METHODICAL RECOMMENDATIONS FOR PRACTICAL CLASSES

ON SUBJECT "International logistics and process management"

TASK 1. The method of supplier selection based on rating

You have to evaluate five suppliers and make decision about choosing the best one. Use the method of supplier selection based on rating. Justify your answer.

№	Criteria	Suppliers					Rank
		1	2	3	4	5	
1							
2							
…							
…							
…							
K							

Where $K = 10 + i$.

i – the last numeral of the credit book

Methodical recommendations for the performance of work

This method relates to Multicriteria decision group. On the first step we set a list of criteria from the next groups:

1) relay – give the answer "yes" or "no" (for example certificate availability);
2) quantitative;
3) qualitative.

Primarily check the relay criteria and exclude that suppliers who have answer "no".

On the second step we calculate weight of quantitative and qualitative criteria by the following formula:

$$W_i = \frac{2(K - r + 1)}{K(K + 1)},$$

where W_i – weight of criteria i, $i \in \overline{1, K}$;

K – total amount of criteria (except relay criteria);

r – rank of criteria i (the smallest value belongs to the most important criteria, the biggest value- to the least important criteria);

Then we define the extremum of criteria (max or min) and find out this value iterating through all suppliers.

Calculate quantitative criteria by the following formula:

- when extremum "max"

$$Z_j = \frac{K_{actualj}}{K_{reference}},$$

- when extremum "min"

$Z_j = \frac{K_{reference}}{K_{actualj}}$, $j \in \overline{1,m}$, m – amount of suppliers

where $K_{reference}$ - reference value of criteria, $K_{actualj}$ - actual value of supplier j by criteria.

The weighted value is calculated as:

$$D_i = Z_i \cdot W_i .$$

The qualitative criteria is calculated with help of scale

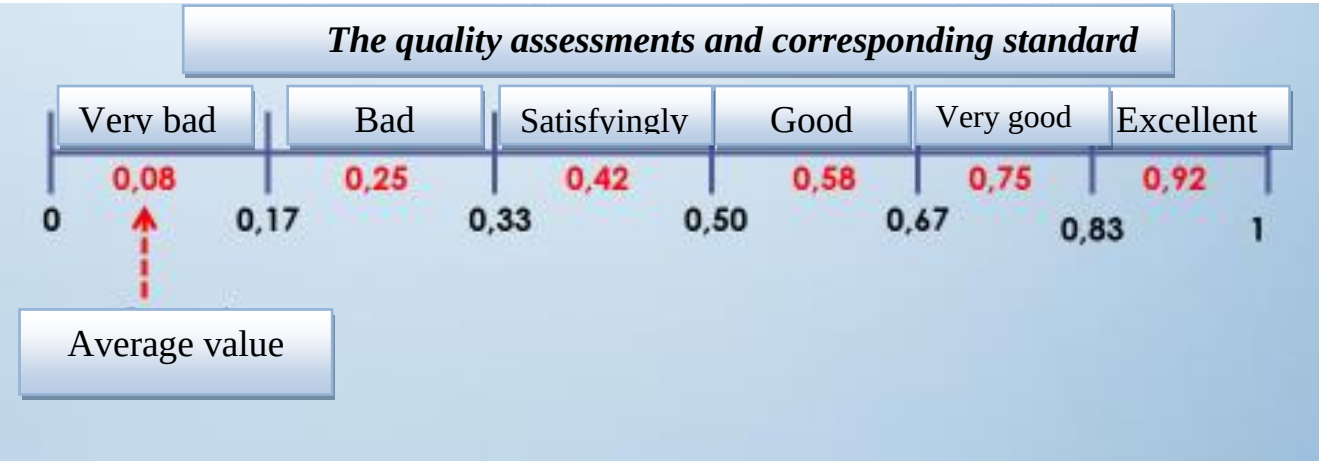
Table 1

The quality assessments and corresponding standard assessments

Quality assessment	Corresponding standard assessment
Excellent	0,92
Very good	0,75
Good	0,58
Satisfyingly	0,42
Bad	0,25
Very bad	0,08

The rating is sum of weighted value of quantitative and qualitative criteria.

First of all, we select quality assessment for example, 7 assessments. Than we chose the maximum value, in our case it is 1. After that we should divide 1 to 7 (equal to 0,17) and find interval of each assessment. Than we can chose the average value of each interval.



TASK 2. International Transportation and batch optimization

Output data.

Construct a graph that shows the changes of the international transportation. Determine the average time of resources during the transportation, the average inventory and average daily shipments of resources. Input data are given in Table 1. Make the optimization of batch using the Gantt chart.

Table 1 - Graph of changes in transport inventory (Period (***P***) – 40 days)

Number of shipment	Date of shipping **January**	Quantity (batch), t ***Q***	Period of transportation, days ***t***
1	1	45-i	7
2	3	5+i	14-i
3	7	15+i	10
4	12	25	8
5	13	10+i	15
6	18	15+i	6
7	20	35-i	7
8	22	40-i	3
9	24	25	1+i
10	30	60-i	5

Where i – the last numeral of the credit book
j – the previous numeral of the credit book

Solution

Inventory during the transportation – is a product of inventory for industrial and technical purposes, being at the time of registration during the transportation that is territorial displacement from the supplier to the consumer or to the **whole**sale (оптовые) trade enterprises.

