JOURNAL OF TRANSPORT

ISSUE 1, 2026 vol. 3
E-ISSN: 2181-2438
ISSN: 3060-5164

SLIB.UZ
Scientific library of Uzbekistan

RESEARCH, INNOVATION, RESULTS

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

JOURNAL OF TRANSPORT

RESEARCH, INNOVATION, RESULTS

E-ISSN: 2181-2438
ISSN: 3060-5164

VOLUME 3, ISSUE 1

MARCH, 2026

jot.tstu.uz

TASHKENT STATE TRANSPORT UNIVERSITY

JOURNAL OF TRANSPORT

SCIENTIFIC-TECHNICAL AND SCIENTIFIC INNOVATION JOURNAL

VOLUME 3, ISSUE 1 MARCH, 2026

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.

Published quarterly, the journal provides a broad spectrum of high-quality research articles across diverse areas, including but not limited to:

- Economics of Transport
- Transport Process Organization and Logistics
- Rolling Stock and Train Traction
- Research, Design, and Construction of Railways, Highways, and Airfields, including Technology
- Technosphere Safety
- Power Supply, Electric Rolling Stock, Automation and Telemechanics, Radio Engineering and Communications
- Technological Machinery and Equipment
- Geodesy and Geoinformatics
- Automotive Service
- Air Traffic Control and Aircraft Maintenance
- Traffic Organizatsion
- Railway and Road Operations

The journal benefits from its official recognition under Certificate No. 1150 issued by the Information and Mass Communications Agency, functioning under the Administration of the President of the Republic of Uzbekistan. With its E-ISSN 2181-2438, ISSN 3060-5164 the publication upholds international standards of quality and accessibility.

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.

Developing a project for organizing environmental monitoring on urban roads through digitalization

M.T. Mamatkulov[1] [a], K.O. Muminov[1]
[1]Tashkent state transport university, Tashkent, Uzbekistan

Abstract: The rapid growth of urban transportation systems has significantly increased environmental pressure on city road networks. Air pollution, noise emissions, and surface runoff contamination have become major concerns for sustainable urban development. This study focuses on developing a project for organizing environmental monitoring on urban roads through digitalization technologies. The proposed approach integrates modern digital tools such as sensor networks, geographic information systems (GIS), Internet of Things (IoT) devices, and real-time data processing platforms to monitor key environmental indicators including air quality, noise levels, traffic intensity, and road surface conditions. The project framework aims to create a digital monitoring infrastructure that enables continuous data collection, automated analysis, and visualization of environmental parameters on urban roads. The implementation of such a system allows transportation authorities and city planners to identify critical pollution zones, evaluate the environmental impact of traffic flows, and support data-driven decision making for sustainable road management. The study also highlights the role of digital platforms in improving environmental safety, reducing ecological risks, and enhancing the overall efficiency of urban transport systems. The results demonstrate that digitalized environmental monitoring can significantly contribute to smarter and more sustainable urban road management.

Keywords: environmental monitoring, urban roads, digitalization, intelligent transportation systems, environmental impact, IoT sensors, GIS technologies, air pollution monitoring, noise pollution, smart city transportation

Raqamlashtirish orqali shahar yo‘llarida ekologik monitoringni tashkil etish loyihasini ishlab chiqish

Mamatkulov M.T.[1] [a], Mo‘minov Q.O.[1]
[1]Toshkent davlat transport universiteti, Tashkent, O‘zbekiston

