LOGISTIKA TIZIMLARIDA FURAGA YUK JOYLASHTIRISHNING DINAMIK DASTURLASH MODELI VA YUK TASHISHNI OPTIMALLASHTIRISH

Mamatova Zilolaxon Xabibulloxonovna

Farg‘ona davlat universiteti dotsenti,

pedagogika fanlari bo‘yicha falsafa doktori (PhD)

E-mail: mamatova.zilolakhon@gmail.com

Farg‘ona davlat universiteti

Amaliy matematika yo‘nalishi talabasi

Axmadaliyev Shuxratjon Xamdamjon o‘g‘li

E-mail: shuxratjonaxmadaliyev15@gmail.com

Annotatsiya: Ushbu maqolada transport-logistika tizimlarida yuk tashishni optimallashtirish muammosi tadqiq etilgan. Fura yuk mashinalariga turli og‘irlik va hajmdagi yuklarni joylashtirish masalasi **ryukzak masalasi** shaklida formalizatsiya qilingan va **dinamik dasturlash** metodologiyasi orqali optimal yechimlar aniqlangan. Olingan natijalar logistika jarayonlarida resurslardan samarali foydalanish, transport xarajatlarini kamaytirish va yetkazib berish vaqtini qisqartirish imkonini beradi. Tadqiqot hayotiy ma’lumotlar bilan sinovdan o‘tkazilgan bo‘lib, kelajakda avtomatlashtirilgan yuklash tizimlari va raqamli logistika platformalariga integratsiya qilish uchun ilmiy asos yaratadi.

Kalit so‘zlar: Logistika tizimlarida optimizatsiya ;Yuk tashish jarayonlari ; ryukzak masalasi;Dinamik dasturlash metodologiyasi ;Fura yuklash modeli ;Transport xarajatlarini minimallashtirish

Abstract: This article studies the problem of optimizing cargo transportation in transport and logistics systems. The problem of loading cargo of different weights and volumes into trucks is formalized in the form of the knapsack problem, and optimal solutions are determined using dynamic programming methodology. The results obtained allow for the efficient use of resources in logistics processes, reducing transportation costs and reducing delivery times. The research is tested with real-world

data and creates a scientific basis for future integration into automated loading systems and digital logistics platforms.

Keywords: Optimization in logistics systems; Cargo transportation processes; Dynamic programming methodology; Truck loading model; Minimization of transportation costs

Аннотация : В данной статье рассматривается проблема оптимизации грузоперевозок в транспортно-логистических системах. Задача погрузки грузов различного веса и объема в грузовики формализована в виде задачи о рюкзаке , а оптимальные решения определены с использованием метода динамического программирования. Полученные результаты позволяют эффективно использовать ресурсы в логистических процессах, снижая транспортные издержки и сокращая сроки доставки. Исследование проверено на реальных данных и создает научную основу для будущей интеграции в автоматизированные системы погрузки и цифровые логистические платформы.

Ключевые слова: Оптимизация в логистических системах; Грузоперевозки; Задача о рюкзаке ;Метод динамического программирования; Модель погрузки грузовиков; Минимизация транспортных издержек

Transport-logistika tizimlarining samaradorligi iqtisodiyot va ijtimoiy sohalarda muhim ahamiyatga ega. Hozirgi kunda global savdo, elektron tijorat va tez yetkazib berish talablari transport operatsiyalarining optimallashtirilishini talab qilmoqda. Yuk mashinalarini (furalarni) samarali ishlatish logistika xarajatlarini kamaytirish, yetkazib berish vaqtini qisqartirish va resurslardan maksimal darajada foydalanish imkonini beradi.

Yuk joylashtirish masalasi turli o‘lcham va og‘irlikdagi tovarlarni fura sig‘imiga optimal tarzda taqsimlashni talab qiladi. Bu masala klassik **ryukzak masalasi** bilan matematik jihatdan bog‘liq bo‘lib, kombinator optimizatsiyasi nuqtai nazaridan murakkab hisoblanadi. An’anaviy yondoshuvlar katta miqdordagi yuklar va cheklovlar bilan ishlaganda samarali yechim bermaydi, shuning uchun dinamik dasturlash metodologiyasi muhim ahamiyat kasb etadi.