We calculate the average residence time of resources during the transportation that is defined as the ratio of the sum of all the resources during the transportation over period to the sum of all shipments. Thus, the average residence time of resources during the transportation equal to:

$$T_{tr.avr=} \frac{\sum Q_i \cdot t}{\sum Q_i}, \quad (1)$$

Average inventory equal to the ratio of the sum of all resources during the transportation over period (months) to the number of days in the period:

$$Q_{tr.avr} = \frac{\sum Q_i \cdot t}{P}, \tag{2}$$

Average daily shipment of resources defined as the ratio of the sum of all shipments over the period and the number of days in the period and equal to:

$$q_{avr} = \frac{\sum Q_i}{P}, \tag{3}$$

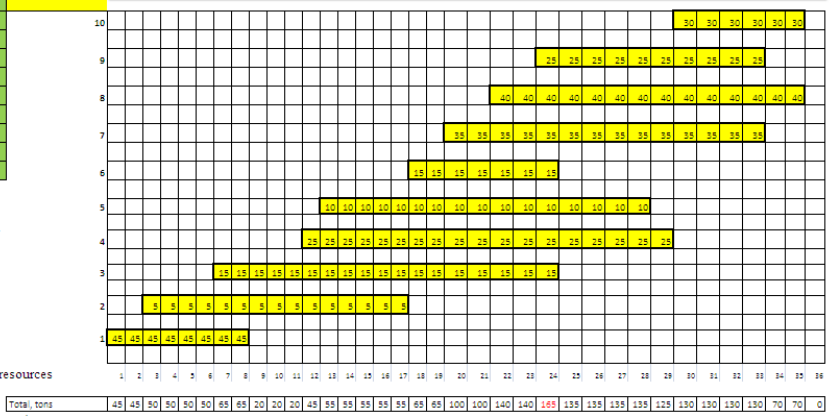
Example

Number of shipment	Date of shipping	Day of delivery	Quantity, t (Q)	Period of transportation, days (t)
1	1	8	45	7
2	3	17	5	14
3	7	24	15	17
4	12	29	25	17
5	13	28	10	15
6	18	24	15	6
7	20	33	35	13
8	22	35	40	13
9	24	33	25	9
10	30	35	30	5
P	35			

1	$T_{tr.avr} = \frac{\sum Q_i \cdot t}{\sum Q_i}$	10,84	Average residence time of resources during the transportation
2	$Q_{tr.avr} = \frac{\sum Q_i \cdot t}{P}$	75,86	Average inventory
3	$q_{avr} = \frac{\sum Q_i}{P}$	7,00	Average daily shipment of resources

