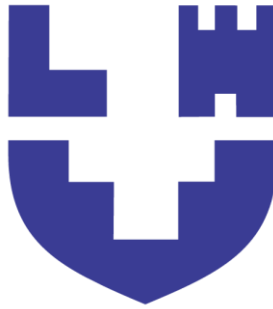


Міністерство освіти і науки України



SUPPLY CHAIN MANAGEMENT

методичні вказівки до практичних занять
для здобувачів другого (магістерського) рівня вищої освіти
освітньої програми «Транспортно-логістичні системи автомобільних
перевезень»
галузі знань J Транспорт та послуги
спеціальності J8 Автомобільний транспорт
денної та заочної форм навчання

Луцьк 2026

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У 67

Рекомендовано до видання вченою радою факультету транспорту та інженерії ЛНТУ, протокол № ____ від « ____ » вересня 2026 р.

Голова вченої ради
факультету транспорту та інженерії _____ І. МУРОВАНІЙ

Електронна копія друкованого видання передана для внесення в репозиторій ЛНТУ. Директор бібліотеки _____ Н. ПОЛІЩУК

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У 67 **Supply Chain Management:** метод. вказівки до практичних занять для здобувачів другого (магістерського) рівня вищої освіти освітньої програми «Транспортно-логістичні системи автомобільних перевезень» галузі знань J Транспорт та послуги спец. J8 Автомобільний транспорт денної та заочної форм навчання / уклад.: В.І. КОТЕНКО. – Луцьк : ЛНТУ, 2026.– 43 с.

Методичні вказівки складені відповідно до програми курсу «Supply Chain Management» з метою формування системи знань і розуміння концептуальних основ управління ланцюгами постачання, набуття практичних навичок планування, організації, координації та оцінювання логістичних і транспортних процесів, а також підготовки фахівців до прийняття ефективних управлінських рішень у сфері автомобільного транспорту.

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PRACTICAL SESSION 1

Topic: Theoretical and Methodological Foundations of Supply Chain Management

Objective: To familiarize with the concepts of supply chain and supply chain management; to reveal the subject, purpose, and tasks of the academic discipline and its relationship with other disciplines.

Discussion Points:

- 1.1. The Essence of Supply Chain Management.
- 1.2. Conditions for the Development of Supply Chain Management.
- 1.3. Evolution of the Conceptual Model of Supply Chain Management.
- 1.4. The Role of Supply Chain Management in Improving the Efficiency of Enterprises.

Practical Task: Transportation Evaluation

Objective: Analyze how the transportation company managed the delivery process from origin to destination.

Content of the Work: Determining how companies make decisions regarding routing, mode of transportation, and timing.

The goal of this assignment is to help you review the different types of transportation in a format that most of you are familiar with. This assignment will also help you determine how companies make decisions regarding routing, mode of transportation, and timing.

Task

Select an express delivery firm that operates in the United States or Ukraine and explain how its transportation network is structured. You can choose a shipment from Nova Poshta, Meest Express, or Ukrposhta, or use one of the examples below.

In detail, examine a specific shipment and analyze how the transportation company managed the delivery process from origin to destination.

Please complete the following:

- Calculate the distances and time between the locations mentioned on the tracking statement.
- Identify the role that each leg of the journey plays (e.g. pick-up, line haul, delivery, etc.).
- Identify the mode of transportation that is likely used.
- Explain the routing between origin and destination (e.g. how much of a straight line between origin and destination).

- Analyze the efficiency of the routing (e.g. why the company likely chose this routing).
- Express any areas of difficulty.
- Reflect on what you learned in this assignment.

Examples:

Table 1 - FedEx Tracking Table

Date	Time	Activity	Location
Wednesday	10:04 am	Shipment information sent to FedEx	-
Wednesday	4:00 pm	Picked up	Rogers, MN
Wednesday	5:54 pm	Arrived at FedEx location	Rogers, MN
Thursday	1:37 am	Left FedEx origin facility	Rogers, MN
Sunday	3:47 pm	Arrived at FedEx location	Hagerstown, MD
Sunday	9:34 pm	Departed FedEx location	Hagerstown, MD
Monday	4:52 am	At local FedEx facility	North Wales, PA
Monday	7:30 am	On FedEx vehicle for delivery	North Wales, PA
Monday	1:56 pm	Delivered	Valley Forge, PA

Table 2 - UPS Tracking Table

Date	Time	Activity	Location
Tuesday	10:27 AM	Billing information received	-
Tuesday	09:01 PM	Origin scan	Windsor Locks, CT
Tuesday	09:37 PM	Departure scan	Windsor Locks, CT
Wednesday	12:54 AM	Arrival scan	Parsippany, NJ
Wednesday	03:38 AM	Departure scan	Parsippany, NJ
Wednesday	05:44 AM	Arrival scan	West Chester, PA
Friday	05:29 AM	Out for delivery	West Chester, PA
Friday	01:36 PM	Delivered	King of Prussia, PA

Table 3 - Nova Post Tracking Table

Date	Time	Activity	Location
08.02.2025	16:35	Order created, awaiting shipment	-
08.02.2025	18:01	Accepted at branch	Rozsoshenci, Branch 1
08.02.2025	19:40	Departed from branch	Rozsoshenci, Branch 1
08.02.2025	19:46	Arrived at terminal	Poltava
08.02.2025	21:36	Departed from terminal	Poltava
09.02.2025	02:56	Arrived at terminal	Kyiv, KIT
09.02.2025	06:21	Departed from terminal	Kyiv, KIT
09.02.2025	12:22	Arrived at terminal	Lutsk
09.02.2025	13:58	Departed from terminal	Lutsk
09.02.2025	14:32	Arrived at branch	Lutsk, Branch 4
10.02.2025	16:22	Received at branch	Lutsk, Branch 4

Literature: 1, 2, 4, 5, 6, 7, 9, 10.

PRACTICAL SESSION 2

Topic: Conceptual Framework of Supply Chain and Its Management

Objective: To familiarize with the components of the supply chain and the peculiarities of supply chain formation.

Discussion Points:

2.1. Supply Chain: Definition, Functions, Structure.

2.2. The Mission of Logistics Management.

2.3. Functional Areas of Supply Chain Management.

Literature: 1, 5, 7, 8, 9, 10, 11, 14, 17, 28.

PRACTICAL SESSION 3

Topic: Supply Chain Planning and Design

Objective: To familiarize with the tasks of supply chain planning and the logic of supply chain design.

Discussion Points:

- 3.1. Goals and Objectives of Supply Chain Planning.
- 3.2. Factors Affecting the Structure of the Supply Chain.
- 3.3. Main Stages of Supply Chain Design.
- 3.4. Supply Chain Network Structure.

Practical Task 1: Planning of Supply Chain

Objective: Learn to build supply chains depending on the number of intermediaries.

Content of the Work: Construction of the optimal supply chain for a given number of intermediaries.

Brief Theoretical Information

The structure of the supply chain determines the number of participants of different types, including wholesale enterprises, warehouses, logistics centers, etc., which means it forms the necessary infrastructure. At the same time, the placement of each structural element of the infrastructure on the logistics field is very important. Some structures of the standard supply chain "stock-on-line" are shown for regional (Fig. 1) and mixed-regional (Fig. 2) distribution, and the structure of the supply chain is shown in Fig. 3.