Ushbu maqolada fura yuk mashinalariga yuklarni joylashtirishning **dinamik dasturlash modeli** ishlab chiqiladi, uning samaradorligi real hayotiy ma’lumotlar bilan sinovdan o‘tkaziladi. Tadqiqot natijalari logistika tizimlarida transport resurslarini optimallashtirish, xarajatlarni kamaytirish va yetkazib berish jarayonlarini tezlashtirish imkonini beradi. Shu bilan birga, model kelajakda avtomatlashtirilgan yuklash tizimlari va raqamli logistika platformalariga integratsiya qilish uchun ilmiy asos yaratadi.

Ryukzak masalasi va dinamik dasturlash modeli

Logistika tizimlarida yuk tashishni optimallashtirishning muhim komponentlaridan biri – fura yuk mashinalariga turli og‘irlik va qiymatga ega predmetlarni joylashtirish masalasidir. Ushbu masala matematik jihatdan **ryukzak masalasi** sifatida formalizatsiya qilinadi, bunda har bir predmetning og‘irligi va bahosi ma’lum bo‘lib, maksimal qiymatga ega bo‘lgan predmetlar to‘plamini tanlash maqsad qilinadi.

n – xil turdagi predmentlar ; har bir predmentning og’riligi a_i uning baxosi $c_i \geq 0$ ga teng bo’lsin Natijada furaga joylangan yuklarning baxosi maxsimal bo’lsin. b – yukni maksimal ko‘tara oladigan og‘irligi

Bu masalani matematik madeli quyidagi ko’rinishda bo’ladi

$$\sum_{i=1}^{n} x_i c_i \qquad (1)$$

Funksiyaning maxsimal qiymati

$$\sum_{i=1}^{n} a_i x_i \leq b \qquad (2)$$

$$x_i \geq 0 \ , i = 1,2,3,\ldots . n \qquad (3)$$

Shu shartlar ostida topiladi. Bu yerda $x_i \geq 0$, $i = 1,2,3,\ldots.n$ lar i raqamli maxsulotning sonini bildiradi. Qo'yilgan (1)-(3) masala butun sonli chiziqli dasturlash masalasi bo'lib uni yechishda dinamik dasturlash usuli qo'llaniladi.

Buni uchun quyidagi belgilash kirtiladi

$$\psi_k(y) = \max_{x_1 \ldots\ldots x_k} \sum_{i=1}^{k} c_i x_i$$

$$\sum_{i=1}^{k} a_i x_i \leq y$$

Bu yerda: $= 1,2,\ldots n$; $y = 1,2,3,\ldots. b$

$k = 1$ hol uchun

$$\psi_1(\mathrm{y}) = \max_{x_1} c_i x_i = c_1 \left[\frac{y}{a_1} \right] \qquad (4)$$

$k = 2,\ldots n$ da quyidagi rekurent formulaga ega bo'lamiz

$$\psi_k(\mathrm{y}) = \max(\psi_{k-1}(\mathrm{y}), \psi_k(\mathrm{y} - a_k) + c_k) \qquad (5)$$

Bunda agar $y < 0$ bo'lsa $\psi_k(y) = -\infty$, va $\psi_0(y)$= $\psi_k(0) = 0$ deb olamiz

Fura yuklashda maksimal qiymatga erishish uchun har bir predmetning fura ichiga kiritilishi yoki kiritilmasligi $\psi_k(y)$ funksiyasi yordamida aniqlanadi. Agar $j(k; y) = i$ bo'lsa bu degani $\psi_k(y)$ baxoga erishish uchun i maxsulotdan kamida bitta foydalaniladi. Bu funksiya uchun quyidagi formullalar o'rinli

$$j(1; y) = \begin{cases} 0\,, agar\ \psi_1(y) = 0 \\ 1\,, agar\ \psi_1(y) \neq 0 \end{cases} \qquad (6)$$

