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The “Journal of Transport” publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

The journal is published 4 times a year and contains publications in the following main areas:

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Tashkent State Transport University had the opportunity to publish the scientific-technical and scientific innovation publication “Journal of Transport” based on the Certificate No. 1150 of the Information and Mass Communications Agency under the Administration of the President of the Republic of Uzbekistan. Articles in the journal are published in Uzbek, Russian and English languages.

CONTEXT / MUNDARIJA

Study of the effect on the amount of cargo flow between Uzbekistan and Kyrgyzstan by the method of multiple regression

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Abstract: The main goal of the work is to identify the factors affecting the speed of freight trains and systematize them. Factors affecting the established technical standards of freight train movement speed on railway sections and routes were analytically analyzed and their impact levels on the performance of the main indicators of the train movement schedule were determined. As a result, the "Ishikawa" scheme for determining the factors affecting the speed of freight trains was developed. The random factors affecting the speed of freight trains on the section and route were classified in terms of levels and tasks of their systematization were proposed.

Keywords: Railway section and route, section speed, route speed, train movement schedule, factor, station

O‘zbekiston va Qirg‘iziston o‘rtasidagi yuk oqimi miqdoriga ko‘p regressiya usuli bilan ta’sirini o‘rganish

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Annotatsiya: Ishdan asosiy maqsad yuk poyezdlari harakat tezliklariga ta’sir ko‘rsatuvchi omillarni aniqlash va ularni tizimlashtirishdan iborat. Temir yo‘l uchastka va yo‘nalishlari bo‘yicha yuk poyezdlari harakat tezliklarining o‘rnatilgan texnik me’yorlariga ta’sir ko‘rsatuvchi omillar analitik tahlil qilindi hamda ularning poyezdlar harakati grafigi asosiy ko‘rsatkichlari bajarilishiga ta’sir darajalari aniqlandi. Natijada yuk poyezdlari harakat tezliklariga ta’sir ko‘rsatuvchi omillarini aniqlashning “Isikava” sxemasi ishlab chiqildi. Yuk poyezdlari uchastka va marshrut tezliklariga ta’sir ko‘rsatuvchi tasodifiy omillar darajalar kesimida tasniflandi va ularni tizimlashtirish vazifalari taklif etilgan.

Kalit so‘zlar: Temir yo‘l uchastkasi va yo‘nalishi, uchastka tezligi, marshrut tezlik, poyezdlar harakati grafigi, omil, stansiya

1. Kirish

Mamlakatimiz uchun transport koridorlarini rivojlantirish, jahon bozorlariga tez va erkin chiqish juda muhim shu bois transport koridorlarni rivojlantirish mamlakatimiz uchun muhim ahamiyat kasb etadi.

Transport davlatning ishlab chiqarish infratuzilmasining eng muhim elementi bo’lib, milliy va jahon iqtisodiyotining rivojlanishini ta’minlaydi va ijtimoiy ishlab chiqarishning real sektorini boshqarish sub’ektlarining rolini kuchaytirishning zamonaviy tendentsiyalarini aks ettiradi.

Ushbu strategiyada noaniqlik va xavf ostida yuk aylanishini prognoz qilish muhim rol o’ynaydi. Adabiyotlarni tahlil qilish shuni ko’rsatadiki [1,2,5,6], transport oqimining prognozini modellashtirish uchun asosan ikkita usul qo’llaniladi – korrelyatsion-regressiya tahlili va prognozli ekstrapolyatsiya usuli.

Birinchi usul korrelyatsion-regressiya tahlili korrelyatsion va regressiya tahlili usullari yoki omillarga bog’liqlikni o’rganishning boshqa statistik usullari bilan omillarni o’zgarish dinamikasi sabab-ta’sir mexanizmini rasmiylashtiradigan matematik modelni shakllantirishni nazarda tutadi. Birinchi usulni barqaror iqtisodiy sharoitlarda va transport oqimini qisqa muddatli prognozlashda qo’llash maqsadga muvofiqdir [7,8].

2. Tadqiqot metodikasi

Biz matematik model tuzish maqsadida iqtisodiy ko‘rsatkichlarning O‘zbekiston va Qirg‘iziston o‘rtasidagi yuk oqimi miqdoriga ko‘p regressiya usuli bilan ta’sirini o‘rganamiz.

