HOW TO REDUCE DOWNTIME OF FREIGHT CARS AWAITING LOADING?

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ABSTRACT

The process of ensuring car loading is much dependent on stochastic factors. The presence of such a dependence forces operators to create technological reserve at the point of loading operations. The authors considered the impact of fragmentation of freight rolling stock on the stock level and economic results of work, as well as opportunities to consolidate resource management under a single basis in order to increase productivity and profitability of the industry.

Keywords: *railway, freight yard, loading operations, stochastic factors, car stock, loss reduction, car management consolidation.*

Background. *Market relations affect significantly the efficiency of freight rolling stock use. For example, on the basis of the network meeting held on 19–20 February 2015 in Tyumen «Modern methods of car fleet management» it was noted that in 2014 daily about 340 thousand cars, which were on the tracks of public use of the Russian Railways network were not in demand. At the same time most of them were standing on operational yard and were idle while waiting for loading. Prior to formation of operator's service market this situation has not been observed.*

According to the report of Russian Railways in 2014, reduction of efficient use of rolling stock is related to internal risks of the holding company. At the same time it is necessary to understand that it is unprofitable for anybody to specially keep cars in nonproductive idle hours. Neither for private operators, nor for JSC Russian Railways. The main reason for congestion of empty cars in places of loading is the presence of uncertainty [1, 4, 10, 11].

Objective. *The objective of the authors is to consider possible ways or reduction of downtime of freight cars awaiting loading.*

Methods. *The author uses general scientific methods, comparative approach, mathematical method.*

Results. *According to statistics, the average length of an empty run is 3,5 hours. When transporting export goods this time is much larger. Therefore, at the time of sending the car to loading station it is impossible to know either exact number of required units of wheeled equipment, nor time of their arrival. To ensure the order operators are forced to create dynamic reserves (reserve stock) of empty cars at loading. And the greater is uncertainty factor, the greater is the number of cars that should be kept in reserve.*

Reserve of cars at loading places can be divided into two categories:

– dynamic (insurance) – which allows to ensure uninterrupted supply of cargo operations at fluctuations of loading volume and the number of arrived cars;

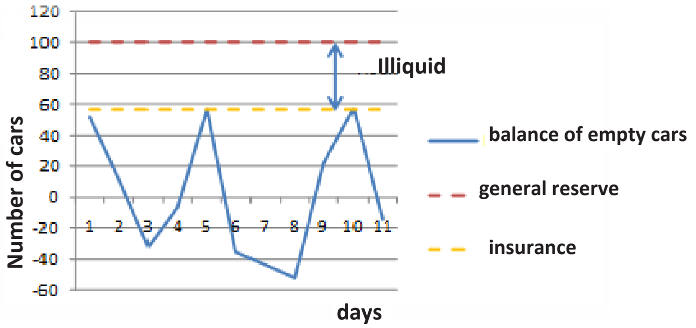
– illiquid – when cars are not used for a long time.

The presence of dynamic reserve allows to ensure loading in case of formation of daily car deficit. Not demanded reserve (illiquid) leads to unnecessarily large downtime of cars waiting for loading. The presence of illiquid reserve is highly undesirable, as it leads to a decrease in average daily yield of cars and makes it difficult to operate the station.

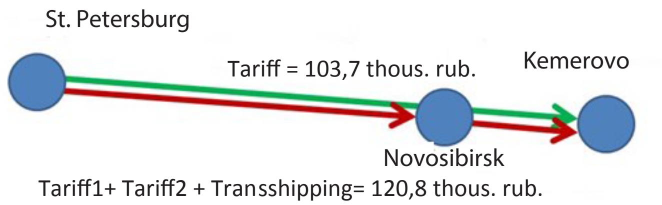
Most of rolling stock operators and shippers for guaranteed provision of loading have to form dynamic reserves of empty cars. However, it is necessary to understand that despite the need for reserves, it is not nothing but a simple unproductive downtime of cars. Eventually cargo owner pays for it. And thus reducing such reserves will reduce the share of transport component in the cost of final products and increase its competitiveness.