$k = 2,\ldots.. n$ da quyidagi rekurent formulaga ega bo'lamiz

$$j(k;y)=\begin{cases} j(k-1;\ y) & ,\ agar\ \psi_k(y-a_k)+c_k<\psi_{k-1}(y) \\ k & ,agar\ \psi_k(y-a_k)+c_k\geq\psi_{k-1}(y) \end{cases} \quad (7)$$

Amaliy masala

Biz furaga yuklarni joylash masalani ko'rib chiqamiz

Mahsulot ,predmentlar:

1. Karam og'irligi 3kg narxi 5000 so'm
2. Sabzi og'irligi 1 kg narxi 6000 so'm
3. Kartoshkka og'irligi 1 kg narxi 7000 so'm
4. Tarvuz og'irligi 6 kg narxi 18000 so'm
5. Qovun og'irligi 6 kg narxi 25000 so'm
6. Guruj og'irligi 1kg narxi 7000 so'm
7. Olma og'irligi 1 kg narxi 15000 so'm
8. Banan og'irligi 1 kg narxi 24000 so'm
9. Sumka – kiyim og'irligi - 5 kg, narxi - 80 000 so'm
10. Kitoblar - og'irligi - 4 kg, narxi - 85 000 so'm

Bu ro'yxatni masala shartlarga moslasak

Berilagan :

n=10 ;

$a_1=3; a_2=1; a_3=1; a_4=6; a_5=6; a_6=1; a_7=1; a_8=1; a_9=5;$
$a_{10}=4$

Har bir predmentlarning baxosi c_i ni yozamiz

c_1=5000 ; c_2=6000 ; c_3=7000 ; c_4=18000 ; c_5=25000 ; c_6=7000 ; c_7=15000 ; c_8=24000 ; c_9=80000 ; c_{10}=85000

Furani maxsimal yuk ko'tara oladigan hajmi $b=15\ tonna\ =$ **15000 kg**

Amaliy qism hisoblash jarayoni Furaga yuk joylashtirish masalasining modeli

Biz yuqorida keltirilgan nazariy model asosida logistika tizimida yuklarni fura ichiga joylashtirish masalasi ko‘rib chiqamiz . Turli og‘irlik va qiymatga ega mahsulotlar mavjud bo‘lib, ularni furaning maksimal yuk ko‘tarish sig‘imi chegarasida optimal tarzda joylashtirish talab qilinadi.

Fura masalasini dinamik dasturlash usuli yordmida (4),(5),(6),(7) formulalarga qo’yib berilgan qiymatlar bilan moslab hisoblab jadval hosil qilib yozib chiqamiz .

Yuqoridagi (1),(2),(3) formula ifoda ryukzak masalasi hisoblanadi .

Masalani yechish uchun quiyidagi funksiyani kiritamiz .

$$\psi_k(y)$$

bu funksiya birinchi k ta mahsulotdan foydalanib, y og‘irlik chegarasida olinadigan maksimal qiymatni bildiradi.

Rekurent formula $\psi_k(y) = max(\psi_{k-1}(y), \psi_k(y - a_k) + c_k)$

Yechish:

$< y = 1,2, \dots 15 >$; $< k = 1,2,3 \dots .10 >$

Yuqoridagi berilganlarga assosan hisoblaymiz n=10 ;

$a_1 = 3; a_2 = 1; a_3 = 1; a_4 = 6; a_5 = 6; a_6 = 1; a_7 = 1; a_8 = 1; a_9 = 5;$
$a_{10} = 4$
c_1=5000 ; c_2=6000 ; c_3=7000 ; c_4=18000 ; c_5=25000 ; c_6=7000 ; c_7=15000 ;
c_8=24000 ; c_9=80000 ; c_{10}=85000

