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RESEARCH, INNOVATION, RESULTS



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Method for calculating the share of vehicles searching for parking in traffic congestion on multi-lane roads

G.Kh. Khalilova¹^a, A.S. Rakhmonov¹^b, R.G. Samatov¹^c

¹Tashkent state transport university, Tashkent, Uzbekistan

Abstract: This article examines the issue of searching for parking and stopping along central urban streets, particularly those with a high concentration of socio-economic facilities. It is observed that parked vehicles along the roadside reduce road capacity, increase congestion, and disrupt the flow of traffic for other vehicles. A method has been developed to calculate the share of vehicles searching for parking in overall traffic congestion.

The impact of parked vehicles on overall traffic flow has been analyzed, and regulatory recommendations have been proposed. The study specifically focuses on the areas around Chorsu Bazaar, including Beruniy, A. Navoi, and Sakichmon streets, using observational and mathematical modeling techniques. The influence of parked and parking-seeking vehicles on traffic flow has been assessed, and their contribution to congestion has been quantified. The results indicate that, on average, vehicles searching for parking account for approximately 32% of traffic congestion in the studied areas. Due to the high demand for parking near socio-economic facilities, the average time spent searching for a parking spot was found to be between 6 and 10 minutes.

Keywords: Traffic congestion, parking, space searching, time, multi-lane roads, observation method, city centers, vacant spaces, pricing, efficiency improvement

Ko'cha chetida turargoh qidirgan avtomobillarning tirbandlikdagi ulushini hisoblash uslubi

Khalilova G.Kh.¹^a, Raxmonov A.S.¹^b, Samatov R.G.¹^c

¹Tashkent davlat transport universiteti, Toshkent, O'zbekiston

Annotatsiya: Ushbu maqolada, shahar markaziy ko'chalarida ayniqsa, atrofida ijtimoiy-iqtisodiy obyektlar ko'p bo'lgan ko'chalarda turargoh qidirish, ko'cha chetida to'xtab turish holatlarini uchratamiz. Yo'l chetida to'xtab turgan avtomobillar sababli yo'lining o'tkazuvchanlik qobiliyati pasayishi, tirbandlikning ortishi va to'xtamoqchi bo'lgan avtomobillarning yo'ldan o'tayotgan transport oqimiga halaqit berish holatlariga ko'p guvoh bo'lganmiz. Ko'chada turargoh qidirib yurgan transport vositalarining tirbandlikdagi ulushini hisoblash usuli ishlab chiqilgan.

Ko'cha chetida to'xtab turgan transport vositalarining umumiy yo'ldagi avtomobillarga ko'rsatadigan ta'siri tadqiq qilinib, tartibga solish bo'yicha tavsiyalar ishlab chiqilgan. Maqolada Chorsu bozori atrofi Beruniy, A.Navoiy, Sakichmon ko'chalari kuzatish, matematik hisob-kitoblar usullari orqali yo'ldagi transport vositalariga ko'cha chetiga to'xtab turgan va to'xtamoqchi bo'lgan avtomobillarning ta'siri hisoblab chiqilgan. Shu bilan birga ko'cha chetida to'xtab turgan avtomobillarning tirbandlikdagi ulushi hisoblab topilgan. Ushbu ulush tadqiq etilgan ko'chalarda o'rtacha 32 % ni tashkil etgan. Avtomobillarning ijtimoiy-iqtisodiy obyektlar atrofida avtoturargohga bo'lgan talabi yuqori bo'lganligi sababli, ko'chada joy izlab yurish vaqti tadqiq etilganda o'rtacha 6-10 minutni tashkil etishi aniqlandi.

Kalit so'zlar: Tirbandlik, avtoturargoh, joy qidirish, vaqt, ko'p palasali yo'l, kuzatish usuli, shahar markazlari, bo'sh joy, narxlash, samarasini oshirish

1. Kirish

Avtomobillar har bir manzilga borishi bilan to'xtab turishi kerak. Shaxsiy transport vositalari har kuni o'rtacha 20 soat to'xtab turish holatida bo'ladi va bir nechta avtoturargohdan foydalanadi. Hozirda avtoturargoh muammolariga shahar rejalashtiruvchilari, operatorlar, dizaynerlar duch kelmoqda. Bu esa ta'minot nuqtai nazaridan (juda kam joylar) yoki boshqaruv jihatidan

(mavjud imkoniyatlardan foydalanish) yuzaga kelayotgan muammo hisoblanadi [1].