3. Natija va muhokamalar

O‘zbekiston va Qirg‘iziston o‘rtasidagi yuk oqimini regressiya tahlili uchun quyidagi omillar ko‘rib chiqildi

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[3,4]:

- O‘zbekiston YAIM qiymati omili – X_1;
- Qirg‘iziston YAIM qiymati omili – X_2;
- O‘zbekiston va Qirg‘iziston o‘rtasidagi yuk oqimi ko‘rsatkichi - Y_t

O‘zbekiston va Qirg‘iziston o‘rtasidagi yuk oqimi ko‘rsatkichiga X_1, X_2, omillarining ta’sirini o’rganish va ular orasidagi korrellatsion bog’lanishni tahlil qilish, hamda regression modellar qurish masalasini ko’rib chiqamiz.

X_1, X_2 ta’sir omillarini ko‘rib chiqilayotgan statistik ma’lumotlari o‘rtasidaga bog‘liqlik mavjudligini miqdoriy baholash va tanlab olingan omillar yuk oqimiga bog‘liqligini sonli ko‘rsatkich bilan aniqlash imkonini beradi. Bu quyidagi formula orqali aniqlanadi:

$$r_{xy} = \frac{\sum(x_i - \bar{x}) \cdot (y_{1_i} - y_1)}{\sqrt{\sum(x_i - x)^2 \cdot \sum(y_{1_i} - \bar{y}_1)^2}}. \qquad (1.1)$$

bu yerda: X namunasida olingan qiymatlar;
y_1 - X uchun o‘rtacha qiymat;
$\bar{x}$ – X uchun o‘rtacha qiymat;
$\bar{y}_1$ – Y uchun o‘rtacha qiymat.

Buning uchun dastlab yuqoridagi ko’rsatkichlarning korrellatsiya koeffisentlarini hisoblaymiz. Regressiya tahlili uchun yillar bo‘yicha omillar statistikasi 1.1-jadvalda keltirilgan.

1.1-jadval

Regressiya tahlili uchun yillar bo‘yicha omillar statistikasi

№	Yil	X_1, mlrd. doll. AQSH	X_2, mlrd. doll. AQSH	Y_t - O‘zbekiston va Qirg‘iziston o‘rtasida yuk oqimi, mln. ton.
1	2017	62,08	7.70	0.8
2	2018	52.87	8.27	1.2
3	2019	60.28	9.37	1.3
4	2020	60.22	8.27	1.2
6	2021	69.6	9.24	1.6
7	2022	80.39	11.54	2.0
8	2023	90.9	13.7	1.4

O‘zbekiston va Qirg‘iziston o‘rtasidagi yuk oqimi ko‘rsatkich Y_t va X_1 omil uchun korrelyatsiya koeffitsienti $r_{xy1} = 0.828$ huddi shunday Y_t va X_2 uchun korrelyatsiya koeffitsienti $r_{xy2} = 0.863$ aniqlandi. Olingan korrelyatsiya taxlillari natijalarni olib shuni xulosa qilash mumkinki O‘zbekiston va Qirg‘iziston o‘rtasidagi yuk usish hajmi O‘zbekiston va Qirg‘iziston yalpi ichki maxsulotining o‘sish ko‘rsatkichlariga bog‘liq.

O‘zbekiston va Qirg‘iziston o‘rtasidagi yuk oqimining ko‘p omilli regressiyasining umumiy tenglamasi quyidagicha:

$$Y_t = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_t. \qquad (1.1)$$

bu yerda α_0, α_1, α_2 va – regressiya koeffitsientlari.

Tenglamaning noma’lum koeffitsientlarini matritsa usuli bilan aniqlaymiz:

$$A = (X^T \cdot X)^{-1} \cdot X^T \cdot Y_t, \qquad (1.2)$$

bu yerda A – regressiya tenglamasi koeffitsientlarining ustun vektori;
X^T – transpozitsiyalangan matritsasi;
X – n - qatorlar va (k) X_1, X_2, ta’sir qiluvchi ma’lum omillar ustunlarining o‘lchamlari matritsasi;
Y_t o‘lchovli kuzatuvlar vektori – ustuni (bu yerda n = 7 ga teng kuzatuvlar soni; k - 2 ga teng ta’sir qiluvchi omillar soni).