Annotatsiya: Shahar transport tizimlarining jadal rivojlanishi shahar avtomobil yo‘llariga tushayotgan ekologik bosimning sezilarli darajada oshishiga olib kelmoqda. Havo ifloslanishi, shovqin darajasi va yo‘l yuzasidan oqib chiqadigan ifloslangan suvlar barqaror shahar rivojlanishi uchun muhim muammolardan biriga aylanmoqda. Ushbu tadqiqot shahar yo‘llarida ekologik monitoringni raqamlashtirish texnologiyalari orqali tashkil etish loyihasini ishlab chiqishga bag‘ishlangan. Taklif etilayotgan yondashuv zamonaviy raqamli vositalar — sensor tarmoqlari, geografik axborot tizimlari (GIS), Internet of Things (IoT) qurilmalari hamda real vaqt rejimida ma’lumotlarni qayta ishlash platformalarini integratsiya qilishga asoslanadi. Ushbu tizim orqali havo sifati, shovqin darajasi, transport oqimi intensivligi hamda yo‘l qoplamasi holati kabi asosiy ekologik ko‘rsatkichlarni doimiy monitoring qilish imkoniyati yaratiladi. Loyiha doirasida shahar yo‘llarida ekologik ko‘rsatkichlarni uzluksiz yig‘ish, avtomatik tahlil qilish va vizual tarzda aks ettirish imkonini beruvchi raqamli monitoring infratuzilmasini yaratish ko‘zda tutiladi. Bunday tizimni joriy etish transport boshqaruvi organlari va shahar rejalashtiruvchilariga ekologik jihatdan muammoli hududlarni aniqlash, transport oqimining atrof-muhitga ta’sirini baholash hamda barqaror yo‘l boshqaruvi bo‘yicha ilmiy asoslangan qarorlar qabul qilish imkonini beradi. Tadqiqot natijalari shuni ko‘rsatadiki, ekologik monitoringni raqamlashtirish shahar transport tizimlarining samaradorligini oshirish, ekologik xavfsizlikni ta’minlash va barqaror rivojlanishni qo‘llab-quvvatlashda muhim ahamiyatga ega.

Kalit so‘zlar: ekologik monitoring, shahar avtomobil yo‘llari, raqamlashtirish, intellektual transport tizimlari, ekologik ta’sir, IoT sensorlari, GIS texnologiyalari, havo ifloslanishini monitoring qilish, shovqin ifloslanishi, aqlli shahar transporti

[a] https://orcid.org/0000-0002-9997-2509

1. Kirish

So‘nggi yillarda raqamli texnologiyalar va “aqlli shaharlar” (Smart City) konsepsiyasi shahar boshqaruvining barcha yo‘nalishlariga kirib kelmoqda. Xalqaro tajriba [5, 6, 7] shuni ko‘rsatadiki, raqamli infratuzilma, ma’lumotlar tahlili (Big Data), sun’iy intellekt (AI) va IoT texnologiyalari integratsiyasi orqali ekologik muammolarni erta aniqlash va oldini olish imkoniyati yaratiladi.IoT asosidagi sensor tarmoqlari [3, 11] havo sifati, namlik, tebranish, shovqin va chiqindi gazlarni aniqlashda samarali vosita sifatida qo‘llanilmoqda. [1] tomonidan ishlab chiqilgan WSN asosidagi kuzatuv tizimi, [2] ning avtomobilga o‘rnatilgan mobil sensor tarmoqlari (VSN) bilan uyg‘unlashganda, transport harakati bilan bog‘liq ifloslanish zonalarini aniq aniqlash imkonini beradi. Bundan tashqari, [9, 10] tadqiqotlari shuni ko‘rsatadiki, raqamli iqtisodiyot va ekologik rivojlanish samaradorligi o‘rtasida kuchli muvofiqlik mavjud. Bu shaharlarning raqamlashtirilgan infratuzilmasi nafaqat boshqaruvni avtomatlashtiradi, balki yashil va barqaror rivojlanishni ham ta’minlaydi.

Bugungi kunda urbanizatsiya jarayonlarining tezlashuvi shaharlarning ekologik holatiga sezilarli ta’sir ko‘rsatmoqda. Transport vositalarining ko‘payishi va sanoat faoliyatining kengayishi natijasida havo sifati yomonlashib, inson salomatligi va yashash sifati uchun xavf kuchaymoqda [8]. Shu sababli, shahar yo‘llarida ekologik holatni real vaqt rejimida nazorat qilish bugungi kunning eng dolzarb masalalaridan biridir.

Raqamli texnologiyalar, IoT va sun’iy intellekt asosidagi yechimlar ekologik monitoringni takomillashtirishda muhim rol o‘ynamoqda [6], [5]. Xalqaro tajribalar, xususan Jahon bankining Global Smart City Partnership Programi [7], shahar boshqaruvini raqamlashtirish ekologik xavfsizlikni ta’minlashda samarali natija berishini ko‘rsatadi. IoT asosidagi Wireless Sensor Network (WSN) va Vehicle Sensor Network (VSN) tizimlari havo ifloslanishini aniqlash va fazoviy tahlil qilishda samarali vosita bo‘lib xizmat qilmoqda [1], [2]. Ular orqali karbon oksid, chang zarrachalari va shovqin darajasi kabi parametrlarni avtomatik qayd etish va GIS asosida xaritalash imkoniyati yaratiladi.