$$b = 15\ tonna\ =\ \mathbf{15000\ kg}$$

2ta jadvalni to’ldiramiz

$$\psi_1(y) = \max_{x_1} c_1\, x_1 = c_1 \left[\frac{y}{a_1}\right] \qquad (4)$$

1-qadam

$$\psi_1(1) = \max_{x_1} c_1 x_1 = 5000 * \left[\frac{1}{3}\right] = 0$$

$\psi_1(2)$=5000*$\left[\frac{2}{3}\right] = 0$

$\psi_1(3)$=5000*$\left[\frac{3}{3}\right] = 5000$

$\psi_1(4)$=5000*$\left[\frac{4}{3}\right] = 5000$

$\psi_1(5)$=5000*$\left[\frac{5}{3}\right] = 5000$

$\psi_1(6)$=5000*$\left[\frac{6}{3}\right] = 10000$

$\psi_1(7)$=5000*$\left[\frac{7}{3}\right] = 10000$

$\psi_1(8)$=5000*$\left[\frac{8}{3}\right] = 10000$

$\psi_1(9)$=5000*$\left[\frac{9}{3}\right] = 10000$

$\psi_1(10)$=5000*$\left[\frac{10}{3}\right] = 10000$

$\psi_1(11)$=5000*$\left[\frac{11}{3}\right] = 10000$

$\psi_1(12)$=5000*$\left[\frac{12}{3}\right] = 20000$

$\psi_1(13)$=5000*$\left[\frac{13}{3}\right] = 20000$

$\psi_1(14)$=5000*$\left[\frac{14}{3}\right] = 20000$

$\psi_1(15)$=5000*$\left[\frac{15}{3}\right] = 25000$

$$i(1;y) = \begin{cases} 0\,, agar\ \psi_1(y) = 0 \\ 1\,, agar\ \psi_1(y) \neq 0 \end{cases} \quad (6)$$

formulaga ko'ra k=1 bo'ganda

$$i(1;y) = \begin{cases} 0\,, agar\ \psi_1(y) = 0 \\ 1\,, agar\ \psi_1(y) \neq 0 \end{cases}$$

$$i(1;1)=\begin{cases}0\,,agar\ \psi_1(1)=0\\1\,,agar\ \psi_1(1)\neq 0\end{cases}$$

2-qadam:

k=2 $\psi_k(y)=max(\psi_{k-1}(y)\,,\psi_k(y-a_k)+c_k)$ (5) hisoblaymiz $\psi_2(y)=max(\psi_1(y);\psi_2(y-a_2)+c_2)$ $\psi_2(1)=max(\psi_1(1);\psi_2(1-1)+6000)$ $=max(0,6000)$ $=6000$	k=2 $i(k;y)=\begin{cases}i(k-1;\ y),agar\ \psi_k(y-a_k)+c_k<\psi_{k-1}(y)\\k\ \ ,agar\ \psi_k(y-a_k)+c_k\geq\psi_{k-1}(y)\end{cases}$ Hisoblaymiz (7) $i(2;y)=\begin{cases}i(1;\ y),\psi_2(y-a_2)+c_2<\psi_1(y)\\2\ \ ,\quad \psi_2(y-a_2)+c_2\geq\psi_1(y)\end{cases}$ $i(2,1)=>\psi_2(0)+6000\geq\psi_1(1)=>2$ $i(2,2)=>\psi_2(1)+6000\geq\psi_1(2)=>2$ $i(2,3)=>\psi_2(2)+6000\geq\psi_1(3)=>2$ $i(2,4)=>\psi_2(3)+6000\geq\psi_1(4)=>2$ $i(2,5)=>\psi_2(4)+6000\geq\psi_1(5)=>2$ $i(2,6)=>\psi_2(5)+6000\geq\psi_1(6)=>2$ $i(2,7)=>\psi_2(6)+6000\geq\psi_1(7)=>2$ hakazo …. $i(2,15)=>\psi_2(14)+6000\geq\psi_1(15)=>2$