Ko'pgina avtoturargohlarda tashkil etilgan tizimlar unchalik murakkablikka ega emas va ular avtoturargohga bo'lgan talabni 5-15% gacha kamaytirishi mumkin. Lekin avtoturargohlarni tashkil qilishdagi keng qamrovli dastur belgilangan hududdagi turargohga bo'lgan talabni 20-40 % gacha qisqartirishi mumkin.

^a <https://orcid.org/0009-0009-7448-7898>

^b <https://orcid.org/0000-0003-1640-8839>

^c <https://orcid.org/0009-0007-4701-2518>



Avtoturargoh qidirishning o'rtacha vaqti yirik shaharlarda 18-20 daqiqa [2], o'rtacha shaharlarda 6-14 daqiqani tashkil qiladi. Ko'chalardagi tirbandlikning esa 33 foizini avtoturargoh qidirib yuradigan avtomobillar tashkil etadi. [3].

Shahar ko'chalarida avtomobillarning ko'cha chetidan turar joy qidirish tirbandlik darajasining oshishiga sabab bo'lmoqda. Ammo, tirbandlikning hosil bo'lishiga avtoturargohning yetishmasligi va haydovchilarning b'sh joy izlashi qanchalik darajada ta'sir ko'rsatishini aniqlash bir muncha qiyin masaladir [4].

Ishlash tartibiga ko'ra avtoturargohlar quyidagilarga bo'linadi:

1.Cheklanmagan ish vaqti bilan;

2.Avtomobilning turish vaqtini cheklash;

3.Cheklangan (bir ish kunida) ish vaqti bilan;

Ikkinchi turdagi avtoturargohdan tirbandlik va yurish cheklanishi yuzaga kelgan sharoitli joylarda qo'llaniladi. Masalan, g'arb mamlakatlari ayrim shaharlarida yo'l chetida to'xtash joylari tashkil etilgan bo'lib, ular "yashil zona" deb ataladi. Bu zonada to'xtab turish vaqti 1,5 soatdan oshmasligi kerak. Ammo, bu zonadan foydalanuvchi ishga kelgan shaxslar uchun bu cheklovlar amal qilmaydi.

1-jadvalda dunyoning rivojlangan shaharlari ko'chalaridagi tirbandlikka avtoturargoh qidirib yurgan transport vositalarining ulushi va ularning o'rtacha joy izlashga ketadigan vaqtlari keltirilgan.

1-jadval

Shaharlar ko'chalarida turargoh qidirgan avtomobillarning tirbandlikdagi ulushi va joy izlashga ketgan o'rtacha vaqt

Yil	Shahar	Tirbandlikdagi ulushi	O'rtacha joy qidirish vaqti
1977	Freiburg	74 %	6 daqiqa
1985	Cambridge	30 %	11,5 daqiqa
1993	Nyu York	8 %	7,9 daqiqa
2007		45%	
2008			3,8 daqiqa
2005	Los Angeles	68 %	3,3
2011	Barselona	18 %	
2015	Brisbane		15,4
2001	Sydney		6,5 daqiqa

Ushbu yuqorida ko'rsatilgan ma'lumotlardan aytishimiz mumkinki, avtoturargoh va undan joy izlashning tirbandlikka ta'siri sezilarli darajada ekan.

2. Tadqiqot metodologiyasi

Hozirgi kunda transport vositalarining ko'payishi va boshqarilmaydigan avtoturargohlarning tashkil etilishi, avtomobillarning to'g'ri va qulay tarzda to'xtab turish joyiga borishini qiyinlashtirmoqda. Shu sababli samarali va aqlli to'xtash tizimini tashkil etishga ehtiyoj tug'ilmoqda. Avtoturargohni boshqarishning aqlli tizimi haydovchiga ko'plab qulayliklar yaratadi. Bu tizim asosan, tig'iz yo'llarda avtoturargoh qidirishdagi yo'qotishlarni kamaytiradi. Aniq prognoz, real vaqt rejimida avtoturargohdagi bo'sh joyni aniqlash, joyni band qilish va to'lov qilish orqali ortiqcha vaqt, yonilg'i sarflanmaydi. Shu bilan birga, atmosferaga zararli gazlar chiqish va haydovchining psixofiziologik holati yomonlashishining oldi olinadi. Ayniqsa, ijtimoiy-iqtisodiy ob'ektlar atrofida avtomobilni turar joyga joylashtirish haydovchilar uchun asabiy holatdir. Avtomobillarning turargoh izlash natijasidagi tirbandligi va undan kelib chiqadigan muammolarning yagona yechimi "aqlli avtoturargoh" tizimidir.

