

JOURNAL OF TRANSPORT



ISSUE 2, 2025 vol. 2

E-ISSN: 2181-2438

ISSN: 3060-5164



RESEARCH, INNOVATION, RESULTS



**TOSHKENT DAVLAT
TRANSPORT UNIVERSITETI**

Tashkent state
transport university



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VOLUME 2, ISSUE 2

JUNE, 2025



jot.tstu.uz

TASHKENT STATE TRANSPORT UNIVERSITY

JOURNAL OF TRANSPORT

SCIENTIFIC-TECHNICAL AND SCIENTIFIC INNOVATION JOURNAL

VOLUME 2, ISSUE 2 JUNE, 2025

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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.

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Flow of automobile transport vehicles and the laws of time distribution of service

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Abstract: This article examines the flow of automobile transport vehicles and the laws of time distribution for service. Automobile transport plays a crucial role in the modern economy, being essential for the efficient organization of cargo and passenger transportation processes in urban and rural areas. The research explores the dynamics of transport flow, the time distribution in service processes, and strategies aimed at improving the efficiency of the transport system.

The flow of automobile transport vehicles and the distribution of service time are significant in addressing issues related to enhancing the efficiency of transport infrastructure and improving transport systems both intercity and within cities. This article identifies situations in loading points where multiple transport vehicles may simultaneously enter service or where certain transport vehicles may be temporarily unavailable for service, resulting in idle (unproductive) time. The focus is on reducing the service time for vehicle flow and minimizing idle time.

Keywords: automobile transport, cargo flow, time, service to transport vehicle flow, distribution, efficiency, idle time, freight transportation

Avtomobil transporti vositalari oqimi va xizmat ko'rsatish vaqtining taqsimlanish qonunlari

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Annotatsiya: Mazkur maqolada avtomobil transporti vositalarining oqimi va xizmat ko'rsatish vaqtining taqsimlanish qonunlari o'rganilgan. Avtomobil transporti, zamonaviy iqtisodiyotda muhim rol o'ynab, shahar va qishloq joylarida yuk va yo'lovchi tashish jarayonlarini samarali tashkil etish uchun zarurdir. Tadqiqot davomida transport oqimining dinamikasi, xizmat ko'rsatish jarayonidagi vaqt taqsimoti, shuningdek, transport tizimining samaradorligini oshirishga qaratilgan strategiyalar ko'rib chiqiladi. Avtomobil transporti vositalarining oqimi va xizmat ko'rsatish vaqtining taqsimlanishi, transport infratuzilmasining samaradorligini oshirish, shaharlararo va shahar ichidagi transport tizimlarini yaxshilash kabi masalalarni hal qilishda muhim ahamiyatga ega.

Ushbu maqola, yuklash punktidagi ish jarayonlarida bir vaqtning o'zida bir necha transport vositasi xizmat ko'rsatishga kirib kelishi yoki ayrim muddat transport vositalari xizmat ko'rsatishda bo'lmashligi, ya'ni yuklash vositasi bekor (unumsiz) turib qolish holatlari aniqlangan. Avtotransport vositalari oqimiga xizmat ko'rsatish va unumsiz turish vaqtlarini kamaytirilishga qaratilgan.

Kalit so'zlar: avtomobil transporti, yuk oqimi, vaqt, transport vositalari oqimiga xizmat ko'rsatish, taqsimlanish, samadorlik, unumsiz vaqt, yuk tashish

1. Kirish

Jahon miqyosi transport tizimlarida avtomobil transporti vositalarining oqimi va xizmat ko'rsatish vaqtining taqsimlanishi muhim ahamiyatga ega. Ushbu mavzu transport iqtisodiyoti, logistika va transport menejmenti sohalarida tadqiqotlar va amaliyotlar uchun asosiy yo'nalishlardan biridir. Avtomobil transporti, o'zining harakatlilik va moslashuvchanligi bilan, shaharlararo va shahar ichidagi yuk va yo'lovchi tashish jarayonlarini samarali ravishda tashkil etishga imkon beradi. Biroq, transport oqimining samaradorligi ko'plab omillarga bog'liq bo'lib, xizmat ko'rsatish vaqtining taqsimlanishi va yuklash punktlaridagi jarayonlar bu omillar orasida muhim o'rin

