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PRACTICAL ASPECTS OF IMPROVING THE OPERATION INTERACTION OF THE STATION AND SIDINGS

Summary. This research deals with the analysis of the main parameters of the freight operation at the railway station. The modern scientific works on improving the interaction of the station and sidings were analysed. In order to improve the operation interaction of sidings with the Dnipro-Holovnyi railway station and to reduce the time of cars` inactivity, an improved technology of work was proposed. The variants of operation interaction of the station and sidings according to the existing and improved technology were compared. The improved technology of the station's operation makes it possible to significantly reduce the inactivity of local car and the average duration of the car's standing under one cargo operation. The track occupancy coefficient in the receiving-departure yard decreases as well.

1. INTRODUCTION

The Dnipro-Holovnyi railway station is located on the major line of the two-track main line Verkhivtseve – Nyzhnodniprovsk-Vuzol. According to the volume and complexity of work, the Dnipro-Holovnyi station is classified as out-of-class one. According to the purpose and nature of work, the Dnipro-Holovnyi station is a union one. It is intended for long-distance, short-distance and suburban passenger services, as well as for servicing and repair of passenger trains and cars. In addition, the station provides the needs of the city enterprises in the cargo transportations from private tracks. According to the conditions of train processing, the station is a terminal intermediate passenger one, where some trains start and finish their running, while others transit.

According to the scheme, the Dnipro-Holovnyi passenger station is the station of transverse type. The track lay-out of the station consists of three parallel yards: receiving-departure yard, sorting yard and servicing terminal. The specialization of the yards ensures the timely receiving and departure of trains and shunting movements, reducing the number of hostile routes, the minimum time for train processing and shuntings.

2. LITERATURE REVIEW AND DEFINING THE PROBLEM

Many scientists have dealt with the issue of interaction between the station and sidings. The overview of their works is presented below. The article [1] emphasizes that under conditions of fluctuations in the volumes of freight transportations, unproductive inactivity of freight cars at stations and sidings increase, which causes increase in the expenditures of railways and cargo owners.

The study [2] states that to ensure the qualitative interaction between the railways and cargo owners, it is necessary to take into account the interests of station and siding. In order to choose the optimal strategy for interaction between the station and siding, the authors propose to use the theory of games to minimize the operating costs for transportation.

The work [3] develops the tasks to optimize the delivery of local cars to the sidings and freight fronts of stations and to optimize the formation of multi-group trains. These tasks are aimed at improving the quality of rolling stock usage, reducing the inactivity of local cars at the stations, and accelerating the turnaround of the local car.

Scientists in the work [4] developed the technology of planning the freight and local operation before the beginning of every day in order to create optimal conditions for the operation of freight fronts and timely delivery of cars to freight stations. The given technology makes it possible to automate the development of operation plan for the delivery of local cars to the stations and their supply to cargo fronts.

The article [5] focuses on the introduction of resource-saving technologies into the technological chains of interaction between the mainline and industrial railway transport. The authors of the research believe that increasing the efficiency of interaction between the station and siding can be achieved by electrifying the running line between the freight station and the transfer station of the siding. At this, no feasibility studies for this solution were given, although it is well known that the running line electrification requires significant capital investments.

The team of authors in the study [6] states that the technological process of the station should be developed taking into account the interaction of all its elements with each other and the schedule of train movement at the adjacent railway sections. In order to detect and eliminate various mismatches between the elements of the station, it is necessary to investigate the interconnections of the parameters of the individual internal processes at the station.

The authors of the article [7] proposed to manage the cargo delivery on the basis of determining the values of duration of cargo handling at each stage of the schedule fulfilment. The evaluation of delivery process will be carried out using the device of fuzzy sets. The evaluation of deviations at all stages of transportation using the linguistic definitions of conditions makes it possible to quantify such an indicator as the transportation quality.

The study [8] proposes a method that allows predicting control points for scheduled stages of goods delivery, taking into account the conditions of real operational work. Information about the events with controlled objects (cargoes, cars) is stored in the database of the automated system. Due to this there is a possibility of coordination in the actions of all participants of the transportation process.

The article [9] addresses the problem of minimizing the general operating costs for the delivery of freight traffic volume, while meeting the restrictions on available resources and train-handling capacity of stations, as well as the restrictions on transportation priorities. Improving the interaction of the station and sidings is one of the elements that influence the functioning of the entire transportation system.