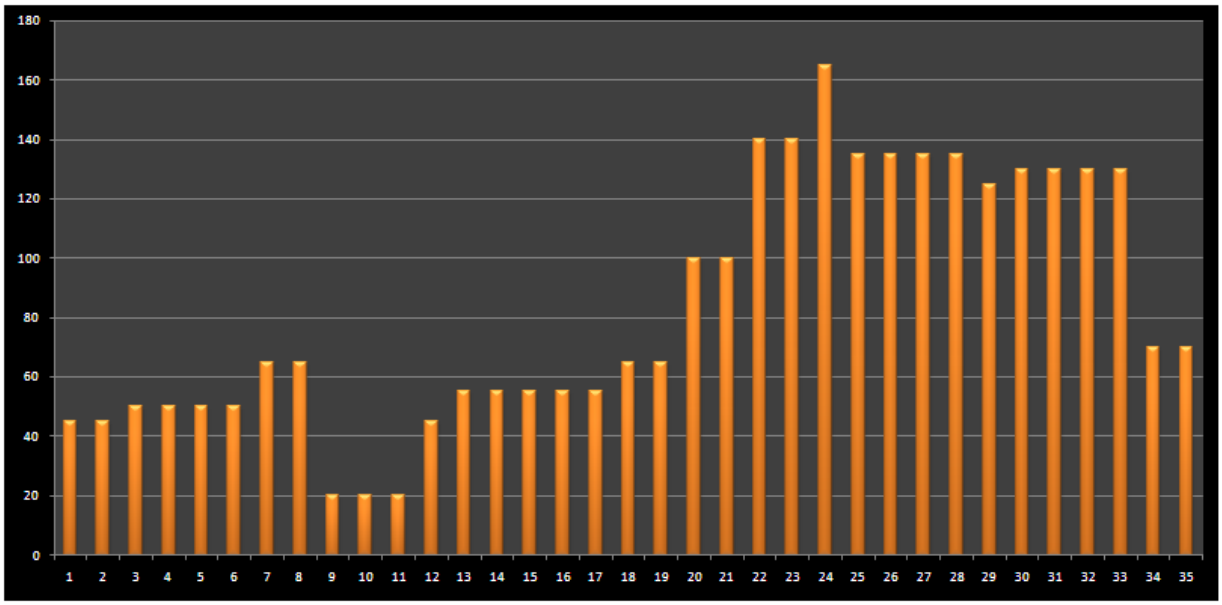
Number of shipment

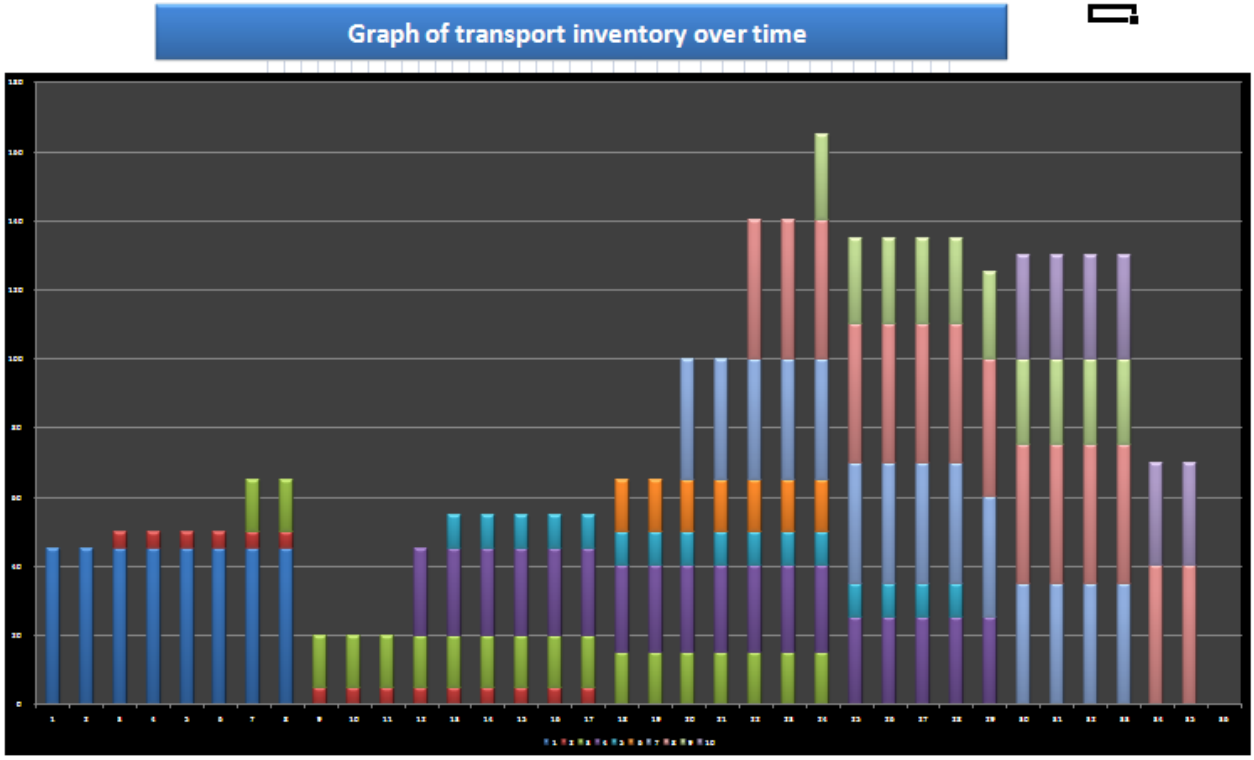
Traffic of inventory over time



Total, tons: 45 45 50 50 50 65 65 20 20 20 45 55 55 55 55 65 65 100 100 140 140 165 135 135 135 135 125 130 130 130 70 70 0

Graph of changes in the level of transport inventory

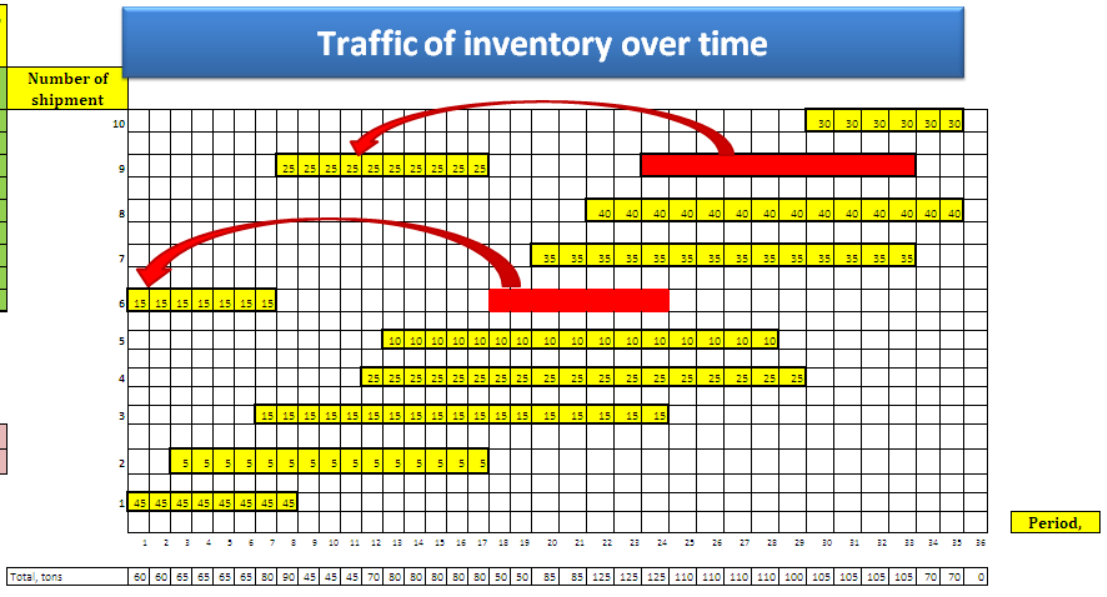




AFTER OPTIMIZATION

Number of shipment	Date of shipping	Day of delivery	Quantity, t
1	1	8	45
2	3	17	5
3	7	24	15
4	12	29	25
5	13	28	10
6	18	24	15
7	20	33	35
8	22	35	40
9	24	33	25
10	30	35	30

