https://doi.org/10.30932/1992-3252-2019-17-4-208-217

Commercially Focused Dynamic Priorities in the Organisation of the Transit of Cargo Trains

Victor A. SHAROV **Almas A. TLEUKHANOV**

Sharov, Victor A., *Russian University of Transport, Moscow, Russia.*
Tleukhanov, Almas A., *LLP Engineering Center, JSC KazATK, Astana, Kazakhstan.*

ABSTRACT

One of the main tasks in improving management of the transportation process is the transition to enhanced quality of transport service focused on meeting users' requirements while achieving the most economical results for all the components of the technological process stages. The quality of the services offered by railway transport is gradually becoming an increasingly significant indicator of economic efficiency for both carriers and cargo owners.

Customers are ready to buy more and more qualitative services to save time, expand their business, and meet new needs. This necessitates development of modern approaches to optimizing the use of existing railway infrastructure, including by establishing priorities in organizing traffic.

The objective of the research was to study the procedure for establishing dynamic priorities for organizing transit of cargo trains. To achieve this goal, a comparative analysis method, special engineering calculation methods associated with organization of train traffic were used.

During the study comparative analysis of main characteristics of a number of world railways was carried out. Following clearly defined strategy of railways of the Russian Federation aimed at customer focus, this article provides preliminary research results, the findings of which revealed the expediency of establishing dynamic priorities for cargo trains transit. It is especially important to implement these approaches in the context of an operational change in the train situation in the event of emergency events on the infrastructure and for a possible reduction in the financial losses of consignors and consignees.

The same approaches can rightfully be used on the railway of the Republic of Kazakhstan.

Keywords: railway, priority of transit of cargo trains, quality of service, management, transportation, train schedule, customer focus.

---

* Information about the authors:
Sharov, Victor A. – D.Sc. (Eng), professor, head of the department of operational work and transport safety management of Russian University of Transport, Moscow, Russia, vasharov_miit@mail.ru.
Tleukhanov, Almas A. – chief specialist of LLP Engineering Center, JSC KazATK, Astana, Kazakhstan, hatkz888@mail.ru.

Article received 31.01.2019, revised 12.07.2019, accepted 25.08.2019.

For the original Russian text of the article please see p. 208.

Background. Currently, in many countries, cargo transportation by rail occupies a leading position, this is especially true for Russia and Kazakhstan. However, in the competition for distribution of customers between modes of transport, indicators characterizing quality of transportation, including timeliness, are becoming increasingly important. Under these conditions, it is necessary to develop modern approaches to finding ways to optimize the use of existing railway infrastructure.

Objective. The objective of the study is to study the procedure for establishing dynamic priorities for organizing transit of cargo trains.

Methods. The authors used general scientific methods, a comparative analysis method, special engineering calculation methods related to organization of train traffic.

Results.

International experience in organizing cargo rail transportation: common approaches

When studying the international experience of railway transport, attention is drawn to: «American» and «European» experience in formation of models of the market for cargo rail transportation; the presence under the conditions of highly developed market institutions and the economy of both powerful directions of cargo flows and lines with a small load; features due to the geographical location of each country and the prevailing environment of competition of railways with alternative modes of transport.

In North America today, within the framework of a single railway network, there is a division into 3 classes. The first class includes seven railways (BNSF Railway, Canadian National, Canadian Pacific, etc.). More than 550 railways are assigned to the second and third classes, including short lines and local railways. According to the Association of American Railroads, first-class railways account for about 70 % of the total length of US railways and 90 % of the total number of people employed in railway transport [1].

The possibility of adapting the American model for Russian railways was considered in one's time in the framework of the recommendations of the OECD and the World Bank, as well as by the well-known American economist Russell Pittman, who noted that the railway network of the Russian Federation in its European part allows implementing a competition scheme for integrated companies [2, p. 11].

The experience of Germany, in which the reform of railway transport began back in 1994 is recognized as one of the most successful in Europe. The essential fact was that it happened not just as a corporization of a state owned enterprise, but as a merger of two railway enterprises: Deutsche Bundesbahn (Germany) and Deutsche Reichsbahn (former GDR) into one company Deutsche Bahn AG (DB AG). At the same time, the Federal Railways Authority (Eisenbahnbundesamt) was formed, which issued DB AG permission to operate the infrastructure and to carry out passenger and cargo transportation [3].