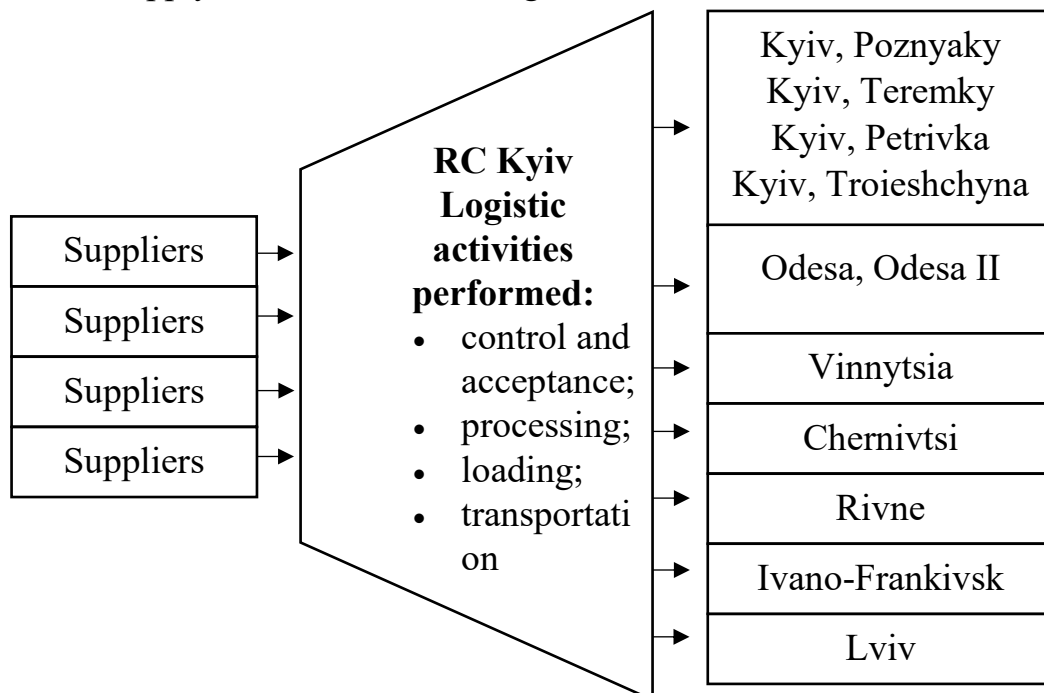


Figure 1 – Structure of the Standard Supply Chain "stock-on-line" in the Network for Regional Distribution

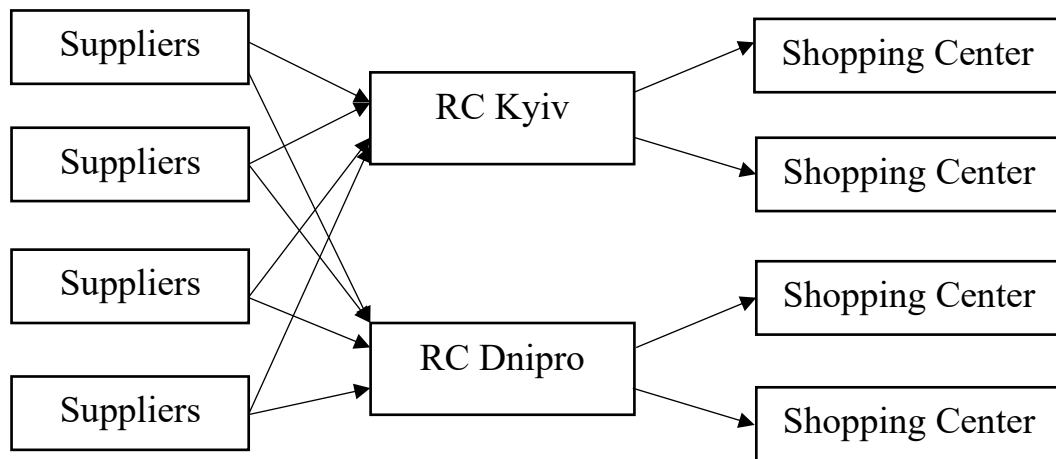


Figure 2 – Structure of the Supply Chain "stock-on-line" for Mixed-Regional Distribution

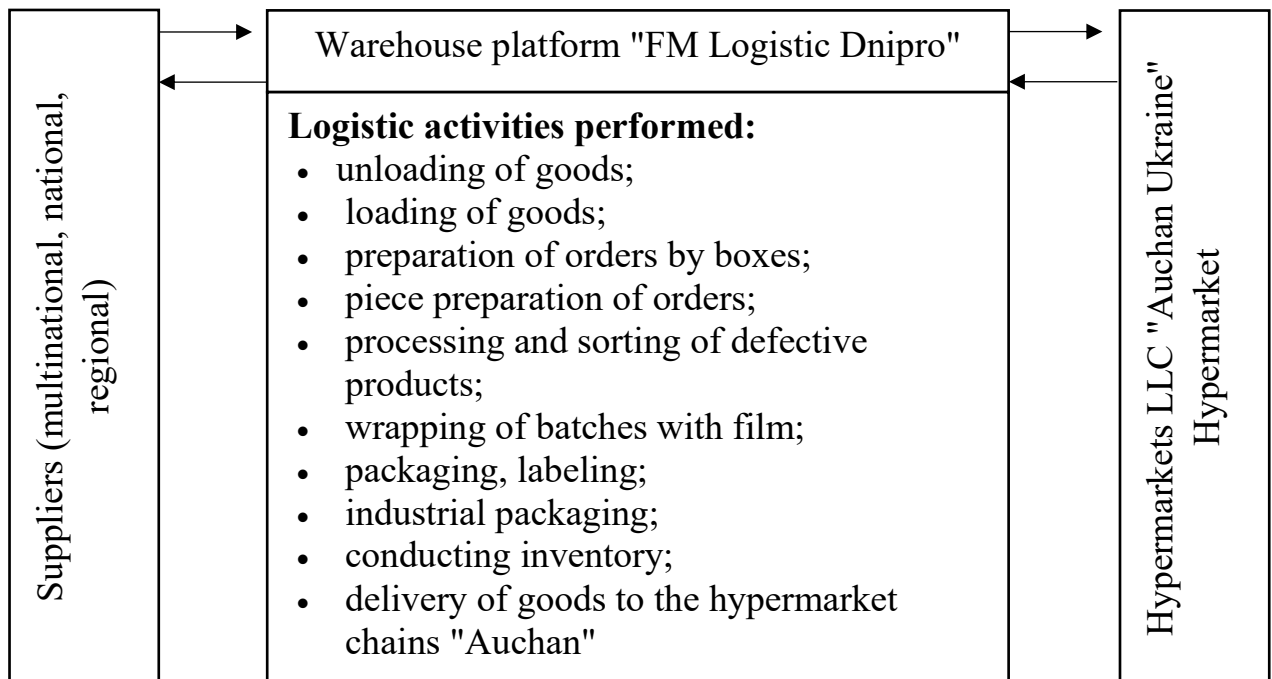


Figure 3 – Structure of the Supply Chain for LLC "Auchan Ukraine" Hypermarket

Task

To develop an effective supply chain for the selected product within Ukraine. Different product options and their distribution are chosen according to the ordinal number of the student's surname in the teacher's journal based on Table 4. The supply chain is constructed according to the given construction schemes (Figures 1, 2).