Raqamli iqtisodiyot va ekologik rivojlanish o‘rtasida uzviy bog‘liqlik mavjud bo‘lib, u barqaror “yashil” shahar infratuzilmasini yaratishda muhim omil hisoblanadi [9], [10]. Maqolaning maqsadi O‘zbekiston shaharlarida - xususan Toshkent, Andijon va Namanganda yo‘l infratuzilmasini raqamlashtirish orqali ekologik monitoring tizimini yaratish konsepsiyasini ishlab chiqishga qaratilgan.

2. Tadqiqot metodologiyasi

Tadqiqotlar ko‘rsatishicha, urbanizatsiya oqibatida havodagi karbon oksid (CO), azot oksidlari (NOx), chang zarrachalari ($PM_{2.5}$, PM_{10}) va shovqin darajalari sezilarli darajada oshadi. Ayniqsa, transport vositalari intensivligi yuqori bo‘lgan markaziy ko‘chalar ekologik xavf zonasiga aylanmoqda. Shahar infratuzilmasi kengaygani sayin, yashil hududlarning qisqarishi va tuproqning asfalt bilan qoplanishi issiqlik orollari effektini kuchaytiradi, bu esa mahalliy mikroiqlimga salbiy ta’sir etadi [5], [8].

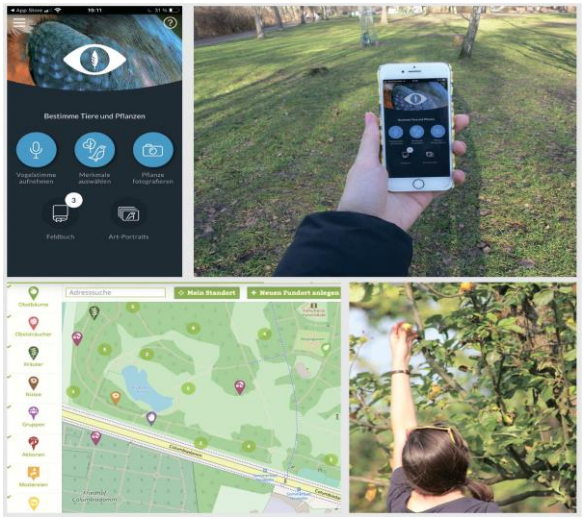
Moss, Voigt va Becker (2021) o‘z tadqiqotlarida raqamli texnologiyalar shahar tabiatini himoya qilishda muhim vosita bo‘lishi mumkinligini ta’kidlaydilar [8]. Ularning fikricha, “raqamli urban tabiat” konsepsiyasi yordamida ekologik ko‘rsatkichlarni raqamli shaklda kuzatish, shahar landshaftlari bilan ularni uyg‘unlashtirish imkonini beradi. Bu yondashuv ekologik xavflarni oldindan aniqlash va boshqaruv tizimlarini optimallashtirishga xizmat qiladi.

Jahon bankining Global Smart City Partnership Program (2023) hisobotida qayd etilishicha, urbanizatsiya jarayonlarini boshqarishning eng samarali usullaridan biri — raqamli ma’lumotlar asosida qaror qabul qilish tizimini shakllantirishdir [7].

Raqamlashtirish orqali shahar infratuzilmasining yuklamasi, transport oqimining ta’siri va ekologik ko‘rsatkichlar o‘zaro bog‘liq holda tahlil qilinadi. Bu esa ekologik siyosatni aniq ma’lumotlarga tayangan holda olib borish imkonini beradi.

Ma, Li, Guo va Wan (2024) tomonidan o‘tkazilgan tadqiqotlarda raqamli texnologiyalar va Big Data tahlili yordamida shaharlar ekologik tizimlarini real vaqt rejimida kuzatish va boshqarish samaradorligi isbotlangan [5]. Bu natijalar, o‘z navbatida, shahar transport tizimini ekologik barqarorlik tamoyillari asosida rejalashtirish zarurligini ko‘rsatadi.

