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Analysis of the current status of the throughput and processing capabilities of the “Q” station

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Abstract: The aim of the work is to systematically analyze the current state of the throughput and processing capabilities of the railway station “Q” and objectively evaluate the results. To achieve this goal, a new approach to assessing and systematically analyzing the throughput of the technical equipment of the station, developing a digital system for monitoring the performance of the station’s performance indicators, taking into account the causes of explicit and hidden losses in regulating the dwell times of transport flows, and calculating throughput capacity (Figure 1) is proposed. This has created an opportunity to increase the throughput and processing capacity of the station, and improve the timely and safe delivery of cargo and passengers.

Keywords: throughput capacity, processing capacity, system analysis, regional railway junction, digitalization

1. Introduction

One of the important issues in the further development of any state transport network is the development of appropriate measures to timely eliminate identified shortcomings based on a systematic analysis of its current state and an objective assessment of the results.

Many regulatory documents are also being adopted in various sectors to develop the transport network of the Republic of Uzbekistan. In particular, the “Uzbekistan – 2030” strategy [1] focuses on the development of the transport network (transition to market principles in the provision of passenger and freight railway transport services, attraction of private and foreign operators to the sector, and increase of transport and transit capacity) and the Resolution of the President of the Republic of Uzbekistan “On measures to radically reform the railway transport sector of the Republic of Uzbekistan” No. PQ-329 [2], which focuses on improving transport processes by creating competition in the railway transport services market and creating an attractive investment environment.

With the opening of new transport corridors and the construction of new routes (including the construction and operation of the China-Kyrgyzstan-Uzbekistan and Uzbekistan-Afghanistan-Pakistan railways), it is urgent to increase the throughput and processing efficiency of railway stations and sections. Therefore, the current state of the “Q” station, part of the “Karshi” regional railway junction branch under the “Railway Infrastructure” of “Uzbekistan Railways” JSC (“O‘TY” JSC), was analyzed. In particular, a systematic analysis of the station’s throughput and processing capabilities of wagon flows was carried out.

2. Research methodology

Many scientists have conducted scientific research in different years to determine and increase the throughput and processing capabilities of railway stations [3, 4, 5]. In this regard, they used various calculation methods. However, no calculations have been carried out that systematically take into account the influence of the parameter of unevenness of transport flows on the technology of station operation. For example, in the work [4], the author proposed to develop a methodology for assessing and analyzing the throughput of technical devices of stations when calculating wagon flows.

The throughput of the station’s throats is traditionally determined by the following formula

$$N_{throughput,capacity} = \frac{1440 \cdot k_{tx} -}{t_{busy} -}$$

there

$t_{busy} -$ throat activity during the day with all types of activities, minutes;

$k_{tx} -$ coefficient taking into account the maintenance time of the throat elements, 0,85÷0,95.

General directional movements for equivalent wagon flows $n=\{1, 2, \ldots, i; 400, 450, \ldots, j\}$ (1-jadval), Time to pass through the station's strait and engage in each type of operation $(n_i^j, t_{z(i)}^j)$ will be different$n_1^j \cdot t_{z(1)}^j, n_2^j \cdot t_{z(2)}^j, \ldots, n_i^j \cdot t_{z(i)}^j$

Table 1

The actual number of movements through the station’s throat

Technological processes	Equivalent wagon flow					
	400	450	500	550	…	j
1	n_1^{400}	n_1^{450}	n_1^{500}	n_1^{550}		n_1^j
2	n_2^{400}	n_2^{450}	n_2^{500}	n_2^{550}		n_2^j
3	n_3^{400}	n_3^{450}	n_3^{500}	n_3^{550}		n_3^j
…						
i	n_i^{400}	n_i^{450}	n_i^{500}	n_i^{550}		n_i^j

The duration of all movements of station gates during the day is determined by the following expression for the (t_{busy}^j) equivalent wagon flow

$$t_{busy}^j = n_1^j \cdot t_{b(1)}^j + n_2^j \cdot t_{b(2)}^j + \ldots + n_i^j \cdot t_{b(i)}^j, min$$

there

$n_1^j, n_2^j, \ldots, n_i^j -$ number of movements when accepting loaded routes and sending trains with empty wagons;

$t_{b(1)}^j, t_{b(2)}^j, \ldots, t_{b(i)}^j -$ duration of a specific technological operation, minutes.