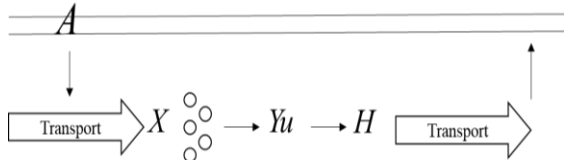
tutadi. Ushbu mavzuni o'rganish orqali, transport oqimining dinamikasi, vaqt taqsimoti va xizmat ko'rsatish jarayonlarining samaradorligini oshirishga qaratilgan strategiyalarni ishlab chiqish mumkin. Shuningdek, transport infratuzilmasining samaradorligini oshirish, yuk tashish jarayonlarini optimallashtirish va ekologik ta'sirni kamaytirish kabi masalalarni hal qilishda muhim yondashuvlar aniqlanadi. Natijada, avtomobil transporti vositalarining oqimi va xizmat ko'rsatish vaqtining taqsimlanish qonunlarini chuqur o'rganish, transport tizimlarining rivojlanishi va kelajakdagi muammolarni hal qilishda muhim rol o'ynaydi. Maqolaning maqsadi, avtomobil transporti vositalarining oqimi va xizmat ko'rsatish vaqtining taqsimlanishini chuqur tahlil qilish orqali, transport sohasidagi muammolarni hal qilishga yordam berishdir.

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2. Tadqiqot metodologiyasi

Avtotransport vositalarining yuklash punktiga kirib kelish jarayonini ko'rib chiqamiz. Avtotransport korxonasi (A) bilan yuklarni tashish uchun tuzilgan shartnomalarga muvofiq va avtotransport korxonasi (ATK)ga tushgan yuk buyurtmalar asosida ATK ekspluatatsiya bo'limi avtotransport vositalarini ta'minot ombori (X)ga jo'natadi (1-rasm).

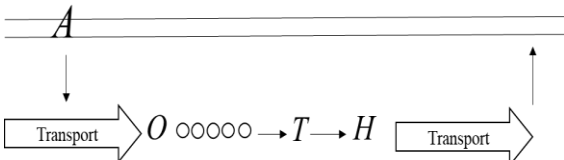


1-rasm. Avtotransport vositalarining yuklash punktiga kirib kelish va chiqib ketishi harakat sxemasi

Bu jarayonda ta'minot omborida ma'lum miqdordagi transport vositalarining mavjudligi ehtimolini hisobga olish muhimdir. Avtotransport vositalari tartib bilan yuklash (Yu) punktiga yuboriladi. Yuklash texnologiyasiga mos ravishda yuklangan avtotransport vositalari yuk tashishdagi me'yoriy hujjat (H)larni rasmiylashtirish jarayoniga yo'naltiriladi va belgilangan marshrut (yunalish)ga harakatlanish uchun ta'minot omboridan chiqib ketadi. Yuk ortish punktidagi ish sikli shu tarzda uzluksiz vaqt davomida diskret holatlarda davom etadi.

Yuklash punktidagi ish jarayonlarini amaliy kuzatish davomida bir vaqtda bir nechta avtotransport vositasi xizmat ko'rsatishga kirib kelishi yoki ayrim avtotransport vositalarining xizmat ko'rsatmasligi, ya'ni yuklash vositalarining bekor (unumsiz) turishi mumkinligi aniqlandi. Bu holat yuklash-tushirish jarayonlarini murakkablashtiradi.

Avtotransport vositalarining yuk qabul qilish punkt ob'ektlariga kirib kelish sxemasi. Xizmat ko'rsatish punktida yuklangan avtotransport vositasi (A)ni buyurtmalar asosida belgilangan yuk qabul qiluvchi ob'ektiga (O)ga jo'natadi (2-rasm).



2-rasm. Avtotransport vositalarining yuk qabul qilish punk ob'ektiga kirib kelishi, yuk tushirishi va chiqib ketishi harakat sxemasi

Bunda buyurtmachining yuk qabul qilish punkt ob'ektlaridagi o'tish yo'llari orqali yuk tushiriladigan manzil (T)ga uzatiladi. Tushirish ishlari bajarilgach, avtotransport vositalari yuk to'g'risidagi hujjat (H)larni rasmiylashtirish jarayoniga yo'naltiriladi hamda belgilangan marshrut bo'yicha yukni yetkazish uchun yana yuk junatish punkt omboriga qaytadi. Yuk qabul qiluvchining ob'ektidagi yukni tushirish jarayoni ish sikli shu tarzda uzluksiz vaqt davomida diskret holatlarda davom etadi.

