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Method of Improvement of Efficiency Transportation Technology

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Annotation — This article analyzes the main factors that cause local wagons to stay on the rail when it comes to freight wagons, and develops technological processes for the processing of trains on technical stations. A formula for determining the total number of shipments from the station is also proposed. The interrelation of the operations carried out during the interval between train departure stations to the established stations, and the method of finding the overestimated hours during the operation of inter-sectional distance. The authors have developed a formula for determining the total number of operations from train stations to the designated stations, as well as an algorithm for calculating rail carriages from station to station.

Keywords: Railway, technical station, intermediate station, technical operations, delivering of freight, assembled trains.

I. INTRODUCTION

Currently, in the delivery of goods by rail for local carriage, the delivery dates are usually determined based on the current standards at the destination, after accepting the goods [1-3].

Delivery terms for domestic carriers are defined in accordance with the rules of carriage and are defined in accordance with section 14 of the Rules of Carriage:

Delivery time for cargo handling and shipping is prolonged for 1 day and starts from 00-00 o'clock. This date is displayed in the calendar stamp and also recorded a distance of 330 km/day

Currently, there are lawsuits from customers using the railway services due to the shortcomings in the timely delivery of goods to the JSC "Uzbekiston temir yullari" [4].

Due to the fact that the railroad employees had to work with the clients further, no complaints were filed.

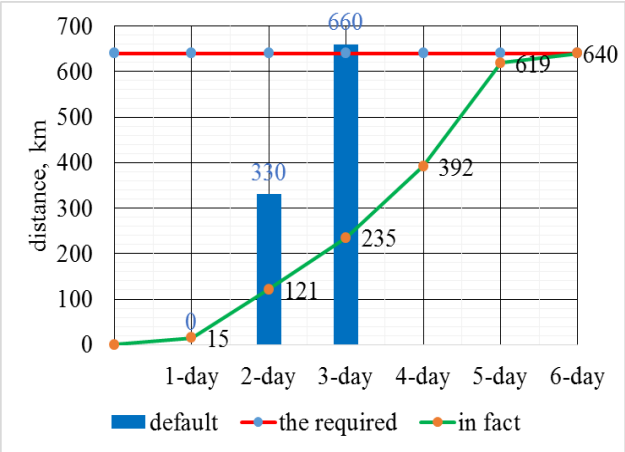

Figure 1. Schedule of current and normal traffic of wagon delivery.

As an example, we can see the freight car traveling in Bekabad and New Zarafshan (according to the report 2018). According to the Rules of transportation, the wagon is loaded 330 km/day from 00:00 on the day of acceptance of the wagon. Here we see our existing car running 121km (Figure 1). Our wagon has traveled 235 km in 3 days. According to the timing of the delivery of goods by rail, this wagon must be delivered to the address (New Zarafshan station) within 4 days and the consignee of the station must hand over the goods to the owner. This train was delivered to the destination within 7 days [4]. The analysis shows that today the freight carriages at JSC "UTY" are 175 km daily, although in the domestic regulations, it should be 330 km/day [2].

The urgency of the problem. Timely delivery of goods by rail is to the intended destination. Preventing the imposition of a certain amount of penalties on freight carriage due to untimely delivery of wagons to freight owners during railway transportation and providing quality transport services to customers.

The purpose of the article. Ensure timely delivery of wagons to the station at "Uzbekistan Railways"

Functioning. Development of a method of delivery of cargos to ensure timely delivery of carriages to their owners in "Uzbek Railways" Joint Stock Company.

Method of solving the problem. Analysis of cargo delivery technology and ways to identify and reduce adverse effects.

The mathematical solution to the problem. To substantiate the mathematical model and algorithm of factors influencing them according to the formula for determining the delivery time.