From Table 1 it can be seen that the indicators of the Russian railway network are significantly different from the railways of the leading EU countries being larger and much closer than they to the indicators of Canada and the United States.

In Kazakhstan, in June 2016, as a result of the project on a phased transition to the new organizational structure as part of the Business Transformation Program, the functions of providing cargo transportation services were transferred to JSC KTZ–Freight Transportation. This project allowed to optimize a number of subsidiaries of JSC NC KTZ [4].

The national carrier of Kazakhstan (Kazakhstan Temir Zholy) has signed several strategic agreements:

1) on cooperation in the transport and logistics sphere with DHL (Germany) and John Deere (USA). The agreement provides for creation of a center for consolidation and distribution of John Deere products on the Eurasian market in the territory of Free Economic Zone (SEZ) Khorgos–Vostochnye Vorota;

2) on development, supply and maintenance of locomotives with General Electric Transportation (USA) (the transaction amount is estimated at $900 million) [5].

In 2017 the volume of the transport and logistics market in Russia was estimated at 2,5

Table 1

The influence of conditions of functioning of the railway network on the choice of a model of structural organization of the industry

Countries	Average weight of a cargo train, tons	Average number of cars in a cargo train	Average distance of cargo transportation, km
Germany	500	12	320
France	380	10	375
Great Britain	800	20	215
Poland	640	17	245
Canada	2900	72	1100
USA	2850	69	915
Russian Federation	2255	61	1700

Source: IPEM analysis.*

trillion rubles, and the basic transportation service unconditionally remained the main service in the market (the share in the total volume of transport and logistics services was 88 %), which for the purpose of implementation of transportation growth potential is an incentive for development of new services [6, p. 15]. To achieve this goal, in 2017, development of a single catalog of services provided by the Russian Railways holding began, which also became a natural reaction to growing activities of other modes of transport. Competition with road transport for transporting goods on medium and long-distance routes arises quite regularly, due particularly to a shortage of carrying capacities at individual railway sections. But at present, for relations between modes of transport, the importance of quality of transport services, and, first of all, of such an indicator as timely delivery of goods, is becoming increasingly higher, setting the task of finding ways to optimize transit of cargo trains.

Possible ways to prioritize transit of cargo trains

According to the Rules for technical operation of railways of the Russian Federation [7, clause 5 of Appendix No. 6], cargo transportation is in the ninth place in the established priority order of trains, which is explained by safety requirements. Then it is ranked from commercial positions and when planning cargo transportation, the final priority is embodied in the train schedule [8, pp. 33–35].

An important step in improving movement of cargo trains according to schedule was made with the approval of the «Integrated program for a phased transition to organizing movement of cargo trains according to schedule for 2011–2015» and «Integrated integrated technology for managing movement of cargo trains according to schedule» developed at JSC Russian Railways [9], where these priorities are set in advance. Currently, priorities in development of cargo train schedules are given primarily to those trains that have a higher commercial value.

The circulation options of such trains are scientifically substantiated and published in open access [10, p. 21]. In our studies, we set the task of addressing the issue of feasibility of setting dynamic priority for transit of cargo trains, that is, a priority that is changing in the context of an operational change in the transportation situation.

The work of the railway section as of a transport system in the absence of trains of high priority with a different traffic mode, primarily depends on the load factor γ, defined as:

$$\gamma = \frac{N_f(T_{pl})}{N_n(T_{pl})} = \frac{\lambda}{\mu}, \quad (1)$$

where $N_f(T_{pl})$ – actual number of trains that have passed through the section for the period T_{pl};

$N_n(T_{pl})$ – maximum possible number of trains that can run through the section, based on the available transit capacity for the period T_{pl};

λ – intensity of delivery of trains that should be passed through the section (input train flow);

μ – intensity of train transit through the section (service of the incoming train flow).

The influence of γ on performance of the section is expressed through a change in the

* [Electronic resource]: http://ipem.ru/files/files/research/23_04_2013_rail_foreignreform.pdf; http://ipem.ru/news/publications/676.html.

speed of the train flow transit (for example, $\beta_{sec} = f(\gamma)$), the need to create additional track facilities at operation points (buffer units) for the conditions of a potential violation of the normal mode of operation of the section due to technical or technological failures.