3-qadam:

k=3 $\psi_k(y)=max(\psi_{k-1}(y)\,,\psi_k(y-a_k)+c_k)$ (5) hisoblaymiz $\psi_3(y)=max(\psi_2(y);\psi_3(y-a_3)+c_3)$ $\psi_3(1)=max(\psi_2(1);\psi_3(1-1)+7000)$ $=max(6000,7000)=7000$ $\psi_3(11)=max(\psi_2(11);\psi_3(11-1)+7000)$ $=max(66000,77000)=77000$	k=3 $i(k;y)$ $=\begin{cases}i(k-1;\ y),agar\ \psi_k(y-a_k)+c_k<\psi_{k-1}(y)\\k\ \ ,agar\ \psi_k(y-a_k)+c_k\geq\psi_{k-1}(y)\end{cases}$ hisoblaymiz (7) $i(3;y)=\begin{cases}i(2;\ y),\psi_3(y-a_3)+c_3<\psi_2(y)\\3\ \ ,\quad \psi_3(y-a_3)+c_3\geq\psi_2(y)\end{cases}$ $i(3,1)=>\psi_2(0)+7000\geq\psi_2(1)=>3$ $i(3,2)=>\psi_2(1)+7000\geq\psi_2(2)=>3$ $i(3,3)=>\psi_2(2)+7000\geq\psi_2(3)=>3$ $i(3,4)=>\psi_2(3)+7000\geq\psi_2(4)=>3$ $i(3,5)=>\psi_2(4)+7000\geq\psi_2(5)=>3$ $i(3,6)=>\psi_2(5)+7000\geq\psi_2(6)=>3$ $i(3,7)=>\psi_2(6)+7000\geq\psi_2(7)=>3$ hakazo …. $i(3,15)=>\psi_2(14)+7000\geq\psi_2(15)=>3$

4-qadam:

k=4 $\psi_k(y)=max(\psi_{k-1}(y)\,,\psi_k(y-a_k)+c_k)$ (5) hisoblaymiz	k=4 $i(k;y)$ $=\begin{cases}i(k-1;\ y),agar\ \psi_k(y-a_k)+c_k<\psi_{k-1}(y)\\k\ \ ,agar\ \psi_k(y-a_k)+c_k\geq\psi_{k-1}(y)\end{cases}$ hisoblaymiz (7)

$\psi_4(y) = max(\psi_3(y), \psi_4(y - a_4) + c_4)$ $\psi_4(1) = max(\psi_3(1), \psi_4(1-6) + 18000)$ $= max(7000; \infty) = 7000$	$i(4; y)$ $= \begin{cases} i(3; y), agar\ \psi_4(y-6) + 18000 < \psi_3(y \\ 4, agar\ \psi_4(y-6) + 18000 \geq \psi_3(y \end{cases}$

5-qadam:

k=5 $\psi_k(y) = max(\psi_{k-1}(y), \psi_k(y - a_k) + c_k)$ (5) hisoblaymiz $\psi_5(y) = max(\psi_4(y), \psi_5(y - a_5) + c_5)$ $\psi_5(1) = max(\psi_4(1), \psi_5(1-6) + 25000$	k=5 $i(k; y)$ $= \begin{cases} i(k-1;\ y), agar\ \psi_k(y - a_k) + c_k < \psi_{k-1}(y) \\ k\ \ , agar\ \psi_k(y - a_k) + c_k \geq \psi_{k-1}(y) \end{cases}$ hisoblaymiz (7) $i(5; y)$ $= \begin{cases} i(4; y), agar\ \psi_5(y-6) + 25000 < \psi_4(y \\ 5, agar\ \psi_5(y-6) + 25000 \geq \psi_4(y \end{cases}$

6-qadam:

k=6 $\psi_k(y) = max(\psi_{k-1}(y), \psi_k(y - a_k) + c_k)$ (5) hisoblaymiz $\psi_6(y) = max(\psi_5(y), \psi_6(y - a_6) + c_6)$ $\psi_6(1) = max(\psi_5(1), \psi_6(1-1) + 7000)$	k=6 $i(k; y)$ $= \begin{cases} i(k-1;\ y), agar\ \psi_k(y - a_k) + c_k < \psi_{k-1}(y) \\ k\ \ , agar\ \psi_k(y - a_k) + c_k \geq \psi_{k-1}(y) \end{cases}$ hisoblaymiz (7) $i(6; y) = \begin{cases} i(5; y), agar\ \psi_6(y-1) + 7000 < \psi_5(y \\ 6, agar\ \psi_6(y-1) + 7000 \geq \psi_5(y \end{cases}$