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The main factors influencing delivery time during transportation are shown in Figure 2 [7]

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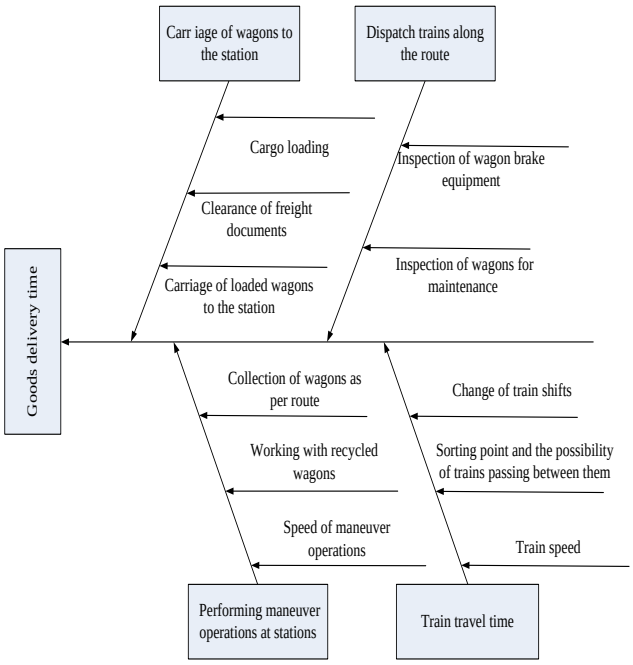

Figure 2. The main factors influencing the delivery of goods

Besides, there are the following factors that cause delays in the delivery of goods:

• lack of sufficient manoeuvrability and train locomotives in shifts;
• expiration of the existing shunting and train locomotives;
• unsatisfactory performance of manoeuvres at stations;
• a warning is given to limit speed on hauls;
• inadequate execution of train dispatching and dispatch of trains, etc.

As a result of the aforementioned factors, the following may occur:

• long-standing stops on loaded wagons and station tracks;
• cases of loading of wagons at train stations after technical and commercial inspection;
• cases of train failure on sections;
• cases of untimely transfer of loaded wagons to unloading stations and station tracks at destination stations;
• failure of clients to cooperate with railway transport;
• breakdown of perishable goods, etc.

Delivery time depends on the type of shipment, speed of transportation (freight, bulk and passenger) and type of flights (direct, indirect, mixed, international).

Currently, delivery time is determined by the formula [7,8,13]:

$$T_{w.t.} = t_{sh.r}. + 24 \cdot \left(L_{\text{cargo}} / v_{day}\right) + \sum t_{\text{add}} \qquad (1)$$

where: $t_{sh..r}$ - time spent on shipping and receiving cargoes;
L_{cargo} - the distance between the consignee and the receiving station, km;
Y_{day} - consignment speed, km / milk
T_{add} - The time spent in additional activities.

The time spent on shipping and handling of cargoes, the designated freight rates, and the time spent on additional operations are considered in accordance with the Cargo Rules.

To comply with the terms of delivery of goods: to ship the accepted luggage not later than the day of acceptance and at least the next day; comprehensive reduction of car stops at technical and freight stations; increase the speed of trains; It is necessary to pay special attention to improving the interaction of rail transport with other types of transport and to carry out other technological operations in fixed terms [10,14,].

The technical stations consider the time spent at the station and the speed of movement at the station until the freight arrives at the train station and arrives at the freight station [11,19,20].

After departure from train station, we determine the train traffic time according to the defined section by the following formula [17,18,20]:

$$t_{\text{area}} = \frac{L_{\text{area}}}{v_{\text{area}}} = \frac{l_a^1 + l_a^2 + \ldots + l_a^n}{v_{\text{area}}} \qquad (2)$$

L_{area} - distance between technical stations, km;

l_a^1 - distance between points of distribution, km;

v_{area} - train speed on the section, km / min.

The train time to the arrival of the technical station is determined by the following formula:

$$t_{\text{t.t.}} = t_{\text{r.p.}} + t_{\text{t.a.}} + t_{\text{c.f.}} + t_{\text{l.d.}} \qquad (3)$$

where: $t_{\text{r.p.}}$ - train route preparation, min;

$t_{\text{t.a.}}$ - train acceptance, min;

$t_{\text{c.f.}}$ - fleets fixing, min;

$t_{\text{l.d.}}$ - disconnection from the locomotive, min.

After acceptance of the train wagons are subject to technical and commercial inspection ($t_{\text{tech}}^{\text{com}}$). The time spent for technical and commercial inspection is calculated using the following formula:

$$t_{\text{tech}}^{\text{com}} \quad \frac{(\tau \cdot m_q) \cdot 60}{x} + \alpha \qquad (4)$$

where: $\tau -$ Average time spent on technical inspection of one wagon, (0,014-0,016);

$m_q -$ number of wagons in train, wagon;

x - number of employees in the technical inspection team;

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

We will consider the factors that influence the wagons stalling during maintenance processing at technical stations.