The introduction of trains with a differentiated transit mode, which have a higher priority when in transit through the section and violate the principle of «first come, first served», should certainly affect the selected indicators.

Within that example, train transit processes have two different types of priorities: static priority and dynamic priority. Priorities are simply conditional values expressing the relative importance that must be assigned to a process or process object. The higher is the priority, the greater are its chances of accessing the service.

Thus, static priority does not change over time (in our case, these are the requirements of Rules for technical operation (RTO), where the priority of train transit is set to cargo trains, and cargo trains are ranked within the standard schedule), and the dynamic priority decreases or increases for a particular cargo train over extra time waiting for service (or with regard to ensuring timely delivery of goods).

For clarity, one can imagine static priorities when time slots are set within the standard schedule for speedy cargo trains (container trains, trains with perishable goods, etc.) and for trains with an agreed arrival time, and dynamic priorities when it is necessary to make changes to the schedule to allow transit of late cargo trains or of a cargo train with special requirements for time of delivery to its recipient (for example, train with cargo that should close a shipload in a port or hindering the technological process of the enterprise due to the lack of incoming raw materials).

At the preliminary planning stage, we assume that the moments of train arrival for service and duration of this service are known, i.e. we can consider the system as deterministic.

Due to the specifics of train formation, as well as due to technical and technological failures in the section's operation, deviations from the stationary state may occur during certain periods, and by the time $t = t_0$, sporadic formation of queues $N_0(t) = \{0, 1, 2, ..., m\}$ may occur, where m is the maximum number of requirements in the system awaiting for service, determined by system's capacity (in our example, the number of tracks at an operation point).

Therefore, virtual unloading time of the system is of interest, when the queue is completely eliminated and the next request for service arrives without delay (the system returns to a stationary state) for the cases when priorities exist or are absent.

If we consider t_{waiti} as the permissible residence time of the i-th request in the system, then the request for which the

remaining permissible residence time in the system is minimal, is selected for service. With this description, the priority class is a function of the time during which the request is in the queue.

For the considered problem, the approach changes somewhat due to the fact that the criteria for assigning priority are not t_{waiti}, but $\Delta T(l_j)$ and the financial indicators resulting from this (either income D_i, if $\Delta T(l_j) = T_i^f(l_j) - T_i^n(l_j) \le 0$; or a fine F_i, if $\Delta T(l_j) > 0$). To assess the likelihood of obtaining income or paying a fine depending on the value $\Delta T(l_j)$, we use the mathematical tool previously described in [11, pp. 110–112].

Dynamic priority should be established using the potential loss indicator $L_i(l_j)$ for the i-th dispatch at the j-th object. Its value is defined as:

$$L_i(l_j) = F_i^D(1 - P\left\{T(l_s) \le T_D^N \left| \Delta T_i(l_j) \right.\right\}), \qquad (2)$$

where F_i^D – the amount of fine for the i-th dispatch in accordance with the contract;

$P\{T(l_s) \le T_D^N | \Delta T_i(l_j)\}$ – probability of fulfilling the contractual delivery time for sending T_D^N if at the object j the deviation from the standard value $T_i^N(l_j)$ is $\Delta T_i(l_j)$.

The trends in transportation of «expensive» goods, for example, perishable or grain, are most typical in that context. The growth in the volume of transportation of grain cargo by rail is characterized by uneven shipment over the periods of the year, on weekends and holidays, and by a low level of routing [12, p. 43]. Accelerating the turnover of cars of a specialized rolling stock, especially when forming shiploads, also becomes relevant. The approved «Single list of works and services rendered by JSC Russian Railways in organization of cargo transportation» (No. 1574/r dated July 24, 2018) also makes it possible to single out the priority of cargo transportation for the provision of Cargo Express service in transportation of goods and empty wagons with high speed, etc. [13].

Brief conclusions. Thus, we can conclude that even with the developed schedule for cargo trains with static priorities, it is possible and advisable to use dynamic priority in some operational cases in order to reduce company losses when there is a risk of violation of delivery time of the shipment, leading to serious financial losses.