Before	Max	165
After	Max	125



TASK 3. "Determine the variant of storage and transportation of goods"

Determine variant of storage and transportation of goods (n = 7, 6, 5, 4, 3, 2) which has the minimum total costs. Create the graphs of the Volume of products from the manufacturer and Volume of products from the intermediary for each variant of number of orders. The bench mark data is given in the table.

Table 1– The bench mark data for calculating

Criteria	Dimension	Value
Daily demand of goods for intermediary	ton/day	5 + *0,1*i*
Storage cost of 1 product per day from the manufacturer	uah per day/ton	25 +i
Storage cost of 1 product per day from the intermediary	uah per day/ton	5 + *0,1*i*
Cost to place a single order	uah	50 + *i*
Fuel cost of 1 liter	uah\liter	18
Transportation tariff per 1 ton	uah\ton	1+0,1*i
The volume of fuel that is consumed during transportation	liters	10+j

Where i – the last numeral of the credit book
j – the previous numeral of the credit book

Methodical recommendations for the performance of work

Purpose of task is necessity to determine that variant of storage and transportation of goods which has the minimum total costs.

The total costs of storage and transportation of goods on distribution stage are calculated by following formula:

$$C_{total} = C_s^m + C_o + C_{tr} + C_s^i$$

C_s^m, C_s^i - accordingly storage costs of products from manufacturer and intermediary, uah;

C_o - ordering cost, uah;

C_{tr} - transportation cost from manufacturer to intermediary, uah.

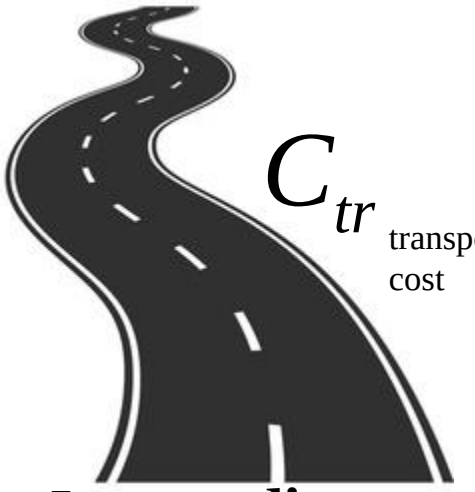
Storage costs of products from manufacturer and intermediary are determined by following way:

$$C_s^m = Q_s^m \cdot c_{1t}^m$$
$$C_s^i = Q_s^i \cdot c_{1t}^i$$

where Q_s^m, Q_s^i - are total volume of products, which are stored by the manufacturer and intermediary during certain period of time, ton\week;

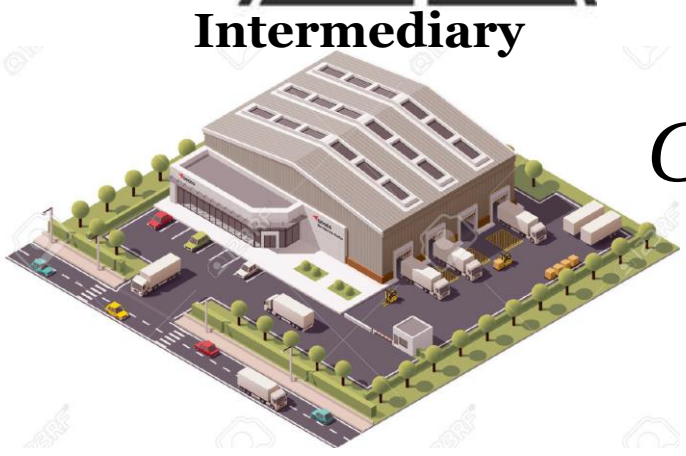
c_{1t}^m, c_{1t}^i - storage cost of 1 product per day from the manufacturer and intermediary, uah per day\ton.

C_s^m storage costs of products in the manufacturer's warehouse



C_o ordering cost

C_{tr} transportation cost



C_s^i storage costs of products in the intermediary's warehouse

Ordering cost:

$$C_o = U \cdot n$$

where U – cost to place a single order;
n – the number of orders.

$$n = \frac{Q}{S}$$

where Q – the total volume of products that is ordered by intermediary for whole period of time, ton,

S – one order quantity, ton/day.

Transportation cost:

$$C_{tr} = (c_{tr}^1 \cdot S + q_f \cdot c_f) \cdot n$$

where c_f – fuel cost of 1 liter, uah;

c_{tr}^1 - transportation tariff per 1 ton, uah\ton;

q_f - the volume of fuel that is consumed during transportation, liters.

TASK 4. Theme «ABC/XYZ analyses of inventory control»

The company sells mass commodity. The head of the company decided to expand the trading range of products, which should lead to an increase competitiveness and strengthen position of the company in the market. However, the free financial resources, as well as storage space is not enough.

