International Journal of Engineering & Technology, 7 (4.3) (2018) 246-250

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Safeguarding of Goods During Railway Shipping

D.V. Lomotko[1], A.O. Kovalov[1], O.V. Kovalova[1], J.V. Shuldiner[1]

[1] *Ukrainian State University of Railway Transport,*
**Corresponding author E-mail: kovalovanton1979@gmail.com*

Abstract

The definition of estimation criterion of rolling stock availability for certain freight loading is given in this work. The level of commercial availability of cars is proposed as a criterion. The graphic display of the availability level of cars for loading depending on the service life of a car and with account for corresponding repair works and maintenance is represented. The dependence of the type of goods or the group of goods on the level of commercial car availability required for safeguarding during transportation of goods, for safety of operation and continuity of the rolling stock is introduced to provide the corresponding level of commercial rolling stock availability for the freight owner. The variant of the requirement formation for provision of cars using the category of commercial availability and the quantity of cars of the corresponding type is given, and the example of problem solving of supplying the freight owner with the cars of commercial availability that are not lower than needed is also proposed.

Keywords: *Commercial car availability, safety of transportation service, fulfillment of requirements.*

1. Introduction

During the sector reforms, the operation systems of freight transportation management and marketing will be developed based on the latest information technologies. In this context, providing with the qualitative technologies of safeguarding of goods during the transportation by the Ukrainian railways is very important. One of the main factors that influence safeguarding of goods during railway shipping is technical and commercial condition of the rolling stock.

Both to preparation of goods for transportation and to provision of the commercial availability to the rolling stock should be focused on, that in its turn allows reducing the amount of unpreserved goods during the transportation, that directly depends both on the rate of commercial breakdowns and on the total time of technical breakdowns of goods.

2. Existing Work

The current statutory acts contain no clear definition of the commercial availability of the rolling stock [1, 2], therefore arguments appear between the railway and the freight owner when the availability of cars for certain freight loading is determined. In order to avoid arguable points, the criterion for definition of cars availability should be developed. The level of commercial availability for certain freight loading can be such a criterion [3]. However, multiple factors influence a clear definition of the proposed criterion, such as type of rolling stock, operation intensity, operation life time, transportations rate, changes in the statutory acts, human factor etc. Therefore the level of commercial availability of certain car can be determined far more exactly with the help of the mathematical means of fuzzy sets [4-10].

In [11], the problems of the preventive activity planning in railway services are considered. The purpose is to preserve the railway infrastructure in the appropriate working conditions at low costs. The equipment deteriorates due to operation and time, and a goods safeguarding program can considerably reduce its insecurity in terms of considering the expected failure. Such approaches can be also used for the rolling stock in the context of its commercial availability.

3. Proposed Work

The commercial availability of cars for certain freight loading depends on their technical condition and the rate of operation. That is why the definition of the rolling stock allocation option is directly related to receiving of correct information about its level of commercial availability.

This level is proposed to be defined as follows

$$R(t) = \bigcup_{i \in [1,m]} \left[\mu_{K_i}(\lambda(t)) \cap \mu_{\mathbf{K}_i}(\lambda(t)) \right] \quad (1)$$

where $R(t)$ – level of commercial availability of the rolling stock, %;

K_i, $\mathbf{K}_i$ – consequently variety of types of actual and existing in the standards commercial breakdowns, by quantity, m;

$\lambda(t)$ – rate of commercial operation of the rolling stock, l/year;

$\mu_{K_i}(\lambda(t))$, $\mu_{\mathbf{K}_i}(\lambda(t))$ – operators allowing quantitative estimation of the effect of the rate of operation on the existence of commercial breakdown consequently and according to the standards.

The graphic display of car availability for loading depending on the period of car operation is given by (figure 1).

In order to provide the car availability for loading at the definedlevel, a car should be kept constantly in operational condition.