Bu tizimdan foydalanish butunlay internetga asoslangan va yuqori tezlikdagi tarmoqdan foydalanish kerak. Shuningdek, kameralar, sensorlar va display blokini o'z ichiga olgan avtomatik tahlil tizimiga bog'liq bo'lganligi sababli aqlli avtoturargohlar tizimi murakkablashadi.

Shahar transportining asosiy muammolarida bu avtomobillar to'xtab turish joyi hisoblanadi. Aqlli avtoturargoh tizimi bu masalani bartaraf etishda ko'plab

imkoniyatlarga ega, ammo bu tizimni tashkil qilish uchun yangi arxitektura, telematik vositalar va boshqarish funksiyalari talab etiladi. Faqatgina zamonaviy boshqaruv tizimi avtomobil to'xtash joyiga oshib borayotgan ehtiyojni tartibli ravishda hal qiloladi.

Aqlli avtoturargoh tashkil qilish maqsadlari:

-Avtoturargoh talab va taklifni balansda ushlash.

-Innovatsion avtoturargohlar boshqaruvini joriy etish;

-Mobil ilovalar orqali tezda turargohlarni topish.

Shu tarzda, Babik va boshqalar ta'kidlaganidek [12], shahar joylari tezroq harakatlanishga, osonroq avtomobillarni to'xtash joyiga yetkazishga, mavjud avtoturargohlardan samarali foydalanishni ta'minlashi orqali foyda olishlari mumkin.

Aqlli avtoturargohning o'ziga xos sifatleri quyidagicha va ular muammolariga yechim bo'ladi.

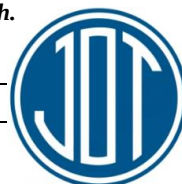
1) **Real vaqt rejimida bo'sh joy mavjudligi haqida ma'lumot berish.** Amerikaliklar yiliga o'rtacha 17 soatni to'xtash joyiga sarflaydi. Ushbu faktning asosiy sababi to'xtash joylarining yetishmasligi emas, balki mavjud avtoturargohlardan samarasiz foydalanishdir.

Yechim: Haydovchiga eng yaqin avtoturargohdan bo'sh joy mavjudligi haqidagi ma'lumotlarni yetkazish orqali haydovchining to'xtash joyini qayerdaligini aniq bilishi va qidirib yurishini oldini olish mumkin. Bu tizim orqali xaotik harakatdan chinakam aniq, aqlli tizimga o'tish mumkin.

2) **Intellektual avtoturargohlar infratuzilmasi.**

Eski infratuzilma umumiy xavfsizlik yoki avtoturargoh tizimini buzilishiga olib keladi. Agar eski to'lov tizimi hisoblagichlari yaxshi ishlamasa yoki boshqa uskunalar buzilishi umuman infratuzilmalarning yo'q bo'lishidan ham xavfliroqdir.

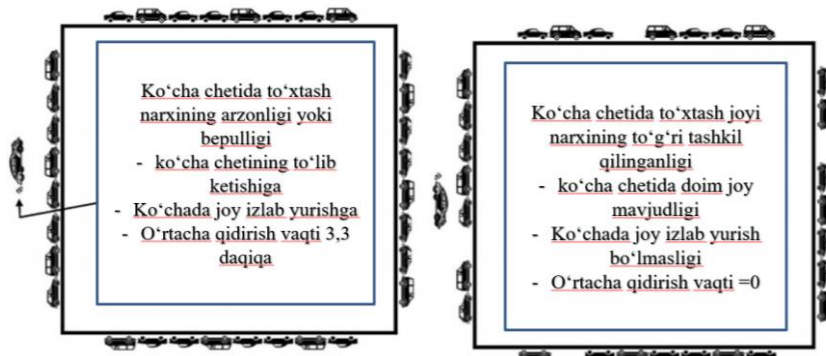
3) **Avtoturargohlarni avtomatlashtirish.**



Avtoturargohlar bilan bog'liq ko'plab murakkab qoidalar mavjud bo'lib, ular tufayli haydovchilar oddiy xatolarga yo'l qo'yadi. Murakkab tizim to'xtash joyini topishni osonlashtirmaydi.

