# METHOD OF DETERMINING CONTAINER SERVICEABILITY OF PRODUCTS

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## ABSTRACT

The concept of container serviceability of products is concretized and a method of determining the degree of its compliance with conditions of transportation, requirements for transportation process based on multicriteria evaluation is proposed. There are three criteria: technological, transport and logistics, and economic. The technique and its projection are refracted in order to strengthen overall management practices and capacities of containerization in the country, which is now behind the world standards.

*Keywords: transport, container transportation, containerization, container serviceability, evaluation criteria, conceptual apparatus.*

**Background.** *Any products, produced in the regions of the country and with the beginning of transportation becoming cargo, can be classified in many ways. Due to the increasing development of containerization in practice division of cargo into container serviceable and container non-serviceable is widespread.*

*However, if you try to understand the definition of «container serviceable cargo» and «container serviceability», it may turn out that in different sources they are given different interpretation.*

*According to the glossary presented on the official website of JSC «TransContainer», container serviceable cargo is goods suitable for transportation in containers or goods for which a container is the best or the only possible means of transportation [1]. The other source gives a definition, close to the above mentioned: container serviceable cargo refers to goods that are expedient to be transported in aggregated units – in packages, on pallets, dolltrailers or special multiwheel trolleys [2].*

*According to the international transport classification of goods, container serviceable goods are those which transportation in containers is possible and economically feasible, and container non-serviceable – goods, which transportation in containers is possible, but economically non-feasible. In the latter case, the emphasis is on economic feasibility, that is, the goods can be considered container non-serviceable even when it is technically possible to transport them in container shipping.*

*Each of the cited definitions refers to optimality/ feasibility of transporting cargo in container shipping, however, optimality criteria and methodology for its calculation are not given.*

*In the foreign literature the division of cargoes into container serviceable and container non-serviceable is based on technical parameters and physico-chemical properties of cargo, because of «technical aspect» of container serviceability – if the goods can be transported with the use of a particular type of container, then it is considered container serviceable[3].*

*In addition, except for division of cargo into container serviceable and container non-serviceable, some studies [4] speak about the classification, according to which it is possible to select another group of goods –»in principle container serviceable», but it is not clear how to determine to which of the suggested categories cargo belongs.*

**Objective.** *The objective of the author is to investigate methods of determining container serviceability of products.*

**Methods.** *The author uses general scientific methods, evaluation approach, mathematical calculations.*

**Results.** *Obviously, in the connection of mentioned aspects, it is necessary to clarify a concept of «container serviceable products». To this end it is proposed to use an indicator «degree of container serviceability», which reflects container serviceability of products on a scale from «0» (completely container non-serviceable products) to «1» (completely container serviceable products). The indicator calculation can be performed using the procedure below.*

*Let* $J_{ij}^{k}$ *is a degree of container serviceability of the k-th products, located in the i-th point and requiring transportation to the j-th point. Given the multiplicity of destinations j, we obtain:* $\frac{1}{n}\sum_{j=1}^{n} J_{ij}^{k} = J_{i}^{k}$, *where* $J_{i}^{k}$ *is a total average degree of container serviceability of k-th products in point i.*

*The degree of container serviceability of products is determined on the basis of three criteria: technological, transport and logistics and economic [5, 6, 7].*

**1. Technological criterion.**

*The degree of container serviceability of products according to technological criterion (* $J_{tech}^{k}$ *) is determined based on the required type of container, as well as additional technical means necessary to perform transportation of the k-th products in container shipping.*

$J_{tech}^{k} = 1$, *if products k can be transported in a standard container without additional equipment investments.*

*Let* $\Delta T_{+}^{k}$ *is additional unit costs necessary to perform transportation of the k-th products in container (costs of resin sealed bearings, use of equipment for loading a container, a conveyor, pneumatic and vacuum equipment, container tilting device, inclined chassis / sloping platform [6] etc.), and* $T$ *is rate for transportation of the k-th products in container. If the products are not suitable for transportation of container shipment, then it is assumed that* $\Delta T_{+}^{k} = \infty$ *.*

Then the value $J^k_{tech}$ will be determined by the formula:

$$J^k_{tech} = \frac{T^k_+}{T^k_+ + \Delta T^k_+}; J^k_{tech} \in [0,1]. \quad (1)$$

**2. Transport and logistics criterion.**

One advantage of using a container (like a removable reusable transport holder) for transportation of goods is that it allows to significantly simplify loading / unloading of cargo and its transshipment from one vehicle to another, thereby increasing the efficiency of intermodal transportation – when it is necessary to use two or more modes of transport [8, 9, 10].

Transport and logistics criterion can consider this fact when calculating the degree of container serviceability of products. Obviously, it is connected not only with the type of products k, and transportation route from point i to point j and a mode of transport.

To calculate a degree of container serviceability according to transport and logistics criterion ( $J^k_{\log i}$ ), we denote:

$M^k_{ij}$ is a volume of the k-th products, located in a point i and requiring transportation to a point j with transshipment en route from one mode of transport to another;

$P^k_{ij}$ is a total volume of transportation of the k-th products from the i-th point to the j-th point.

Then the total volume of produced products in the i-th point, requiring transshipment in transit, and overall traffic volume of the k-th products will be calculated by the formula:

$$M^k_i = \sum_{j=1}^{n} M^k_{ij} \; ; P^k_i = \sum_{j=1}^{n} P^k_{ij}. \quad (2)$$

In this case a degree of container serviceability according to transport and logistics criterion we determine as:

$$J^k_{\log i} = \frac{\sum_{j=1}^{n} M^k_{ij}}{\sum_{j=1}^{n} P^k_{ij}} \; ; J^k_{\log i} \in [0,1]. \quad (3)$$

If in the process of transportation from the i-th point to the point j products k is not transshipped from one transport mode to another or even not transported from the point i, in this case for these i and k $J^k_{\log i} = 0$.