Urbanizatsiya ta’sirini kamaytirishning asosiy yo‘nalishlaridan biri — raqamli ekologik monitoring tizimlarini joriy etishdir. Bu tizimlar IoT sensorlari, GIS texnologiyalari va sun’iy intellekt yordamida atmosferadagi zararli gazlar, chang va shovqin darajasini avtomatik ravishda aniqlash va baholash imkonini beradi [1], [2], [11].



1-rasm. Naturblick va Mundraub ilovalari hamda ularning qo‘llanilishi

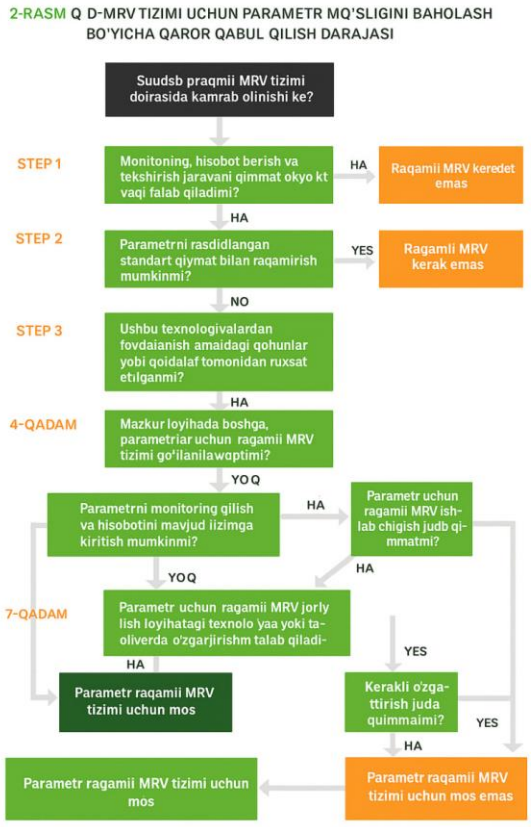
Izoh: 1-rasmda chap yuqori rasmda Naturblick ilovasining asosiy menyusi ko‘rsatilgan (manba: muallifning ekran tasviri). O‘ng yuqori rasmda esa Naturblick ilovasidan foydalanish jarayoni tasvirlangan (manba: muallifning fotosurati). Chap pastki rasmda Mundraub xaritasi ko‘rsatilgan (manba: https://mundraub.org/map saytining ekran tasviri). O‘ng pastki rasmda esa Mundraub ilovasidan foydalanish jarayoni tasvirlangan (manba: https://mundraub.org/press)

Ekologik monitoring - bu tabiiy va antropogen omillar ta’siri ostida atrof-muhitning holatini doimiy ravishda kuzatish, o‘lchash, tahlil qilish va baholash jarayonidir. Uning asosiy maqsadi — ekologik tizimlarda sodir bo‘layotgan

o‘zgarishlarni aniqlash, ularning salbiy oqibatlarini bashoratlash va ularni kamaytirish bo‘yicha ilmiy asoslangan qarorlar qabul qilishdir [7].

So‘nggi yillarda raqamli ekologik monitoring yo‘nalishi alohida e’tibor qozonmoqda. Wen va boshq. (2013) [1] tomonidan ishlab chiqilgan Wireless Sensor Network (WSN) modeli yordamida shahar atmosferasidagi karbon oksid darajasini aniqlash va vaqt bo‘yicha o‘zgarishini kuzatish imkoniyati yaratilgan. Diviacco va hamkorlari (2022) [2] esa Vehicle Sensor Network (VSN) tizimi orqali avtomobillarga o‘rnatilgan mobil sensorlar yordamida havo sifatini aniqlashni amalga oshirishgan.

Zeng, Pang va Tang (2023) [3] tadqiqotlarida ekologik monitoring tizimlarida Internet of Things (IoT) texnologiyalarining roli keng yoritilgan bo‘lib, ular real vaqt rejimida ekologik ma’lumotlar oqimini yig‘ish va markazlashgan tahlil tizimlariga uzatish imkonini beradi. Shu tariqa, raqamli monitoring tizimlari ekologik xavflarni erta aniqlash va boshqaruv qarorlarini tezkor qabul qilish imkoniyatini yaratadi.



