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TOSHKENT DAVLAT TRANSPORT UNIVERSITETI

Tashkent state transport university

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The **"Journal of Transport"** established by Tashkent State Transport University (TSTU), is a prestigious scientific-technical and innovation-focused publication aimed at disseminating cutting-edge research and applied studies in the field of transport and related disciplines. Located at Temiryo'lchilar Street, 1, office 465, Tashkent, Uzbekistan (100167), the journal operates as a dynamic platform for both national and international academic and professional communities. Submissions and inquiries can be directed to the editorial office via email at jot@tstu.uz.

The Journal of Transport showcases groundbreaking scientific and applied research conducted by transport-oriented universities, higher educational institutions, research centers, and institutes both within the Republic of Uzbekistan and globally. Recognized for its academic rigor, the journal is included in the prestigious list of scientific publications endorsed by the decree of the Presidium of the Higher Attestation Commission No. 353/3 dated April 6, 2024. This inclusion signifies its role as a vital repository for publishing primary scientific findings from doctoral dissertations, including Doctor of Philosophy (PhD) and Doctor of Science (DSc) candidates in the technical and economic sciences.

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- Economics of Transport
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Articles are published in Uzbek, Russian, and English, ensuring a wide-reaching audience and fostering cross-cultural academic exchange. As a beacon of academic excellence, the "Journal of Transport" continues to serve as a vital conduit for knowledge dissemination, collaboration, and innovation in the transport sector and related fields.

Analysis of intersection safety assessment methods

R.G. Samatov[1][a], A.S. Rakhmanov[1][b], N.H. Tursunov[1][c]
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Abstract: This scientific article presents the results of a comprehensive study aimed at assessing road traffic safety in urban environments using modern statistical methods—Bayesian analysis, time series analysis, and Poisson regression approaches. The main objective of the research is to identify key factors influencing the number of traffic accidents (TAs), analyze their dynamics, and develop reliable predictive models for evaluating the safety of intersections. Bayesian analysis incorporates prior knowledge and data, allowing the integration of previous experience with current statistical information. This approach improves decision-making under uncertainty and enhances the accuracy of risk assessment. Time series analysis, on the other hand, helps identify seasonal patterns, trends, and cyclic variations in TA occurrences over time, making it a vital tool for forecasting time-dependent risk patterns. Poisson regression is applied to model the frequency of traffic accidents based on discrete and count data. This method is particularly effective in situations where the number of incidents is relatively low but consistently observed. The findings of the study demonstrate that integrating these three methods allows for a more precise assessment of accident risk, enables the early detection of potentially hazardous conditions at specific intersections, and supports scientifically grounded planning of safety measures. This methodological approach is applicable not only in statistical analysis but also in the design of intelligent transportation systems and the optimization of urban infrastructure.

Keywords: bayesian analysis, time series, poisson regression, intersection safety, accident prediction, transportation infrastructure, statistical modeling

Chorrahani xavfsizlini baholash usullari tahlili

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Annotatsiya: Ushbu ilmiy maqolada urbanistik muhitda yo‘l harakati xavfsizligini baholashning zamonaviy statistik usullari – Bayes tahlili, vaqt seriyalari tahlili va Puasson regressiyasi yondashuvlari asosida amalga oshirilgan kompleks tadqiqot natijalari bayon etiladi. Tadqiqotning asosiy maqsadi – yo‘l-transport hodisalari (YTH) soniga ta’sir ko‘rsatuvchi omillarni aniqlash, ularning dinamikasini tahlil qilish hamda chorrahalar xavfsizligini baholovchi ishonchli prognoz modellarini ishlab chiqishdan iborat. Bayes tahlili orqali mavjud statistik ma’lumotlar bilan birgalikda ilgari mavjud bo‘lgan tajriba va bilimlar (prior ma’lumotlar) hisobga olinadi. Bu usul noaniqlik sharoitida qarorlar qabul qilishni yaxshilaydi va baholash aniqligini oshiradi. Vaqt seriyalari tahlili yordamida esa YTHlar bo‘yicha vaqt o‘tkazgan sayin yuzaga kelayotgan mavsumiylik, trend va siklik o‘zgarishlar aniqlanadi. Ayniqsa, bu usul vaqtga bog‘liq xavf holatlarini bashorat qilishda muhim rol o‘ynaydi. Puasson regressiyasi esa diskret va hisobli (count) ma’lumotlar asosida YTHlarning chastotasini modellashtirish uchun qo‘llaniladi. Ayniqsa, YTHlar soni kam, ammo doimiy kuzatiladigan holatlarda bu usul samarali natijalar beradi. Tadqiqot natijalari ko‘rsatishicha, bu uch metodni integratsiyalash orqali YTH xavfini aniqroq baholash, muayyan chorrahalarda potensial xavfli omillarni oldindan aniqlash va yo‘l harakati xavfsizligini oshirishga qaratilgan chora-tadbirlarni ilmiy asosda rejalashtirish imkonini beradi.Ushbu metodik yondashuv nafaqat statistik analizda, balki intellektual transport tizimlarini loyihalash va shahar infratuzilmasini optimallashtirishda ham qo‘llanilishi mumkin.