For the logistics department is necessary to review methods of inventory control for the possibility of minimizing the storage space, as well as cash which is in unnecessary things. Input data us given in table 1.

Task:

1. Perform ABC - analysis of the goods, taking into account the share of inventory for each item in the total volume of inventory. Construct the graph of ABC - analysis. Write the conclusions about results.

2. Perform XYZ- analysis. Construct the graph of XYZ - analysis. Write the conclusions about results.

3. Create matrix of ABC/ XYZ methods. Explain the results.

4. Describe proposition about inventory control (Determine which stocks of items should most closely be monitored).

Table 1. Input data for ABC/XYZ analyses

№ позиції	Середній квартальний запас за позицією	Реалізація за квартал			
		1 квартал	2 квартал	3 квартал	4 квартал
1	500+40j	120+10j	124+10j	140+10j	136+10j
2	152+40j	48+10j	36+10j	44+10j	32+10j
3	600+40j	100+10j	280+10j	80+10j	140+10j
4	112+40j	28+10j	30+10j	34+10j	28+10j
5	22+40j	2+10j	0+10j	12+10j	10+10j
6	376+40j	104+10j	106+10j	80+10j	86+10j
7	38+40j	8+10j	8+10j	10+10j	14+10j
8	3410+40j	900+10j	920+10j	880+10j	860+10j
9	54+40j	8+10j	12+10j	20+10j	8+10j
10	800+40j	202+10j	206+10j	210+10j	190+10j
11	1800+40(j+i)	448+10(j+i)	440+10(j+i)	460+10(j+i)	452+10(j+i)
12	450+40(j+i)	106+10(j+i)	112+10(j+i)	108+10(j+i)	114+10(j+i)
13	196+40(j+i)	46+10(j+i)	52+10(j+i)	54+10(j+i)	48+10(j+i)
14	68+40(j+i)	20+10(j+i)	12+10(j+i)	14+10(j+i)	10+10(j+i)
15	62+40(j+i)	16+10(j+i)	20+10(j+i)	16+10(j+i)	12+10(j+i)
16	48+40(j+i)	12+10(j+i)	16+10(j+i)	18+10(j+i)	10+10(j+i)
17	34+40(j+i)	6+10(j+i)	10+10(j+i)	8+10(j+i)	8+10(j+i)

18	24+40(j+i)	4+10(j+i)	6+10(j+i)	2+10(j+i)	12+10(j+i)
19	92+40(j+i)	40+10(j+i)	20+10(j+i)	24+10(j+i)	12+10(j+i)
20	14+40(j+i)	4+10(j+i)	0+10(j+i)	4+10(j+i)	8+10(j+i)
21	44+40(j+i)	10+10(j+i)	8+10(j+i)	8+10(j+i)	14+10(j+i)
22	136+40(j+i)	40+10(j+i)	38+10(j+i)	38+10(j+i)	36+10(j+i)
23	4+40(j+i)	0+10(j+i)	1+10(j+i)	1+10(j+i)	6+10(j+i)
24	36+40(j+i)	8+10(j+i)	10+10(j+i)	8+10(j+i)	14+10(j+i)
25	478+40(j+i)	142+10(j+i)	134+10(j+i)	160+10(j+i)	116+10(j+i)
26	26+40(j+i)	6+10(j+i)	10+10(j+i)	8+10(j+i)	8+10(j+i)
27	4680+40(j+i)	1056+10(j+i)	1120+10(j+i)	1120+10(j+i)	1200+10(j+i)
28	8+40(j+i)	2+10(j+i)	4+10(j+i)	2+10(j+i)	0+10(j+i)
29	42+40(j+i)	10+10(j+i)	14+10(j+i)	6+10(j+i)	10+10(j+i)
30	224+40(j+i)	60+10(j+i)	80+10(j+i)	40+10(j+i)	40+10(j+i)
31	6+40i	2+10i	2+10i	3+10i	1+10i
32	16+40i	0+10i	4+10i	4+10i	16+10i
33	64+40i	14+10i	10+10i	16+10i	8+10i
34	2720+40i	580+10i	632+10i	640+10i	660+10i
35	88+40i	20+10i	28+10i	36+10i	28+10i
36	12+40i	2+10i	6+10i	6+10i	2+10i
37	72+40i	16+10i	20+10i	18+10i	18+10i
38	1080+40i	352+10i	160+10i	112+10i	456+10i
39	28+40i	2+10i	6+10i	16+10i	8+10i
40	2210+10i	500+10j	520	540	488
41	70+10j	16+10j	18	18+10i	12+10j
42	256+10j	64	68+10j	60	64
43	332	112	116	76+10j	56+10i
44	80+10j	20+10i	22	20	18
45	100	24	28+10i	26+10j+10j	34
46	176	46+10j	46	40	28+10j
47	420+10i	108	120	88+10i	100
48	10+10j	4+10j	4+10j	6	2+10j
49	1450	300	440	340	360
50	280	60+10i	70	72+10j	78

Where i – the last numeral of the credit book
j – the previous numeral of the credit book

Methodical recommendations for the performance of work

1. ABC – analysis

The ABC analysis provides a mechanism for identifying items that will have a significant impact on overall inventory cost, while also providing a mechanism for identifying different categories of stock that will require different management and controls.