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The existing method does not allow taking into account the influence of random factors and the resulting delays and failures in the processing of wagon flows, which leads to errors in estimating the occupancy of the stations.

The throughput of the parks can also be estimated by calculating the throughput of the station's station (Figure 1).

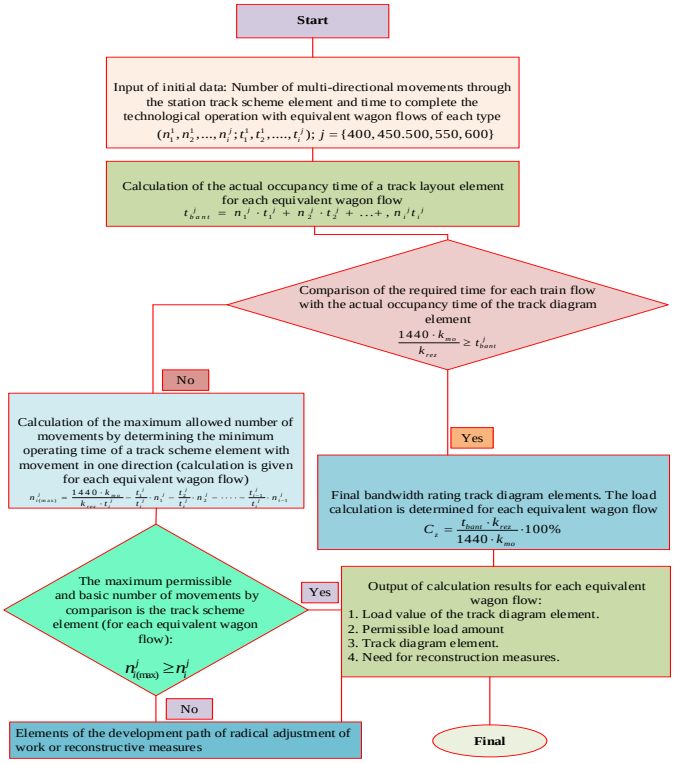

Figure 1. Flowchart of the algorithm for assessing and analyzing the throughput of station technical devices

A new methodological approach (Figure 1) is proposed for calculating and analyzing the throughput capacity of technical devices of power plants. It is based on assessing throughput capacity, identifying the main factors affecting it, and determining the required throughput capacity.

3. Result and discussion

In order to objectively assess the current state of the station's operation (throughput and processing capabilities), a systematic analysis method was used, which allows analyzing all parameters of the station (track capacity, train formation locations, transport (train, wagon) flows, shunting operations, etc.) [3, 4].

Station "Q" belongs to the highest class in terms of its workload. The station borders the following stations (Figure 2): in the odd direction - station Q-yo (single-track, two-way auto-blocking, electrified section); in the even direction - stations T and D (single-track, two-way auto-blocking (Q-D section semi-auto-blocking), non-electrified section (Q-D section electrified)) [6].

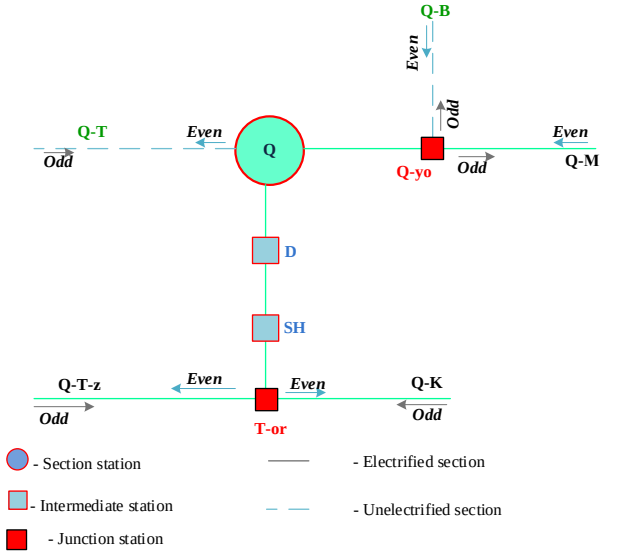

Figure 2. Sections along the border of the "Q" station by train flows in odd and even directions

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The station "Q" consists of 3 fleets with a total of 33 tracks (receiving-dispatching - 10, sorting - 16, dispatching - 7). In a systematic analysis of the station's wagon flow throughput and processing capabilities, it is important to study the capacity of the station tracks (Figures 3-5).