Scientists in their study [10] concluded that the most effective means of improving the efficiency of the railway network is the implementation of projects for the improvement of technological operations for the stations with the "highest centrality" indicator, while investments in an arbitrary station of the network do not influence transport criteria in general.

The analysis of scientific works shows that the issues of interaction between the station and sidings remain unresolved. In each situation, one should choose the individual rational technology of interaction. In one case, this may be a decrease in the intervals of car supply to the siding, in the other – the use of a more powerful shunting locomotive capable of transporting more cars per one supply, etc. In any case, the rational technology of interaction between the station and sidings should be supported by the appropriate technical and economic calculations. In this research, the practical aspects of improving the interaction of the Dnipro-Holovnyi station and sidings will be considered.

3. **METHODOLOGY**

The diagrammatic layout of the Dnipro-Holovnyi station is shown in Figure 1.

There are five sidings adjoining the Dnipro-Holovnyi station:

1. The "Dniprometyz" PC siding No. 1 adjoins the station track No. 37 by the turnout switch No. 222;

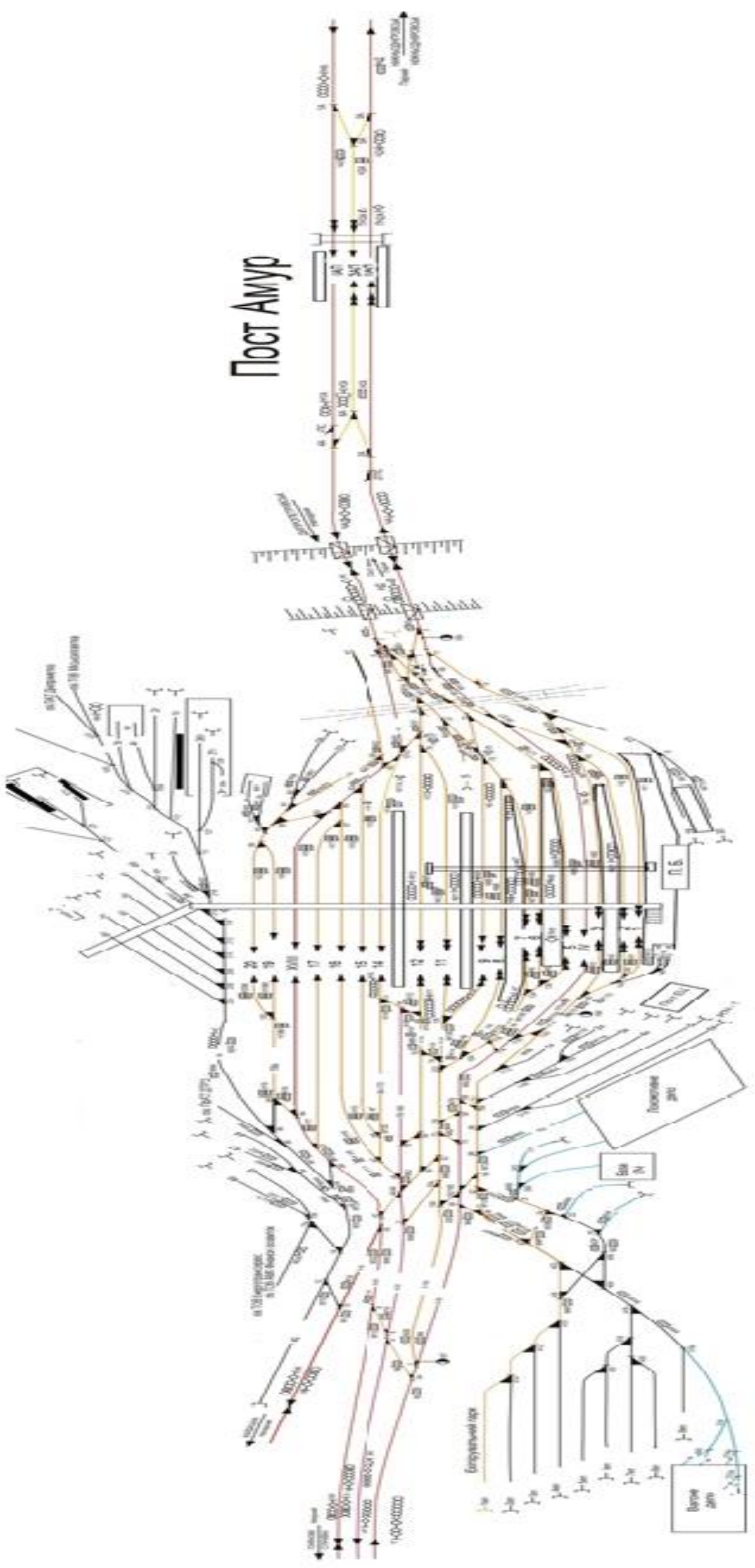

Fig. 1. The diagrammatic layout of the Dnipro-Holovnyi station

2. The siding No. 2 of the "Municipal Railway Branch" LLC adjoins the track No. 37 by the turnout switch No. 222;

3. The siding No. 3 of PJSC "Dnipropetrovsk Diesel Locomotive Repair Plant" ("DDLRP") adjoins the station track No. 76 by the turnout switch;

4. The siding No. 4 of the "Enerhotransservis" LLC adjoins the station track No. 33 by the turnout switch No. 18;

5. The siding No. 5 of the "Finance and Development" LLC ICA, adjoins the siding No. 4 of the "Enerhotransservis" LLC by the turnout No. 1, which in turn adjoins the station track No. 33 by the turnout switch No. 18.

According to the data from previous years, the average number of cars arriving at the station per day is shown in Figure 2.

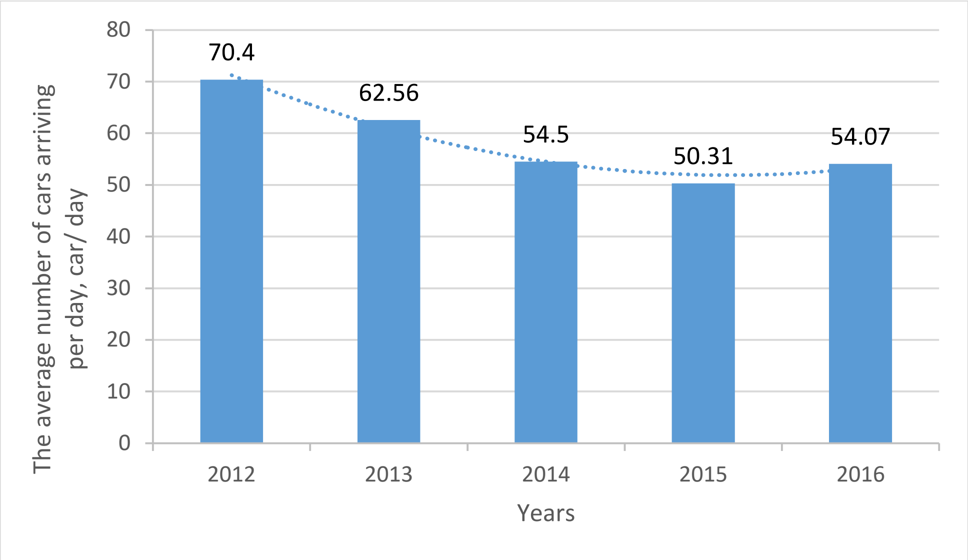

Fig. 2. The histogram of the average number of cars arriving at the station per day

Similarly, we will construct the histogram for the average number of cars departing from the station per day. The histogram is shown in Figure 3.

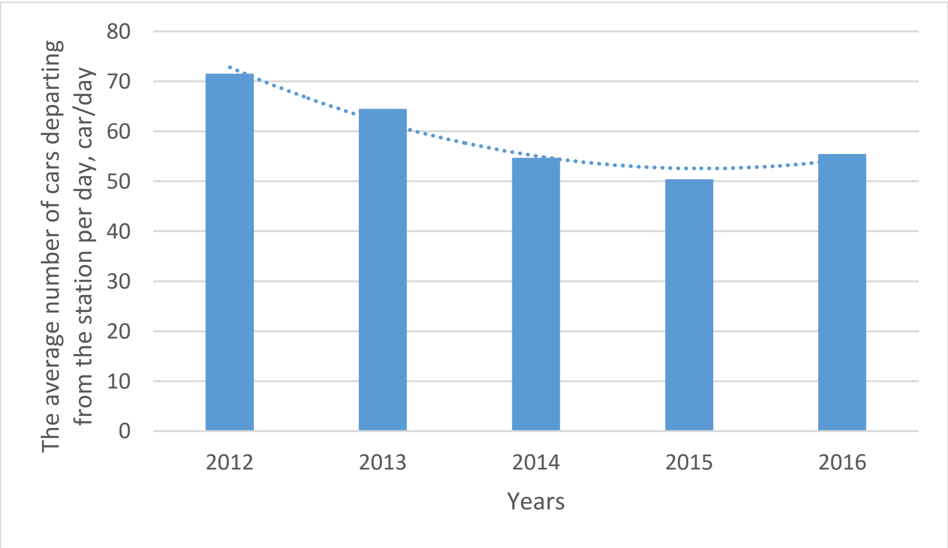

Fig. 3. The histogram of the average number of cars departing from the station per day

The histogram for the car loading indicator on average per day is shown in Figure 4.