Table 4 - The initial data for completing the practical task

No	Company (Surname of the student)	Suppliers	Wholesale Enterprises	Warehouses	Distribution Centers	Standard Supply Chain "stok-on- line"	Supply Chain "stok-on-line" with Mixed- Regional Distribution
1		5	2	1	2	+	-
2		1	4	2	1	-	+
3		4	6	4	2	+	-
4		2	5	3	1	-	+
5		1	3	2	1	+	-
6		2	7	4	3	+	-
7		6	8	2	4	+	-
8		8	10	3	4	+	-
9		4	9	3	4	-	+
10		2	3	1	3	-	+
11		2	5	1	2	+	-
12		1	8	3	1	-	+
13		1	4	1	1	-	+
14		6	6	2	2	+	-
15		2	7	2	4	-	+
16		2	9	3	4	-	+
17		1	3	2	1	+	-
18		1	4	1	2	+	-
19		2	7	1	2	-	+
20		4	6	2	2	+	-

Practical Task 2: Using the Gravitational Rule of Population Placement in Retail Trade

Objective: to learn how to determine the proportion of purchases made from different logistics centers.

Task content: to define the boundaries of “indifference zones,” which represent the territorial range of market influence.

Brief Theoretical Information

To establish the purchase proportion made by residents of city C, located between cities A and B, the following formula is used:

$$k_1 = \frac{P_A}{P_B} = \frac{\varphi_A}{\varphi_B} \times \left(\frac{L_B}{L_A} \right)^2, \quad (8.1)$$

where φ_A, φ_B — populations of cities A and B

L_A, L_B — distances from city C to cities A and B respectively

For applying the gravity model to the investment goods market, the population is replaced with production service indicators (for A – N, in million UAH, and for B – N_B):

$$k_2 = \frac{N_A}{N_B} \times \left(\frac{L_B}{L_A} \right)^2, \quad (8.2)$$

Using Reilly's law, the boundary of the zone of indifference between cities A and B (the point where residents will equally choose either location) is:

$$D_{AB} = \frac{L_{AB}}{1 + \frac{\varphi_A}{\varphi_B}}, \quad (8.3)$$

And based on production volume instead of population:

$$D_{AB} = \frac{L_{AB}}{1 + \frac{Q_A}{Q_B}}, \quad (8.4)$$

Where L_{AB} is the distance between cities A and B.

Task

Determine the proportion of purchases made by residents of city C, located between cities A and B.

Residents of city C buy goods from distant city B ($L_B = 94 + n$ km, population $\phi_B = 387\,000$), and closer city A ($L_A = 64 + n$ km, population $\phi_A = 94\,000$).

Production volumes:

For A: $Q_A = 95 + n$ million UAH

For B: $Q_B = 350 + n$ million UAH

Distance between A and B: $158 + n$ km.

Where n is the student's number in the class register.

Example

Using formula (8.1):

$$k_1 = \frac{387}{94} \times \left(\frac{64}{94} \right)^2 = 1.91$$

This means: for every 100 purchases made in city A, 191 are made in city B — residents of city C prefer shopping in city B despite the greater distance.

Using formula (8.2):

$$k_2 = \frac{350 \cdot 10^3}{95 \cdot 10^3} \times \left(\frac{64}{94}\right)^2 = 1.71$$

So, based on production volume, city B attracts 71% more purchases than city A.

Zone of Indifference Calculation

Using population-based formula (8.3):

$$D_{AB} = \frac{158}{1 + \frac{94}{387}} = 127 \text{ km}$$

Using production-based formula (8.4):

$$D_{AB} = \frac{158}{1 + \frac{95}{350}} = 124 \text{ km}$$

Thus, the indifference boundary between cities A and B lies approximately 124–127 km from city A depending on the model used.

Literature: 1, 4, 6, 9, 11, 12, 14, 21, 23.

PRACTICAL SESSION 4

Topic: Integration and Collaboration in Supply Chains

Objective: To familiarize with the principles of collaboration in supply chains, the concept of integrated interaction between supply chain counterparts, and types of collaboration in supply chains.

Discussion Points:

4.1. Definition of Integration and Collaboration in Supply Chains.

4.2. Organizational Forms of Integration.

4.3. Models and Strategies for Collaboration in Supply Chains.

Practical Task: Options for the Functioning of Supply Chain Subsystems

Objective: To learn how to ensure and maintain a high level of reliability in the operation of an individual logistics system.

Content of the Work: Determining the reliability level of the system using the Gaussian normal distribution parameter.

Brief Theoretical Information

As is known, the amount of a company's inventory is determined by the following formula:

$$Q = b + u \times \sigma \quad (3.1)$$

The average daily sales and the standard deviation of sales are determined by the formulas:

$$b = \frac{\sum_{i=1}^n b_i}{n} \quad (3.2)$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (b - b_i)^2}{n}} \quad (3.3)$$

The amount of inventory is calculated using Gauss's formula:

$$Q = 393 + u \times 192,6 \quad (3.4)$$

Regarding the managerial decision in formula (2), the key parameter is the Gaussian normal distribution. It has been established that this parameter corresponds to the reliability of the expected event $P(x)$, i.e., the reliability of supply, which can be interpreted as the quality of logistical service with a certain degree of approximation.

Task

The problem of improving the reliability of the functioning of a specific logistics system can be considered during the process of solving the firm's inventory optimization task. Let us assume that the features of product realization are determined by statistical data from Table 5.

Table 5 – Product sales statistics of the firm

Time Interval	Actual Realization	$b - b_i$	$(b - b_i)^2$
1	$300 + n$	93	8649
2	$200 + n$	193	37249
3	$600 + n$	-207	42849
4	$500 + n$	-107	11449
5	$650 + n$	-257	66049
6	$700 + n$	-307	94249
7	$360 + n$	33	1089
8	$250 + n$	143	20449
9	$150 + n$	243	59049
10	$220 + n$	173	29929
Total	$3930 + n$	...	371010

where n is the serial number of the student's surname in the register.

Solution: Table 6 presents the most typical combinations of the parameters of the Gaussian normal distribution and the required level of inventory for this.

Table 6 – Relationship between inventory level and logistics service level

Indicator s	Variants of the level of logistic service								
u	0	0.50	1.00	1.50	1.65	2.00	2.33	2.50	3.00
P(x), %	50.0	69.1	84.1	93.3	95.0	97.7	99.0	99.3	99.8
	0	5	3	2	5	2	0	8	7
Q	393	489	586	682	710	778	842	874	971

The choice of the system's reliability level largely depends on the area of its operation. Many systems related to ensuring human life safety must have the maximum possible reliability (military equipment, energy installations, transportation vehicles, especially aircraft). As seen from Table 6, such a level, close to the absolute (99.87%), is achieved with a normal distribution parameter of $\sigma = 3.0$. This condition is known as the "three-sigma rule": for designing such systems, a safety margin is provided, which is adequate to three times the standard deviation from the average functioning parameter of this system.

In this case, such a solution is not appropriate: what is needed is not the maximum possible, but the optimal reliability of the system (logistics service level) that contributes to the maximum profit. In the most general form, the relationship of profit (as the difference between the income from sales and inventory costs) is shown in Figure 4.

Specialized literature indicates a decrease in the company's profit if the logistics service level exceeds 95%, but no explanation for this phenomenon is provided.