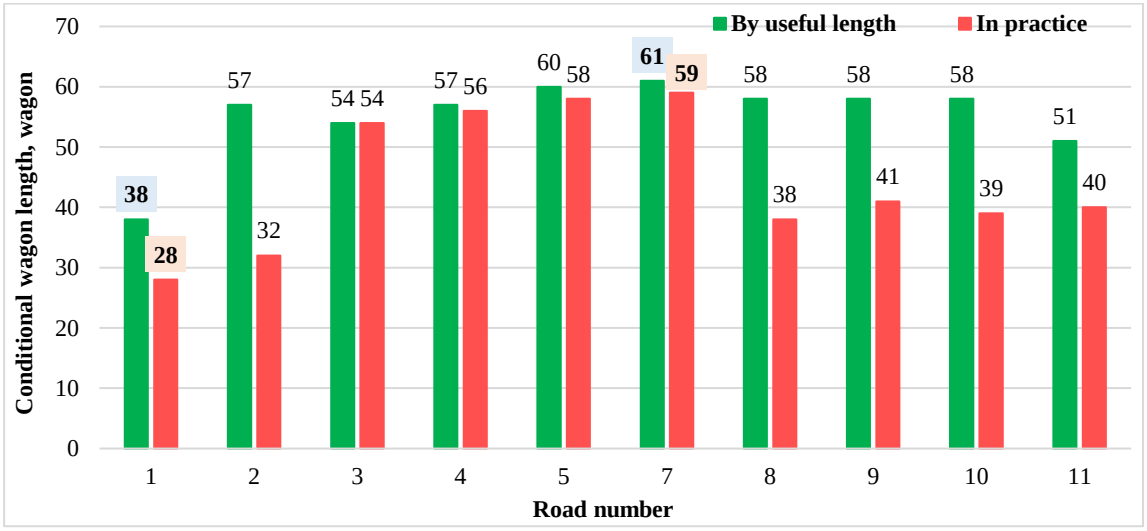

Figure 3. Capacity of the roads of the receiving and sending park of the station "Q"

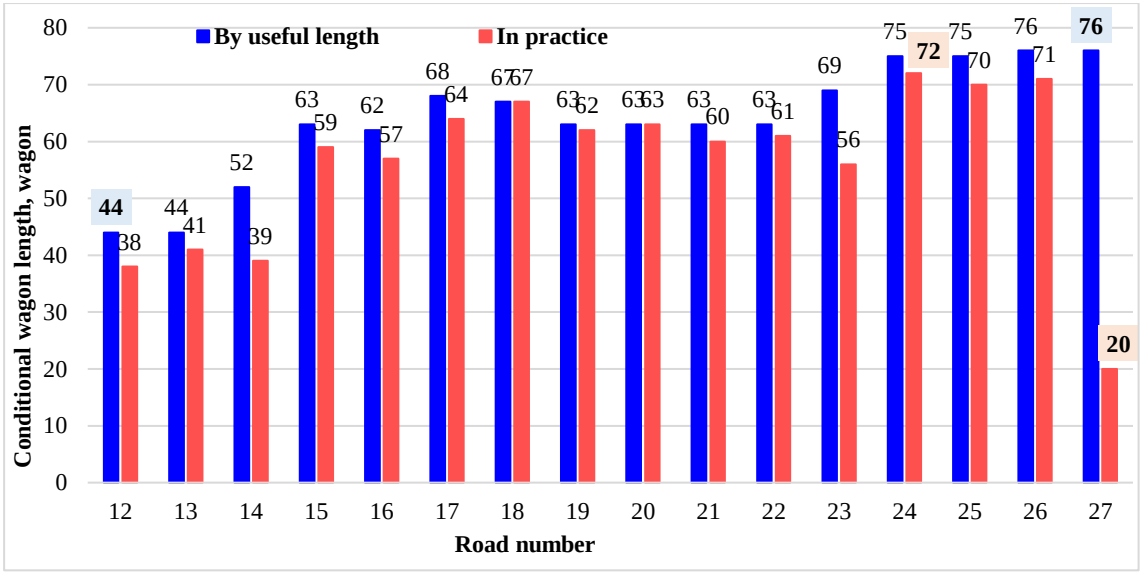

Figure 4. Capacity of the sorting park tracks at station "Q"

