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The Method To Measure Time Spent On Wagons' Technological Operations at Stations

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ABSTRACT: In this article the main factors causing demurrage of local cars, when delivering loaded cars on rail transport are analyzed. Successive technological processes with trains coming for a revision to technical stations have been also developed. The formula for determining the total time spent on operations performed when sending goods at stations is also proposed. The authors have developed a scheme of algorithm for determining the total time spent on operations from the departure station to the target station.

KEY WORDS: railway, technical station, intermediate station, technical operations, delivering of freight.

I. INTRODUCTION

Currently, cargo, adopted to ensure the terms of delivery of cargo to send not later than the date of receipt or the next day; reducing stopping of wagons in technical and freight stations; increase the speed of train movement; it is necessary to pay special attention to the improvement of interaction of railway transport with other types of carriages in cargo transportation, as well as other technological processes within the established timeframe. These factors, which negatively affect shunk operations in the stations, include the delay of stationed wagons on stationary and station routes, maintenance after the technical and commercial inspection of the wagons, the timely implementation of trains at stations, is generally locomotive deficiencies in the plot [1,2,3].

II. SYSTEM ANALYSIS

This article examines the time spent on technological operations at the station and the time spent on site hikes until the freight wagons are loaded at the technical stations and reached the cargo location after the train is shipped.

After the departure of the train station, we determine the time of movement of the train from the station by the following formula:

$$t_{\text{distance}} = \frac{L_{\text{distance}}}{v_{\text{distance}}} = \frac{l_a^1 + l_a^2 + \ldots + l_a^n}{v_{\text{distance}}}, \text{ min} \quad (1)$$

here is: L_{distance} - distance between technical stations, km;

l_a^1 - distance between separation points, km;

v_{distance} - speed of the train on the track, km / min.

The time taken to receive the train at the technical station along the route is determined by the following formula [4]:

$$t_{\text{receive}} = t_{\text{prepara.route}} + t_{\text{train receipt}} + t_{\text{fixing content}} + t_{\text{disp.locom.}}, \text{ min} \quad (2)$$

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here is: $t_{\text{prepara.route}}$ - preparation of the train route, min;

$t_{\text{train receipt}}$ - train receipt, min;

$t_{\text{fixing.content}}$ - fixing content, min;

$t_{\text{disp.locom.}}$ - displacement from the locomotive, min.

After the train is accepted, the wagons are technically and commercially inspected ($t_{\text{technic}}^{\text{wag.str}}$).The time spent for technical and commercial inspection is calculated by using the following formula [5]:

$$t_{\text{technic}}^{\text{wag.str}} \frac{(\tau \cdot m_c) \cdot 60}{x} + \alpha \text{, min} \quad (3)$$

here is: $\tau -$ average time of a technical inspection of a wagon, ($\tau =$ 0,014-0,016);

$m_c -$ the number of wagons in train, wagon;

χ - the number of employees in the brigade of technical inspection;

$\alpha -$ time spent for additional operations, min.

We consider the factors that influence the wagons' stall during the train process at the technical stations.

III. INPUT DESIGN

A. Technological processes of trains processed at the sorting stations.

Upon the completion of the technical inspection of the train at the sorting station, the pickup hinge locomotive joins the rear of the structure and drives it to the peak and starts the distribution process.

When the pick-up and sorting parks are in series, the total discharging time is determined by the following formula [6]:

$$t_{\text{busy}} = t_{\text{connection}} + t_{\text{push.time}} + t_{\text{discharge}} + t_{\text{drawn}}\text{, min} \quad (4)$$

here is: $t_{\text{connection}}$ - the time of connection to the content of the top locomotive receiving park, min;

$t_{\text{push.time}}$ - the pushing time of content to the peak, min;

$t_{\text{discharge}}$ – the discharge time of content from peak, min;

t_{drawn} - time of wagons to be drawn on the selection track, min.

After lowering the three or four hills, the wagons are consolidated on the roads of the sorting park.

At the top of the hill locomotive fleet, the connection time is determined as follows:

$$t_{\text{connection}} = 0{,}06 \cdot \frac{\ell_y^{\text{I}} + \ell_y^{\text{II}}}{\vartheta_y} + t_x \text{, min} \quad (5)$$

here is: ℓ_y^{I}, ℓ_y^{II} - length of semi-conductive connections, m;

ϑ_y- average connection speed, km / h;

t_x- peak locomotive changeover time, min.