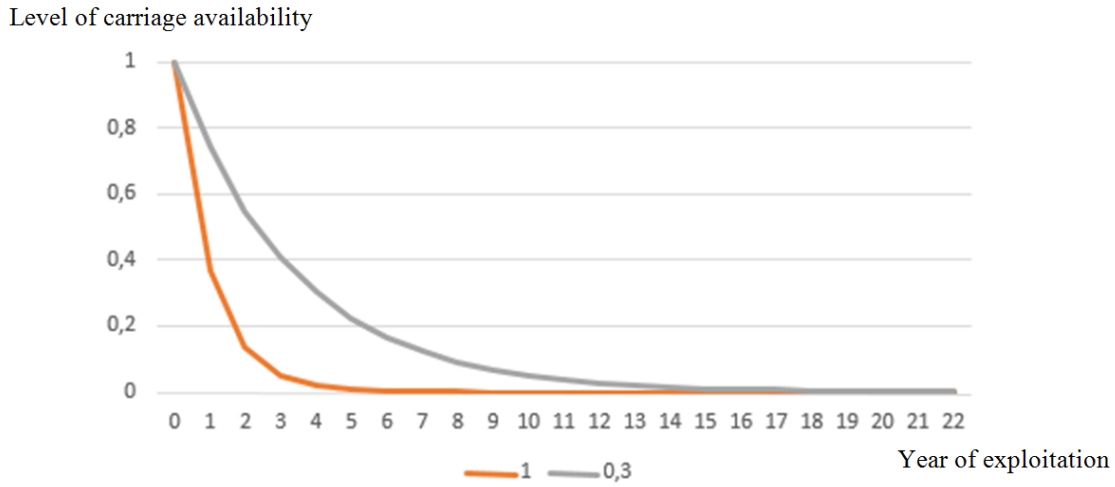


Fig. 1: Dependence of car availability for loading on the period of car operation

Due to the above facts, the rolling stock has an opportunity of the renewal of availability level of the certain freight loading, and according to the known data, the dependence of this index will be given by (Figure 2).

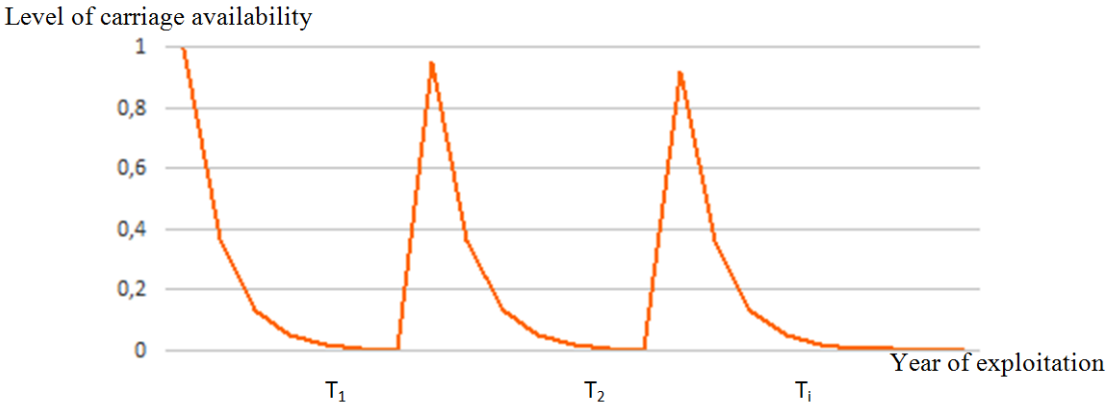


Fig. 2: Dependence of the level of car availability for loading on the period of car operation and conducting the corresponding repairs and maintenance

Since the rate of cars operation and the level of commercial availability of cars are used, a concept of the category of cars availability should be introduced in order to provide the requests of freight owners with the rolling stock of the corresponding condition. For the purpose of more convenient usage, the category of cars availability can take the integral values from the range {0;1;2... n } depending on the set goal.

We proposed the following description of the mathematical model for making up cars into trains, on the basis of which an automated workplace was created.

A railway operating domain is set in the form of a framed graph G. The framing is carried out with the use of values of the distances between the gathering and making up points.

Let $[G] = [r_{ij}]$ is a framed incidence matrix, $i, j = 1, 2, ..., l$, where l is the set of graph nodes (the matrix elements are the distances between the nodes or points).