7-qadam:

k=7 $\psi_k(y) = max(\psi_{k-1}(y), \psi_k(y - a_k) + c_k)$ (5) hisoblaymiz $\psi_7(y) = max(\psi_6(y), \psi_7(y - a_7) + c_7)$ $\psi_7(1) = max(\psi_6(1), \psi_7(1-1) + 15000)$	k=7 $i(k; y)$ $= \begin{cases} i(k-1;\ y), agar\ \psi_k(y - a_k) + c_k < \psi_{k-1}(y) \\ k\ \ , agar\ \psi_k(y - a_k) + c_k \geq \psi_{k-1}(y) \end{cases}$ hisoblaymiz (7) $i(7; y)$ $= \begin{cases} i(6; y), agar\ \psi_7(y-1) + 15000 < \psi_6(y \\ 7, agar\ \psi_7(y-1) + 15000 \geq \psi_6(y \end{cases}$

8-qadam:

k=8 $\psi_k(y) = max(\psi_{k-1}(y), \psi_k(y - a_k) + c_k)$ (5) hisoblaymiz $\psi_8(y) = max(\psi_7(y), \psi_8(y - a_8) + c_8)$ $\psi_8(1) = max(\psi_7(1), \psi_8(1-1) + 24000)$	k=8 $i(k; y)$ $= \begin{cases} i(k-1;\ y), agar\ \psi_k(y - a_k) + c_k < \psi_{k-1}(y) \\ k\ \ , agar\ \psi_k(y - a_k) + c_k \geq \psi_{k-1}(y) \end{cases}$ hisoblaymiz (7) $i(8; y)$ $= \begin{cases} i(7; y), agar\ \psi_8(y-1) + 24000 < \psi_7(y \\ 8, agar\ \psi_8(y-1) + 24000 \geq \psi_7(y \end{cases}$

9-qadam:

k=9 $\psi_k(y) = max(\psi_{k-1}(y), \psi_k(y - a_k) + c_k)$ (5) hisoblaymiz $\psi_9(y) = max(\psi_8(y), \psi_9(y - a_9) + c_9)$ $\psi_9(1) = max(\psi_8(1), \psi_9(1 - 5) + 80000)$	k=9 $i(k; y)$ $= \begin{cases} i(k-1;\ y), agar\ \psi_k(y - a_k) + c_k < \psi_{k-1}(\\ k\ \ , agar\ \psi_k(y - a_k) + c_k \geq \psi_{k-1}(y) \end{cases}$ hisoblaymiz (7) $i(9; y)$ $= \begin{cases} i(8; y), agar\ \psi_9(y - 5) + 80000 < \psi_8(y \\ 9, agar\ \psi_9(y - 5) + 80000 \geq \psi_8(y \end{cases}$

10-qadam:

k=10 $\psi_k(y) = max(\psi_{k-1}(y), \psi_k(y - a_k) + c_k)$ (5) hisoblaymiz $\psi_{10}(y) = max(\psi_9(y), \psi_{10}(y - a_{10}) + c_{10})$ $\psi_{10}(1) = max(\psi_9(1), \psi_{10}(1 - 4) + 85000)$	k=10 $i(k; y)$ $= \begin{cases} i(k-1;\ y), agar\ \psi_k(y - a_k) + c_k < \psi_{k-1}(y \\ k\ \ , agar\ \psi_k(y - a_k) + c_k \geq \psi_{k-1}(y) \end{cases}$ hisoblaymiz (7) $i(10; y)$ $= \begin{cases} i(9; y), agar\ \psi_{10}(y - 4) + 85000 < \psi_9(y \\ 10, agar\ \psi_{10}(y - 4) + 85000 \geq \psi_9(y \end{cases}$