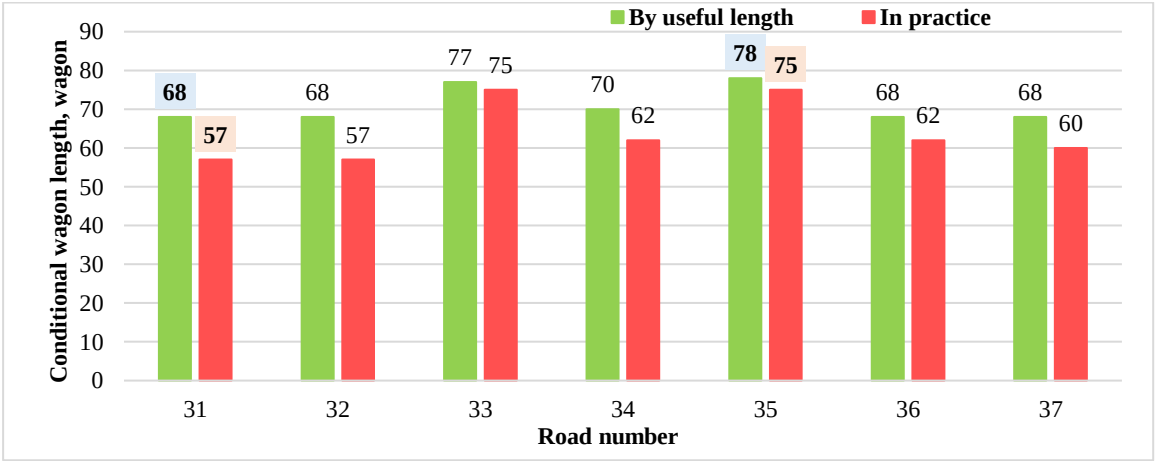

Figure 5. Capacity of the "Q" station dispatch park tracks

From Figures 3÷5, the following conclusions can be drawn:

The capacity of the receiving-dispatching fleet tracks (Figure 3): According to the Technical Management Act (TBD) – 38÷61 wagons; in practice – 28÷59 wagons;

capacity of the sorting fleet tracks (Figure 4): according to the TBD - 44÷76 wagons; in practice - 20÷72 wagons;

capacity of the dispatch fleet tracks (Figure 5): according to the TBD - 68÷78 wagons; in practice - 57÷75 wagons.

From the results of the analysis, it can be concluded that the capacity of the station tracks is actually underused by 2÷24 wagons. Such situations can be associated with a sharp unevenness of the wagon flows or the categories of trains. For example, on the 8th-11th tracks of the receiving-dispatching fleet, the train weight for the Karshi-Termez (Galaba, Regar, Termez, Sariosiyo) mountainous route is set at 3200÷3500 tons according to the "Train Formation Plan" (PTR). Therefore, it is impossible to fully utilize the capacity of these tracks. On the 12th-18th tracks of the sorting fleet, mainly term trains are formed. On the 19th-26th tracks, passing and section trains are formed.

At the "Q" station, 3 shunting locomotives (VL60 and 2 TEM-2) are used to organize and control wagon flows (Table 1).

Table 1

Information about shunting operations

Locomotive series	Year of manufacture	Tractive power, kgs	Energy (fuel) consumption, daily	Average working time per day, hours	Time spent on shift change, equipment and technological breaks, hours
ВЛ-60	1970	4800	28 kvt	21	3
TEM-2	1975	890-1342	225 kg	22,5	1,5
TEM-2	1975	890-1342	220 kg	22,5	1,5

According to the TFP of "O'TY" JSC for 2024-2025, trains will be formed at the "Q" station to the following destinations (Table 2) [7].