Let $A = \{A_i\}$ α1 is a set of points where cars are being gathered, $B = \{B_j\}$ β1 - the set of points where cars are being loaded, $\chi = \{\chi_k\}$ γ1 - the set of technical conditions of a car.

In addition, the following is set: A is the matrix of gathering, that is, a matrix describing the number of cars of the required category that are located in certain points; 3 - the matrix of requirements, that is the number of cars of the specified quality which are required in the specified points; 3' - the matrix of corrected requirements.

The purpose of simulation is making up cars into trains which condition is no worse than in the requirement, provided that the mileage is minimized. But, in addition to minimizing the car mileage, it is necessary to take into account the reduction in the costs of commercial and technical inspection. Thus, we add the cost component for these operations to the specific objective function. Then the objective function will look like:

$$\Phi_{(x_{ijk})} = \sum_{i=1}^{\alpha}\sum_{j=1}^{\beta}\sum_{k=1}^{\gamma}(r_{ij}\omega_k x_{ijk} + x_{ijk}\Delta t_{ij}C_{ij}) \to \min \qquad (2)$$

The constraint system will look as follows

$$\begin{cases} \sum_{j=1}^{\beta} x_{ijk} \le a_{ik}, i = 1,2,...,\alpha; k = 1,2,...,n \\ \sum_{k=1}^{k} 3_{jk} \ge \sum_{k=1}^{k_0} y_{jk}, k_0 = 1,2,...,n-1 \\ \sum_{k=1}^{n} 3_{jk} \ge \sum_{k=1}^{n} y_{jk}, \mathrm{j} = 1,2,...,\beta \end{cases}$$

where $y_{jk} = \sum_{i=1}^{\alpha} x_{ijk}$

r_{ij} – distance between the gathering and making up points (the matrix G elements);

ω_k – the cost of providing one car of the appropriate type and the serviceability for one kilometer;

x_{ijk} – the number of cars of k serviceability category, which are sent from point A_i to point B_j according to the corrected requirement;

Δt_{ij} – saving time for technical and commercial inspection if the car serviceability category differs from the declared one by the cargo owner for a certain cargo;

C_{ij} – unit cost for commercial inspection and technical inspection per hour.

Subsystem I provides quantity, and subsystem II provides quality.

As a result, the schematic representation of the presented model would be as follows (Figure 3).