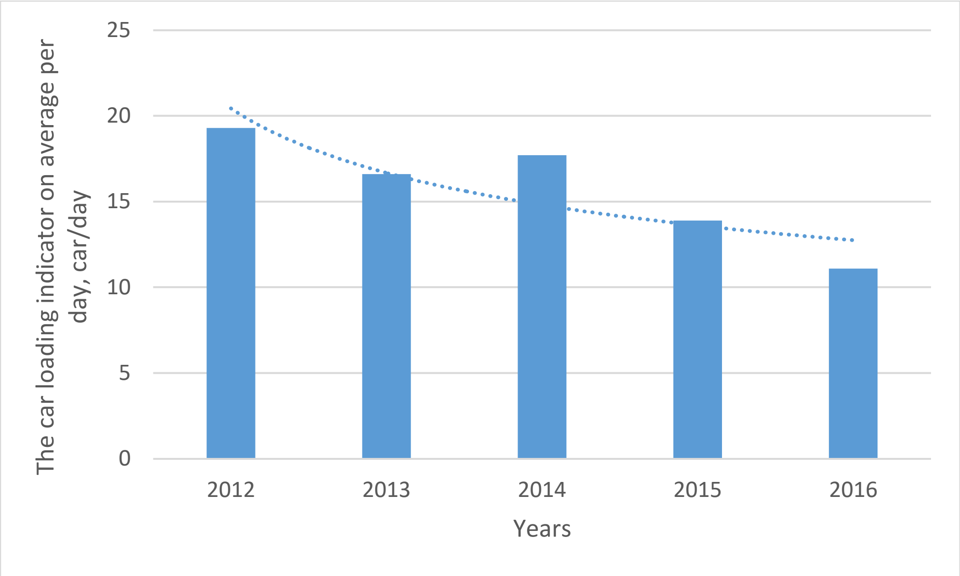

Fig. 4. The histogram of the car loading indicator on average per day

The histogram for the indicator of car unloading on average per day is shown in Figure 5.

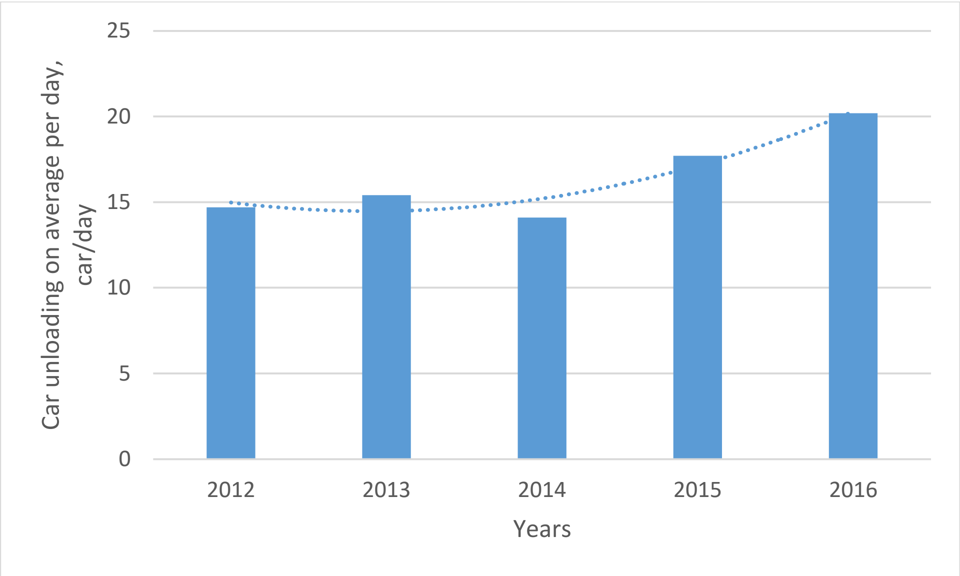

Fig. 5. The histogram for the indicator of car unloading on average per day

The histogram for the average car inactivity under one cargo operation is shown in Figure 6.