Table 2

Information about freight trains forming at the "Q" station

Compiling station	**Receiving end destination station**	**Conditional length of the composition, wagon**	**Train category**
"Q"	Orenburg	58	Passerby
	Kandiagash	58	Passerby
	Aris	*2 ta group*: 1-group – 58; 2-group – 57.	Passerby
	Kokand	*4 ta group*: 1-group – 57; 2-group – 57; 3-group – 57; 4-group – 57.	Assembled, Section
	Xovos	57	Passerby
	Marokand	*3 ta group:* 1-group – 58; 2-group – 57; 3-group – 57.	Assembled, Section
	Bukhoro I	*2 ta group*: 1-group – 56; 2-group – 57.	Assembled, Section
	Binokor	57	Passerby
	Misken	*3 ta group:* 1-group-56, 2-group-57, 3-group – 57.	Passerby
	Termiz	*2 ta group:*1-group – 40; 2-group – 39.	Assembled, Section
	Kumkurgan	*6 ta group:* 1- va 5-group – 42; 2- va 3-group – 40; 4-group – 38; 6-group – 56.	Assembled, Section
	Dushanbe-2	57	Section
	Sariosiyo	38	Assembled
	Amudaryo	*2 ta group:* 1-group – 56; 2-group – 40.	Assembled, Section
	Galaba	40	Passerby
	Kitob	56	Assembled
	Kengsoy	*3 ta group:* 1-group – 56; 2-group – 56; 3-group – 56.	Assembled, Section
	Shurtan	58	Transfer
	Ohangaron	*2 ta group:* l-group – 58; 2-group – 57.	Passerby

Station "Q" is equipped with a small capacity sorting hill (processing up to a maximum of 1340 wagons). Information on the wagons processed at the sorting hill is presented in Figure 6.

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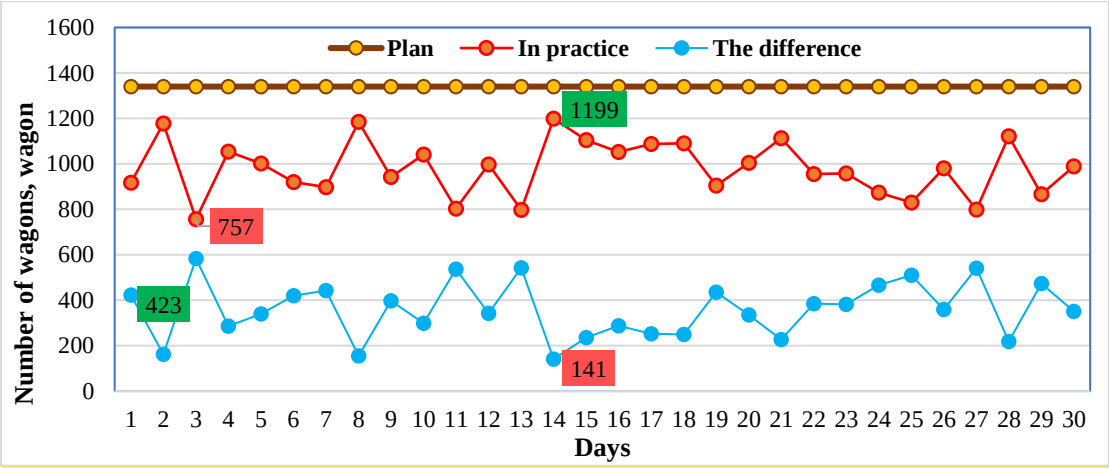

Figure 6. Dynamics of the number of wagons processed at the sorting hill of station "Q"

From the dynamics of the number of wagons processed at the sorting hill (Figure 6), it can be seen that the number of wagons processed in practice, compared to the plan (1340 wagons), is a minimum of 757 and a maximum of 1199, with a difference of 141÷700 wagons. Therefore, the formation of this difference can be explained by internal or external factors.

Data on average daily train flows received, dispatched, and processed from railway routes (Figure 2) were analyzed for March 2024 and March 2025 (Figures 7 and 8), as well as wagon flows for March 2025 (Figure 9).

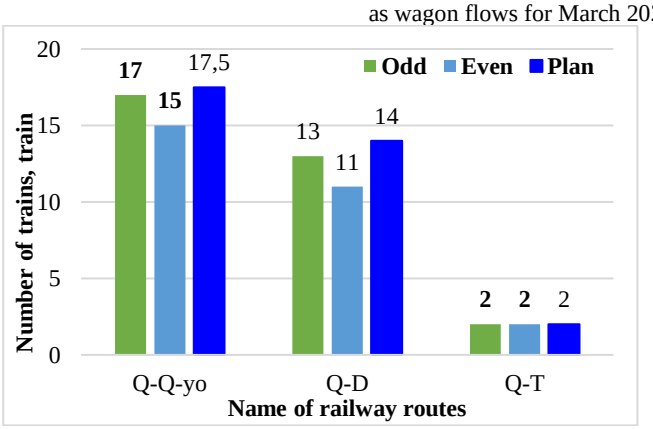

Figure 7. Average daily number of trains received and sent in 2024

According to the analysis results (Figure 7), the average daily number of trains received and sent to the "Q" station by route is as follows: Q-Q-yo – 16 pairs; Q-D – 12 pairs; Q-T – 2 pairs. Thus, the station has a reserve for passing 1.5 and 2 pairs of trains on the Q-Q-yo and Q-D routes, respectively, according to the plan.