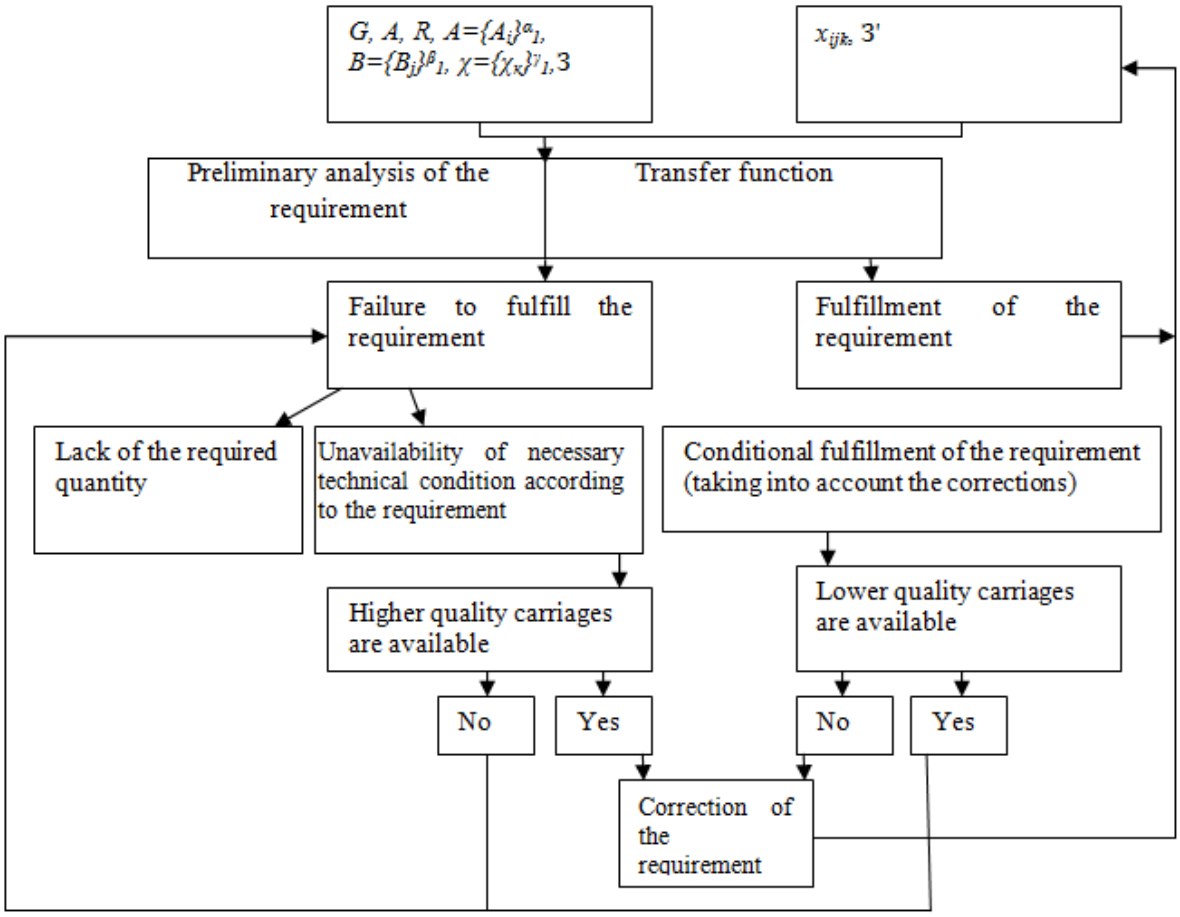


Fig. 3: Modeling algorithm

For provision of the freight owner with the rolling stock of the corresponding level of commercial availability, the dependence of the type of goods or group of goods on the level of commercial availability of a car that is needed for safeguarding during the transportation of goods, safety of operation and continuity of the rolling stock should be introduced (Figure 4).

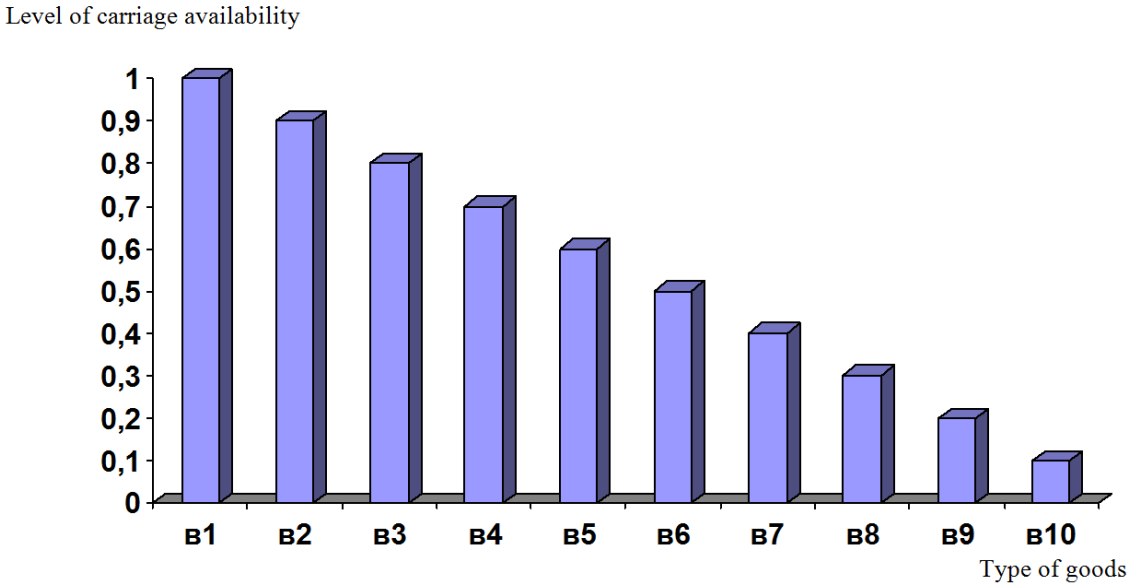
The dependence of the level of car availability for loading on the type of goods can be defined with the help of the expert evaluation method that as a result gives an opportunity to fulfil the freight owners' requests with the help of corresponding rolling stock of every goods.