4) Tarmoqqa ulanish.

Intellektual to'xtash joylari yo'nalishni aniqlash, elektron to'lov tizimi, ma'lumotlarni to'plash va tahlil qilish, shuningdek, boshqa qo'shimcha xizmatlar va imkoniyatlarni yaratadi. Ochiq Web-interfeyslar yordamida murakkab va moslashuvchan xizmatlar tashkil etish mumkin.



1-rasm. Ko'cha chetida to'xtash joyi narxini tashkil qilish

3. Natijalar va muhokamalar

Yurtimiz ba'zi markaziy ko'chalarida avtoturargoh qidirishdan yuzaga kelayotgan muammolar o'rganilib, tahlil qilindi.

Toshkent shahar Chorsu bozori atrofida ko'cha cheti to'xtash joylarining tirbandlikka ta'siri o'rganildi (2-rasm).

Ko'cha cheti turar joylarning oqimdagida tirbandlikka ta'sirini o'rganish uchun quyidagicha jadval tayyorlanib, kerakli ma'lumotlar kuzatuv usuli orqali olinib to'ldirildi.

Bunda, turargohga 1-avtomobil kirishidan oldin o'tib ketgan avtomobillar soni, o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar soni, har bir holat uchun o'tib ketgan avtomobillarning kuzatishlar soniga ko'paytmasi kabi ko'rsatkichlar kuzatish orqali aniqlangan. Ushbu ko'rsatkichlar natijalari tahlil qilinib, formulalar asosida

Avtoturargohlarning tirbandlikka ta'siri, yo'lning o'tkazuvchanlik qobiliyatini kamaytiruvchi omillar va shu kabi masalalarni hal qilish borasida Donald Shoup [5] ko'cha chetidagi avtoturargohlarni to'g'ri narxlash g'oyasini taklif etadi. Bunda u ko'cha chetidagi avtoturargoh ko'chadan tashqaridagi avtoturargoh narxiga teng yoki undan yuqori narxlashni taklif etadi. Ya'ni, ko'cha chetidagi avtoturargoh past narxlanisa yoki bepul bo'lsa, haydovchilar ko'proq avtomobilini ko'cha chetiga joylashtirishga harakat qiladi. Oqibatda tirbandlik yuzaga kelib, turli xil muammolarni yuzaga keltiradi (1-rasm).

tirbandlikdagi avtomobillarning nechi foiz qismi avtoturargoh qidirgan avtomobillar hisobiga to'g'ri kelishi aniqlandi.



2-rasm. Chorsu bozori atrofi A.Navoiy ko'chasi holati

2-jadval

Turargoh qidirgan avtomobillarning tirbandlikdagi ulushini hisoblash ma'lumotlari

Turargohga avtomobil kirishidan oldin o'tib ketgan avtomobillar soni	1- o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar soni, n	O'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar soni, n	Har bir kuzatishning umumiy kuzatishdagi ulushi	Foizlarning yig'indisi (har bir satr uchun umumiy yig'indiga nisbatan foiz)	Har bir holat uchun o'tib ketgan avtomobillarning kuzatishlar soniga ko'paytmasi
1	28	28	31%	31%	28
2	18	18	19 %	50%	36
3	12	12	13%	63%	36
4	18	18	19%	82%	72
5	6	6	6%	88%	30
6	4	4	4%	92%	24
7	4	4	4%	96%	28
8	2	2	2%	98%	16
9	2	2	2%	100%	18
Umumiy	94	94	100 %		288

Yuqoridagi jadval ma'lumotlari asosida quyidagi amallarni bajarib, tirbandlikdagi ulushni topishimiz mumkin (1).

