be used in further studies at considering ships and trunk cars as vehicles.

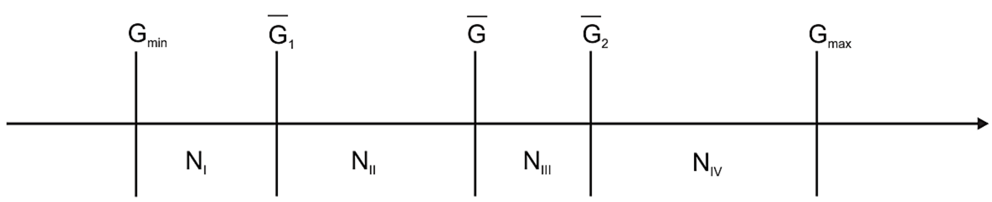

Fig. 1. The scheme of forming subsets of values of the time norm for cargo processing of rolling-stock

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