Yuk tushirish punktidagi ish jarayonlarini kuzatish natijalari shuni ko'rsatdiki bir vaqtda bir nechta avtotransport vositasi qabul qiluvchi ob'ektida yuklarini tushirish joyga kelishi kuzatilmadi. Shu sababli avtotransport oqimlarining xizmat ko'rsatish tizimiga kirib kelishi va xizmat ko'rsatish punktidagi yuklash mexanizmlarini o'zaro muvofiq ishlashning tezkor rejalarini ishlab chiqish masalasini yechimiga e'tibor qaratildi.

Transport oqimlarning xizmat ko'rsatish tizimiga kirib kelishi, ya'ni avtotransporti vositalarining yuklash punktiga kelishining oddiy oqimi Puasson qonuniga bo'ysunishi matematik jihatdan asoslangan [1, 2, 3].

Avtotransport vositalari oqimi harakati bilan bog'liq bo'lgan masalani yechishda Puasson oqimi holatlaridan foydalanilgan. Yalpi xizmat ko'rsatishning istalgan tizimi elementlari asosiy strukturasi buyurtma va xizmat ko'rsatish kanallari hisoblanadi.

“Xizmat ko'rsatishga buyurtma” – xizmat ko'rsatishga bo'lgan zarurat, ya'ni qandaydir xizmat ko'rsatilishini anglatadi.

“Xizmat ko'rsatuvchi kanal” – aniq bir ob'ekt yoki ob'ektlari xizmat ko'rsatish borasida bajariladigan ishlarni bildiradi.

Buyurtmachilar tomonidan berilgan buyurtma asosida xizmat ko'rsatilishida oqim hosil bo'ladi, bu oqim xizmat ko'rsatilgunicha kiruvchi oqim deyiladi, keyin mumkin bo'lgan kutishdan keyin xizmat ko'rsatishning boshlanishi bilan xizmat ko'rsatuvchi punktida oqim hosil bo'ladi, keyinchalik esa buyurtmalarining chiqish oqimi shakllanadi. Yalpi xizmat ko'rsatish nazariyasida buyurtmalar oqimiga xizmat ko'rsatishda oqim jadalligi uning asosiy xarakteristikasi hisoblanadi.

Yalpi xizmat ko'rsatish nazariyasi avtotransport vositalari oqimini rejalashtirish masalalarida ham tadbqiq etilgan [2, 6]. Xizmat ko'rsatishga kiruvchi talabgarlar oqimi va xizmat ko'rsatish vaqtining taqsimlanish qonunlarining umumiy holatlari [2, 5] manbada o'z aksini topgan bo'lib, quyidagi 1-jadvalda hisoblash formulalari va tavsiflari keltirilgan.

1-jadval

Xizmat ko'rsatishga kiruvchi talabgarlar oqimi va xizmat ko'rsatish vaqtining taqsimlanish holatlari		
Tavsifi	Hisoblash formulasi	Izoh
Istalgan avtotransport vositasining tizimga kirib kelishi ehtimoli	$P_k(t) = \frac{(\lambda t)^k}{k!} e^{-\lambda t}$	t – vaqt oralig'i k – avtotransport vositalari soni
Yuklash punktiga avtotransport vositasi kirib kelgandan keyingi t vaqt oralig'ida bironta ham avtotransport vositasi kirib kelmasligi ehtimoli	$P(t) = e^{-\lambda t}$	tasodifiy u kattalik t kattalikdan kichik bo'lmisligi ehtimoliga tengdir, ya'ni: $P(u \geq t) = e^{-\lambda t}$
Avtotransport vositalarining kirish paytlari orasidagi vaqt intervali	$\bar{u} = \frac{\sum_{i=1}^N m_i t_i}{\sum_{i=1}^N m_i}$	$\bar{u}$ – ketma-ket xizmat ko'rsatishga kiruvchi avtotransport vositalarining kirish paytlari orasidagi vaqt intervalining o'rtacha qiymati
Xizmatga kirib keluvchi avtotransport vositalari oqim jadalligi	$\lambda = \frac{1}{\bar{u}}$	ketma-ket xizmat ko'rsatishga kiruvchi avtotransport vositalarining kirish paytlari orasidagi vaqt intervalining o'rtacha qiymatiga teskari kattalik