2-rasm. D-MRV tizimi uchun parametr mosligini baholash bo‘yicha qaror daraxti (D-MRV – Raqamli monitoring, hisobot va tekshirish tizimi)

Smart City konsepsiyasi shahar infratuzilmasini raqamli texnologiyalar, sun’iy intellekt (AI), IoT (Internet of Things), Big Data va GIS tizimlari bilan uyg‘unlashtirish orqali samarali boshqaruvga erishishni nazarda tutadi. Jahon bankining Global Smart City Partnership Program (2023) hisobotiga ko‘ra, raqamli transformatsiya nafaqat texnologik jarayon, balki iqtisodiy, ekologik va ijtimoiy barqarorlikni ta’minlovchi muhim strategik omildir [7].

World Bank tomonidan amalga oshirilgan “Digital Monitoring and Verification Systems for Carbon Markets” (2022) hisobotida raqamli kuzatuv va avtomatlashtirilgan hisobot tizimlari orqali atmosfera chiqindilarini aniqlash, tasdiqlash va kamaytirish samaradorligini oshirish yo‘llari taklif etilgan. Bu yondashuv ekologik monitoringni xalqaro uglerod bozorlari bilan uyg‘unlashtirish imkonini beradi.

Yuqoridagi zamonaviy dasturlar shahar yo‘llarida ekologik holatni real vaqt rejimida kuzatish, tahlil qilish va baholash imkonini beruvchi raqamli monitoring tizimi konsepsiyasini ishlab chiqishdan iborat. Bu tizim IoT (Internet of Things) texnologiyasi asosida ishlovchi sensor tarmoqlar yordamida ma’lumotlarni avtomatik yig‘ish, uzatish va tahlil qilishni ta’minlaydi.

IoT texnologiyasi ekologik kuzatuvda ma’lumot yig‘ishning avtomatlashtirilgan va uzluksiz jarayonini tashkil etadi. Bunda har bir sensor (node) mustaqil ravishda ma’lumotlarni o‘lchab, simsiz aloqa (Wi-Fi, LoRa, NB-IoT) orqali markaziy serverga yuboradi [3], [5], [6]. Ushbu tizim orqali havo sifati, shovqin, tebranish va harorat ko‘rsatkichlari real vaqt rejimida yangilanib turadi.

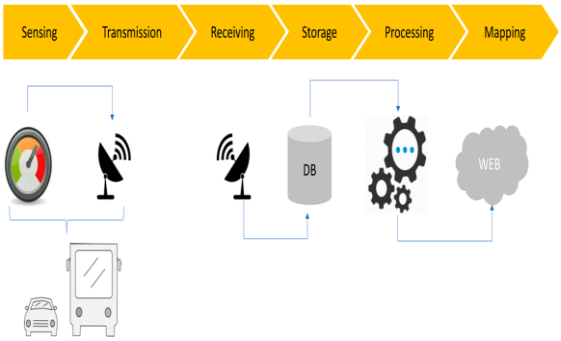
Zeng, Pang va Tang (2023) tadqiqotlariga ko‘ra, IoT asosidagi ekologik monitoring tizimlari ekologik xavflarni erta aniqlash, atrof-muhit sifatidagi keskin o‘zgarishlarga tezkor javob berish va ma’lumotlarni avtomatik qayta ishlash imkonini beradi [3].

1-jadval

IoT sensorlar tarmog‘i yordamida kuzatiladigan asosiy ekologik parametrlar

№	Ekologik ko‘rsatkich	O‘lchov birligi	Asosiy maqsad
1	Karbon oksid (CO)	ppm (parts per million)	Transport chiqindilarini aniqlash
2	Azot oksidlari (NO_2)	µg/m³	Havoning kimyoviy ifloslanishini baholash
3	Chang zarrachalari ($PM_{2.5}$, PM_{10})	µg/m³	Havoning sog‘liqqa ta’sir darajasini aniqlash
4	Shovqin darajasi	dB (desibel)	Transport harakati natijasidagi akustik ifloslanishni baholash
5	Harorat va namlik	°C, %	Mikroiqlimni o‘rganish
6	Transport oqimi jadalligi	avt./soat	Ekologik yuklama bilan korrelyatsiyani aniqlash

Bu bosqichda ifloslanish tendensiyalari va vaqt bo‘yicha o‘zgarishlar aniqlanadi [9], [10].