From Table 6, it is evident that such a reliability level (95.05%) is achieved with a normal distribution parameter ($\sigma = 1.65$), where the inventory level (710 units) is almost equal to the maximum demand volume ($MD = 700$) in the observed process (Table 5). This situation seems optimal when considering the "cost-result" ratio.

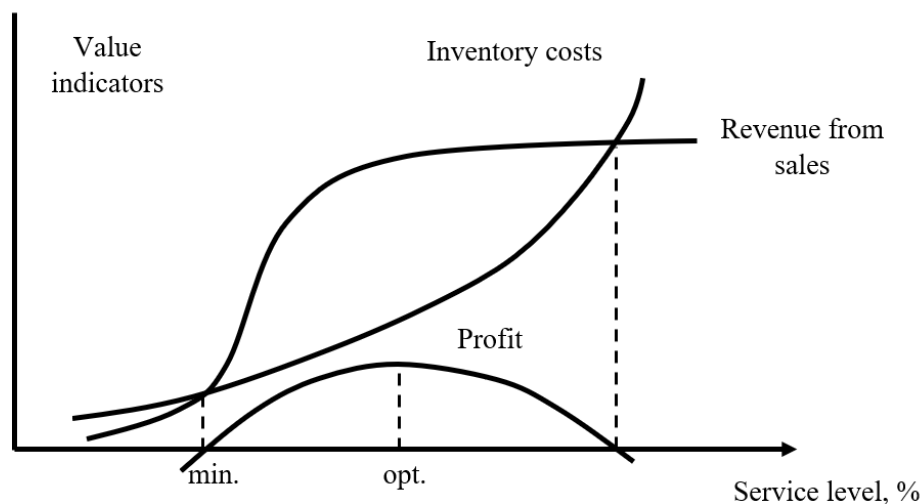


Figure 4 – Determining the optimal reliability level based on the maximum profit criterion.

Thus, under any conditions, including being a subject in the supply chain, the company will be interested in maintaining a logistics service quality from its suppliers that does not exceed 95%, assuming other conditions are equal. Any further increase will be realized through an increase in the inventory of goods and materials, which cannot be considered efficient, as this will lead to the withdrawal of a large amount of working capital from circulation.

Literature: 5, 10, 11, 12, 28, 29.

PRACTICAL SESSION 5

Topic: Decision-Making in Supply Chain Management

Objective: To familiarize with the content and methods of decision-making in supply chain management.

Discussion Points:

5.1. Methods of Justifying Management Decisions.

5.2. Decision-Making in Supply Chain Management Under Uncertainty.

5.3. Application of Management System Standards in Supply Chain Management.

5.4. Overview of Decision Support Methodologies.

Practical Task: Ensuring the Reliability of Supply Chains

Objective: To learn how to use various indicators for selecting a carrier.

Content of the Work: Determining the optimal carrier using qualimetry methods.

Brief Theoretical Information: After verifying quantitative and qualitative indicators, rankings are established (Table 7).

Table 7 – Indicators (Criteria) for Evaluating a Carrier

No	Indicator	Carrier 1	Carrier 2	Carrier 3	Carrier 4	Rank
1	Certificate availability	yes	no	yes	yes	-
2	Reliability	0.90	0.85	0.85	0.95	1
3	Tariff, UAH/km	0.85	0.82	0.78	0.85	3
4	Total time, %	25	20	10	15	2
5	Financial stability	7	6	8	7	5
6	Service frequency	good	bad	satisfactory	very good	7
7	Cargo safety	good	satisfactory	very good	very good	4
8	Special equipment	satisfactory	satisfactory	good	satisfactory	6
9	Shipment tracking	very bad	bad	satisfactory	good	8

The experience of many researchers in selecting not only carriers but also other logistics providers (such as suppliers, freight forwarders, etc.) has made it possible to develop a general algorithm for performing this procedure.

1. All indicators (criteria) are divided into three groups: quantitative, qualitative, and binary ("yes" or "no"), which allows the use of different approaches for their evaluation and the calculation of integrated scores for the logistics carrier (LC).

2. Weight coefficients A_i , which take into account the degree of influence of the indicators on the integrated score, are calculated for quantitative and qualitative indicators considering their overall ranking according to the following formula: For a linear dependence:

$$A_i = \frac{2 \cdot (n - i + 1)}{n \cdot (n + 1)}. \quad (4.1)$$

3. To calculate quantitative indicators, in addition to expert assessments, various information sources are used (reports, directories, price lists, etc.). 4. To evaluate qualitative indicators, it is recommended to apply the desirability function, the value of which is calculated by the formula:

$$a_i = \exp - \exp - y_i, \quad (4.2)$$

where a_i — the value of the desirability function;

y_i — the value of the i-th parameter on the coded scale.

Task

The following criteria have been selected as the basis for evaluating four carriers:

- Quantitative: reliability, tariff, total time, financial stability;
- Qualitative: service frequency, cargo safety, shipment tracking, special equipment;
- Binary: certificate availability.

Example

Carrier No. 2, which does not have a certificate, is excluded from further consideration.

The weight coefficients are calculated according to Formula (3.1) under the condition $n=8$. For example, for the indicator "tariff" with a rank of $i=3$ (Table 3.1), we determine:

$$A_{i=3} = \frac{2 \cdot (8 - 3 + 1)}{8 \cdot (8 + 1)} = \frac{12}{72} = 0,167.$$

The processing of quantitative indicators is carried out using quasimetric methods, which include the following stages:

a) Construction of a table where the indicators are listed in the horizontal rows, and the values of the indicators a_{ij} for the analyzed logistics carriers (LC) are shown in the columns;

b) For each parameter, a reference value is determined — either the maximum or minimum — depending on the influence of the indicator on the overall evaluation;

c) If the reference value is the maximum score (a_{ijmax}), then all values in that row are divided by it. The normalized values are recorded in the table cells as:

$$a'_{ij} = a_{ij} / a_{ijmax}; \quad (4.3)$$

d) If the reference value is the minimum score (a_{ijmin}), then the reference value is divided by the other values in the row. The normalized values are recorded in the table cells as:

$$a''_{ij} = a_{ijmin} / a_{ij}. \quad (4.4)$$

• For evaluating qualitative indicators, it is recommended to apply the desirability function, the value of which is calculated by the formula 4.2.

The values y_i on the coded scale are positioned symmetrically relative to the origin of the coordinate axis.

Table 8 presents the average and boundary values of the desirability function.

Table 8 – Quality evaluations and compliance with standard values on the desirability scale

Interval	Quality Evaluation	Mark on the Desirability Scale	Average Value
3–4	Excellent	More than 0.950	0.975
2–3	Very good	0.876–0.950	0.913
1–2	Good	0.691–0.875	0.783
0–1	Satisfactory	0.368–0.690	0.529
(-1)–0	Poor	0.066–0.367	0.217
(-2)–(-1)	Very poor	0.0007–0.065	0.036
(-3)–(-2)	Very poor	Less than 0.065	—

The application of the desirability function makes it possible to convert qualitative characteristics of indicator evaluation into quantitative ones. The values of these indicators are within the range from 0 to 1.

The sequence of calculating the evaluations of quantitative and qualitative indicators, evaluations considering weight coefficients, as well as the overall and integrated evaluations, is presented in Tables 9 and 10.

The selection of a logistics intermediary based on the above-mentioned algorithm allows the formalization of most calculation procedures and ensures an increase in the objectivity of expert evaluations.