The pushing time of contents to the peak is determined as follows:

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$$t_{\text{push.time}} = 0{,}06 \cdot \frac{\ell_c}{\vartheta_c}, \quad (6)$$

here is: ℓ_c - The length of the slope, m;

ϑ_c- average push speed, km / h.

Discharging time of content from the peak, min:

$$t_{\text{discharge}} = 0{,}06 \cdot \frac{m_{\text{T}} \cdot \ell_{в}}{\vartheta_{\text{T}}} \cdot \left(1 - \frac{1}{2\,\partial}\right), \text{ min} \quad (7)$$

here: m_{T}- number of wagons in structure;

$\ell_{в}$ - average length of wagon, m;

∂- the number of disconnections;

ϑ_{T}- average discharge rate, m/s.

Time of wagons waggling on the way to the sorting park:

$$t_{з} = 0{,}06 \cdot m_c \text{ , min} \quad (8)$$

After completing the technological operations at the sorting hill, the content of the pick-up fleet will be taken to the pickup station.

B. Technological process of trains at the warehouses.

Upon acceptance of trains at the site station, the squad will be screened in its direction. At the site station, the volume of selection works is small, and sections and national trains are drawn up and sorted. Work on the transit trains at the site stations, technical and commercial inspection of the content, replacement of locomotives and brigades, repair of wagons without interruption are the basic ones. At this point, we will consider the technological processes at the station at wagons.

In the carriageway selection, sorting is carried out by shunting locomotives. From the time in the way of content distribution is determined using the following formula [5,7,8]:

$$t_{\text{distribution}} = T_{\text{sorting}} + T_{\text{stopping}} \text{ , min} \quad (9)$$

here is: T_{sorting} - wagons sorting time, min;

T_{stopping} - wagons stopping time, min.

The formula for determining the time spent on technological operations in the classification of wagons on the road to cessation is as follows::

$$T_{\text{sorting}} = A \cdot q_o + \text{Б} \cdot \text{m}_{\text{c}}, \text{ min} \quad (10)$$

here: A and Б $\cdot$ – normal coefficients within minutes.

m_{c} – number of wagons in structure;

q_o – the number of average connections when the contents are reached.

In this case, A and B are manufactured depending on the number(no) of operations on disconnecting wagons. In order to reduce the distance between the wagons, the extra time spent on concentration is determined by the following formula:

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$$T_{\text{stopping}} = 0{,}06 m_c \text{, min} \qquad (11)$$

here: 0,06 – coefficient used for consolidation of one wagon, min;

When collecting wagons on one track or discontinuance of concentration on the path of sediment, the normal time is determined by the following formula:

$$t_{\text{path.sediment}} = T_{\text{птэ}} + T \text{ , min} \qquad (12)$$

here: $T_{nm\text{э}}$ – the technological time associated with the operation of wagons on the sidewalk. This technological time is in accordance with the technical regulations(PTE). Operations related to the carriage of wagons in accordance with the rules of technical use are as follows: correction of carriages by 100 mm or more, longitudinal lifting of wagons. $T_{nm\text{э}}$ is determined by the following formula:

$$T_{nm\text{э}} = B + E \cdot m_c \text{, min} \qquad (13)$$

here: V and E - when designing the content depends on the average number of connection operations on one wagon, norms of coefficients,

T_{removing} – removing the distance between the carriageways on the sidewalk paths by the sedimentation path:

$$T_{\text{removing}} = 0{,}04 \cdot m_c \text{, min} \qquad (14)$$

here: 0,06 – calculation of the cost of spending one wagon.

Once the formation is complete, we define the technological time of transfer to the content wagon's pickup fleet by the following formula:

$$t_{\text{transfer}} = A_{\text{transfer}} + B_{\text{transfer}} \cdot m_{\text{transfer}} \text{, min} \qquad (15)$$

here: - $A_{\text{transfer}}, B_{\text{transfer}}$ - normative coefficients. Carriages and the transfer of all semi-arc A and B standard can be defined as the total of the road, $A_{\text{transfer}} = \Sigma a, B_{\text{transfer}} = \Sigma b;$.

m_{transfer} Average number of wagons in transmitted content.

When designing the content of the sorting park, the content is transmitted through the shunting locomotive.

Train formation must be carried out in strict accordance with the schedule of trains movement and train schedule. The directions and the weight and length of cargo trains on each section shall be determined in accordance with the schedule of train movement and the plan, which shall correspond to the type of locomotive, tracks moving and to the useful length of the receiving-and-departure stations of the stations located on that section.

$$\left.\begin{matrix} q_{\text{В}} \le Q \\ L_y \le L \end{matrix}\right\} \qquad (16)$$

L_y total train length, L normal length of the train on the plot $L_y \le L$, $q_{\text{В}}$ total train mass, normative mass of the train on the plot.