II. TECHNOLOGICAL PROCESSES OF PROCESSING OF TRAINS AT THE SELECTION STATIONS.

After the technical inspection of the trains at the qualifying station, the hill locomotive will be attached to the rear of the structure, which will push it to the top and begin the distribution process.

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When the receiving and sorting parks are consecutive, and when a maneuvering locomotive is operated on a gravity hump, the total drop-down time is calculated by the following formula:

$$t_T = t_c + t_p + t_d + t_s \quad (5)$$

where: t_c - time of joining the hill locomotive to the reception park, min;
t_p - time to push the fleets to the peak, min;
t_d - time to drop fleet, min;
t_s - time of carriagging on sorting park wagons, min.
After three or four components are unloaded, the carriages on the sidewalks will be compacted.
The time of connection the hill locomotive into the receiving park is determined as follows: [6,16,17,18]:

$$t_c = 0{,}06 \cdot \frac{\ell_c^{I} + \ell_c^{II}}{\vartheta_c} + t_m \quad (6)$$

where: ℓ_c^{I}, ℓ_c^{II} - the length of the connecting semiconductors, m;
ϑ_c -average connection speed, m / s;
t_m - time of movement of hill locomotive, min.

The time to move the fleet to the peak is determined as follows:

$$t_m = 0{,}06 \cdot \frac{\ell_m}{\vartheta_m}, \quad (7)$$

where: ℓ_m - the length of the half move, m;
ϑ_m -average move speed.
The wagons release time, min:

$$t_r = 0{,}06 \cdot \frac{m_w \cdot \ell_w}{\vartheta_u} \cdot \left(1 - \frac{1}{2\partial}\right) \quad (8)$$

where: m_w – wagons quantity;
ℓ_w - average wagon length, m;
∂ - number of disruptions in the fleet;
ϑ_u -average unloading rate, m / s
The time spent to settling wagons on the selection park tracks:

$$t_з = 0{,}06 \cdot m_T \quad (9)$$

After performing the technological operations at the qualifying hill, the fleets of the sludge fleet are transported to the dispatch fleet.

III. TECHNOLOGICAL PROCESSES OF PROCESSING OF STATION TRAINS & RESULTS

After the acceptance of trains at the station, the selection of the wagon fleet will be made by their direction. There is a small amount of sorting work at the station and there is a process of compiling and sorting sections and trains. The main activities are to work with station trains, technical and commercial inspection of the fleet, replacement of locomotives and crews, repair of wagons. At the same time, we consider the technological processes performed at the station with wagons [21,22,23].

The sorting of wagons in the acceptance park is carried out by gravity by means of shunting locomotives. Distribution time is determined by the following formula [12,15]:

$$t_{dist} = T_{sel} + T_{set} \quad (10)$$

where T_{sel} – wagon selection time, min;
T_{set} - Time of settling, min.
The formula for determining the time spent on technological operations when selecting wagons for weighing is as follows:

$$T_{sel} = A \cdot q_o + B \cdot m_c \quad (11)$$

where: A and B- Normative coefficients in minutes.
m_c - number of wagons in the structure;
q_o - the number of deductions in the fleet being selected.

Table 1
Value of the coefficients A and B in determining the technological times when selecting wagons for weighing

Type of shunting operations	100 m from the point-of-point zone;	Wagon sorting			
		Wring		Impulse	
		A	B	A	B
Distribution and compilation of fleet	1.5 small	1,01	0,25	0,88	0,22
	1,5 – 4,0	-	-	0,49	0,21
	Greater than 4.0	-	-	0,40	0,20

The additional time spent on compaction to reduce the distance between wagons on the collection tracks is calculated by the following formula:

$$T_{com} = 0{,}06 m_c \quad (12)$$

where: 0.06 - coefficient of time spent on compaction of one wagon;
Normal time for collecting wagons and traction of fleet on a single track is defined by the following formula:

$$t_{traction} = T_{tor} + T_{col} \quad (13)$$

where: T_{tor} – Technological time associated with the operation of wagons sorting. This technological time is in accordance with the technical operation rules (TOR). The time required for the placement of wagons in the train in accordance with the technical regulations. T_{tor} by the following formula:

$$T_{tor} = B + E \cdot m_c \quad (14)$$

where: B and E - normal coefficients, depending on the average number of wagon rip-off operations (n_o). The values of these coefficients are shown in Table 2 below.