There are various ways to reduce the uncertainty factor affecting the size of dynamic reserve. For example, increase in technological discipline, improvement of technology of railways operation and quality of services on the part of the carrier. It is a long, time-consuming and expensive process. However, it has no influence on uncertainty associated with the change in loading volume after sending empty cars.

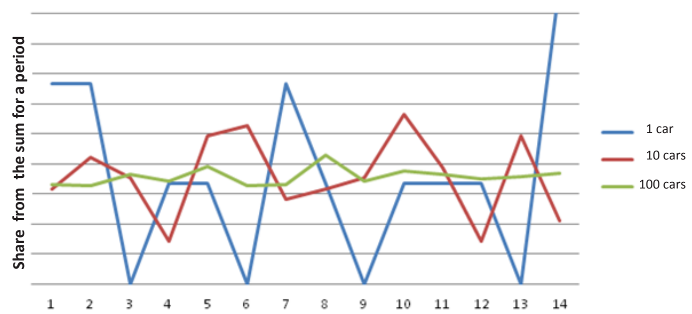
It is possible to use base reference stations in the regions of loading for rapid reallocation of empty car flows. This approach will significantly or completely reduce dynamic reserves. But in this case, the empty run cost increases because the rate of one total empty run is less than the rate of two empty runs, of which it is composed. And the operation of reshipping of empty car is paid. As a result, the use of such a scheme for loading generally becomes economically unviable.



Pic. 1. Need for reserve at daily deficit of cars.



Pic. 2. Comparison of cost for different options of supply of an empty car to a loading station.



Pic. 3. The graphs of relative fluctuations of the number of arriving cars on dates for jets with capacity of 1, 10 and 100 cars a day.

For example, on the route St. Petersburg–Kemerovo the use of reshipping on Novosibirsk stations increases the cost of empty run by 17,1 thousand rubles, which is equivalent to almost a month of unproductive downtime of a car.

The possibility remains to increase stability of car flows due to their consolidation with several operators. Often multiple operators are involved in ensuring loading at the station. And they bring empty cars and form dynamic reserves (insurance stocks) independently of each other. This leads to division of total empty car flow into several smaller ones.

The stability of car flow is significantly affected by the number of shipments in it. Modeling of car flow correspondence, consisting of 1, 10 and 100 carload shipments, shows a significant reduction in relative fluctuations of the number of cars arriving daily at the destination station (Pic. 3).

Pic. 3 shows that the larger is the size of car flow, the less are relative fluctuations in the number of cars arriving at the destination station. And the share of car fleet in a dynamic reserve reduces also without reducing warranty to ensure loading.

According to inventory management theory, the dependence of optimal rate of growth stocks and the rate of demand growth is as follows [2, 3]:

$$n^{ins}_{res} \leftrightarrow \sqrt{U^{ship}}, \qquad (1)$$

where n^{ins}_{res} is required number of cars in insurance reserve at the station of demand (loading);

U^{ship} is average daily number of independent shipments.

We use this dependence, taking into account the specifics of cars fleet management (including a different number of cars in group and route shipments):

$$n^{ins}_{res} = n^{0}_{res}\sqrt{\sum_{1}^{i}\left(U^{i}_{ship}\right)^{2}}, \qquad (2)$$

where i is a number of shipments in a car flow;

U^{i}_{ship} is a number of cars in i-th shipment;

n^{0}_{res} is a value of reserve at a single car flow.

Determination of car stock at a single demand was considered earlier [4]. It is largely affected by the value of mean square deviation of arrival time of cars at the destination station and loading volumes. Knowing the volume amount of loading it is possible to determine average downtime of cars in reserve:

$$t^{req}_{res} = \frac{t^{0}_{res}\sqrt{\sum_{1}^{i}\left(U^{i}_{ship}\right)^{2}}}{n_{ship}}. \qquad (3)$$

On the basis of formula (3) we assess the impact of fragmentation of car fleet on their unproductive downtime. The ratio of downtime of cars in insurance reserve, while ensuring loading by n-th number of operators $t^{ins}_{n\,res}$ and downtime while ensuring by a single operator t^{ins}_{1res} will be as follows:

$$\frac{t^{ins}_{n\,res}}{t^{ins}_{1\,res}} = \frac{\sum_{1}^{n}\sqrt{\sum_{1}^{ni}\left(U^{ship}_{ni}\right)^{2}}}{\sqrt{\sum_{1}^{i}\left(U^{ship}_{i}\right)^{2}}}, \qquad (4)$$

where n is a number of operators, ensuring loading at a station.

