Features of the container accumulation factor in the terminal

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Abstract. This article presents the results of research in the field of formation of container block trains in terms of. A brief overview in the field of container transportation is carried out. A causal analysis of problems in the organization of container block trains was performed. A change in the container-hours of accumulation of arrived containers at the container terminal has been established. The schedule for changing containers-the hours spent at the container terminal of containers to be shipped - has been determined.

1 Introduction

Currently, the main growth in the flow of container cargo in the world is accounted for by the trade turnover between Europe and the Asia-Pacific region, with the main share passing through the CIS countries. In mastering the growing volumes of container transportation, the main competition for railway companies is companies engaged in road transportation with a route speed of 500-700 km per day, when rail transport provides services for single and group transportation of containers with a route speed of up to 450 km per day. The share of container trains running between transport hubs or large stations, allowing to reach a route speed of up to 1000 km or more per day, is only 3% of the total volume of traffic. From this point of view, the current state of railway activity, as well as scientific approaches to substantiate technology and organization of work, cannot fully ensure the efficiency of cargo delivery in containers and compete with related modes of transport. This problem urgently requires the development and implementation of technologies for accelerated cargo delivery.

2 A brief overview of scientific research

For all the time of scientific research in the field of container transportation, there are several groups of directions that are interconnected with each other.

The first group includes technical issues of solutions in the organization of container block trains. Technical issues include the formation and development of container terminals, where empty and loaded containers are accumulated. But the main function of container
terminals in the formation of accelerated trains is to consolidate containers for shipment to the destination [1, 7-12].

The second group includes technological issues of solutions in the organization of container block trains [2-6].

It is necessary to note the technological problems concerning the organization of container transportation and which require scientific evaluation:
— stability of the movement time of container block trains;
— strict execution of the timetable;
— increased delivery speed, priority – predictability and reliability.

In the above-mentioned studies, the authors mainly dealt with the issues of competitiveness of transport products, as well as the rational management of transportation companies focused on the provision of container transportation services by rail. The study also showed that existing scientific approaches do not take into account the interrelation of various factors affecting the organization of container terminals focused on the formation of container block trains; there is no systematic approach to the search and establishment of reference railway stations for the placement of container terminals.

3 Problems in the organization of container block trains

Based on the research, the causes of undesirable events in the organization of container block trains are determined, the order of causal analysis of problems is developed (Fig. 1). The influencing causes and generalized categories - technical and technological, transport service and container terminals are systematized.

![Diagram showing causal analysis of problems in the organization of container block trains]

The developed procedure for the causal analysis of problems in the organization of container block trains allows us to establish agreement on the probable causes that need to be verified empirically.
4 Features of the container accumulation factor

The process of accumulation of containers at the terminal, as well as the process of accumulation of wagons at any other station, is a random and complex process, and it is quite difficult to influence this process.

Let's consider a concrete example of the accumulation of containers at the terminal. After the cargo has been produced and packed in the appropriate container, it must be delivered to the consumer. The finished cargo is loaded into containers, and these containers are delivered to the container terminal by road or rail at a certain interval, after which the accumulation process occurs, in which the finished containers are waiting for their turn for further shipment. At the moment when the required number of containers accumulates, they are formed into a container block train and the whole process repeats again.

There is also an unevenness in the receipt (or dispatch) of containers, which is formed due to the inconsistent operation of rail and road transport. It is possible to eliminate this unevenness only by organizing timely work on the supply (and cleaning) of containers for various types of transport.

Container block trains depart from the container terminal according to consistency or according to a clear schedule. Departure according to the block train schedule is carried out strictly according to the time set at the beginning of the year. The planning and organization of container block trains according to consistency is carried out when the train is ready and is warned 6 hours before departure.

Average time spent by a local container at a container terminal \( t_{kn} \) consists of tenses:
- from the arrival of a local container by rail to the container terminal to its shipment by road \( t_{pr} \);
- finding a container on a motor vehicle (container ship) \( t_a \);
- from the receipt of the local container by road to its shipment by rail \( t_{ot} \).

Time \( t_{pr} \) it can be determined from the graph in Fig. 2. Containers-the hours of finding containers from arrival to delivery by motor transport for departure \( N_c \cdot t_{pr} \) (square \( S_{pr} \), shaded with straight lines) increase in direct proportion to the number of containers in the feed \( N_n \), intervals between car feedings \( I \), as well as the remainder of containers not exported (due to the uneven operation of rail and road transport) \( (\alpha_I - 1) \cdot N_c \) (where \( \alpha_I \) – coefficient of unevenness on arrival, \( N_c \) – average daily arrival of containers) and decrease inversely proportional to the number of containers exported by road \( A \cdot K_a \) in every ride \( (A – quantity, K_a – the capacity of the car in containers) \), and the duration of the ride \( t_n \) (square \( S_{va} \), shaded with oblique lines).

\[
S_{pr} = 24 \cdot (\alpha_I - 1) \cdot N_c + N_c I + 2N_c I + 3N_c I + \ldots + x \cdot N_c I = 0.5x(x+1)N_c I
\] (1)

where \( x \) – number of car deliveries

Square

\[
S_{va} = m \cdot A \cdot K_a \cdot t_a + (m - 1) \cdot A \cdot K_a \cdot t_a + (m - 2) \cdot A \cdot K_a \cdot t_a + \ldots + A \cdot K_a \cdot t_a = 0.5m(m - 1)A \cdot K_a t_a
\] (2)

where \( m \) – the number of car rides.