When dispatching trains, the following parameters should be taken into account [10,11]:

$$t_{\text{dispatching trains}} = t_{\text{locomotives waiting}} + t_{\text{chec.tra.bra.}} + t_{\text{send.train}} + t_{\text{dispatch}} \text{, min} \qquad (17)$$

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here is $t_{\text{locomotives waiting}}$ - train locomotives waiting time, min;

$t_{\text{chec.tra.bra.}}$ - time of checking of train brake equipment, min;

$t_{\text{send.train}}$ - to send a train of standby time, min;

t_{dispatch} - the dispatch time of train, min.

At the technical station it is recommended to specify the general duration of the trains being processed through the following formula:

Total duration of technological operations on acceptance and departure of recycled trains at the sorting station, min:

$$t_{\text{st.sorting}} = \begin{pmatrix} t_{\text{receive}} + t_{\text{technic}}^{\text{wag.str}} + t_{\text{busy}} + \\ + t_{\text{path.sediment}} + t_{\text{transfer}} + \\ + t_{\text{technic}}^{\text{wag.str}} + t_{\text{dispat.tra}} \end{pmatrix}, \text{min} \quad (18)$$

Total time of technological operations on acceptance and departure of trains at the site station, min:

$$t_{\text{st.dis}} = \begin{pmatrix} t_{\text{receive}} + t_{\text{technic}}^{\text{wag.str}} + t_{\text{distribution}} + \\ + t_{\text{path.sediment}} + t_{\text{transfer}} + \\ + t_{\text{technic}}^{\text{wag.str}} + t_{\text{dispat.tra}} \end{pmatrix}, \text{min} \quad (19)$$

Thus, the total time of the technological process, which takes place at the time of the train travel to each site and the station, can be summarized by the following formula:

$$\left.\begin{array}{l} \sum t_{\text{distance}} = t_{\text{distance}}^{1} + t_{\text{distance}}^{2} + \ldots\ldots + t_{\text{distance}}^{n} \\ \sum t_{\text{st}} = t_{\text{st}}^{1} + t_{\text{st}}^{2} + \ldots\ldots + t_{\text{st}}^{n} \end{array}\right\} \quad (20)$$

The total time spent until the shipment from the station to the destination station is specified, that is, ($\sum t_{\text{distance}} + \sum t_{\text{st}}$). The distance between the sender and the receiver stations L_{load} km, the speed of the load according to the Shipping Procedure v_{twenty} km / a day, will be $t_{\text{twenty}} = \frac{L_{юк}}{v_{\text{twenty}}}$. The authors propose a coefficient of determination of coefficient of delivery, which ensures delivery time. The formula for determining the delivery time coefficient of the cargoes will be as follows (φ):

$$\varphi = \frac{\sum t_{\text{distance}} + \sum t_{\text{st}}}{t_{\text{twenty}}} \quad (21)$$

In the case of delivery $\varphi \le 1$, the delivery will be timely, it can be seen that cargo $1 \le \varphi$ is not being performed on time. In case of non-fulfillment of the time limit for delivery of goods, for every delayed day, a non-full day is considered complete, and a penalty of 6% of the rent fee per each late day, but not more than 30% of the rent [9,10,11].

As it can be seen, the time spent on technological operations in the station includes the following: technical and commercial inspection (PTOV), shunting locomotives, additional operations on distribution of content, waiting for the train to arrive at the train, waiting for the departure of the train. It is recommended that authors consider this time. Below is the algorithm for operations with trains that are processed at technical stations.

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IV. RESULTS

The developed method allows to calculate the total time spent on the operations carried out from the train station to the specified stations and the rate of performance of technological operations.

Figure 1: 1-3 - Sending wagons from the technical station to the train station;

4 - time of walking on the plot;

5 - admission of train to technical station;

6 - technical and commercial inspection of wagons;

7 - Wagons, processed at technical stations;

8-13 - dispatching of trains at the pick-up station, technical and commercial inspection of the trains established according to the established norms;

14, 21, 27 - allocation of the norm and defective wagons specified in the parcel;

15 20 - Distribution of processed trains at the site site, technical and commercial examination of the trains established according to the established norms, and their transportation to the shipping fleet;

22 - sending of trains from technical station;

23-24 - time of wagons maintenance at technical stations;

25 - time of wagons on all sections;

26 - equalizing the walking time to a normal time limit;

28-29 - coefficient of the guarantee of delivery time of cargoes;

30 – take out the result.