Table 9 – Calculation of quantitative indicators

Indicator	Weight Coefficient	Reference Value	Carrier 1	Carrier 3	Carrier 4
Reliability	0.222	0.95; max	0.95	0.89	1.00
			0.211	0.198	0.222
Total Time	0.194	10; min	0.50	0.80	0.67
			0.097	0.155	0.130
Tariff	0.167	0.75; min	0.88	0.94	0.88
			0.147	0.160	0.147
Financial Stability	0.111	8; max	0.87	1.00	0.87
			0.097	0.111	0.097
Total quantitative evaluation considering weight coefficients	—	—	0.533	0.663	0.596

Table 10 – Calculation of Qualitative and Integral Evaluations

Indicator	Weight Coefficient	Carrier 1	Carrier 3	Carrier 4
Cargo Safety	0.139	0.783	0.913	0.913
		0.109	0.127	0.127
Special Equipment	0.083	0.529	0.783	0.529
		0.044	0.065	0.044
Service Frequency	0.056	0.783	0.913	0.913
		0.044	0.051	0.051
Shipment Tracking	0.028	0.066	0.529	0.783
		0.001	0.015	0.022
Total qualitative evaluation considering weight coefficients	—	0.198	0.237	0.244
Integral evaluation (rating)	—	0.731	0.900	0.840

Thus, the calculations performed make it possible to conclude the feasibility of further cooperation with the third carrier, as its rating has the highest value – 0.900.

Literature: 2, 5, 7, 11, 12, 13, 14, 15, 16, 21, 24.

PRACTICAL SESSION 6

Topic: Fundamentals of Transport Process Management

Objective: To familiarize with the fundamental principles of transport process management, including its role in the supply chain, key cost factors, and emerging technologies and trends shaping modern transportation systems.

Discussion Points:

6.1. Place in the Supply Chain.

6.2. Transportation Cost Factors and Elements.

6.3. Transport Operations in Consolidation, Break Bulk, and Cross-Docking Warehousing.

6.4. Technology and Trends in Transportation.

Practical Task: Optimization of Carrier Selection in Supply Chains

Objective: Using the factors influencing carrier selection, learn to determine the optimal carrier with the help of a ranking system.

Content of the Work: Determining the optimal carrier using the ranking system.

Brief Theoretical Information: When choosing the mode of transport and transportation routes, it is advisable to consider certain factors that influence the carrier selection (Table 11).

Table 11 – Factors Influencing Carrier Selection

Factor	Comment
Required delivery time	Gains more importance under conditions of cycle time reduction and inventory management
Reliability and service quality	Past customer experience is the best indicator of service quality
Services provided	Availability of specific equipment, inventory management, supply chain management
Type of transported goods	Liquid transportation requires railway tanks, tankers, or pipelines. Transportation of hazardous goods may not be handled by all carriers
Volume of transportation	Large-volume goods are usually transported by rail or road transport
Risk of goods damage	Certain types of goods are at significant risk of damage during transportation (electronics, porcelain products, etc.). In such cases, it is advisable to choose a carrier and delivery method that excludes transferring the goods to another carrier

Cost of transport services	Availability of information on the classification of transportation and tariffs
Financial condition of the carrier	Cargo transportation does not exclude the possibility of damage. The resolution of claims, if any, depends on the financial condition of the carrier
Claims handling	Timely review and resolution of claims related to damage to goods during transportation
Carrier rating system	It is advisable to use the option of selecting a carrier from the top 20% of carriers that ensure 80% of all transactions

To improve the quality of customer service in the supply chain, the ranking of carrier selection criteria is used (Table 12).

Table 12 – Ranking of Carrier Selection Criteria

№	Criteria (Indicators)	Rank
1	Transportation tariffs (costs) "door-to-door"	1
2	Reliability (adherence to delivery (transit) time)	2
3	Total transportation (transit) time "door-to-door"	3
4	Carrier's willingness to negotiate tariff changes	4
5	Financial stability of the carrier	5
6	Availability of additional equipment (for cargo handling)	6
7	Service quality	7
8	Availability of additional services for cargo packaging and delivery	8
9	Cargo safety (prevention of losses and theft)	9
10	Shipment forwarding	10
11	Personnel qualification	11
12	Shipment tracking	12
13	Carrier's willingness to change service options	13
14	Flexibility of transport routing schemes	14
15	Line service	15
16	Application procedure (transportation order process)	16
17	Quality of transport service sales organization	17
18	Special equipment	18

The use of a rating evaluation for carrier selection has limited active practical application, as the involvement of experts in the procedures is not formalized and varies significantly.

Task

The transportation requirements for a particular type of cargo are met by three carriers. The logistics manager has identified the following criteria for carrier selection:

- Transportation tariff;
- Reliability (adherence to delivery time);
- Financial stability of the carrier;
- Cargo safety (prevention of losses and thefts);
- Specialized equipment.

Solution The degree of compliance of these carriers with the chosen evaluation system is assessed by independent experts using a three-point scale: 1 – "Good," 2 – "Satisfactory," 3 – "Unsatisfactory."

The obtained ratings are presented in Table 13. The rank of each criterion is determined based on the data from Table 12. The significance is calculated by dividing

$V_{\max}$ by the rank ($V_{\max}=5$). The rating is the product of the rank, significance, and evaluation.

Develop a rating evaluation in the form of Table 14 and select one of the three carriers using the methodology provided in Table 13.

Table 13 – Rating Evaluation and Carrier Selection

№	Criteria	Rank	Significance	Carrier					
				I		II		III	
				score	rating	score	rating	score	rating
1	Tariff	1	5	3	15	1	5	3	15
2	Reliability	2	2.5	2	5	2	10	3	7.5
3	Financial Stability	5	1	1	5	2	10	2	10
4	Cargo Safety	9	0.56	3	1.68	1	0.56	3	1.68
5	Specialized Equipment	18	0.28	2	0.56	3	0.84	2	0.56
Total				11	27.24	11	26.4	13	34.74

Table 14 – Initial Data for Completing the Practical Task

№	Criteria number from Table 12	Carrier number and its rating
1	2, 5, 7, 12, 18	I – 3,2,1,2,1,3; II – 2,3,1,2,2; III – 1,1,2,3,3
2	1, 4, 9, 11, 13, 17	I – 3,3,1,1,2; II – 2,3,2,1,2; III – 2,3,3,1
3	3, 6, 8, 10, 14	I – 3,2,1,1,3; II – 2,2,3,1,2; III – 3,2,1,2
4	1, 7, 8, 13, 15	I – 2,1,3,1,3; II – 1,2,2,2,3; III – 3,3,2,2
5	2, 4, 7, 10, 18	I – 3,3,1,2; II – 2,3,1,2,2; III – 1,1,3,3
6	3, 5, 6, 17, 18	I – 1,2,1,3,3; II – 2,3,1,1,3; III – 2,1,2,2,3
7	1, 3, 5, 7, 9	I – 3,3,1,1,2; II – 2,3,2,1,2; III – 2,3,3,1
8	2, 4, 6, 8, 10	I – 3,2,1,1,3; II – 2,2,3,1,2; III – 3,2,1,2
9	3, 9, 11, 13, 15	I – 2,1,3,1,3; II – 1,2,2,2,3; III – 3,3,2,2
10	4, 9, 10, 12, 18	I – 3,3,2,1,1; II – 1,1,3,3,2; III – 3,1,2,3
11	1, 13, 14, 15, 18	I – 3,2,1,3; II – 2,3,1,2,2; III – 1,2,3,3
12	2, 5, 6, 12, 13	I – 2,3,2,1,2; II – 2,3,3,1; III – 3,2,1,2
13	1, 7, 8, 9, 17	I – 3,3,1,1,2; II – 2,3,2,1,2; III – 2,3,3,1
14	1, 3, 4, 17, 18	I – 2,3,1,3,1; II – 1,2,1,3,3; III – 2,3,2,2
15	2, 3, 5, 7, 13	I – 3,3,2,1,1; II – 1,2,1,3,3; III – 2,2,3,1
16	1, 3, 6, 10, 11	I – 2,1,3,1,3; II – 2,3,1,1,3; III – 2,1,2,2,3
17	2, 3, 6, 14, 15	I – 3,3,1,1,2; II – 2,3,2,1,2; III – 1,2,3,3,1
18	1, 5, 8, 10, 16	I – 3,2,1,1,3; II – 2,2,3,1,2; III – 3,2,1,2
19	3, 5, 7, 13, 14	I – 2,1,1,3,3; II – 1,2,2,2,3; III – 1,3,2,2
20	1, 6, 8, 11, 15	I – 3,3,2,1,1; II – 1,1,3,3,2; III – 3,1,3,1,2