The ABC analysis suggests that inventories of an organization are not of equal value. Thus, the inventory is grouped into three categories (A, B, and C) in order of their estimated importance.

A items are very important for an organization. Because of the high value of these A items, frequent value analysis is required. In addition to that, an organization needs to choose an appropriate order pattern (e.g., "Just- in- time") to avoid excess capacity.

B items are important, but of course less important, than A items and more important than C items. Therefore, B items are intergroup items.

C items are marginally important.

Approach to calculate the ABC analysis:

1. Determine the annual usage for each item
2. Multiply the annual usage of each item by its cost to get its total annual usage in monetary unit
3. List the items according to their annual usage in monetary unit in descending order
4. Calculate the cumulative annual usage in monetary unit and the cumulative percentage of items
5. Examine the annual usage distribution and group the items into three classes A, B and C. Class A contains about 20% products, with priority importance in terms of volume and value. Class B the next 30% and class C the remaining 50% of products.

We should identify the right classes of ABC analysis. For this we should use the information in table 1.

Table 2. Classes of ABC analysis

Classes of ABC analysis	% of products	% of value
Class A contains about 20% of products and with priority importance in terms of volume and value about 80%	20	80
Class B is the next 30% of products and with priority importance in terms of volume and value about 15%	30	15
Class C is the remaining 50% of products and value about 5%.	50	5
Total	100	100

2. **XYZ-Analysis**

The XYZ analysis is a method to classify products according to their variance of demand.

group X – goods of high selling rate;
group Y – products of average selling rate;
group Z – goods of low selling rate

Procedure for XYZ Analysis:

1. Determine the relevant items
2. Calculate the coefficient of variation of each item
3. Sort the coefficient of variation by increasing.

The coefficient of variation equals to the standard deviation multiplied by 100% over average X.

$$\nu = \frac{\sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}}}{\bar{x}} 100$$

x_i - value of demand in the *i*-th period (month, quarter, year);
$\bar{x}$ - The average demand;
n - number of periods (months, years).

Then we should identify the group of each item. For this we should use the information in the next table.

Table 3. - Classes of XYZ analysis

Classes of XYZ analysis	Interval
X	$0 \le \nu \prec 10$
Y	$10 \le \nu \prec 25$
Z	$25 \le \nu \prec \infty$

3. Recommendation regarding ABC/XYZ combination:

Table 4. ABC/XYZ combination

	X	Y	Z
A	**AX Group** High turnover in terms of value, high and even periodical consumption (daily, weekly demand). Highly reliable forecasts.	**AY Group** High turnover in terms of value, high and even periodical consumption (daily, weekly demand). Less reliable forecasts (significant forecast errors).	**AZ Group** High turnover in terms of value, high and even periodical consumption (daily, weekly demand). Very low reliability of forecasts.
B	**BX Group** Medium turnover in terms of value, high and even periodical consumption (daily, weekly demand). Highly reliable forecasts.	**BY Group** Medium turnover in terms of value, high and even periodical consumption (daily, weekly demand). Less reliable forecasts (significant forecast errors).	**BZ Group** Medium turnover in terms of value, high and even periodical consumption (daily, weekly demand). Very low reliability of forecasts
C	**CX Group** Low turnover in terms of value, high and even periodical consumption (daily, weekly demand). Highly reliable forecasts.	**CY Group** Low turnover in terms of value, high and even periodical consumption (daily, weekly demand). Less reliable forecasts (significant forecast errors).	**CZ Group** Low turnover in terms of value, high and even periodical consumption (daily, weekly demand). Very low reliability of forecasts.

Using the ABC/XYZ analyses helps us to regulate the demand of products and develop a strategy of inventory management in the enterprise.

4. Stock control methods
Classification of Inventory control system

1. Fixed batch quantity.

This system assumes formation of an order at the threshold level. For this system, the order size is constant. This system is best suited for production of Y-group (XYZ-analysis).

2. Fixed interval between orders.

For this system, the interval between orders is constant. This system is best suited for production of X-group (XYZ-analysis).

3. Fixed periodicity of replenishment inventories to a constant level.

This system is a combination of the two systems: fixed batch quantity and fixed interval between orders. This system assumes formation of an order at the threshold level and also formation of an order between intervals. This system is best suited for production of Z-group (XYZ-analysis).

4. Maximum – minimum.

The basis for this system is to minimize the supply of their high cost compared with the cost of storage. So, in these conditions, the slightest probability of shortages of goods in stock will be in storage product groups X or Y, where Y group products should be stored under these conditions, only at very high cost of delivery. The calculations is possible to take that group X is rational stored with this system, if the ratio of "the cost of shipping / storage units per day" is 2000 ... 5000, and Y group - if the ratio is more than 5,000.