Bunda ρ avtoturargoh qidirgan avtomobillarning umumiy tirbandlikdagi ulushi hisoblanadi.

$$\rho = \frac{n}{\sum_{i=1}^n x_i} = 0.32 \quad (1)$$



$$\sum_{i=1}^n X_1 = 28 * 1 + 18 * 2 + 12 * 3 + 18 * 4 + 6 * 5 + 4 * 6 + 4 * 7 + 2 * 8 + 2 * 9 = 288$$

Bu yerda:

n – kuzatuvlar soni

$\sum_{i=1}^n X_1$ – nechinci bo'lib kirgan avtomobil va ularning umumiy soning yig'indisi

Quyida formula orqali dispersiya va ishonch oralig'ini aniqlaymiz (2,3).

Baholash dispersiyasi:

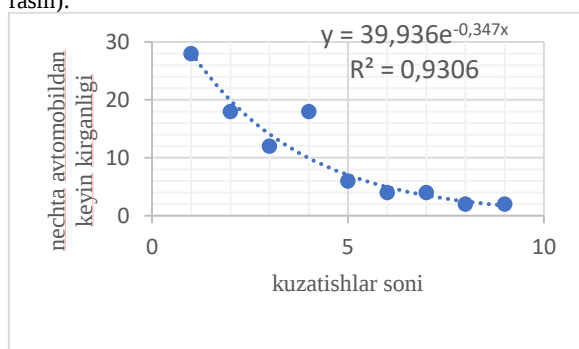
$$\sigma^2 = \frac{\rho^2 * (1 - \rho)}{n} = 0,027 \quad (2)$$

93 % ishonch oralig'i:

$$\rho \pm 1,96\sigma \quad (3).$$

$$0,26 \leq \rho \leq 0,37$$

Turargohga 1-avtomobil kirishidan oldin o'tib ketgan avtomobillar soni va o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar sonining bog'liqligi quyidagicha (3-rasm):

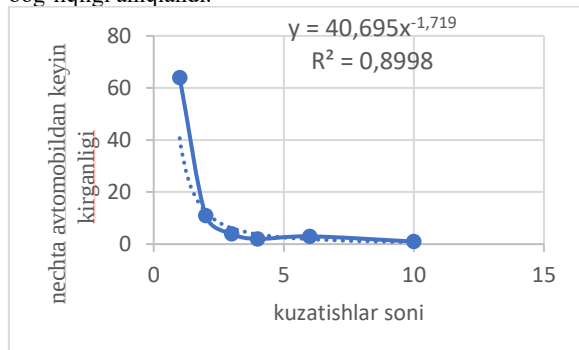


3-rasm. A.Navoiy ko'chasi yo'l chetiga 1-avtomobil to'xtashidan oldin o'tib ketgan avtomobillar soni va o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar sonining bog'liqligi

Bu grafikdan ma'lumki, A.Navoiy ko'chasi yo'l chetiga 1-avtomobil to'xtashidan oldin o'tib ketgan avtomobillar soni va o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar sonining bog'liqligi va ushbu o'zgarish qonuniyati quyidagicha:

$$y = 39,936e^{-0,347x} \quad (4),$$

Xuddi shunday kuzatish va hisob kitoblar chorsu bozori atrofida Beruniy va Sakichmon ko'chalarida o'rganilib hisoblab chiqilganda quyidagi Turargohga 1-avtomobil kirishidan oldin o'tib ketgan avtomobillar soni va o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar sonining bog'liqligi aniqlandi.



4-rasm. Beruniy ko'chasi ko'cha chetiga 1-avtomobil to'xtashidan oldin o'tib ketgan avtomobillar soni va o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar sonining bog'liqligi

Yuqoridagi grafikda esa, Beruniy ko'chasi ko'cha chetiga 1-avtomobil to'xtashidan oldin o'tib ketgan avtomobillar soni va o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar sonining bog'liqligi va ushbu o'zgarish qonuniyati quyidagicha:

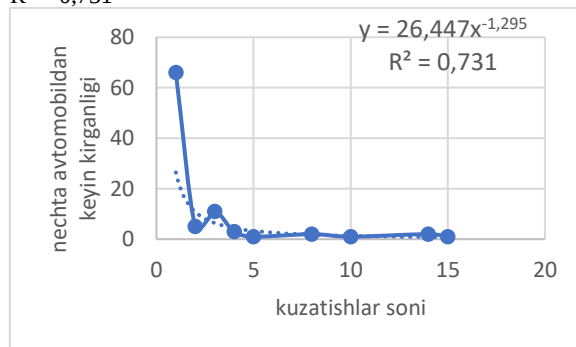
$$y = 40,695x^{-1,719} \quad (5),$$

$$R^2 = 0,8998$$

Demak, 3- o'rganilgan ko'cha Sakichmon ko'chasi bo'lib, bunda Sakichmon ko'chasi yo'l chetiga 1-avtomobil to'xtashidan oldin o'tib ketgan avtomobillar soni va o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar sonining bog'liqligi o'zgarish qonuniyati quyidagicha:

$$y = 26,447x^{-1,295} \quad (6),$$

$$R^2 = 0,731$$



5-rasm. Sakichmon ko'chasi yo'l chetiga 1-avtomobil to'xtashidan oldin o'tib ketgan avtomobillar soni va o'tib ketgan avtomobillar soni bilan bog'liq kuzatishlar sonining bog'liqligi

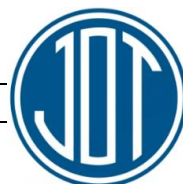
Yuqorida kuzatish olib borilgan hududlarda tirbandlik muammosiga, avtoturargoh qidirib yurgan avtomobillarning ulushi sezilarli darajada deb baholashimiz mumkin. Olingan ma'lumotlar tahlil qilinganda o'rtacha 32 % tirbandlik avtoturargoh izlab yurgan avtomobillar hisobiga to'g'ri kelishi aniqlandi. Shu bilan birga, haydovchilarning bo'sh joy izlash vaqti o'rganilganda o'tacha 6-10 daqiqa vaqt sarflanishi aniqlandi.

Yangi texnologiyalardan foydalangan holda avtoturargohlar ishi samaradorligini yanada oshirishimiz mumkin bo'lib, shu bilan birgalikda aniqlangan tirbandlikni, behuda sarflangan vaqt va yonilg'ini kamaytirishimiz mumkin bo'ladi.

4. Xulosa

Demak, ijtimoiy-iqtisodiy obyektlar atrofida ko'chalarda turargoh izlab yurgan va ko'cha chetida to'xtab turgan avtomobillarning umumiy tirbandlikka ta'siri kuchli bo'ladi. Tadqiqotlar shuni ko'rsatadiki, ko'cha chetida to'xtab turgan va bo'sh joy izlab yurgan avtomobillar ushbu kuzatishlar olib borilgan ko'chalarda umumiy tirbandlikning o'rtacha 32 % qismini tashkil etadi. Bu esa katta ko'rsatkich hisoblanadi. Ushbu muammoni bartaraf etishda haydovchiga avtoturargohlar holati va ulardagi bo'sh joylar sonini real vaqt rejimida ko'rsatib va ma'lumot yetkazib turuvchi tizim ishlab chiqilsa maqsadga muvofiq bo'ladi.

Yangi texnologiyalar amaliyotga qo'llanilishi natijasida avtoturargoh xizmat sifatini oshirishimiz, haydovchilarning avtoturargoh izlashdagi xarajatlarini kamaytirishimiz mumkin bo'ladi.



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Mualliflar to‘g‘risida ma’lumot/ Information about the authors

Xalilova Gulira’no	Toshkent davlat transport universiteti “Transport intellektual tizimlari boshqaruvi” kafedrasida dotsent.
Xolmurot qizi / Gulirano	E-mail: xalilovagulirano444@gmail.com
Xalilova	Tel.: +99897 530- 05-17
Raxmonov Azimjon	https://orcid.org/0009-0009-7448-7898
Sattorovich / Azimjon Rakhmonov	Toshkent davlat transport universiteti “Transport intellektual tizimlari boshqaruvi” kafedrasida dotsent v.b.
	E-mail: azimjonrakhmonov81@gmail.com
	Tel.: +998 97 430 89-20
	https://orcid.org/0000-0003-1640-8839
Samatov Rustam	Toshkent davlat transport universiteti “Transport intellektual tizimlari boshqaruvi” kafedrasida dotsenti.
Gafforovich / Rustam Samatov	E-mail: samrustar@mail.ru
	Tel: +9989 99 796 50-05
	https://orcid.org/0009-0007-4701-2518



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