Olib borilgan tadqiqotlar natijasida olingan oqim oddiy bo'lganligi sababli, unda uning parametri λ asosida mazkur oqimni to'la-to'kis ravishda Puasson funksiyasini taqsimlanishi yordamida formatlashtirish mumkin. Qo'yilgan masalani yalpi xizmat ko'rsatish (YaXK) tizimi sifatida qarash va uni yaxshilash yo'llari haqida ma'lum xulosalar chiqarish mumkin bo'ladi.

Kuzatishlar natijasida avtotransport vositasining yuk jo'natish manzillariga kirib kelish vaqtlari aniqlangan. Shu tarzda, bu vaqtlar oralig'idagi interval va ularning amplitudasi belgilandi. Amplituda oralig'i sakkizta oraliqqa bo'lingan bo'lib, ushbu oraliqlarga tushadigan kirish paytlaridagi intervallarning optimal soni Sterdjes formulasi yordamida hisoblangan (1). Aniqlangan oraliqlarning qaytarilish chastotalari taqsimlanishi ko'rsatkichli qonun bilan ifodalanganligi uchun unda tahlil etilayotgan kiruvchi oqimni oddiy oqim deb hisoblash mumkin.

Kuzatishlar asosida avtomobil transporti vositasining yuk jo'natish manzillariga kirib kelish vaqtlari belgilangan va shu tarzda bu paytlar oralig'idagi vaqt intervallari, ular qiymatlarining amplitudasi aniqlandi. Amplituda oralig'i sakkizta oraliqqa bo'lindi va bu oraliqchalarga tushadigan kirish paytlaridagi intervallarning optimal soni Sterdjes formulasi orqali hisoblendi (1). Aniqlangan oraliqlarning qaytarilish chastotalari taqsimlanishi ko'rsatkichli qonun bilan ifodalanganligi uchun unda tahlil etilayotgan kiruvchi oqimni oddiy oqim deb hisoblash mumkin.

Xizmat ko'rsatuvchi punktga kirib keluvchi transport oqimi vaqt oraliqlari guruhlashtirish intervallarining optimal sonini Sterdjes formulasi orqali quydagicha aniqlanadi:

$$k = 1 + 3,332 \lg \sum m_i \quad (1)$$

bu yerda k –optimal intervallar soni; $\lg$ –o'nlik logarifm; $\sum m_i$ –umumiy kuzashilar soni.

$$k = 1 + 3,332 \lg \sum m_i = 1 + 3,332 \lg 225 = 8$$

Oraliq vaqt intervallarini quydagicha aniqlaymiz:

$$\Delta t = \frac{t_{\max} - t_{\min}}{k} = \frac{64 - 2}{8} = 8 \quad (2)$$

bu yerda t_i –oraliq vaqt intervali; $t_{\max} - t_{\min}$ xizmatga kirib kelgan transport vositasi xizmat ko'rsatilishini kutishining mos ravishda maksimal va minimal vaqti, daq.

3. Natija

Olib borilgan kuzatish natijalari avtomobil transporti vositalarining yuklash punktida xizmat ko'rsatishni kutib turish vaqtlari 2-jadvalga keltirilgan.

2-jadval

Avtomobil transporti vositalarining yuklash punktida xizmat ko'rsatishni kutib turish vaqtlari (kuzatish natijalari)