AX - Just in time

AY,BY,CY	**BX,CX**	**AZ,BZ,CZ**
Inventory control system		
Fixed batch quantity	Fixed interval between orders	Fixed periodicity of replenishment inventories to a constant level

Q –annual demand quantity (according to the total of each control system)

S –fixed flat cost per order (not a per unit cost, but the cost associated to the operation of ordering and shipping) = ***8*****00+i*j Uah**

$C_{storage}$ - cost of storage = **0.2 uah/day**

T **–** period of control = **365 days**

Delivery time = **3 days**

Possible time for delay delivery = **1 day**

Table 5. – Parameters of Inventory control systems

№	Parameters	Fixed batch quantity	Fixed interval between orders	Fixed periodicity of replenishment inventories to a constant level	Maximum - minimum
1	Demand, pcs	Input data			
2	Economic order quantity , pcs	$q^* = \sqrt{\frac{2 * Q * S}{C_{storage} * T}}$	***Q*** – the annual demand quantity ***S*** –fixed flat cost per order (not a per unit cost, but the cost associated to the operation of ordering and shipping) $C_{storage}$ - cost of storage ***T*** – period of control.		
3	The interval between orders, days	-	I=(T*[2])/[1]		
4	Delivery time, days	Input data			
5	Possible time for delay delivery, days	Input data			
6	Expected daily consumption, pcs / day	[1]/T			
7	Realization time of inventories, days	[2]/[6]	-		

Cont. table 5.

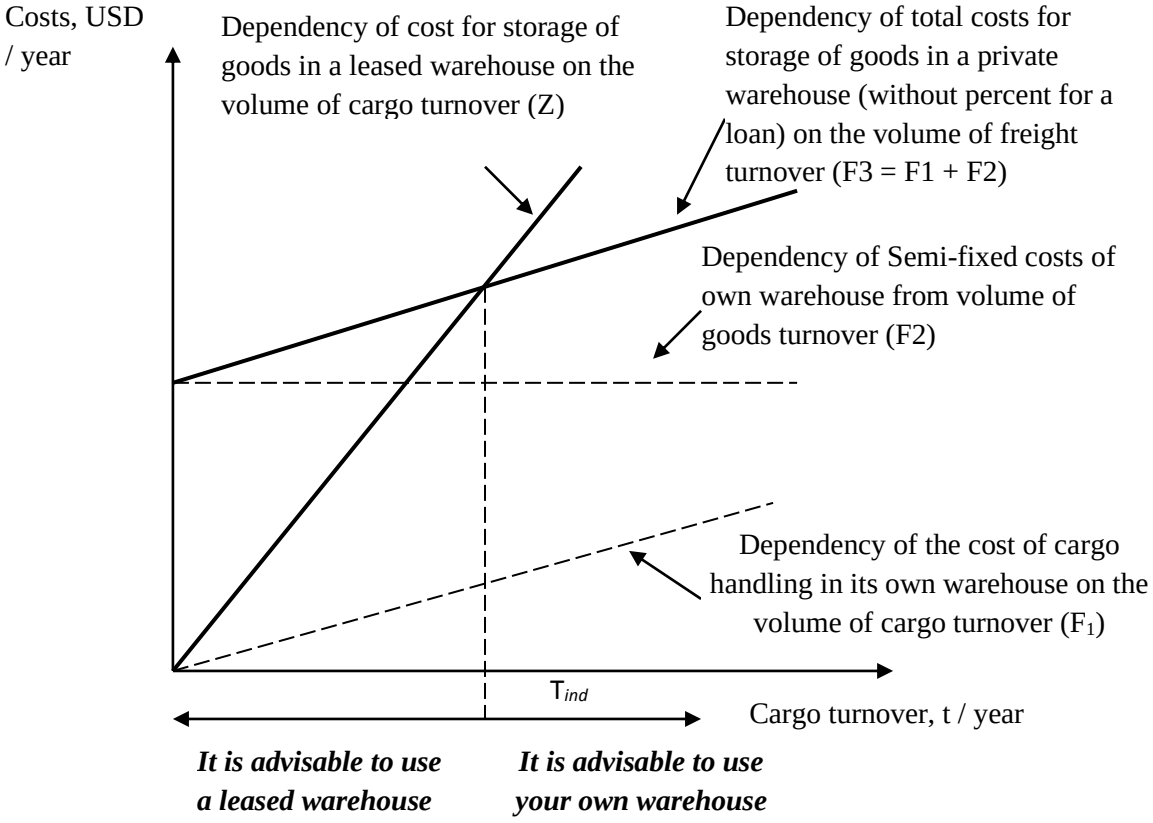
8	Expected inventories consumption during delivery, pcs	[4]*[6]			
9	Maximum inventories consumption during delivery, pcs	([4]+[5])*[6]			
10	Reserve stock, pcs	[9]-[8]			
11	The threshold level of inventories, pcs	[10]+[8]	-	[10]+[8]	
12	The maximum volume of inventories, pcs	[10]+[2]	[10]+[3]*[6]	[11]+[3]*[6]	
13	Realization time of inventories to the threshold level , days	([12]-[11])/[6]	-		
14	Order size	[2]	[12]+[8]-CS		
			CS - current stock		

TASK 5. Decision-making about the use of leased (rented) warehouse services

The determination of the actual cost of cargo handling in a warehouse allows us to make informed decisions on the critical value of the freight turnover of a warehouse.

Wholesalers today most often have to choose between the organization of their own warehouse and the use of stock for the public warehouse. In the latter case, the warehouse owner includes the performance of logistics operations in the cost of storage.

The choice between privet and leased (rented) warehouse may be determined from the graph shown in Fig. 1.