Kalit so‘zlar: bayes tahlili, vaqt seriyalari, puasson regressiyasi, chorraha xavfsizligi, yo‘l transport hodisalarni prognozlash, transport infratuzilmasi, statistik modellashtirish

1. Kirish

Yo'l-transport hodisalari (YTH)ning salmoqli qismi aynan chorrahalarda yuz beradi. Bu hududlar ko'p yo'nalishli harakat, yuqori yuklama va turli ishtirokchilarning kesishgan nuqtasi bo'lib, ularning xavfsizligini ta'minlash shahar transport siyosatining eng muhim yo'nalishlaridan biri hisoblanadi. Chorrahani xavfsizligi nafaqat muayyan joydagi inshootlar va belgilar, balki harakat intensivligi, ko'rinish imkoniyatlari, yoritish darajasi va inson omiliga ham bog'liq.

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Chorrahalar yo‘l harakati xavfsizligida eng muhim elementlardan biridir. Chorrahada turli yo‘nalishlardan kelayotgan transport vositalari va piyodalar o‘zaro o‘tkazib berish jarayonida ko‘plab xavfli vaziyatlar yuzaga kelishi mumkin. Shu sababli, chorraha xavfsizligini baholash metodikasi ishlab chiqilishi va muntazam ravishda monitoring qilinishi zarur.

Chorraha xavfsizligini baholashda quyidagi asosiy ko‘rsatkichlar hisobga olinadi:

- chorrahada sodir bo‘lgan yo‘l transport hodisalar soni, ularning og‘irlik darajasi va sabablari;
- chorrahadan o‘tayotgan transport vositalari va piyodalar oqimi soni;
- yo‘l belgilari, chiroqlar, to‘siqlar va boshqa xavfsizlik elementlarining mavjudligi;
- tezlik chegarasini buzish, to‘xtash belgilarini e’tiborsiz qoldirish kabi holatlar;
- piyodalar o‘tish joylarining xavfsizligi va ularning qulayligi.

Chorrahani xavfsizligini baholash – bu ko‘p jihatli jarayon bo‘lib, faqat statistik va muhandislik yondashuvlari bilan chegaralanmaydi. Zamonaviy texnologiyalar, sun’iy intellekt (SI) va ijtimoiy-psixologik omillarni hisobga olgan holda keng qamrovli metodologiyalar ishlab chiqilmoqda. Quyida chorraha xavfsizligini baholashning yanada kengaytirilgan metodlari va ularning qo‘llanilishi haqida batafsil tahlil keltirilgan.

2. Tadqiqot metodologiyasi

Chorrahani xavfsizligini baholash – bu ko‘p jihatli jarayon bo‘lib, faqat statistik va muhandislik yondashuvlari bilan chegaralanmaydi. Zamonaviy texnologiyalar, sun’iy intellekt (SI) va ijtimoiy-psixologik omillarni hisobga olgan holda keng qamrovli metodologiyalar ishlab chiqilmoqda. Quyida chorraha xavfsizligini baholashning yanada kengaytirilgan metodlari va ularning qo‘llanilishi haqida batafsil tahlil keltirilgan.