3-rasm. COCAL tizimi va infratuzilmasi sxemasi

Izoh. COCAL qurilmalari avtobuslar va avtomobillarga o‘rnatilgan bo‘lib, ular havo sifati sensorlari hamda ma’lumot uzatish moslamalarini o‘z ichiga oladi. Ma’lumotlar mobil aloqa tarmog‘i orqali uzatiladi va OGS markaziy saqlash hamda qayta ishlash tizimiga yuboriladi. Qayta ishlangan ma’lumotlar loyiha veb-portalida vizuallashtiriladi (https://cocal.ogs.it, 2022-yil 1-noyabrda murojaat qilingan)

3. Natija va muhokamalar

O‘zbekiston shaharlarida urbanizatsiya jarayonlarining jadallashuvi transport oqimining ko‘payishi, havoning ifloslanishi va akustik yuklamaning ortishiga olib kelmoqda. Ayniqsa, **Toshkent**, **Andijon** va **Namangan** shaharlarida avtomobil chiqindilari havodagi **CO, NO_2, $PM_{2.5}$** miqdorini me’yordan oshirib yuborayotganini kuzatish mumkin.

Mazkur muammolarni samarali hal etish uchun **raqamli ekologik monitoring tizimini joriy etish** dolzarb hisoblanadi. Ushbu tizim yordamida havo sifati, shovqin darajasi, transport oqimi va mikroiqlim o‘zgarishlari real vaqt rejimida kuzatilib, **data-driven (ma’lumotga asoslangan)** boshqaruv qarorlari qabul qilinadi (2-jadval).

2-jadval

Joriy etish imkoniyatlari (hududlar kesimida)

Shahar	Texnik imkoniyatlar	Ekologik muammo darajasi	Raqamli infratuzilma	Joriy etish bosqichi
Toshkent	4G/5G, optik internet, ko‘p sonli yo‘l sensori va kameralar	Yuqori (transport zichligi, CO konsentratsiyasi)	Yuqori	Pilot loyiha uchun tayyor
Andijon	Mobil tarmoq, o‘rta darajadagi raqamli infratuzilma	O‘rta ($PM_{2.5}$, chang)	O‘rta	Sinov bosqichida
Namangan	Avtomobil harakati nisbatan past, lekin shamol yo‘nalishi ekologik muvozanatga ta’sir qiladi	O‘rta	O‘rta	Boshlang‘ich bosqichda

Toshkent shahri raqamli infratuzilmaning yuqori darajasi tufayli pilot loyiha uchun eng qulay hudud hisoblanadi. Bu yerda IoT sensorlar, bulutli tahlil serverlari va AI algoritmlarini birlashtirish orqali “Smart Eco-Monitoring” tizimini ishga tushirish mumkin.

Andijon va Namangan shaharlarida esa dastlab kichik ko‘lamli Wireless Sensor Network (WSN) tizimlari o‘rnatilib, transport yo‘nalishlari bo‘yicha mahalliy ekologik xaritalar shakllantiriladi.

Raqamli monitoring tizimi quyidagi texnik komponentlardan tashkil topadi:

- sensor modullar (IoT nodes): CO, NO_2, $PM_{2.5}$, PM_{10}, shovqin, harorat, namlik, GPS moduli bilan;
- ma’lumot uzatish tarmog‘i: Wi-Fi, LoRaWAN, 4G/5G;
- markaziy server: PostgreSQL + PostGIS ma’lumotlar bazasi;
- tahlil platformasi: Python + TensorFlow + QGIS integratsiyasi;
- foydalanuvchi interfeysi: Veb-panel va mobil ilova shaklida;
- quvvat manbai: Quyosh panellari (off-grid rejimida ishlovchi).

Raqamli monitoring tizimini joriy etish dastlabki bosqichda muayyan xarajatlarni talab etadi, biroq uzoq muddatda u shahar boshqaruvi va sog‘liqni saqlash tizimi uchun katta iqtisodiy foyda keltiradi.