Literature: 2, 3, 6, 7, 8, 13, 18.

PRACTICAL SESSION 7

Topic: Monitoring the Economic Efficiency of Supply Chain Management

Objective: To familiarize with the efficiency indicators of supply chain performance and the essence of integrated evaluation of supply chain functioning.

Discussion Points:

7.1. Methods of Monitoring and Analyzing Performance.

7.2. The Value Chain as a Competitive Advantage.

7.3. Supply Chain Performance Indicators.

Practical Task: Optimization of Transportation Costs in the Case of Joint Transportation of Different Cargoes

Objective: to learn how to determine the main performance indicators of front loaders under various operating conditions.

Task content: Determination of the key performance indicators of front loaders.

Brief Theoretical Information

When calculating the costs of transporting mixed cargoes by road, two approaches are used: based on the coefficient of payload utilization and based on the coefficient of volumetric capacity utilization.

The estimated mass of the cargo (in conditional tons) is defined as:

$$Q = Q_a \cdot \gamma, \quad (6.1)$$

where Q_a – actual mass of the shipment;

γ – payload utilization coefficient, calculated as:

$$\gamma = Q_{max} / q, \quad (6.2)$$

where Q_{max} – maximum amount (in tons) of cargo in a single-type transport
- q – payload capacity of the vehicle

Task

It is required to calculate the transportation costs when transporting mixed cargo by road. A truck with a payload capacity of 20 tons and a volume capacity of 80 m³ is used to transport tobacco products and juices. The amount of transported cargo is provided in Table 15.

Table 15 – Transport Characteristics

Cargo Type	Weight, t	Volume, m ³
Tobacco products	14–0.2n	70
Juices	5 + 0.2n	10
Total	19	80

Example

To determine the transportation costs associated with the joint transportation of different cargoes, the payload utilization coefficient is calculated separately for each type of cargo.

For tobacco products, the payload utilization coefficient is:

$$\gamma = \frac{16}{20} = 0.8$$

For juices, the payload utilization coefficient is:

$$\gamma = \frac{20}{20} = 1.0$$

Based on the obtained payload utilization coefficients, the equivalent cargo mass expressed in conditional tons is determined.

For tobacco products:

$$Q = \frac{14}{0.8} = 17.5 \text{ conditional tons}$$

For juices:

$$Q = \frac{5}{1.0} = 5.0 \text{ conditional tons}$$

Thus, the total equivalent cargo mass transported by one vehicle is:

$$Q_{\text{total}} = 17.5 + 5.0 = 22.5 \text{ conditional tons}$$

Assuming that the total transportation cost amounts to 10,000 UAH, the costs are allocated between the cargo types in proportion to their equivalent masses.

Accordingly, the transportation cost attributable to tobacco products is:

$$C_{\text{tobacco}} = 7,778 \text{ UAH}$$

The transportation cost attributable to juices is:

$$C_{\text{juices}} = 2,222 \text{ UAH}$$

Therefore, the proportional allocation of transportation costs makes it possible to account for differences in vehicle capacity utilization associated with the transportation characteristics of each cargo type.

Literature: 3, 7, 8, 9, 11, 28, 29, 30.

PRACTICAL SESSION 8

Topic: Information Technologies in Supply Chain Management

Objective: To familiarize with information technologies in supply chain management and modern information systems for supply chain monitoring.

Discussion Points:

- 8.1. Supply Chain Information Technology.
- 8.2. Supply Chain Software Market and Its Functions.
- 8.3. Short-Term Supply Chain Technology Trends.

Practical Task: Calculation of the Optimal Localization of the Central Warehouse

Objective: to learn how to determine the optimal location of a central warehouse within a specific area.

Task content: to determine the coordinates of the optimal location for a particular object (warehouse).

Brief Theoretical Information

To optimize the placement of a wholesale base in a specific area, taking into account the location of suppliers and retail stores, we use a coordinate method. We define the coordinates of suppliers as X_i, Y_i and the coordinates of retail stores as X_j та Y_j .

The final formulas for determining the optimal coordinates of the central warehouse are:

$$X = \frac{\sum(p_i \cdot x_i) + \sum(q_j \cdot x_j)}{\sum p_i + \sum q_j}, \quad (7.1)$$

$$Y = \frac{\sum(p_i \cdot y_i) + \sum(q_j \cdot y_j)}{\sum p_i + \sum q_j}, \quad (7.2)$$

where p_i — supply volume from the i -th supplier

q_j — demand from the j -th store

This method is based on the economic interpretation of the "center of gravity" of a distributed load, where the chosen location minimizes transport costs.

Task

A trading company has five retail stores with annual sales volumes q_i (Table 16), and three main product suppliers with annual supplies p_i . To minimize

transportation costs, the company wants to determine the optimal location of the central warehouse that will serve all stores.

Table 16 – Input data for solving the problem

Store demand q_j (X; Y)					Supplier capacity p_i (X; Y)		
q_1	q_2	q_3	q_4	q_5	p_1	p_2	p_3
$100+n$	$300+n$	$100+n$	$150+n$	$150+n$	$200+n$	$150+n$	$450+n$
$5+n$; $9+n$	$0;0$	$7+n$; $22+n$	$21+n$; $12+n$	$26+n$; $5+n$	$13+n$; $14+n$	$17+n$; $2+n$	$2+n$; $18+n$

Example

Start the coordinate system from the south-west corner of store M2. Using graphical interpretation, determine the coordinates of suppliers and stores.