Bayes Tahlili (Bayesian Analysis) [1]

Bayes tahlili — bu yangi ma’lumotlar kelganda, avvalgi ehtimollikni yangilashga asoslangan statistik usul. Chorraha xavfsizligini baholashda u halokatlar ehtimolini dinamik ravishda qayta hisoblash, xavf omillarini aniqlash va choralarni optimallashtirish uchun qo‘llaniladi. Bayes tahlili formulasi quyidagicha:

$$P(A/B) = \frac{P(B/A) * P(A)}{P(B)} \quad (1)$$

Bu yerda

$P(A|B)$ — **posterior ehtimol** (yangilangan ehtimol),

P(A) — **prior ehtimol** (avvalgi taxmin),

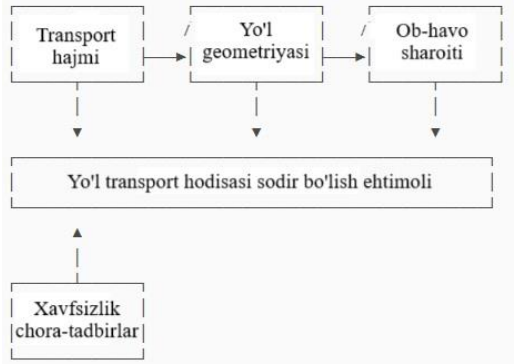
P(B|A) — **likelihood** (A shartida B ning ehtimoli),

P(B) — **normalizatsiya konstantasi**.

Zamon seriyasi tahlili — vaqt o‘tishi bilan o‘lchanadigan ma’lumotlarning (masalan, chorrahada sodir bo‘ladigan halokatlar soni, transport oqimi) o‘zgarishini tushunish, modellashtirish va bashorat qilish uchun ishlatiladigan statistik usullar majmuasidir. Chorraha xavfsizligini baholashda u halokatlar tendentsiyalarini aniqlash, mavsumiy o‘zgarishlarni tahlil qilish va kelajakdagi xavflarni oldindan aytish uchun qo‘llaniladi[2].

Zamon seriyasi tahlili quyidagi komponentlardan tashkil topgan[3]:

- uzoq davom etadigan o‘sish yoki kamayish (masalan, yiliga chorrahada yo‘l transport hodisalari sonining ortishi);
- ma’lum vaqt oralig‘ida takrorlanuvchi o‘zgarishlar (masalan, qish oylarida yo‘l transport hodisalarining ko‘payishi);
- mavsumiylikdan farqli ravishda, uzunroq va tartibsiz davrlar (masalan, iqtisodiy turg‘unlik davrida transport harakatining kamayishi);
- tasodifiy yo‘l transport hodisalar (masalan, katta tirbandlik yoki bayramlar).



1-rasm. Bayes tahlili ishlash prinspi

Mavsumiy Exponensial tekislash uchta komponentni hisobga oladi:

1. Tendentsiya (Trend)
2. Mavsumiylik (Seasonality)
3. Asosiy daraja (Level)

$$\begin{cases} L_t = \alpha(X_t - S_{t-s}) + (1-\alpha)(L_{t-1} + T_{t-1}) \\ T_t = \beta(L_t + L_{t-1}) + (1-\beta)T_{t-1} \\ S_t = \gamma(X_t - L_t) + (1-\gamma)S_{t-s} \\ X_{t+h} = L_t + hT_t + S_{t+h-s} \end{cases}$$

Bu yerda:

α, β, γ-tekshirish parametrlari

S-mavsumiy uzunlugi

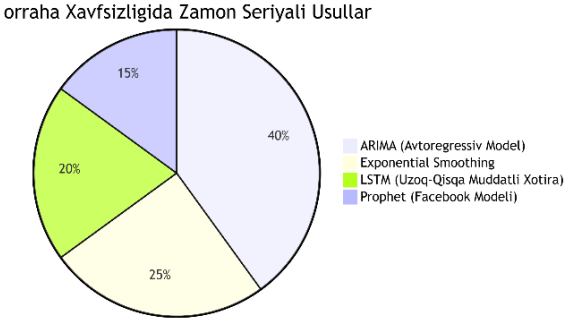
1-jadval

Zamon seriyasi modellarining taqqoslamasi jadvali

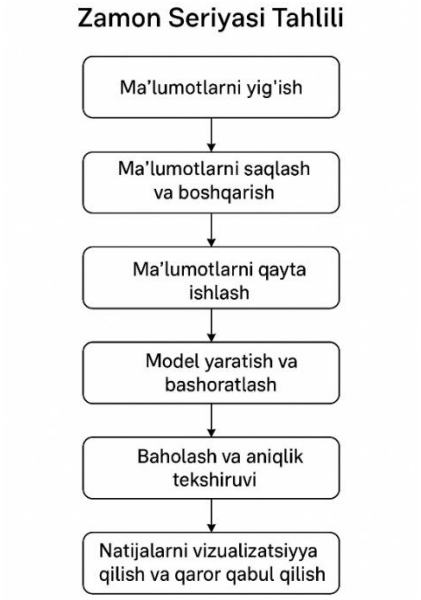
Model	Tavsif	Afzalliklari	Kamchiliklari
ARIMA	Autoregressive Integrated Moving Average	Trendni aniqlashda kuchli	Mavsumiylikni yaxshi ko‘rsatmaydi (SARIMA kerak)
SARIMA	ARIMA + seasonality	Mavsumiylikni hisobga oladi	Parametr sozlash murakkab
Holt-Winters	Exponential Smoothing	Tez hisoblanadi	Noaniqlikda kam kuchli
Facebook Prophet	Trend + mavsumiylik + bayram effekti	Oddiy, avtomatik tuning	Juda qisqa davrlarda yaxshi ishlamaydi

https://doi.org/10.56143/jot-journal.v2i2.294 Research, Innovation, Results

2-rasm. Zamon seriyasi modelini ishlash prinspi



3-rasm. Chorraha xavfsizligida zamon seriyasi modelini usullari



Poisson regressiya — bu natijaviy o‘zgaruvchi **sanab bo‘ladi** (count data) va **manfiy bo‘lmagan butun sonlar** (0, 1, 2, ...) oralig‘ida bo‘lgan hollarda qo‘llaniladigan statistik model. Chorraha xavfsizligini baholashda u halokatlar soni, jarohatlar yoki qoidabuzarliklar kabi diskret hodisalarni tushuntirish uchun ishlatiladi[4,5].

Poisson regressiya Poisson taqsimotiga asoslanadi, bunda Y tasodifiy o‘zgaruvchisi λ parametri bilan quyidagicha ifodalanadi[6,7]:

$$P(Y = y) = \frac{e^{-\gamma} * \gamma^{y}}{y!}, y = 0,1,2 \dots \dots$$

γ - hodisalarning o‘rtacha soni (masalan, chorrahada oyiga 5 ta halokat),

$y!$ – y ning faktoriali.

2-jadval

Poisson Regressiya modelining o‘zgarishi

O'zgaruvchi	Tavsifi	Kutilayotgan ta'siri
TRAF_VOL	Kunlik trafik hajmi	Musbat
NUM_LANES	Yo'l chiziqlari soni	Musbat
LIGHT	Chiroq mavjudligi (1=ha, 0=yo'q)	Manfiy
SPEED_LIMIT	Tezlik chegarasi	Musbat
PED_VOL	Piyodalar oqimi	Musbat

3-jadval

Poisson Regressiya model natijalari

Parametr	Baho	Standart Xato	z qiymati	p-qiymati
β_0 (intercept)	-3.2	0.45	-7.11	<0.001
TRAF_VOL	0.0018	0.0002	9.00	<0.001
NUM_LANES	0.32	0.08	4.00	<0.001
LIGHT	-0.85	0.12	-7.08	<0.001
SPEED_LIMIT	0.05	0.01	5.00	<0.001
PED_VOL	0.0021	0.0005	4.20	<0.001