Xarajat turi	Miqdor (USD, taxminiy)	Izoh
IoT sensor modullari (100 dona)	25 000	Har biri 250 USD atrofida
Aloqa tarmog‘i va server	15 000	LoRaWAN gateway + server sozlamalari
Dasturiy platforma (AI + GIS)	10 000	Python + QGIS + web interfeys
Texnik xizmat va ma’lumotlar saqlash	5 000/yil	Server va tarmoq xarajatlari
Umumiy investitsiya (1-bosqich)	**~50 000 USD**	Toshkent shahri uchun pilot loyiha

Iqtisodiy foyda:

- sog‘liq uchun xavfli ifloslanish holatlarini erta aniqlash orqali sog‘liqni saqlash xarajatlarini 15–20% kamaytiradi;
- transport boshqaruvini ekologik ko‘rsatkichlar bilan integratsiya qilish yoqilg‘i sarfini 8–10% qisqartiradi;
- shahar infratuzilmasida ekologik xavfli zonalarni oldindan aniqlash orqali yo‘llarni ta’mirlash va rejalashtirish xarajatlari kamayadi;

ekologik nazoratning shaffofligi oshadi, bu esa xalqaro ekologik grantlar va “yashil investitsiyalar”ni jalb etish imkonini beradi.

4. Xulosa

Xulosa qilib aytganda, shahar avtomobil yo‘llarida ekologik monitoringni raqamlashtirish asosida tashkil etish zamonaviy shahar transport tizimlarini samarali boshqarish va ularning atrof-muhitga ta’sirini kamaytirishda muhim

ahamiyat kasb etadi. Transport oqimlarining ortib borishi, avtomobillar sonining ko‘payishi hamda urbanizatsiya jarayonlarining jadallashuvi natijasida shahar hududlarida ekologik muammolar, xususan havo ifloslanishi, shovqin darajasining ortishi va yo‘l infratuzilmasidan kelib chiqadigan ekologik xavflar tobora kuchayib bormoqda. Shu sababli ekologik holatni doimiy nazorat qilish va uning o‘zgarishlarini tezkor aniqlash muhim vazifalardan biri hisoblanadi. Tadqiqot doirasida taklif etilgan raqamli monitoring tizimi sensor texnologiyalari, IoT qurilmalari, geografik axborot tizimlari (GIS) hamda real vaqt rejimida ishlovchi ma’lumotlarni qayta ishlash platformalarining integratsiyasiga asoslanadi. Bunday tizim orqali shahar yo‘llarida havo sifati, shovqin darajasi, transport oqimi intensivligi, yo‘l qoplamasining texnik holati kabi muhim ekologik ko‘rsatkichlarni uzluksiz kuzatish imkoniyati yaratiladi. To‘plangan ma’lumotlar raqamli platformalarda qayta ishlanib, tahlil qilinadi va vizual ko‘rinishda aks ettiriladi, bu esa transport boshqaruvi organlari hamda shahar rejalashtiruvchilariga muhim analitik axborot beradi. Shuningdek, raqamli monitoring tizimining joriy etilishi ekologik xavf yuqori bo‘lgan hududlarni aniqlash, transport oqimlarini optimallashtirish, shovqin va havo ifloslanishini kamaytirishga qaratilgan muhandislik choralarini ishlab chiqish imkonini beradi. Natijada, transport tizimining ekologik samaradorligi oshadi, shahar aholisi uchun sog‘lom va xavfsiz yashash muhiti yaratiladi hamda shahar infratuzilmasining barqaror rivojlanishi ta’minlanadi. Umuman olganda, ekologik monitoringni raqamlashtirish shahar transport tizimlarini boshqarishda innovatsion yondashuvlardan biri bo‘lib, u aqlli shahar (Smart City) konsepsiyasini amalga oshirishda muhim rol o‘ynaydi. Kelgusida bunday tizimlarni rivojlantirish va amaliyotga keng joriy etish shahar avtomobil yo‘llarining ekologik holatini yaxshilash, transport tizimining samaradorligini oshirish hamda atrof-muhitni muhofaza qilishga xizmat qiladi.