REFERENCES

1. Golomolzin, A. N. Reforms led to success on the railways of America and Europe [*Na zheleznykh dorogakh Ameriki i Evropy reformy priveli k uspekhu*]. [Electronic resource]: http://www.rostransport.com/article/4427/. Last accessed 20.02.2019.

2. Pittman, R. Railway Competition: Options for the Russian Federation. *CEFIR Working Paper*, 2002, No. 14, pp. 1–11.

3. Arslanov, M. Railway reform in Germany: the power of the state [*Zheleznodorozhnaya reforma v Germanii: sila gosudarstva*]. [Electronic resource]: https://cfts.org.ua/articles/43554. Last accessed 20.02.2019.

4. JSC KTZ – Freight transportation [*AO KTZ – Gruzovie perevozki*]. [Electronic resource]: https://ktzh-gp.kz/ru/about/. Last accessed 20.02.2019.

5. Department of economic conditions and strategic development of JSC Russian Railways. Development and reform of foreign railways. Annual analytical report [*Departament ekonomicheskoi kon'yunktury i strategicheskogo razvitiya OAO «RZD». Razvitie i reformirovanie zarubezhnykh zheleznykh dorog. Godovoy analiticheskiy otchet*]. Moscow, 2018, 58 p.

6. Sharov, V. A. Development of a single catalog of services provided by the holding company Russian Railways [*Razrabotka edinogo kataloga uslug, okazyvaemykh kholdingom «RZD»*]. *Zheleznodorozhniy transport*, 2016, Iss. 6, pp. 9–15.

7. Rules for technical operation of the railways of the Russian Federation. Approved by order No. 286 dated December 21, 2010 of the Ministry of Transport of the Russian Federation (as amended by the orders of the Ministry of Transport of Russia dated June 04, 2012 No. 162, dated March 30, 2015 No. 57) [*Pravila tekhnicheskoi ekspluatatsii zheleznykh dorog Rossiiskoi Federatsii. Utverzhdeny prikazom № 286 ot 21.12.2010 Ministerstva transporta Rossiiskoi Federatsii (v red. prikazov Mintransa Rossii ot 04.06.2012 № 162, ot 30.03.2015 № 57)*].

8. Sharov, V. A., Baturin, A. P. Priority of cargo trains as a criterion for substantiation of speeds [*Prioritetnost' gruzovykh poezdov kak kriteriy obosnovaniya skorostei*]. *Zheleznodorozhniy transport*, 2017, No. 3, pp. 33–35.

9. Comprehensive program of a phased transition to organization of movement of cargo trains according to schedule for 2011–2015. Approved by First Vice-President of JSC Russian Railways V. N. Morozov on 16.03.2011 [*Kompleksnaya programma poetapnogo perekhoda na organizatsiyu dvizheniya gruzovykh poezdov po raspisaniyu na 2011–2015 gody. Utv. Pervym vice-prezidentom OAO «RZD» V. N. Morozovym 16.03.2011*].

10. Lemeshko, V. G., Sharov, V. A. On transition to a technology for organizing movement of cargo trains according to schedule [*O perekhode na tekhnologiyu organizatsii dvizheniya gruzovykh poezdov po raspisaniyu*]. *Zheleznodorozhniy transport*, 2010, Iss. 8, pp. 18–26.

11. Sharov, V. A. Technological support for cargo transportation by rail in a market economy [*Tekhnologicheskoe obespechenie perevozok gruzov zheleznodorozhnym transportom v usloviyakh rynochnoi ekonomiki*]. Moscow, Intext publ., 2001, 198 p.

12. Kuzhel, A. L. A comprehensive approach is needed [*Neobkhodim kompleksniy podkhod*]. *Zheleznodorozhniy transport*, 2018, Iss. 9, pp. 41–43.

13. The single list of works and services provided by JSC Russian Railways in organization of cargo transportation (approved by the order of JSC Russian Railways of 24.07.2018 No. 1574/r) [*Ediniy perechen' rabot i uslug, okazyvaemykh OAO «RZD» pri organizatsii perevozok gruza (utv. rasporyazheniem OAO «RZD» ot 24.07.2018 No. 1574/r*].