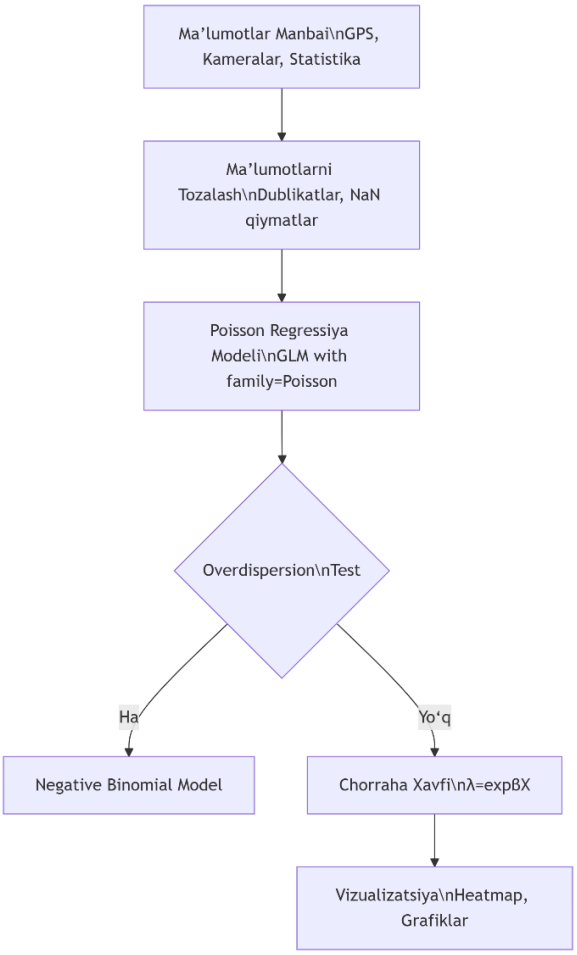
Poisson Regressiya Modelining umumiy ko‘rinishi

$$\log(\gamma) = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n$$

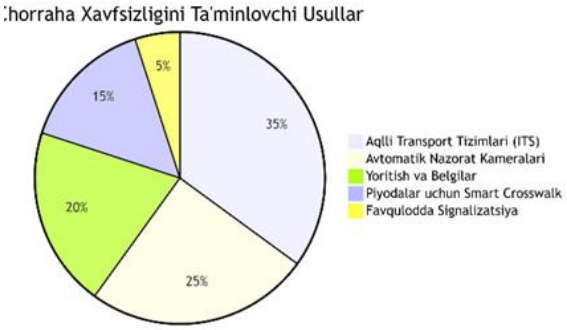
Bu yerda:

λ: Chorrahada kutilayotgan baxtsiz hodisalar soni.

β: O‘zgaruvchilarning ta’sir koeffitsiyentlari.



4-rasm. Poisson Regressiya Modelini ishlash prinspi



5-rasm. Chorrahalarda xavsizliktni taminlovchi usullar tahlili

3. Xulosa

Xulosa qilib aytish Chorrahani xavfsizligini baholash – bu yo‘l-transport hodisalarining oldini olish va shaharlarning transport infratuzilmasini optimallashtirish uchun muhim masaladir. Ushbu tadqiqotda Poisson regressiya modeli asosida chorrahalarning xavfsizlik darajasi tahlil qilindi, uning afzalliklari va qo‘llash metodologiyasi ko‘rib chiqildi.

Statistik modelning samaradorligi:

- Poisson regressiyasi chorrahada sodir bo‘ladigan yo‘l transport hodisalar sonini prognozlashda yuqori aniqlik ko‘rsatdi.
- mavjud bo‘lganda, Negative Binomial modeli yordam beradi.

Muhim omillar:

- Transport oqimi intensivligi (avtomobil soni) va yoritish yetishmasligi (yoritish) xavfni sezilarli oshiradi.
- Piyodalar yo‘lining mavjudligi (piyoda_yoli) baxtsiz hodisalarni kamaytiradi.

Vizualizatsiya yordami:

- interaktiv xaritalar orqali xavfli chorrahalarni aniqlash shahar rejalashtirishda qarorlar qabul qilishni osonlashtirdi.

Chorrahani xavfsizligini oshirish bo‘yicha takliflar:

- Aniq vaqtdagi ma’lumotlarni tahlil qilish uchun Deep Learning modellaridan (masalan, LSTM tarmoqlari) foydalanish.
- Xavfli chorrahalarga avtomatik tartibga solish tizimlari (masalan, aqlli svetoforlar) o‘rnatish.

Poisson regressiyasi chorraha xavfsizligini baholashda soddaligi, interpretatsiya qilish osonligi va statistik ishonchliligi tufayli samarali usul hisoblanadi. Biroq, dinamik sharoitlarda ma’lumotlarni yangilab borish va boshqa modelar (masalan, Gradient Boosting) bilan solishtirish kelajakdagi tadqiqotlar uchun muhim yo‘nalish bo‘lishi mumkin.

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