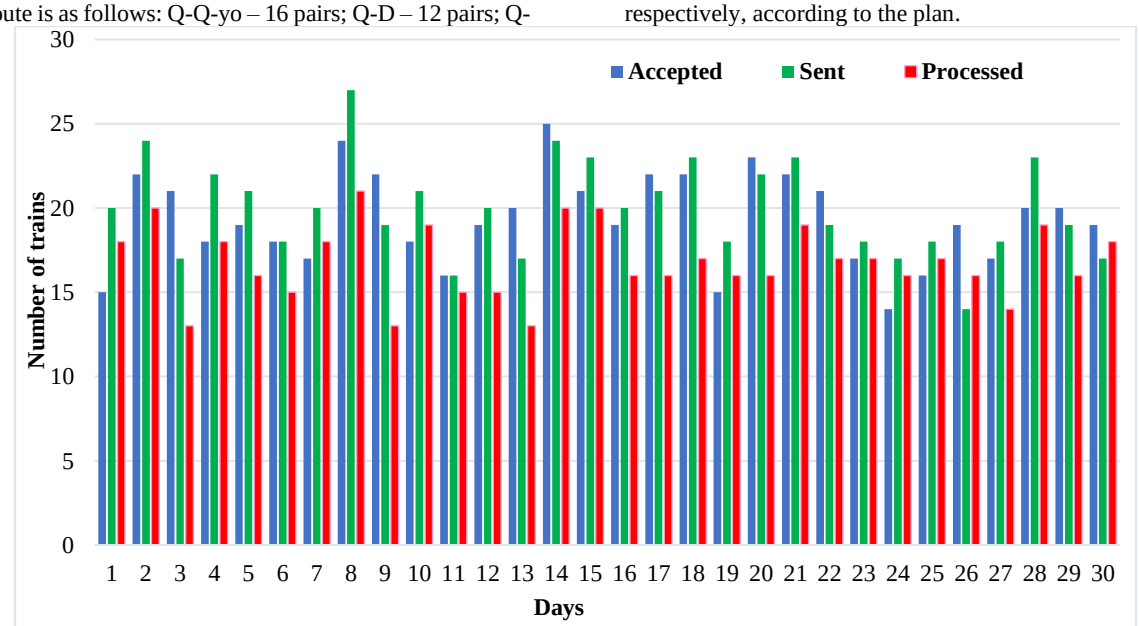

Figure 8. Dynamics of the number of trains received, sent and processed per day in March 2025

As can be seen from Figure 8, the number of trains received at the station is 14÷25, sent - 16÷27, and processed - 13÷20. This means that an average of up to 7 transit trains pass through the station per day.