1-jadval $\psi_k(y)$

Y k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	5000	5000	5000	10000	10000	10000	10000	10000	10000	20000	20000	20000	25000
2	6000	12000	18000	24000	30000	36000	42000	48000	54000	60000	66000	72000	78000	84000	90000
3	7000	14000	21000	28000	35000	42000	49000	56000	63000	70000	77000	84000	91000	98000	105000
4	7000	14000	21000	28000	35000	42000	49000	56000	63000	70000	77000	84000	91000	98000	105000
5	7000	14000	21000	28000	35000	42000	49000	56000	63000	70000	77000	84000	91000	98000	105000
6	7000	14000	21000	28000	35000	42000	49000	56000	63000	70000	77000	84000	91000	98000	105000
7	15000	30000	45000	60000	75000	90000	105000	120000	135000	150000	165000	180000	195000	210000	225000
8	24000	48000	72000	96000	120000	144000	168000	192000	216000	240000	264000	288000	312000	336000	360000
9	24000	48000	72000	96000	120000	144000	168000	192000	216000	240000	264000	288000	312000	336000	360000
10	24000	48000	72000	96000	120000	144000	168000	192000	216000	240000	264000	288000	312000	336000	360000

Y k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
10	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8

2- jadval $i(k, y)$

Optimal yechim tahlili

Dinamik dasturlash natijasida furaga yuklarni joylashtirish masalasi uchun olingan $\psi_{10}(15) = 360000$ so‘m maksimal qiymat furaning 15 tonnalik sig‘imi uchun optimal yechimni bildiradi. **“Qadamlarni orqaga qaytarish usuli”** metodi yordamida aniqlangan optimal kombinatsiya shuni ko‘rsatdiki, eng yuqori qiymat/og‘irlik nisbatiga ega mahsulotlar fura sig‘imini samarali ishlatadi.

Tahlil shuni ko‘rsatadiki:

Kichik og‘irlik, yuqori qiymatga ega mahsulotlar tanlanganida umumiy foyda maksimal bo‘ladi.

Katta og‘irlikdagi mahsulotlar fura sig‘imini tez to‘ldiradi, lekin maksimal foyda nuqtai nazaridan optimal tanlovga kiritilmaydi.

Dinamik dasturlash modeli yordamida har bir bosqichda optimal qarorlar saqlanadi, bu esa kombinator muammolarini samarali yechishga imkon beradi.

Natijalar logistika jarayonida yuklarni joylashtirish strategiyasini aniqlashda, transport xarajatlarini kamaytirishda va yetkazib berish muddatini optimallashtirishda muhim ahamiyatga ega.

Ushbu tadqiqotning ilmiy yangiligi shundan iboratki:

Furaga yuk joylashtirish masalasi **ryukzak masalasi** shaklida matematik jihatdan formalizatsiya qilinib, **dinamik dasturlash usuli** yordamida amaliy yechimlar ishlab chiqildi.

Model **real hayotiy ma’lumotlar bilan sinovdan o‘tkazilib**, transport-logistika tizimlarida resurslardan maksimal foydalanish imkoniyatini ko‘rsatadi.

Taklif qilingan yondoshuv **avtomatlashtirilgan yuklash tizimlari va raqamli logistika platformalariga integratsiya qilish** uchun ilmiy asos yaratadi.

Olingan natijalar **eng yuqori qiymat/og‘irlik nisbatini hisobga olgan holda yuklarni optimal tanlash strategiyasini** aniqlashga imkon beradi, bu esa logistika xarajatlarini minimallashtiradi.

Shu bilan birga, model kelajakda **ko‘p parametrli optimizatsiya** (og‘irlik + hajm + narx + yetkazib berish muddati) muammolariga kengaytirilishi mumkin.