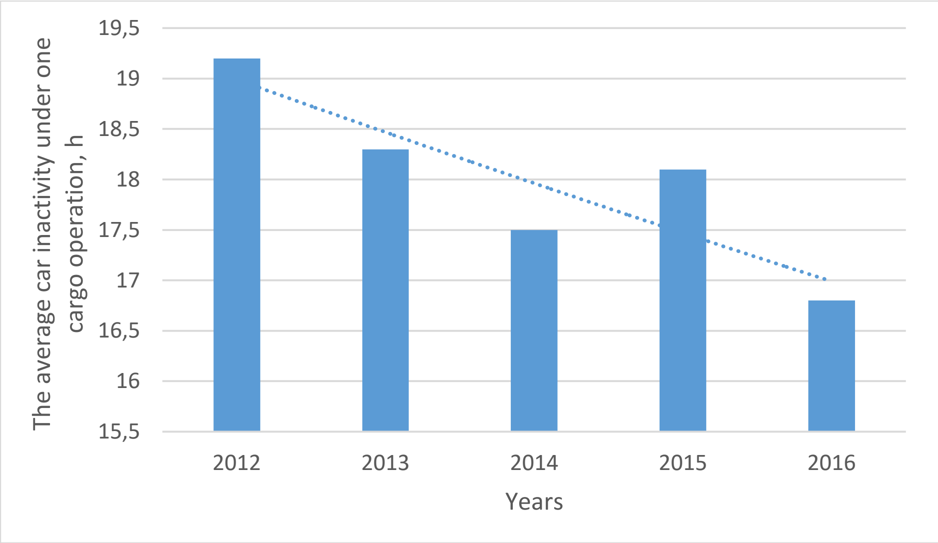

Fig. 6. The histogram for the average car inactivity under one cargo operation

In order to improve the operation interaction of sidings and the Dnipro-Holovnyi railway station and reduce the inactivity of cars, it is proposed to introduce the additional dispatching locomotive that will operate in the light time of day from 8:00 a.m. to 8:00 p.m. The locomotive arrives at the station and passes through the K-DH running line. The movement duration along the running line is 12 minutes. The station shunting locomotive will operate in the servicing terminal and supply (remove) cars to the tracks of receiving-departure yard for the trains of its formation, as well as perform operations for finishing of the making and breaking-up of trains. According to calculations, the duration of car group rearrangement is 6 minutes, the return of the locomotive – 3 minutes, the duration of formation is 25 minutes, breaking-up – 20 minutes.

Let us also change the order of servicing sidings. The work at all sidings is performed in the light time of the day from 8:00 a.m. to 20:00 p.m.

The station performance indicators were determined using the daily plan schedule.

Calculation of the loading factor for the receiving-departure yard [4, 5] was performed using the Table 1.

Table 1

Calculation of the loading factor of tracks

Number of the track	Occupancy duration, *min*	Loading factor
1	488	0.34
2	425	0.3
3	198	0.14
5	359	0.25
6	475	0.33
7	173	0.12
8	408	0.29
9	193	0.13
11	273	0.19
12	205	0.14
14	304	0.21
15	0	0
16	58	0.04
17	168	0.12
19	331	0.23
20	418	0.29

Based on the calculations, we will make a comparison of the variants for interaction between the station and sidings. The improved variant of interaction between the station and sidings involves the operation of three shunting locomotives: one locomotive in the receiving-departure yard (as in the usual variant of interaction) and two shunting locomotives in the servicing terminal (in the usual variant of interaction only one locomotive is used). In this case, at the usual variant of interaction, the loading factor of the first locomotive was 0.62, the second locomotive – 0.91. In the case of improved variant of interaction, the loading factors of locomotives will be as follows: the first locomotive – 0.54; the second – 0.57; the third – 0.53. Due to this the average car inactivity at the station decreased by 2.69 hours. This is achieved due to decrease in the average time: the waiting time of supply for sidings – by 1.33 hours, the waiting time for the beginning of cargo operations – by 0.06 hours, waiting for removal – by 1.1 hours, waiting time for accumulation – by 0.2 hours.

4. CONCLUSIONS

Having analysed the obtained indicators, it can be concluded that due to the proposed improvement of the station operation technology, the local car inactivity and the average duration of car`s standing under one cargo operation is significantly reduced, the rate of track occupancy in the receiving-departure yard decreases, thus the train-handling and estimated capacity of the station increase. The working conditions for locomotive crews, especially for the crew working in the servicing terminal, are also improved.

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