If the supply of empty cars is performed by carload shipments, then the formula (4) takes the following form:

$$\frac{t^{req}_{n\,res}}{t^{req}_{1\,res}} = \frac{\sum_{1}^{n}\sqrt{U^{n}_{ship}}}{\sqrt{\sum_{1}^{n}\left(U^{n}_{ship}\right)}}, \qquad (5)$$

where U^{n}_{ship} is a daily average volume of loading of the n-th operator.

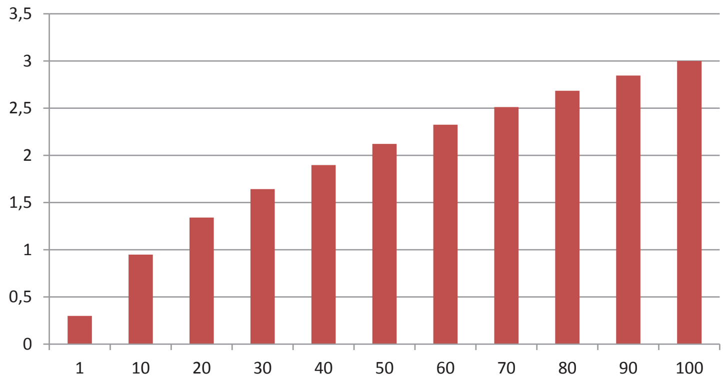
Using the formula (5) it is possible to determine the change in downtime of cars awaiting loading depending on the number of operators working at the station. For example, if the daily average loading of 16 cars instead of one operator to order the cars in four equal shares, the average downtime of cars in dynamic reserves will increase 2-fold:

$$\frac{t^{req}_{n\,res}}{t^{req}_{1\,res}} = \frac{4\cdot\sqrt{4}}{\sqrt{16}} = 2[0,1].$$

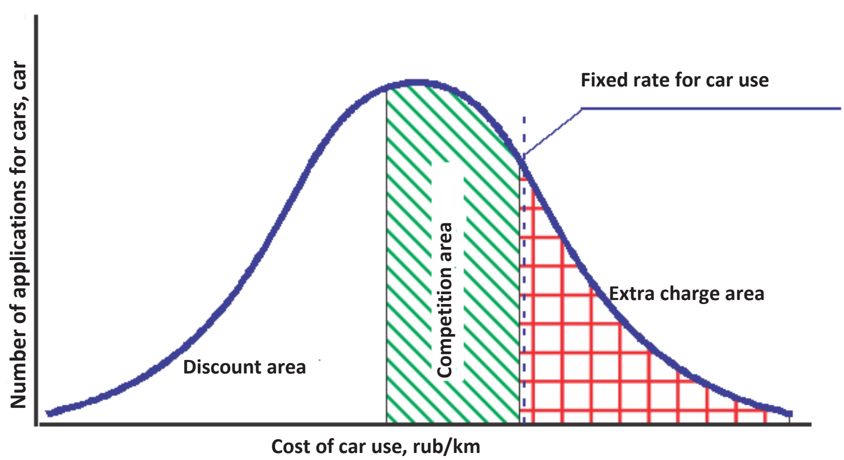
Table 1

Comparison of consolidation of car fleets of the largest owners on railways of the USA and Russia

Name of a railway in the USA	Number of cars, thous.cars		Name of operator in Russia
Union Pacific (UP)	103820	675317	JSC Freight One
Burlington North, and Santa Fe (BNSF)	103061	216865	JSC Federal Freight
Norfolk Southern (with subsidiaries)	90459	183480	CJSC NefteTransService
CSX Transportation (CSX)	72504	149719	JSC Novaya Perevozochnaya
Grand Trunk Corporation (CNGT)	64442	113837	LLC Transoil
Soo Line (SOO)	52071	91391	LLC Gazpromtrans
Total:	1,3mln	1,3 mln	



Pic. 4. Dependence of downtime of cars left in reserve on the number of operators with the average daily value of loading of 100 cars.