Using the formulas above, calculate the coordinates of the optimal warehouse (CW):

$$x = \frac{(200 \cdot 13 + 150 \cdot 17 + 450 \cdot 2) + (100 \cdot 5 + 300 \cdot 0 + 100 \cdot 7 + 150 \cdot 21 + 150 \cdot 26)}{200 + 150 + 450 + 100 + 300 + 100 + 150 + 150} = 7.2$$

$$y = \frac{(200 \cdot 14 + 150 \cdot 2 + 450 \cdot 18) + (100 \cdot 9 + 300 \cdot 0 + 100 \cdot 22 + 150 \cdot 12 + 150 \cdot 5)}{200 + 150 + 450 + 100 + 300 + 100 + 150 + 150} = 10.5$$

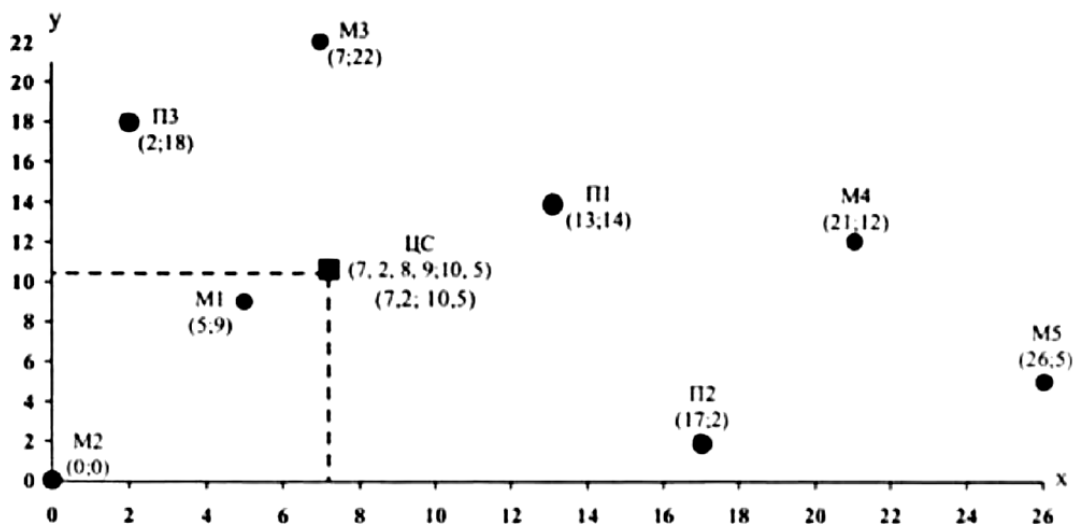


Figure 5 – Graphical Interpretation of the Optimal Warehouse Location

The optimal warehouse location has coordinates: $X = 7.2$; $Y = 10.5$

Considering the proportionality of distance to transport costs, this placement minimizes the objective function under ideal conditions. However, real-world implementation may require adjustments due to existing transport infrastructure and different unit transport costs.

Literature: 2, 6, 7, 8, 14, 21, 23, 24.

PRACTICAL SESSION 9

Topic: Global Supply Chain Management

Objective: To familiarize with the key risks and challenges of global supply chains, identify the factors affecting their vulnerability, and examine approaches to risk management and supply chain resilience.

Discussion Points:

- 9.1. The Trend Towards Globalisation in the Supply Chain.
- 9.2. Global Logistics Intermediaries and Their Role.
- 9.3. Main Sources and Types of Risks in Global Supply Chains.
- 9.4. Supply Chain Disruptions, Volatility, and Uncertainty.
- 9.5. Risk Management and Resilience Strategies in Global Supply Chains.

Practical Task: Risk Assessment and Adaptation of a Global Supply Chain

Case 1. Nokia and Ericsson: Supply Disruption after the Philips Plant Fire

Situation

In March 2000, a fire occurred at a Philips semiconductor manufacturing facility in Albuquerque, New Mexico. The plant supplied radio-frequency components used by two major mobile-phone manufacturers, Nokia and Ericsson. As a result of the fire, both companies suddenly faced a disruption in the supply of critical electronic components.

Nokia reacted rapidly to the disruption. The company established an executive-led team to monitor the situation and worked with Philips to obtain additional production capacity from other facilities. At the same time, Nokia engineers redesigned affected components so that alternative suppliers in Japan and the United States could manufacture them. This combination of supplier diversification, product adaptation, and close coordination with the supplier helped Nokia reduce the impact of the disruption.

Ericsson was more dependent on the affected source of supply and experienced significantly greater consequences from the disruption. The event later became an important driver for the company to develop a more systematic approach to supply chain risk management. Ericsson introduced processes for identifying, assessing, monitoring, and managing risks throughout its supply chain and strengthened requirements for suppliers and sub-suppliers.

Risk factors to consider

Students should consider the dependence on a critical supplier, limited alternative sourcing, visibility of lower-tier suppliers, lead time for

semiconductor production, the possibility of component redesign, and the consequences of production interruption.

Adaptation problem

Assume that your company receives information that a critical Tier-2 supplier has stopped production because of a major accident. The component is required for several key products, while existing inventories are sufficient only for a limited period.

Develop a response strategy that would allow the company to maintain operations and reduce the consequences of the disruption.

Questions for analysis

1. What were the main supply chain risks revealed by the Philips plant fire?
2. Which part of the supply chain represented the greatest vulnerability?
3. How would you assess the probability and impact of the identified risks?
4. What short-term actions could be taken immediately after the disruption?
5. What alternative suppliers or production capacities could be used?
6. Could product or component redesign reduce dependence on the disrupted supplier?
7. What long-term changes should be introduced to increase supply chain resilience?
8. Compare the different responses of Nokia and Ericsson and identify the risk-management practices demonstrated by the case.

More details: [Flexibility in the Face of Disaster: Managing the Risk of Supply Chain Disruption — Knowledge at Wharton](#). Norrman, A. & Jansson, U. (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident

Case 2. Toyota: Supply Chain Disruption after the 2011 Tohoku Earthquake

Situation

On March 11, 2011, the Great East Japan Earthquake and tsunami caused extensive damage to industrial facilities, transport infrastructure, energy systems, and supplier networks in Japan. Toyota's supply chain was affected not only at the level of direct suppliers but also through second-tier and lower-tier suppliers. Toyota subsequently identified 659 affected supplier sites, while procurement problems were estimated to involve approximately 1,260 parts and materials, potentially affecting up to 80% of the vehicle models produced globally.

One of the particularly important disruptions concerned automotive microcontrollers manufactured by Renesas Electronics and supplied to Toyota through first-tier suppliers such as Denso. The disruption demonstrated the vulnerability of a highly interconnected, multi-tier supply network and the

difficulties of identifying critical dependencies beyond direct suppliers. Academic analysis of the case notes that it took approximately three months for Toyota to return to its pre-earthquake production level.

Toyota responded by collecting detailed information about damaged suppliers, sending teams to supplier locations, coordinating recovery activities, and working with suppliers and other automotive companies to restore production. The experience highlighted the importance of better visibility into lower-tier suppliers and stronger mechanisms for managing critical components and disruption risks.

Risk factors to consider

Students should consider geographic concentration of suppliers, dependence on specialized components, Tier-2 and Tier-3 supplier visibility, infrastructure disruption, production capacity constraints, long recovery times, and the consequences of a disruption spreading through a global production network.

Adaptation problem

Assume that a natural disaster has affected a region where several suppliers of critical automotive components are located. Some Tier-1 suppliers remain operational, but their own suppliers cannot deliver key materials and electronic components.

The manufacturer must determine how to restore production while also redesigning the supply chain to reduce vulnerability to similar disruptions in the future.

Questions for analysis

1. What types of supply chain risks were triggered by the earthquake and tsunami?
2. Why did disruption at lower-tier suppliers affect Toyota's global production?
3. Which suppliers and components should be classified as critical?
4. How could Toyota evaluate the probability and potential impact of similar disruptions?
5. What short-term recovery measures should receive priority?
6. Would dual sourcing, safety stocks, alternative production sites, or supplier diversification improve resilience?
7. How can a company improve visibility beyond Tier-1 suppliers?
8. How should the supply chain structure be adapted to balance efficiency and resilience?