Matritsalarni tuzamiz.

$$X = \begin{Bmatrix} 1 & 62.08 & 7.70 \\ 1 & 52.87 & 8.27 \\ 1 & 60.28 & 9.37 \\ 1 & 60.22 & 8.27 \\ 1 & 69.60 & 9.24 \\ 1 & 80.39 & 11.54 \\ 1 & 90.9 & 13.7 \end{Bmatrix}; \; Y_t = \begin{Bmatrix} 0.8 \\ 1.2 \\ 1.3 \\ 1.2 \\ 1.6 \\ 2.0 \\ 1.4 \end{Bmatrix}$$

Keyin transpozitsiyalangan matritsani tuzamiz:

$$X^T = \begin{Bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 62.08 & 52.87 & 60.28 & 60.22 & 69.60 & 80.39 & 90.9 \\ 7.70 & 8.27 & 9.37 & 8.27 & 9.24 & 11.54 & 13.7 \end{Bmatrix}$$

E’tibor bering, $|X^T \cdot X|$ matritsaning determinanti $1{,}031 \cdot 10^{21}$ ga teng, ya’ni matritsa ($X^T \cdot X$) xato emas.

A matritsa elementlarining hisoblangan qiymatlaridan foydalanib, biz regressiya tenglamasini yozamiz:

$$Y_t = 2.77 + 0.0526 \cdot X_1 + 2.17 \cdot X_2 \qquad (1.3)$$

Olingan regressiya tenglamasining ahamiyatli ekanligini Fisherning F mezoniga (F - mezon) muvofiq tekshiramiz. Buning uchun regressiya teglamasi ahamiyatsiz, ya’ni barcha koeffetsiyentlar nolga tengligi haqidagi H_0 gipoteza tekshiriladi. Quyidagi mezonni kiritamiz:

$$F_{his} = \frac{\frac{1}{k} \cdot Q_R}{\frac{1}{n-k-1} \cdot Q_{\text{ост}}}. \qquad (1.4)$$

H_0 gipotezani tekshirish uchun (1.4) statistik mezondan foydalanamiz, ma'lumki bu tasodifiy miqdor erkinlik darajasi (k) va (n – k-1) bo’lgan F taqsimotiga ega.
Bu yerda
k – omillar soni, bizning holda 2 ga teng;
Q_R - og‘ish kvadratlarining yig‘indisi;
n – kuzatuvlar soni;
Q_{ost} - kuzatuv natijalarining og‘ish kvadratlari yig‘indisi.

$$Q_R = \sum_{i=1}^{n} (Y_t)^2, \qquad (1.5)$$

$$Q_{ost} = \sum_{i=1}^{n} (Y_t - \hat{Y}_t)^2. \qquad (1.6)$$

Fisher taqsimotining qiymatlar jadvalidan erkinlik darajasi (k) va (n – k-1) bo’lgan F_{krit} -qiymat topiladi. Gipotezani tekshirish qoidasiga ko’ra, agar $F_{his} > F_{krit}$ bo’lsa H_0 gepoteza rad etiladi. Aks holda H_0 gepotezani rad etishga asos yo’q deyiladi. Demak agar $F_{his} > F_{krit}$ tengsizlik o’rinli bo’lsa topilgan regressiya tenglamasi statistik ahamiyatli deyiladi, aks holda tenglama ahamiyatsiz bo’ladi. Agar regressiya tenglamasi ahamiyatsiz bo‘lsa, ya’ni tenglamaning barcha koeffitsientilari nolga

teng bo‘lsa, unda regressiya tenglamasini tahlil qilish mantiqiy emas. Regressiya tenglamasi uchun hisob-kitobni 1.2-jadvalga kiritamiz.

1.2-jadval

***F* - mezon bo‘yicha regressiya tenglamasining ahamiyatini tekshirish**

№	X_1	X_2	Y_t	$\hat{Y}_t$	$\hat{Y}_t^2$	$(Y_t - \hat{Y}_t)^2$
1	62.08	7.703	0.8	7.70	60.37	47.61
2	52.87	8.271	1.2	8.27	66.42	49.98
3	60.28	9.371	1.3	9.37	76.74	65.12
4	60.22	8.27	1.2	8.27	72.93	49.98
5	69.6	9.249	1.6	9.24	98.01	58.36
6	80.39	11.54	2.0	11.54	128.37	91.01
7	90.9	13.7	1.4	13.7	111.94	151.29
Q_R= 614.78		Q_{ost}= 513.35				