Pic. 5. Efficiency of a fixed rate for car use in market conditions.

Pic.4 shows the dependence of change in downtime of cars in reserve when the number of operators increases from 1 to 100, provided that cars are supplied in carload shipments.

From this point of view the experience of foreign railways is interesting. For example, on US roads the size of car fleet is comparable to car fleet in the Russian Federation. But there is not any dominant carrier (Table 1) [5].

The shipper in North America has an opportunity to order transportation in any company. But due to vertically integrated management system loading of one client, and as a rule, of one station is provided by one or two companies. This reduces the size of dynamic reserve of car fleet. It should be noted that railways in North America put much emphasis on performance of freight cars in conjunction with cargo owners. Due to high specialization of rolling stock the empty run ratio is about 50%. Therefore, the main focus is to reduce the downtime of cars at cargo operations stations, management of car fleet size based on anticipated traffic volume and increase in load capacity.

On European railways, where rail traffic management system is similar to management system in the Russian Federation, most of the car fleet is owned by a dominant company with up to 70–80% of their total number. It also creates *preconditions to reduce dynamic reserves at loading stations.*

Significant impact on transport market is exerted by attempts of JSC Russian Railways to create a consolidated fleet of gondola cars. On the basis of fleets «AG», «VSP», «KP».

«AG» fleet is gondola cars, attracted by JSC Russian Railways under control on «agency scheme» from March 2011 to April 2012 from the holding's subsidiaries.

«VSP» fleet is own cars attracted under control from LLC VGK (later Federal Freight): November 2011 – July 2013.

«KP» fleet is technological outsourcing, in which private cars control is performed by JSC Russian Railways according to the balance method principle. The period of existence was from January 2013 to December 2013.

All three attempts were not developed further due to the negative financial result. At the same time operational characteristics of car use in fleets «VSP» and «KP» have been significantly better than that of the operators of rolling stock. For example, a car turnover was improved by 2–3 days, car performance by 20–30% (minutes of network meeting – Tobolsk, Tyumen, 19–20.02.2015).

This effect was achieved including due to consolidation of car fleet, minimization of risks associated with uncertainty in the planning, because the distribution of cars at stations was carried out in the regions of loading in the framework of shift-day planning.

The paradox of losses while improving process performance can be attributed to limited capacities of JSC Russian Railways in commercial work with customers. Thus, the cost of car use was tied to the price list 10–01, and only later it was permitted to provide a small discount of 10%. While the transportation market is not homogeneous and has a large spread in the cost of services.

For example, the total cost of car use in the correspondence with the greater speed of handling will be cheaper. The direction is equally important. If loading is carried out in the direction of following empty car flows, the cost of car use can be 1,5–2 times cheaper [6–9].

As a result transportation, which has the cost of car use much lower than the price list 10–01, at the expense of discounts was taken by other operators of rolling stock. And transportation with high production costs went to JSC Russian Railways (Pic. 5).

Reimbursement of expenses in performance of unprofitable transportation with high cost has become impossible due to removal of profitable transportation to rolling stock operators.

Nevertheless, the existing technological reserve of more efficient use of cars can yield positive economic results in qualitative organization of commercial work.

Conclusion. *Now JSC Russian Railways offers rolling stock operators services of technological outsourcing, reserving management of empty car flows and commercial work with cargo remains under the supervision of operating companies. This interaction allows to satisfy the existing demand for consolidated car fleet management, in which efficiency of the balance method of car management is combined with implementation of market-based management principles.*

That is, taking into account the railway transport management structures on Russian roads consolidation of car fleet of the same kind under a single management becomes perhaps the most reliable method to improve performance of freight car fleet.

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