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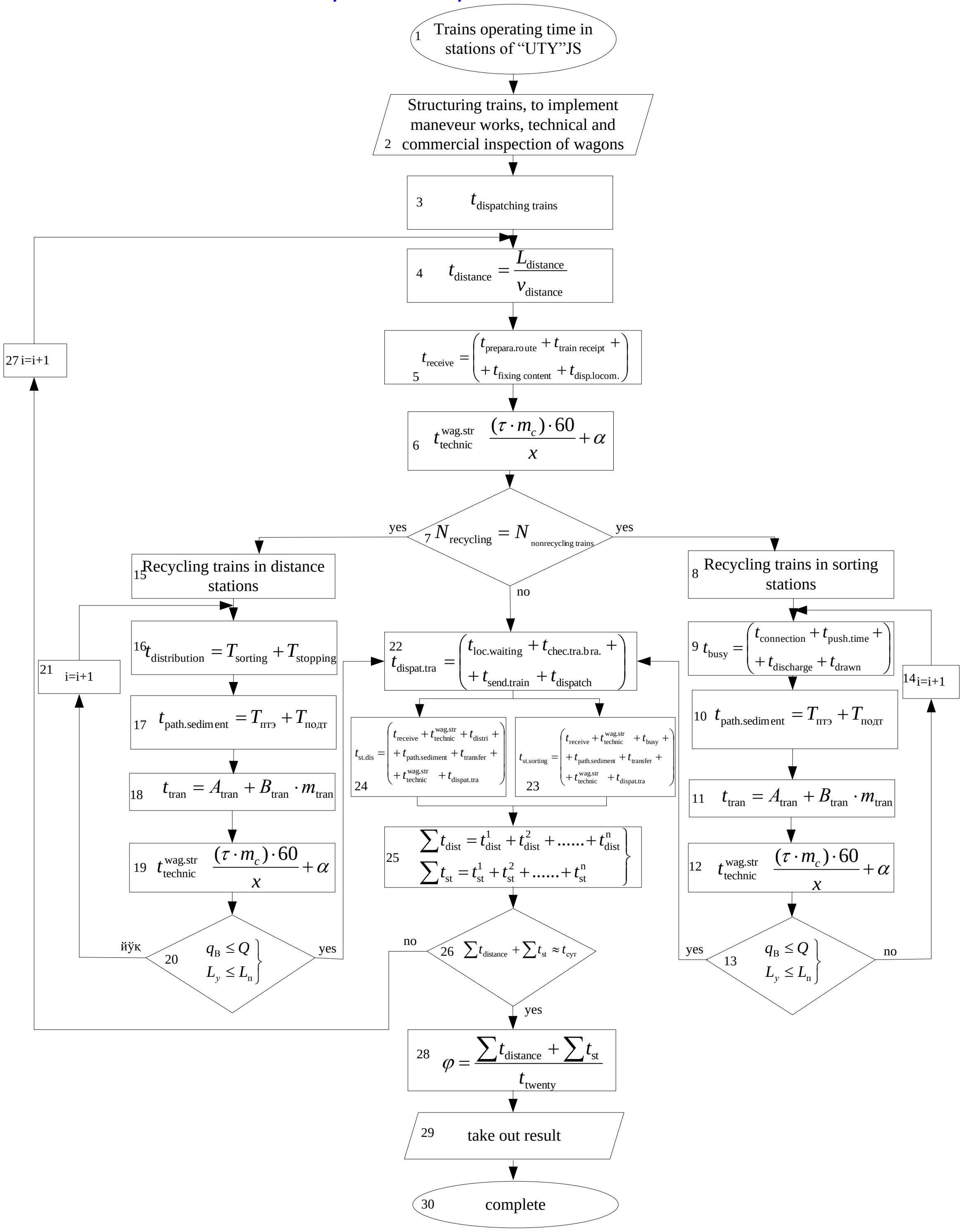

Figure 1. Algorithm of calculation of time of technological operations with trains, processed at technical stations.

Summary: This article describes the method of calculation and calculation of algorithm for determining time of wagons being stationed on the station as well as walking distance in sections as a result of train processing at technical stations. Thus, the proposed method and algorithm in the article will help to detect inefficient time losses during technological operations until the wagons are shifted from the station. The article presents the formula for determining the coefficient of coefficient, which ensures the delivery time of the goods.

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