Table 2
Coefficients B and E for determining the technological times when placing wagons in accordance with the rules of technical operation

n_o	B	E	n_o	B	E
0	-	-	0,55	2,31	0,10
0,05	0,21	0,02	0,60	2,52	0,11
0,10	0,42	0,02	0,65	2,73	0,12
0,15	0,63	0,02	0,70	2,94	0,13
0,20	0,84	0,03	0,75	3,15	0,14

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0,25	1,05	0,04	0,80	3,36	0,15
0,30	1,26	0,05	0,85	3,57	0,16
0,35	1,47	0,06	0,90	3,78	0,17
0,40	1,68	0,07	0,95	3,99	0,18
0,45	1,89	0,08	1,00	4,2	0,19
0,50	2,10	0,09			

T_{loop} - time spent by carriageways joining wagons to avoid idle loops

$$T_{\text{loop}} = 0{,}04 \cdot m_c \tag{15}$$

where: 0.04 is the calculation of the cost of time spent pulling one wagon.

After the compilation is complete, we calculate the technological time to transfer the fleet of the sludge fleet to the dispatch fleet using the following formula [8]:

$$t_{\text{transfer}} = A_{\text{area}} + B_{\text{area}} \cdot m_{\text{area}} \tag{16}$$

where: $A_{\text{area}}, B_{\text{area}} -$ - Normative coefficients equal to the sum of the normative times $A_{\text{transfer}} = \Sigma a, B_{\text{transfer}} = \Sigma b;$ in all semiconductors in the fleet placement. the values of the coefficients a and b;

$A_{\text{area}}, B_{\text{area}}$ - estimated cost of normative coefficients;

$m_{\text{transfer}} -$ the average number of wagons in the fleet of the transferred fleet.

When completing the fleet formation in the sorting park, the fleet is transmitted through the shunting locomotive.

Train making should be carried out in accordance with train schedule and train schedule. Weight and length norms of freight trains on each section must be defined in the schedule and schedule of train movement, which must correspond to the locomotive type, the sections on which the train is moving, and the length of the receiving and departing stations at the station.

$$\left.\begin{aligned} q_{\text{w}} &\le Q \\ L_l &\le L \end{aligned}\right\} \tag{17}$$

where: L_l - total train length,

L - normal length of train, allowed on site; $L_l \le L$

q_{w} - total weight of train,

Q - Normative mass of train, allowed on site.

The following parameters should be taken into account when sending trains:

$$t_{\text{traindep}} = t_{\text{loc.time}} + t_{\text{brakecheck.}} + t_{\text{traindep.}} + t_{\text{dep}} \tag{18}$$

where $t_{\text{train.dep}}$ - train locomotive waiting time, min;

$t_{\text{brakecheck.}}$ - Train brake equipment inspection time, min;

t_{traindep} -- train waiting time, min;

t_{dep} - train departure time, min.

It is proposed to determine the total length of trains to be processed at the technical station by the following formula:

Total operation time of receiving and sending trains, processed at the sorting station, min:

$$t_{\text{sort.stat}} = \begin{pmatrix} t_{\text{t.t.}} + t_{\text{tech}}^{\text{com}} + t_{\text{T}} + \\ + t_{\text{traction}} + t_{send} + \\ + t_{\text{tech}}^{\text{com}} + t_{\text{traindep}} \end{pmatrix} \tag{19}$$

The total time spent on receiving and sending train processing trains at the station, min:

$$t_{\text{sortstat}} = \begin{pmatrix} t_{\text{t.t.}} + t_{\text{tech}}^{\text{com}} + \text{t}_{\text{tech}} + \\ + t_{\text{traction}} + t_{send} + \\ + t_{\text{tech}}^{\text{com}} + t_{\text{traindep}} \end{pmatrix} \tag{20}$$