Thereafter, taking into account the given information and well-timed conducting of the necessary types of repairs and maintenance, the commercial availability of any car for certain freight loading can be defined.

Then the task of providing the freight owners with the cars of the necessary category of availability according to their requests appears. The points of accumulation of empty cars and the points of making up of train sets are set on the polygon rail.

According to the needs in the making up points, the trains should be sets out of cars that are present in the points of accumulation. The type, the quantity and the level of commercial availability of cars making up the train sets should eb specified.

The type, the quantity and the level of commercial availability are also considered in the points of accumulation.



where в1, в2, …, в10 – types of goods

Fig. 4: Dependence of the level of car availability for loading from the type of goods

The request for cars provision can be made in a tabulated form: the upper series is the category of commercial availability that is arranged only from low to high that means the availability level goes up. The lower series is the quantity of cars of the corresponding type. The request for making up of cars of the corresponding type in the making up point is proposed by means of the table 1.

Table 1: The request for making up train sets of the corresponding type in the point of accumulation

The category of commercial availability	χ_1	χ_2	χ_3	…….	χ_n
Quantity of cars	$З_{j1}$	$З_{j2}$	$З_{j3}$	……	$З_{jn}$

The decision on making up the train set is given after the comparison of the corresponding request for loading and the real quantity of cars of the corresponding type and the necessary category of commercial availability in the points of accumulation of empty cars.

4. Experimental Results

We will illustrate the decision of solving the task of providing the freight owner with the cars of commercial availability that is not lower than the required one with the help of the diagram (Figure 5).

The higher the line is, the higher the level of commercial availability of cars is (the less is the level of unavailability of cars for loading).

5. Conclusion

Thus, the complete information about the rate and the period of car operation for any type allows determining commercial availability for certain freight loading. The determined categories of cars availability of the corresponding type as well as their quantity in the points of accumulation taking into account the freight owners' requests in the points of making up allow safeguarding the goods during railway shipping.

References

[1] Pro zatverdzhennja Statutu zaliznyc' Ukrai'ny: Postanova Kabinetu Ministriv Ukrai'ny № 457 vid 06 kvitnja 1998, available online: http://zakon1.rada.gov.ua/laws/show/457-98-%D0%BF.

[2] Roz'jasnennja prezydii' Vyshhogo gospodars'kogo sudu Ukrai'ny № 04-5/601 vid 29 kvitnja 2002, available online: http://sudpraktika.in.ua/pro-deyaki-pitannya-praktiki-virishennyasporiv-shho-vinikayut-z-perevezennya-vantazhiv-zalizniceyu.

[3] Lomotko D.V., Kovalov A.O., Kovalova O.V., Formation of fuzzy support system for decision-making on merchantability of rolling stock in its allocation, *Eastern-European Journal of Enterprise Technologies*, Vol.6, No.3 (78), (2015), pp.11-17. http://dx.doi.org/10.15587/1729-4061.2015.54496

[4] Shavranskyy V., Using fuzzy logic in support systems decision complications during drilling, *Technology audit and production reserves*, Vol.4, No.1 (6), (2012), pp. 35–36. http://journals.uran.ua/tarp/article/view/4782/4433

[5] Du L., Choi KK, Youn BD, Gorsich D, Possibility-based design optimization method for design problems with both statistical and fuzzy input data, *Journal of Mechanical Design*, Vol.128, No.4, (2006), pp. 928–935. doi: 10.1115/1.2204972

[6] Kuo RJ, Chen C.H., Hwang Y.C., An intelligent stock trading decision support system through integration of genetic algorithm based fuzzy neural network and artificial neural network, *Fuzzy Sets and Systems*, Vol.118, No.1, (2001), pp. 21–45. doi: 10.1016/S0165-0114(98)00399-6