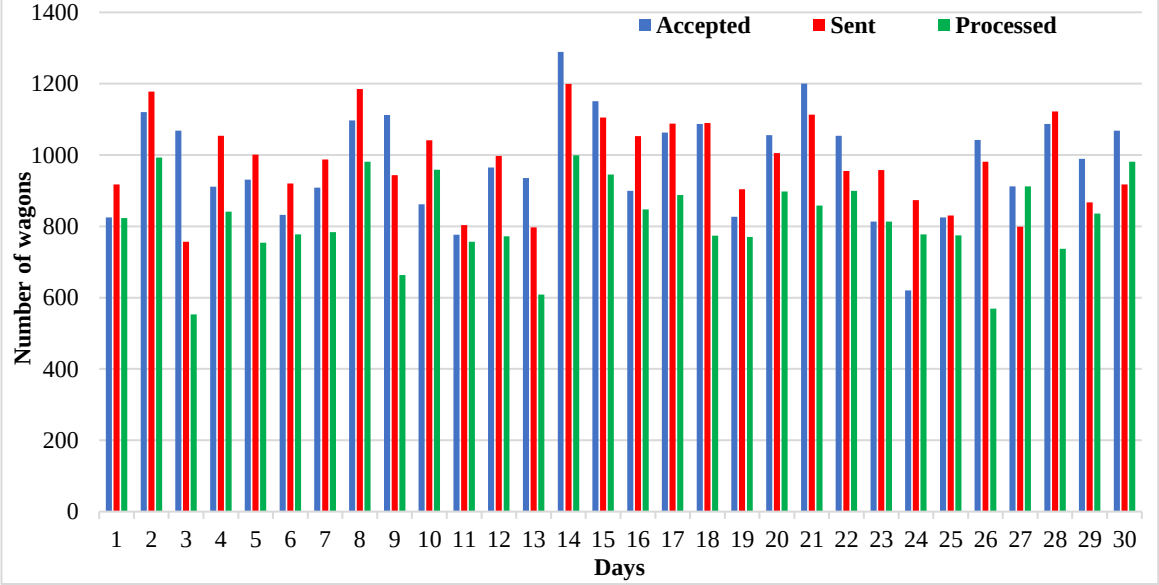

Figure 9. Dynamics of the number of daily received, sent and processed wagon flows in March 2025

From Figure 9, it can be seen that the number of wagon flows received at the station is 620÷1289, sent - 757÷1199, and processed - 684÷1038. Thus, the wagon flows are significantly uneven.

4. Conclusion

It was determined that there is a need to systematically analyze the throughput and processing capabilities of railway stations, taking into account the construction and operation of new railway lines, uneven traffic flows, and changing operating modes.

When determining the throughput and processing capabilities of stations and analyzing their current state, it has been proven that it is appropriate to systematically analyze and objectively assess not only the capacity of technical devices (road capacity, sorting hill capacity, etc.), but also the dynamics of the station's performance indicators. nbc l.

“Based on the results of the analysis conducted on the example of the “Q” station, it is proposed to implement the following measures to increase the throughput and processing capabilities of the “Q” station:

development of a digital system for monitoring the performance of station performance indicators;

taking into account the causes of obvious and hidden losses when regulating the dwell times of transport flows;

evaluating employee performance based on the KPI (Key Performance Indicator) system.

Such measures create opportunities for increasing the station's productivity and effectively using its throughput and processing capabilities.

References

[1] “O‘zbekiston — 2030” strategiyasi to‘g‘risida / O‘zbekiston Respublikasi Prezidentining Farmoni, 11.09.2023 yildagi PF-158-son / https://lex.uz/ru/docs/-6600413

[2] O‘zbekiston Respublikasi temir yo‘l transporti sohasini tubdan isloh qilish chora-tadbirlari to‘g‘risida / O‘zbekiston Respublikasi Prezidentining qarori, 10.10.2023 yildagi PQ-329-son / https://lex.uz/docs/-6631602?ONDATE=11.10.2023%2000.

[3] D.B. Butunov, Ch.B. Jonuzoqov, J.A. Juraboyev, D.J. Kengesbaeva / Temir yo‘l stantsiyalarining o‘tkazuvchanlik va qayta ishlash qobiliyatlariga ta’sir ko‘rsatuvchi omillar / Journal of Transport / https://doi.org/10.56143/2181-2438-2025-2-22-26

[4] Parunakyan V.E Boyko V.A Aksyonov M.L / metodika otsenki i analiza propusknoy sposobnosti texnicheskix ustroystv gruzovoy stansii metallurgicheskogo predpriyatiya // Transport Ta Logistika / 2012 / str. 246-252.

[5] Butunov D.B. Improvement of technical experimental methods for organization of wagon flows and management evaluation at sorting stations. Dis. ... doc. Phil. (PhD). Tashkent: TashIIT. – 2019. – 187 p.

[6] Butunov D. B.. Estimation of inefficient losses in railroad yard operation / D.B. Butunov, A.G. Kotenko // Emperor Alexander I St. Petersburg State Transport University, 2018, Volume 15, Issue 4, Pages 498-512. (https://cyberleninka.ru/article/n/otsenka-neproizvoditelnyh-poter-v-rabote-sortirovochnoy-stantsii)

[7] Qarshi stansiyasining TBD / 1-bo‘lim / str 1-5.

[8] “O‘TY” AJning 2024 – 2025-yillarga mo‘ljallangan yuk poyezdlarini tuzish rejasi / str 39-40.

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