At the same time, each plot can be summarized by the following formula:

$$\left.\begin{aligned} \sum t_{\text{area}} &= t_{\text{area}}^{1} + t_{\text{area}}^{2} + \ldots\ldots + t_{\text{area}}^{\text{n}} \\ \sum t_{\text{st}} &= t_{\text{st}}^{1} + t_{\text{st}}^{2} + \ldots\ldots + t_{\text{st}}^{\text{n}} \end{aligned}\right\} \tag{21}$$

$$T_{w.d.}{}' = \sum t_{\text{area}} + \sum t_{\text{st}} \tag{22}$$

If the total time from the point of departure to the destination station is expressed as follows (), the distance between the consignee and the receiving station shall be, km. Coefficient of delivery time () is found as follows:

$$\varphi = \frac{\sum t_{\text{area}} + \sum t_{\text{st}}}{t_{\text{day}}} \tag{23}$$

If the time of delivery is due, then the timing of delivery can be seen in a timely manner. At the same time, for each delayed delivery of cargo, a fine of 6% will be charged for each delayed day, but not more than 30% of the rent.

In this case, the time spent at the station in addition to technological operations are: waiting for technical and commercial inspection, waiting for the shunting locomotive, additional operations on the distribution of fleet, waiting for the train to arrive at the finished locomotive, and the train departure. The authors are advised to consider these times when calculating the timing of delivery by rail.

The following is an algorithm for determining the time spent on train operations in technical stations (Figure 3).