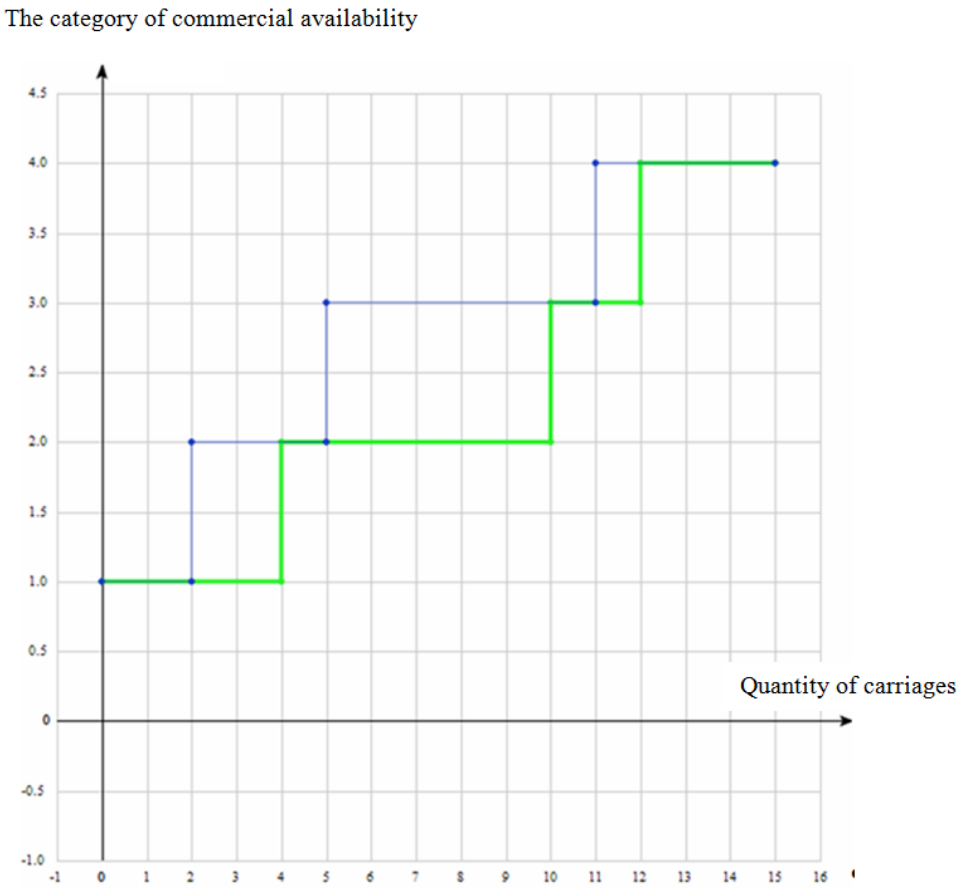
[7] Li D.-F., Multiattribute decision making models and methods using intuitionistic fuzzy sets, *Journal of Computer and System Sciences*, Vol.70, No.1, (2005), pp. 73–85. doi: 10.1016/j.jcss.2004.06.002

[8] Szmidt E., Kacprzyk J., Distances between intuitionistic fuzzy sets, *Fuzzy Sets and Systems*, Vol.114, No.3, (2000), pp. 505–518. doi: 10.1016/S0165-0114(98)00244-9

[9] Hong D.H., Lee S., Do H.Y., Fuzzy linear regression analysis for fuzzy input–output data using shape-preserving operations, *Fuzzy Sets and Systems*, Vol.122, No.3, (2001), pp. 363–542. doi: 10.1016/S0165-0114(00)00003-8

[10] Yang M.-S., Lin T.-S., Fuzzy least-squares linear regression analysis for fuzzy input–output data, *Fuzzy Sets and Systems*, Vol.126, No.3, (2002), pp. 389–399. doi: 10.1016/S0165-0114(01)00066-5

[11] Rita Macedo, Rachid Benmansour, Abdelhakim Artiba, Nenad Mladenović, Dragan Urošević, Scheduling preventive railway maintenance activities with resource constraints, *Electronic Notes in Discrete Mathematics*, Vol. 58, (2017), pp. 215-222.



The diagram of provided cars - blue line
The diagram of announced cars - green line

Fig. 5: The diagram of providing with cars of the category of availability that is not lower than needed