Ahamiyatlilik darajasida 0,05 bo‘lganda *F* – mezon bo‘yicha regressiya tenglamasining ahamiyatini, ya’ni nol gipotezani ushbu ifoda bo‘yicha tekshiramiz.

$$F_{his} = \frac{\frac{1}{2} \cdot 614.78}{\frac{1}{7-2-1} \cdot 513.35} = 22.71$$

F - taqsimot jadvaliga ko‘ra 0,05 ahamiyatlilik darajasi va 3 va 4 erkinlik darajalari uchun biz kritik qiymatni topamiz: F_{krit} (0.05; 3; 4)= 6.59 ga teng. Yuqorida takidlaganligidek $F_{his} > F_{krit}$ bo‘lganligi sababli H_0 gipotezasi rad etiladi. Olingan regressiya tenglamasi ahamiyatga ega.

Topilgan regressiya tenglamasini omillari oldiga koeffitsientlarining statistik ahamiyatli ekanligini tekshirish uchun Stuyudentning *t* testidan foydalanamiz.

t -mezonga ko'ra, ko'rsatkichlarning tasodifiy tabiati, ya'ni ularning noldan ahamiyatsiz farqi to'g'risida H_0 gipotezasi ilgari suriladi. Keyinchalik, baholangan $t_{факт}$ korrelyatsiya koeffitsienti uchun r_{xy} mezonining haqiqiy qiymatlari ularning qiymatlarini standart xato qiymatiga moslashtirish orqali hisoblanadi.

$$t_b = \frac{b}{m_b}; \quad t_a = \frac{a}{m_a}; \quad t_r = \frac{r_{xy}}{m_{r_{xy}}}.$$

Chiziqli regressiya va korrelyatsiya koeffitsienti parametrlarining standart xatolari quyidagi formulalar bilan aniqlanadi:

$$m_b = \sqrt{\frac{\sum(y-\hat{y}_x)^2/(n-2)}{\sum(x-\bar{x})^2}} = \sqrt{\frac{S_{ocm}^2}{\sum(x-\bar{x})^2}} = \frac{S_{ocm}}{\sigma_x\sqrt{n}};$$

$$m_a = \sqrt{\frac{\sum(y-\hat{y}_x)^2}{(n-2)} \cdot \frac{\sum x^2}{n\sum(x-\bar{x})^2}} = \sqrt{S_{ocm}^2 \frac{\sum x^2}{n^2\sigma_x^2}} = S_{ocm}\frac{\sqrt{\sum x^2}}{n\sigma_x};$$

$$m_{r_{xy}} = \sqrt{\frac{1-r_{xy}^2}{n-2}}.$$

Styudentning t –statistikasining haqiqiy va kritik (jadval) qiymatlarini taqqoslash natijasida, ya’ni t_{kr} va t_{his} qiymatlarni taqqoslab H_0 gipotezasini qabul qilanadi yoki rad etiladi.

t_{kr} - qiymat berilgan erkinlik darajasi $k = n-2$ da *va* ahamiyatlilik darajasi $\propto da$ tasodifiy omillar ta'sirida mezonning mumkin bo’lgan eng katta qiymati.

Fisherning *F* -mezoni ($k = 1; m = 1$) va *t* – Styudent mezoni o’rtasidagi bog’liqlik quyidagi tenglama bilan ifodalanadi:

$t_r^2 = t_b^2 = t_r^2 = \sqrt{F}$.

Agar $t_{табл} < t_{факт}$ bo'lsa, u holda H_0 rad etiladi, ya'ni a, b va r_{xy} koeffitsientilarni noldan farq qilishi tasodifiy emas va omillarni tizimli ta'siri ostida hosil bo'ladi. Agar $t_{табл} > t_{факт}$ bo'lsa, H_0 gipoteza rad etilmaydi va a, b yoki r_{xy} koeffitsientilar tasodifiy xarakterga ega.

4. Xulosa

Xulosa qilib aytganda, O‘zbekiston va Qirg‘iziston o‘rtasidagi yuk oqimi yildan yilga oshib bormoqda va bog’liklik borligi va ma’lumotlar ishonchliligi namoyon bo’ldi. O‘zbekiston va Markaziy Osiyo davlatlari bilan ham o‘rtasidagi yuk oqimi modellarini ishlab chiqish zarur.

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