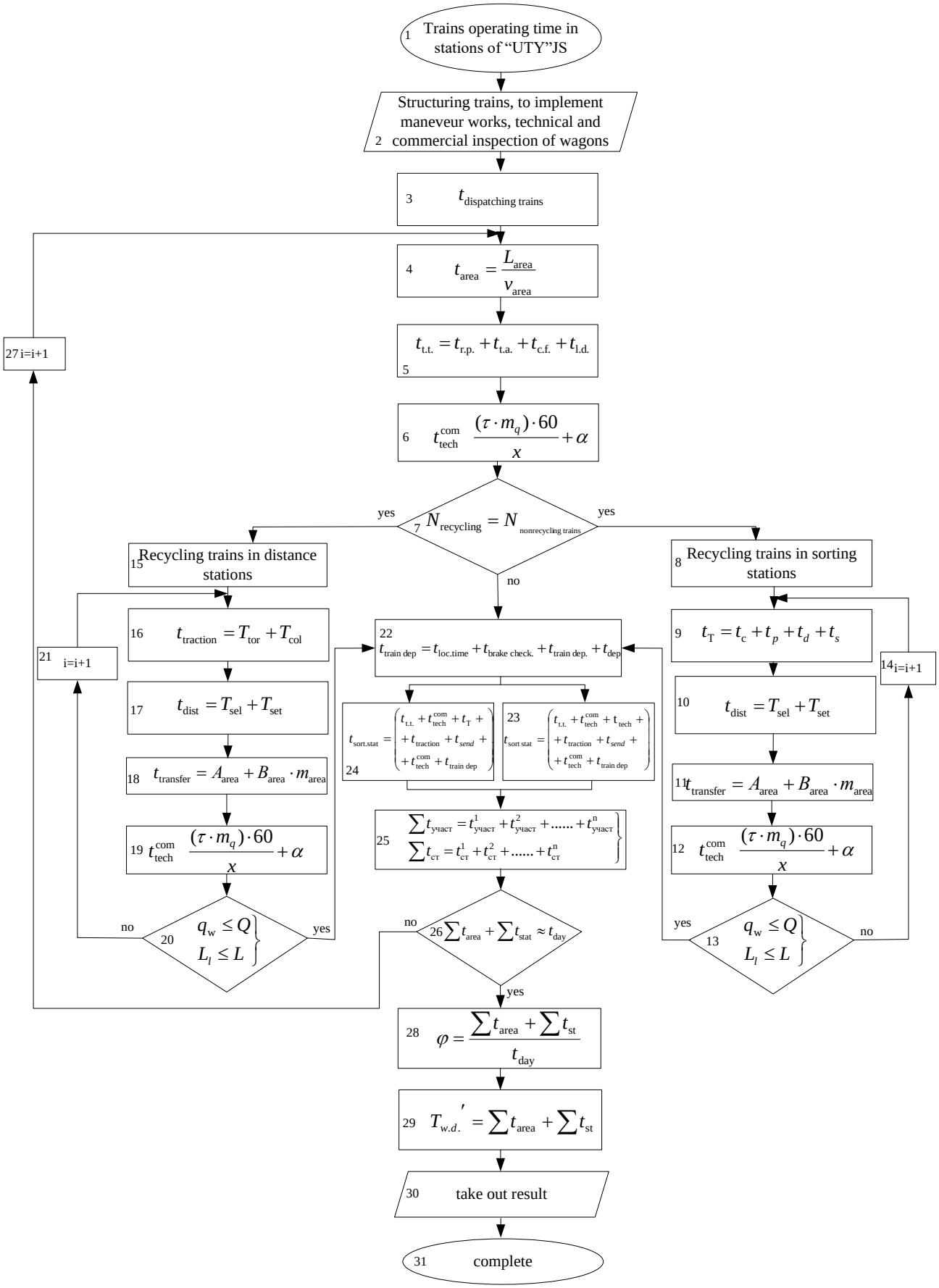

Figure 3. Processing at technical stations technological operations with trains algorithm of time calculation.

Figure 3:
1-3 - dispatch of wagons at intermediate station from station, with train composition;
4 - Walking time on site;
5 - Admission of train to technical station;
6 - Technical and commercial inspection of wagons;
7 - wagons processed at technical stations;
8-13 - Distribution of processed trains at the qualifying station on the hill, technical and commercial inspection of trains, established in accordance with the established norms, transportation to the departure fleet;
14, 21, 27 - separation of standard and defective wagons specified in section
15 20 - Distribution of processed trains at station station by gravity, technical and commercial inspection of trains, established in accordance with established norms, transportation to the departure fleet;
22 - departure of trains from the technical station;
23-24 - total parking time at the technical stations;
25 - time of wagons' movement on all sections;
26 - alignment of walking time with the norm set time;
28 - freight delivery coefficient;
29-30 - Cargo delivery formula;
31 - summing up the result.

The method and algorithm proposed in the article allow us to determine the ineffective time loss of wagons during the operation of the wagons from the station to the receiving station. Based on this algorithm, a software tool has been developed to enable it to detect ineffective time losses.