Avtomobil transporti vositalarining yuklash punktida yuklash uchun navbatda turib qolish vaqti, daq.								
2	33	2	27	4	24	12	2	12
8	7	9	7	8	32	20	8	18
16	12	8	12	10	4	16	16	10
24	8	18	8	16	9	10	24	4
32	18	12	18	25	16	7	32	7
40	14	6	14	32	24	17	40	15
48	12	16	12	40	6	25	48	23
56	3	18	6	48	20	14	3	34
64	22	4	22	4	28	31	8	5
28	8	6	8	12	36	3	15	15
12	22	14	16	4	57	14	12	14
16	30	22	4	10	16	34	24	24
2	38	28	20	5	25	21	16	15
14	46	40	15	3	33	8	19	4
22	2	48	6	10	12	10	32	9
2	10	56	20	16	20	2	16	16
8	4	64	7	20	32	8	24	9
16	12	4	11	32	17	16	4	8
24	4	10	16	43	20	24	9	15
32	15	15	25	18	34	32	16	2
40	23	12	12	26	20	4	10	9
48	31	14	18	38	8	6	18	32
52	39	22	26	49	7	16	20	6
4	47	33	34	33	6	11	4	12
8	48	2	6	26	4	7	5	33

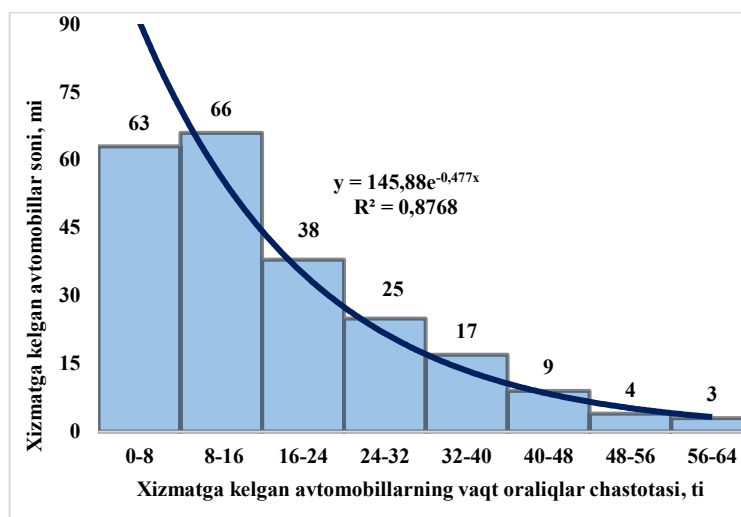
Avtotransport vositalarining yuk jo'natish punktiga kirib kelish oralig'idagi vaqt intervallari 3-jadvalga keltirilgan va 3-rasmda guruhlashtirish bo'yicha taqsimlanish gistogrammasi qurilgan.

3-jadval

Avtotransport vositasining yuk jo'natish manziliga ketma-ket kirib kelish paytlari orasidagi vaqt intervallarining taqsimlanishi ko'rsatkichli qonun asosida amalga oshiriladi

Oraliq vaqt intervali, i	1	2	3	4	5	6	7	8	
Guruhlashtirilgan vaqt oraliqlari, daq. t_i	0-8	8-16	16-24	24-32	32-40	40-48	48-56	56-64	$\Delta t = 8$
Intervallardan guruhlashtirilgan vaqt oraliqlariga tushadigan soni, m_i	63	66	38	25	17	9	4	3	$\sum m_i = 225$
Guruhlashtirilgan vaqt oraliqlarini o'rtasi, daq. $\bar{t}_i$	4	12	20	28	36	44	52	60	
$m_i \bar{t}_i$	252	792	760	700	612	396	208	180	3900
$\lambda \bar{t}_i$	0,231	0,692	1,154	1,615	2,077	2,538	3,000	3,462	
$e^{-\lambda \bar{t}_i}$	0,7939	0,5004	0,3154	0,1988	0,1253	0,0709	0,0498	0,0314	
$m_{ix} = \sum m_i \lambda \Delta t e^{-\lambda \bar{t}_i}$	82,45	51,97	32,76	20,65	13,01	8,20	5,17	3,26	$\chi^2 = 11,72$
$\left(\frac{(m_i - m_{ix})^2}{m_{ix}} \right)$	4,587	3,790	0,840	0,918	1,221	0,078	0,265	0,021	





3-rasm. Yuklash manziliga avtomobillar kirib kelish paytlari oralig'idagi vaqt intervalining taqsimlanish gistogrammasi va qonuni

Yuqorida tuzilgan gistogramma asosida mazkur taqsimlanishning ko'rsatkichli qonunga mos kelishi haqida dastlabki gipotezani qabul qilish mumkin. Endi esa, ushbu qonunning parametrlarini hisoblab, gipotezaning ishonchlilik darajasini tahlil qilamiz.