Foydalangan adabiyotlar / References

[1] Wen, T.-H., Jiang, J.-A., Sun, C.-H., Juang, J.-Y., & Lin, T.-S. (2013). Monitoring street-level spatial-temporal variations of carbon monoxide in urban settings using a wireless sensor network (WSN) framework. International Journal of Environmental Research and Public Health, 10(12), 6380–6396. https://doi.org/10.3390/ijerph10126380

[2] Diviacco, P., Iurcev, M., Carbajales, R. J., Potleca, N., Viola, A., Burca, M., & Busato, A. (2022). Monitoring air quality in urban areas using a vehicle sensor network (VSN) crowdsensing paradigm. Remote Sensing, 14(21), 5576. https://doi.org/10.3390/rs14215576

[3] Zeng, F., Pang, C., & Tang, H. (2023). Sensors on the Internet of Things systems for urban disaster management: A systematic literature review. Sensors, 23(17), 7475. https://doi.org/10.3390/s23177475

[4] Liang, Y. (2024). Exploration of the application of digital technologies in urban ecological environment management. Academic Journal of Environment & Earth Science, 6(1), 29–33. https://doi.org/10.25236/AJEE.2024.060104

[5] Ma, X., Li, J., Guo, Z., & Wan, Z. (2024). Role of big data and technological advancements in monitoring and development of smart cities. Heliyon, 10(15), e34821. https://doi.org/10.1016/j.heliyon.2024.e34821

[6] Kumar, V., et al. (2024). Sense (and) the city: From Internet of Things sensors and open data platforms to urban observatories. IET Smart Cities, 6(4), 291–311. https://doi.org/10.1049/smc2.12081

[7] World Bank. (2023). Global Smart City Partnership Program: Engagement Guidance Note. Washington, DC: World Bank Group.

[8] Moss, T., Voigt, F., & Becker, S. (2021). Digital urban nature. City, 25(3–4), 255–276. https://doi.org/10.1080/13604813.2021.1935513

[9] Jiang, Y., Li, L., & Xu, Y. (2025). Can digital economy improve urban ecological development? Evidence based on double machine learning analysis. Frontiers in Environmental Science, 13, 1542363. https://doi.org/10.3389/fenvs.2025.1542363

[10] Liu, Y. (2025). Coupling and coordination evaluation of digital economy and green development efficiency in eight urban agglomerations in China. Scientific Reports, 15, 26829. https://doi.org/10.1038/s41598-025-07967-7

[11] S., S. R., Aburukba, R., & El Fakih, K. (2025). Wireless sensor networks for urban development: A study of applications, challenges, and performance metrics. Smart Cities, 8(3), 89. https://doi.org/10.3390/smartcities8030089

[12] Zeng, F., Pang, C., & Tang, H. (2023). Sensors on the Internet of Things systems for urban disaster management: A systematic literature review. Sensors, 23(17), 7475. https://doi.org/10.3390/s23177475.

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

Mamatkulov Muzaffar / Muzaffar Mamatkulov	Toshkent davlat transport universiteti “Shahar infratuzilmalari muhandisligi va sun’iy intellekt” kafedrasi dotsenti v.b, t.f.f.d., (PhD) E-mail: mamatkulov9090@gmail.com Tel.:+998903384838 https://orcid.org/0000-0002-9997-2509
Mo‘minov Qurbon / Kurbon Muminov	Toshkent davlat transport universiteti “Yo‘l muhandisligi va telematikasi” kafedrasi katta o‘qituvchisi. E-mail: mqurbon1966@gmail.com Tel.:+ 998977370348

CONTEXT / MUNDARIJA

A. Abdullaev
Development of entrepreneurial activity in the construction industry……..***205***
M. Mamatkulov, A. Kungradbaeva
Road safety as a pressing issue: official statistics and analysis on deaths and injuries……..***210***
M. Mamatkulov, K. Muminov
Developing a project for organizing environmental monitoring on urban roads through digitalization……..***216***
G. Ubaydullaev, R. Khakimzyanov
Selection of technological bases for transport vehicle parts during their manufacture……..***221***
A. Adilkhodjaev, I. Kadirov, F. Abdukadirov
Strategy for modifying cement systems with finely dispersed mineral fillers……..***226***