1. Determine the cost of storage in your own warehouse.
2. Determine the cost of storage in a leased (rented) warehouse.
3. Construct the graphs that show the total costs in the warehouse. Identify areas of expediency of using warehouses.
4. Derive a formula for determining the "turnover of indifference".

№	Criteria	Absolute value notation	Dimension	Value
1	Unit cost of cargo handling in own warehouse	C_{unit}	Uah/ton	4 + 0,1*(i+j)
2	Semi-fixed costs of own	F_2	Uah/year	30000 +

	warehouse			1000*(i+j)
3	Tariff for leased (rented) warehouse services	α	Uah per $1m^2$ per day	0,3 + 0,1*i
4	The number of days of turnover of stocks product	D_{turn}	Days	60 + (i+j)
5	The number of working days per year	D_{work}	Days	250 + 10*j
6	Load on 1 m2 of storage area in a leased (rented) warehouse	η	Ton/m^2	2 + 0,1*i
7	Probable turnover of stocks product	T	Ton	0, 3000, 5000, 7000, 9000, 13000, 15000

Where i – the last numeral of the credit book
j – the previous numeral of the credit book

Methodical recommendations for the performance of work

1. Cost of cargo handling in its own warehouse

$$F_1 = C_{unit} \cdot T, \quad (1)$$

Where C_{unit} - Unit cost of cargo handling in own warehouse,
T - turnover of stocks product.

2. Storage costs in private (own) warehouse.

$$F3 = F1 + F2, \quad (2)$$

Where F2 - Semi-fixed costs of own warehouse.

3. Cost for storage of goods in a leased warehouse

$$Z = \alpha \cdot S \cdot D_{work}, \quad (4)$$

Where α - Tariff for leased (rented) warehouse services
S - Required area of the leased warehouse
D_{work} - The number of working days per year

4. Required area of the leased warehouse

$$S = \frac{D_{turn} \cdot T}{D_{work} \cdot \eta} \quad (5)$$

Where η - Load on 1 m^2 of storage area in a leased (rented) warehouse

TASK 6. Calculation of the turnover of indifference of the warehouse

1. Calculate the total cost of the warehouse functioning.
2. Determine the profit of the warehouse.
3. Determine "turnover of indifference".
4. Build a graph of the relationship between costs and revenues from the value of the turnover of the warehouse.

№	Criteria	Absolute value notation	Dimension	Value
1	The average cost of procurement of goods,	$C_{av.proc}$	Uah/ton	6000+100*(i+j)
2	The coefficient for calculating the payment of interest for a loan,	k	-	0,045+0,001*i*j
3	Trade mark-up for the wholesale sale of goods	$T_{mark-up}$	%	7,8+0,1*i*j
4	Costs for renting a warehouse	C_{rent}	Uah/year	170000+1000*(i+j)
5	Costs for amortization of equipment	C_{amor}	Uah/year	30000+1000*(i+j)
6	Electricity costs	C_{el}	Uah/year	80000+1000*(i+j)
7	Costs for staff and specialists	C_{staff}	Uah/year	20000+1000*(i+j)
8	The cost of cargo handling, per 1 ton of cargo turnover of the warehouse,	$C_{hand/1t}$	Uah/ton	14+i
9	The current turnover of the warehouse,	T_{cur}	Ton/year	1600+100*j

Where i – the last numeral of the credit book
j – the previous numeral of the credit book

Methodical recommendations for the performance of work

1. The total cost of the warehouse functioning

$$C_{total} = C_{s\text{-}f} + C_{s\text{-}v}, \quad (1)$$

$C_{s\text{-}f}$ - Semi-fixed costs
$C_{s\text{-}v}$ - Semi-variable costs

2. Semi-fixed costs:

$$C_{s\text{-}f} = C_{rent} + C_{amor} + C_{el} + C_{staff}, \quad (2)$$

C_{rent} - Costs for renting a warehouse

C_{amor} - Costs for amortization of equipment
C_{el} - Electricity costs
C_{staff}, - Costs for staff and specialists

3. Semi-variable costs:

$$C_{s\text{-}v} = C_{cr} + C_{hand}, \quad (3)$$

C_{cr} - credit costs
C_{hand} - the cost of cargo handling

4. Credit costs:

$$C_{cr} = k \cdot T_{cur} \cdot C_{av.proc}, \quad (4)$$

Where k - The coefficient for calculating the payment of interest for a loan,
T_{cur} - The current turnover of the warehouse
$C_{av.proc}$ - The average cost of procurement of goods

5. The cost of cargo handling:

$$C_{hand} = C_{hand/1t} \cdot T_{cur}, \quad (5)$$

Where $C_{hand/1t}$ - the cost of cargo handling, per 1 ton of cargo turnover of the warehouse

6. Profit of warehouse:

$$P = Inc - C_{total}, \quad (6)$$

Inc – warehouse income

7. Warehouse income:

$$Inc = \frac{T_{cur} \cdot C_{av.proc} \cdot T_{mark-up}}{100}, \quad (7)$$

T_{cur} - the current turnover of the warehouse,
$C_{av.proc}$ - the average cost of procurement of goods,
$T_{mark\text{-}up}$ - Trade mark-up for the wholesale sale of goods