Xizmat ko'rsatuvchi yuklash punktiga ketma-ket yoki izma-iz kirib keluvchi avtomobil transporti vositalarining kirish paytlari orasidagi vaqt intervalining o'rtacha qiymati ($\bar{u}$) aniqlanadi [2, 4]:

$$\bar{u} = \frac{\sum_{i=1}^N m_i t_i}{\sum_{i=1}^N m_i} = \frac{3900}{225} = 17,33 \quad (3)$$

Yuklash uchun kirib keluvchi avtotransport vositalari oqim jadalligi λ quyidagicha aniqlanadi [2]:

$$\lambda = \frac{1}{\bar{u}} = \frac{1}{17,666} = 0,0577 \approx 3,5 \text{ avt/daq.} \quad (4)$$

Natijada interval u parametrlil $\lambda = 0,0577$ bo'lgan ko'rsatkichli qonun bilan ifodalanadi. Bunda vaqt intervali u ning nazariy hisobdagi chastotasi m_{ix} har bir guruhlashtirilgan vaqt oraliqlari uchun (2) ifodaga muvofiq hisoblanadi [2, 3], ya'ni

$$m_{ix} = \sum m_i \lambda \Delta t e^{-\lambda t_i}$$

$$m_1 = 255 \cdot 0,0577 \cdot 8 \cdot 2,716^{-0,231} = 82,45 \text{ vah.k.}$$

bu yerda $\sum m_i$ – kuzatilgan tasodifiy kattalikning umumiy soni; t_i – guruhlashtirilgan i -chi oraliq vaqt boshlang'ich qiymati; Δt – tasodifiy sonni guruhlashtirish oraliq vaqt intervali.

Hisoblangan nazariy taqsimlanishning empirik taqsimlanishga qanchalik mos kelishini – XI kvadrat (Pirson) mezonni yordamida baholaymiz. Bizning misolimizda Pirson mezonni $\chi^2 = 11,72$ ga teng (3-jadval).

3-jadvaldan olingan ma'lumotlar asosida xizmatga kirib keluvchi avtomobil transporti vositalari oqim ko'rsatkichlar quyidagi tavsifi aniqlandi: $\sum m_i = 225$ ta, $R = 8 - 2 = 6$, $\chi^2 = 11,72$, $P(\chi^2) = 0,95$.

Aniqlangan natijani XI kvadrat (Pirson) mezonni asosida nazariy va eksperimental taqsimlanishlarining o'zaro yaqinligini yetarli darajada deb hisoblash uchun quyidagi shart bajarilishi zarur:

$$\chi^2 < \chi_{0,05}^2 \quad (5)$$

$\alpha = 0,05$, $\chi_{0,05}^2 = 12,59$ qiymatlarda quyidagi $\chi^2 < \chi_{0,05}^2$ shart bajarildi. Natijada, kuzatilgan xizmat

ko'rsatishga kiruvchi oqimni $\lambda = 0,0577$ parametrlil Puasson oqim deb hisoblashimiz mumkin.

4. Xulosa

Olingan tadqiqot natijalari quyidagi xulosalarni chiqarishga imkon beradi:

– oldindan ishlab chiqilgan reja vazifalarida avtomobilning yuk ko'tarish qobiliyatining oshishi real ish sharoitlarida avtomobil transporti vositalarining tonna va tonna kilometrdagi ishi natijalarining oshishiga olib kelmaydi;

– oldindan rejalashtirilmagan holatlarda qy miqdorining oshishi yuk ko'tarish qobiliyatining to'liq ishlatilmasligiga olib keladi;

– oldindan ishlab chiqilgan jadval bo'yicha avtomobil transporti vositasining orttirilgan yuk ko'tarish hajmidan to'liq foydalanish mumkin emas, chunki tashish smena davomida rejalashtirilgan tashish ishlari avtomobil transporti vositalari o'rtasida taqsimlangan. Bunda har bir qatnov uchun yuk miqdori oldindan rejalashtirilgan bo'ladi. Uzlukli va uzluksiz holatlarda yalpi xizmat ko'rsatish tizimiga kirib kelayotgan avtotransport vositalarining ishini tezkor rejalar asosida ishlab chiqish zarur hisoblanadi.

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