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ЗАСТОСУВАННЯ ХРОМАТИЧНИХ КАРТ ДЛЯ АНАЛІЗУ НЕРІВНОМІРНОСТІ ОБРОБКИ ВАНТАЖІВ ПРИ МУЛЬТИМОДАЛЬНИХ ПЕРЕВЕЗЕННЯХ

APPLICATION OF CHROMATIC MAPS TO ANALYZE THE UNEVENNESS OF CARGO HANDLING DURING MULTIMODAL TRANSPORTATION

д-р техн. наук В.К. Мироненко[1], магістрант І.О. Усов[2]
[1] Державний університет інфраструктури та технологій (м. Київ)
[2] Український державний університет залізничного транспорту, (м. Харків)

V.K. Myronenko[1], Dr. (Tech.), I O. Usov[2], undergraduate
[1]State University of Infrastructure and Technologies (Kyiv)
[2]Ukrainian State University of Railway Transport (Kharkiv)

The analysis of many scientific works devoted to the issues of rational loading of transport infrastructure during multimodal transportation showed that a significant part of them is aimed at solving the issue of regulating the movement of wagons at stations, taking into account the minimization of downtimes and increasing throughput. For cargo stations, methods of operative dispatching influence on the loading of station facilities were mainly proposed, and at places of non-public use – adjustment of the technology of interaction with the connecting stations that serve them. Joint work of freight stations and places of non-general use was considered from the standpoint of maximum loading and unloading capacity at loading points. In modern conditions, it is necessary to take into account the capabilities of the infrastructure to process the growing volumes of freight and wagon flows, and with the random nature of the arrival of wagons at stations and their processing at loading points.

In order to ensure the competitiveness of the railway, sufficient capacity reserves of both railway sections and railway stations are required [1, 2]. Similar models are usually used to evaluate the popularity of sites and Internet applications, the level of loading of supply channels, medical information systems, as well as in geography, medicine, biology.

In general, the application of a chromatic map for a transport object can be represented by an expression

$$T_к = \begin{Bmatrix} M(p_1, p_2, ..., p_n) \\ gradM \\ D_p^M \end{Bmatrix}, \quad (1)$$

where $p_1, p_2, ..., p_n$ – indicators of transshipment of goods for the accounting period;

$M(p_1, p_2, ..., p_n)$ – an array of indicator data;

$grad\ M$ – intensity gradient of array indicators;

D_p^M – overlap distance (clustering of «distances» between array values).

The application of this model in the analysis of indicators of cargo transshipment from rail transport to sea transport will make it possible to visually assess the dynamics of transshipment over the past years (Fig. 1).

months / years	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2021	925,9	718,1	1143,3	1268,0	1420,3	1570,3	1759,7	2211,0	2267,7	2286,6	2173,2	1153,6
2020	856,3	934,0	1158,0	1305,9	1404,1	1403,2	1792,4	2082,4	2354,9	2354,9	2510,6	1304,8
2019	983,5	937,3	1216,9	1369,7	1431,3	1691,6	1876,5	2005,4	2293,0	2433,8	2272,9	1602,0
2018	781,0	751,3	856,8	1039,7	1287,8	1369,2	1533,8	1796,0	2043,2	1993,7	1812,5	1211,4
2017	435,3	678,6	793,3	942,0	985,3	1167,1	1265,3	1502,7	1685,3	1699,4	1671,3	1218,3
2016	596,8	622,7	784,9	870,5	897,2	948,4	1207,8	1388,2	1556,9	1569,9	1569,9	960,0

Figure 1 – Chromatic map of transshipment unevenness of export cargo from railway to sea mode of transport (Chornomorsk seaport), million tons

As can be seen from the chromatic maps of transshipment volumes, there is a significant unevenness in the volume of work of sea ports for exporting goods by month of the year. First of all, this is related to the specialization of ports by cargo nomenclature, which, in turn, leads to the appearance of a seasonality factor in the volume of receipts. For example, seaports with a significant share of transshipment made up of grain cargoes have the largest loading during the harvest period and until the end of the year, and ports specialized in non-seasonal cargoes have more uniform export volumes throughout the year.

Thus, as a result of the processing of statistical data and the construction of chromatic map models, variation and analytical selection or replacement within the scope of the relevant port stations for sea ports is possible.

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