Then

\[
N_c t_{pr} = 0.5x(x+1)N_c I + 24(\alpha_I - 1)N_c - 0.5(m - 1)A \cdot K_a t_b
\] (3)

Since \( N_c x = N_c \) and \( m \cdot A \cdot K_a = N_c \), \( Ix = T_{kn} \), \( m \cdot t_a = T_a \)

where \( T_{kn} \) – duration of operation of the container terminal;

\( T_a \) – duration of operation of cars,

that

\[
t_{pr} = 0.5(T_{kn} - I) = 24(\alpha_I - 1) - 0.5(T_a + t_a)
\] (4)
Meaning $S_{ot}$ it can be determined from the graph shown in Fig. 3. Containers—the hours of finding containers on departure $N_{c,ot}$ are directly proportional to the number of imported containers in each trip $AK_a$, travel time $t_a$ and are inversely proportional to the operating time of cars $T_a$, number of innings $x$ and the intervals between innings $I$ (in Fig. 3, the area shaded with straight lines).

$$N_{c,ot} = 24(\alpha_2 - 1)N_c + 0.5m(m - 1)AK_a t_a + (24 - T_a)N_c + 24(\alpha_2 - 1)$$  \hspace{1cm} (5)

Time

$$t_{om} = 0.5(T_a - t_a) + 24 - T_a - 0.5(T_{kp} - 1) + 24(\alpha_2 - 1)$$  \hspace{1cm} (6)

then the average time spent by local containers at the container terminal will be:

$$t_{km} = t_{pr} + t_a + t_{op} = 0.5(T_{km} - 1) - 0.5(T_a + t_a) + t_a + 0.5(T_a - t_a) +$$
$$+ 24 - T_a - 0.5(T_{km} - 1) + 24(\alpha_2 - 1) + 24(\alpha_1 - 1)$$  \hspace{1cm} (7)

Replacing $I$ through $T_{km}/x$ and having made a reduction, we get:

$$t_{km} = \frac{T_{km}}{x} + 24(2\alpha - 1) - T_a$$  \hspace{1cm} (8)
Fig. 3. Schedule of changes in container-hours spent at the container terminal of containers to be shipped

Also, difficulties may arise in the operation of the container terminal due to the uncoordinated import and export of containers, which in turn will lead to the fact that some containers will be forced to stand idle waiting for their arrival at the terminal, and others waiting for shipment from the terminal. In order to avoid the occurrence of "chaos" at the terminal, it is necessary to establish a reservation when buying a seat in a container on the principle of selling a seat (ticket) in the automated control system Express-3.

Booking of containers-places will allow, first of all, to exclude unauthorized accumulation of containers upon their arrival at the terminal complex, which will also exclude the downtime of ready-made trains. Also, according to the booking of the container space, it is possible to monitor the workload of the terminal complex and organize uniform work.

Fig. 4. Schedule of changes in container-hours spent at the container point of containers to be shipped in a block train
Another important aspect is that it is possible to re-sell the vacant space on the route to the client. In turn, this will allow you to plan work and identify "bottlenecks" in the work of the terminal complex.

5 Discussion of the results

In most cases, the departure of trains on the railway of Uzbekistan occurs as the train is ready for departure, and not according to strictly planned schedule threads, which, in turn, does not ensure timely delivery of goods. In order to carry out the movement of container block trains along the lines of the schedule, it is necessary to take the following measures:

— organize the passage of container trains on the hard (rigid) lines of the schedule;
— strengthen the control of the dispatching apparatus for container trains
— to establish the priority of technical and commercial inspections of container trains at stations;
— to establish the boundaries of processing in technical and commercial terms of block trains and the change of locomotives at technical stations;
— organize preliminary informing of the station employees.

6 Conclusion

The order of causal analysis of problems in the organization of container block trains has been developed. The initial causes of the impact of factors on the problems of the organization of trains have been identified, and the interrelationships of factors affecting the technology of transport processes have been identified and correlated.

It has been established that a system with a fixed amount of container arrivals by road is less flexible in relation to supply failures than a container terminal with a fixed time interval between arrivals.

References