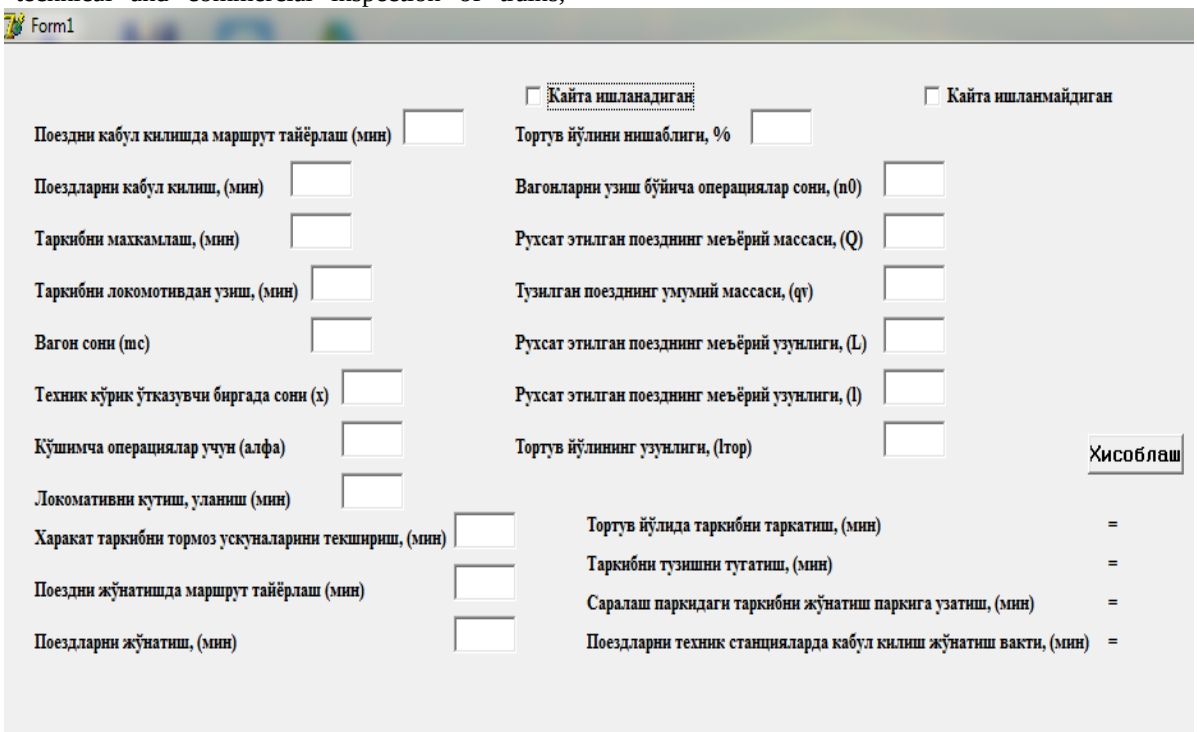

Figure 7. The program for calculating the time spent on train processing at the technical stations in the delivery of goods

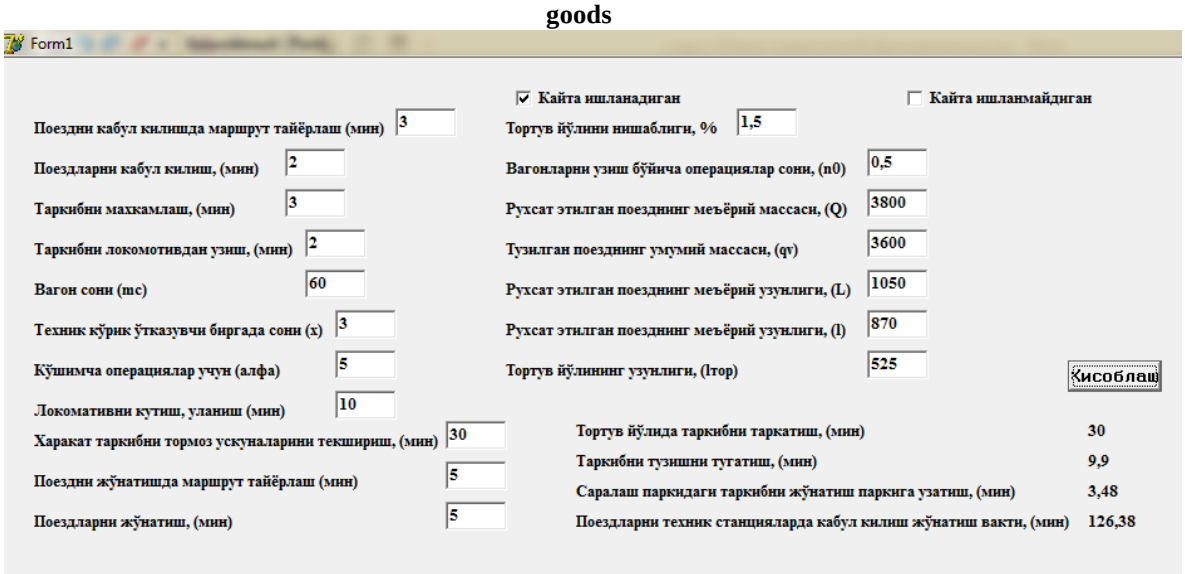

Figure 8. Estimation of time spent on train processing at technical stations

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Based on this algorithm, a program is created in the Delphi language, and it is possible to see that the station's operations using this program exceed the specified number of technological operations. As an example, Figure 7 shows the operations time, while Figure 8 shows the time spent on the train's arrival at the technical station, and Figure 9 shows the time spent committing the train without locomotives. The time spent at technical stations can be seen to exceed the station's technological process. As a result, any shortcomings in the performance of tenological operations by employees can be prevented in the future.

IV. CONCLUSION

1. The article has developed a method and a calculation algorithm for determining the time spent in the way of carriage from the station of departure to the station.

2. Application of the proposed method of transportation of wagons to their destination will allow to reveal deficiencies in the norms of time. In other words, it is possible to detect the cases of non-compliance with established time limits for maneuvering operations, cases of stagnant loading on station tracks, cases of delayed technical and commercial inspection of loaded wagons, and exceeding time limits for technological operations. timely preventive measures can be implemented.

3. This algorithm has developed a computer program "Delphi Determination of the Time spent on Train Processing at Technical Stations in Delivery".

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