**3. Economic criterion.**

A degree of container serviceability according to economic criterion $(J^k_{econ})$ reflects economic feasibility of transportation of the k-th products using containers.

Calculation is performed based on the condition that a degree of container serviceability of products according to economic criterion is the higher:

a) the higher is price of the k-th products relative to the rate $T^k_+$;

б) the larger is normative loss $(L^k)$, caused by cargo damage during its transportation in a «non-container» way, relative to the difference between rate for cargo transportation in container and «non-container» way of transportation.

To calculate $J^k_{econ}$ we determine ranking of degree of container serviceability of products according to economic criterion on the condition «a» and «b», denoting: $S^k$ is cost of the k-th products;

$L^k$ is average normative loss from cargo damage, transported without a container;

$T^k_+$ is rate of transportation of the k-th products in a container;

$T^k_-$ is rate of transportation of the k-th products without container.

Then for each k-th products we can calculate unit weight of a condition «a» – $r_k$ and unit weight of a condition «b» – $P_k$ :

$$S^k = r \times T^k;$$
$$L^k = P_k \times (T^k_+ - T^k_-); \quad (4)$$
$$L > T^k_+ - T^k_-.$$

To calculate rankings of the k-th products $R^k_a$ and $R^k_b$ we calculate maximum values from specific $r_k$ and $P_k$ : $\max_k r_k = r_{\max}$ and $\max_k P_k = P_{\max}$. Then:

$$R^k_{a)} = \frac{r_k}{r_{\max}}, \quad R_a \in [0,1]; \quad (5)$$

$$R^k_{b)} = \frac{R_k}{R_{\max}}, \quad R_b \in [0,1].$$

As a general indicator of degree of container serviceability according to economic criterion $J^k_{econ}$ the following methods are used.

1. Calculation of an average indicator:

$$J^k_{econ} = \frac{R^k_a + R^k_b}{2}. \quad (6)$$

2. Calculation for the best indicator:

$$\begin{cases} J^k_{econ} = R^k_b, \; if \; R^k_b > R^k_a \\ J^k_{econ} = R^k_a, \; if \; R^k_a > R^k_b \end{cases}. \quad (7)$$

3. Calculation for the worst indicator:

$$\begin{cases} J^k_{econ} = R^k_b, \; if \; R^k_b < R^k_a \\ J^k_{econ} = R^k_a, \; if \; R^k_a < R^k_b \end{cases} \quad (8)$$

Note, that «technical» $(J^k_{tech})$ and «economic» $(J^k_{econ})$ criteria do not relate to a specific point i, while «transport and logistics» criterion $(J^k_{\log i})$ depends on an initial point i.

At a final stage we calculate a general degree of container serviceability of the k-th products in the i-th point $(J^k_i)$, i. e. we give a multicriteria as-

*sessment of the k-th products in the i-th point. Strictly speaking, this estimate is a vector* $\vec{J}_i^k = (J_{tech}^k, J_{\log i}^k, J_{econ}^k)$. *With this approach, at the end we can obtain the so-called Pareto-optimal solutions, which are obtained when definitely the worst decision are thrown aside. For this we «convolute» all three criteria in one scalar criterion, using the convolution function* $J_i^k = f(J_{tech}^k, J_{\log i}^k, J_{econ}^k)$. *Since each component* $J_i^k$ *is the proportion of unit that can be compared, we will use the following types of convolution functions:*

*1. Weight sum:*

$$J_i^k = \alpha_1 \times J_{tech}^k + \alpha_2 \times J_{\log i}^k + \alpha_3 \times J_{econ}^k, \quad (9)$$

*where* $\alpha_1, \alpha_2, \alpha_3$ *are weight coefficients, and* $\alpha_1 + \alpha_2 + \alpha_3 = 1$.

*The larger is* $\alpha_l$, *the greater is influence of the criterion number l on the solution.*

*2. Multiplicative criterion:*

$$J_i^k = J_{tech}^k \times J_{\log i}^k \times J_{econ}^k. \quad (10)$$

*It is the most pessimistic approach to assess a degree of container serviceability of products, since the value of* $J_i^k$ *is always less than the smallest value of three components* $J_{tech}^k$, $J_{\log i}^k$ *and* $J_{econ}^k$.

*3. Maximum criterion:*

$$J_i^k = \min\left\{J_{tech}^k, J_{\log i}^k, J_{econ}^k\right\} \to \max. \quad (11)$$

*In this case a general degree of container serviceability of products* $J_i^k$ *will be equal to the smallest of three components* $J_{tech}^k$, $J_{\log i}^k$ *and* $J_{econ}^k$.

**Conclusions.** *The analysis of different interpretations of the concept of «container serviceable goods» offered its clear definition and proposed a method of calculating the degree of container serviceability of products based on multicriteria evaluation.*

*This indicator allows to evaluate a particular container serviceability of a specific cargo base, to set containerization potential of a given region most completely, which is a very important point in the development of measures for the development of container transportation, eliminating imbalances of empty and laden container flows [11, 12] and building a network of container terminals in the country [13].*

*Furthermore, the degree of container serviceability of products can be used in the calculation of used today in transportation science indexes and indicators (such as the level of containerization, the container attractiveness levelof regions and others).*

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