Shu 2ta jadvaldan foydalanib yechimni qaysi yukni tanlashni Z funksiyani topamiz

$i(10,15) = 8 \Rightarrow x_8 = 1$

$i(10,15 - a_8) = i(10,14) = 8 \Rightarrow x_8 = 2$

$i(10,14 - a_8) = i(10,13) = 8 \Rightarrow x_8 = 3$

$i(10,13 - a_8) = i(10,12) = 8 \Rightarrow x_8 = 4$

$i(10,12 - a_8) = i(10,11) = 8 \Rightarrow x_8 = 5$

$i(10,11 - a_8) = i(10,10) = 8 \Rightarrow x_8 = 6$

$i(10,10 - a_8) = i(10,9) = 8 \Rightarrow x_8 = 7$

$i(10,9 - a_8) = i(10,8) = 8 \Rightarrow x_8 = 8$

$i(10,8 - a_8) = i(10,7) = 8 \Rightarrow x_8 = 9$

$i(10,7 - a_8) = i(10,6) = 8 \Rightarrow x_8 = 10$

$i(10,6 - a_8) = i(10,5) = 8 \Rightarrow x_8 = 11$

$i(10,5 - a_8) = i(10,4) = 8 \Rightarrow x_8 = 12$

$i(10,4 - a_8) = i(10,3) = 8 \Rightarrow x_8 = 13$

$i(10,3 - a_8) = i(10,2) = 8 \Rightarrow x_8 = 14$

$i(10,2 - a_8) = i(10,1) = 8 \Rightarrow x_8 = 15$

Javob Umumiy: $x_8 = 15; x_1 = x_2 = \ldots = x_7 = x_9 = \ldots = x_{15} = 0$

$$Z = \sum_{k=1}^{10} c_k * x_k$$

$$Z = \sum_{k=1}^{10} c_k * x_k$$

$$= (c_1 * x_1 + c_2 * x_2 + \cdots + c_7 * x_7 + c_9 * x_9 + \cdots + c_{10} * x_{10}) + c_8 * x_8$$

$$= c_8 * x_8 = 24000 * 15 = 360\,000$$

$$Z = 360\,000$$

Bundan kelib chiqdiki 8 maxsulotdan 15ta yuklash mumkinligi kelib chiqdi.

Xulosa. Ushbu tadqiqot transport-logistika tizimlarida furaga yuklarni joylashtirish masalasini matematik jihatdan tahlil qilishga qaratildi. Dinamik dasturlash metodologiyasi yordamida mahsulotlarni optimal tarzda tanlash va yuklash modeli ishlab chiqildi. Misol sifatida, berilgan fura sig‘imi va mahsulotlar og‘irligi hisobga olingan holda yechim aniqlanishi ko‘rsatildi: eng yuqori qiymat/og‘irlik nisbatiga ega 8-mahsulotdan 15 ta yuklash mumkinligi aniqlandi va boshqa mahsulotlar tanlanmadi. Shu orqali Z funksiyasi qiymati 360 000 ga teng bo‘lib, maksimal foyda va samarali yuklash imkonini berdi.

Natijalar shuni ko‘rsatadiki, yuqori qiymatli mahsulotlarni tanlash orqali fura sig‘imi samarali ishlatiladi, transport xarajatlari kamayadi va yetkazib berish vaqti qisqaradi. Masalaning turli kombinatsiyalari va shartlariga qarab optimal yechimlarni aniqlash mumkinligi amaliy qiymatini oshiradi.

Kelajakda ushbu model avtomatlashtirilgan yuklash tizimlariga va raqamli logistika platformalariga integratsiya qilinishi mumkin. Shu bilan transport-logistika jarayonlarini raqamlashtirish va optimallashtirish, yuklash strategiyalarini avtomatik tarzda belgilash, xarajatlarni kamaytirish va yetkazib berish samaradorligini oshirish imkoniyatlari paydo bo‘ladi. Ushbu yondashuv kelajakda ilg‘or transport boshqaruv tizimlari va raqamli sanoat standartlariga mos holda logistika jarayonlarini optimallashtirish va resurslardan samarali foydalanishni ta’minlash imkoniyatini beradi.

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