More details: [Toyota Motor Corporation — The Great East Japan Earthquake: Measures to Restore Production](#). [Matsuo, H. Implications of the Tohoku earthquake for Toyota's coordination mechanism: Supply chain disruption of automotive semiconductors](#)

Case 3. The Ever Given and the Suez Canal Blockage: Rerouting a Global Supply Chain

Situation

In March 2021, the container ship *Ever Given* became grounded in the Suez Canal, blocking one of the world's major maritime transport corridors for approximately six days. The incident disrupted shipping schedules and created queues of vessels waiting to pass through the canal. Companies had to decide whether vessels should remain in the queue or be rerouted around the Cape of Good Hope.

Maersk and its partners were directly affected by the disruption. During the blockage, the company redirected a number of vessels around southern Africa and continuously reassessed whether additional vessels should be rerouted or remain on their original routes. Maersk also advised customers to prioritize urgent cargo and considered alternative transport solutions, including air and rail, for critical shipments.

The effects continued even after the canal reopened because vessels, ports, terminals, container equipment, and sailing schedules had become unbalanced. Maersk therefore had to manage vessel delays, port congestion, equipment repositioning, booking restrictions, and the restoration of regular schedules.

A later academic study of Maersk's East-West network analyzed 69 vessels affected by the disruption, either through delays or rerouting via the Cape of Good Hope. The study estimated additional costs associated with vessels, inventory carrying, and environmental impacts, demonstrating how a relatively short disruption at a maritime chokepoint can create significant effects throughout a global supply chain.

Risk factors to consider

Students should consider dependence on a strategic transport corridor, uncertainty about disruption duration, additional sailing distance, fuel consumption, delivery delays, inventory costs, port congestion, availability of containers, customer priorities, and alternative modes of transport.

Adaptation problem

A company has high-value and time-sensitive cargo moving from Asia to Europe when the Suez Canal becomes unavailable. At the moment the decision must be made, the company does not know whether the disruption will last three days, one week, or two weeks.

The supply chain manager must decide how to adapt the transportation network.

Possible alternatives include:

- waiting for the Suez Canal to reopen;
- rerouting vessels around the Cape of Good Hope;

- transferring selected urgent shipments to air transport;
- using alternative rail connections for critical cargo;
- changing inventory allocation between regional warehouses;
- prioritizing critical customer orders.

Questions for analysis

1. What risks did the Suez Canal blockage create for global supply chains?
2. Which risks are operational, transport-related, financial, and customer-related?
3. How does uncertainty about the duration of the disruption affect the decision?
4. What factors should be considered when choosing between waiting and rerouting?
5. Which cargoes should be prioritized for alternative transportation?
6. How would rerouting affect transportation cost, lead time, inventory, and customer service?
7. What short-term adaptations could reduce the consequences of the disruption?
8. What long-term measures could reduce dependence on a single maritime corridor?
9. How could scenario planning be used to prepare for similar disruptions?

More details: [Maersk — Update to Vessel Blockage in the Suez Canal](#)

Tran, N. K., Haralambides, H., Notteboom, T. & Cullinane, K. — The costs of maritime supply chain disruptions: The case of the Suez Canal blockage by the Ever Given megaship

Literature: 3, 8, 7, 10, 15, 18, 20, 25, 26, 27, 28, 29, 30.

PRACTICAL SESSION 10

Topic: Innovations in the State Customs Service of Ukraine and Their Impact on Supply Chain Efficiency

Objective: To familiarize with global development trends and innovations in the activities of the State Customs Service of Ukraine.

Discussion Points:

10.1. Global Development Trends and Their Impact on Ukraine's Development.

10.2. Implementation of the New Computerized Transit System (NCTS).

10.3. Introduction of the Authorized Economic Operators (AEO) Institute.

10.4. Use of Customs Digital Products ("Single Window for International Trade," Business Intelligence, and Others).

Literature: 3, 15, 18, 20.

Self-Study Topics and Questions for Self-Assessment

1. Evolution of the Supply Chain Management Concept

Questions for self-assessment:

1. How has the concept of supply chain management evolved from traditional logistics to digital systems?
2. What impact do automation and intelligent transport systems have on SCM development?
3. What is the role of road transport in the evolution of logistics processes?
4. How have efficiency requirements for transportation changed with the growth of global supply chains?

Recommended Sources: 1, 2, 3, 5, 6, 8, 13, 14, 17, 22

2. Logistic Functions of Supply Chain Management

Questions for self-assessment:

1. Which logistics functions are directly related to the organization of road transport operations?
2. How does transport logistics influence the overall efficiency of the supply chain?
3. What is the interrelation between transport, warehouse, and procurement logistics?
4. Which logistics functions help minimize vehicle downtime?

Recommended Sources: 1, 3, 5, 7, 8, 9, 18, 22

3. Forecasting and Demand Planning in Supply Chains

Questions for self-assessment:

1. How does demand forecasting affect the planning of transport resources in an enterprise?
2. Which forecasting methods are most often used for calculating transport flows?
3. How does the change in product demand influence vehicle fleet utilization?
4. How does forecasting accuracy help avoid fuel overconsumption and inefficient trips?

Recommended Sources: 1, 3, 6, 8, 13, 14, 15, 16, 22, 23

4. Fundamentals of Procurement Management in Supply Chains

Questions for self-assessment:

1. What is the role of procurement logistics in supplying an automotive transport enterprise with materials and spare parts?
2. How does supplier selection affect vehicle reliability and technical condition?
3. How is the logistics of fuel and lubricant supply organized at motor transport enterprises?
4. How does procurement optimization contribute to reducing transportation costs?

Recommended Sources: 1, 2, 5, 7, 11, 18, 22

5. Methods and Tools for Risk Management in Supply Chains

Questions for self-assessment:

1. What are the main risks typical for transportation within supply chains?
2. What methods are applied to assess risks in route and trip planning?
3. How is cargo and vehicle insurance integrated into the risk management system?
4. What tools enhance the resilience of transport logistics against external threats?

Recommended Sources: 12, 13, 15, 16, 24, 25, 26, 27

6. Fundamentals of Warehouse Management in Supply Chains

Questions for self-assessment:

1. What warehouse functions are the most important for transport and logistics operations?
2. How does the location of a warehouse affect the efficiency of transport routes?
3. What is the significance of warehouse automation for reducing loading and unloading times?
4. How do WMS systems help coordinate transport and warehouse activities?

Recommended Sources: 1, 3, 5, 7, 8, 18, 22

7. Reverse Logistics and Sustainability

Questions for self-assessment:

1. What is the role of road transport in reverse logistics processes?
2. How does the collection and recycling of used parts or tires contribute to environmental sustainability?

3. Which transport solutions help minimize the environmental impact of logistics?
4. How does telematics optimize routes to reduce CO₂ emissions?
5. What are the specific features of organizing transportation for reverse cargo flows?

Recommended Sources: 8, 12, 13, 14, 17, 22

8. Application of Artificial Intelligence in Supply Chain Management

Questions for self-assessment:

1. How is artificial intelligence used to optimize cargo transportation routes?
2. What opportunities does machine learning offer for predicting vehicle technical conditions?
3. How do AI systems assist in vehicle load planning?
4. What are the practical examples of AI implementation in fleet management?

Recommended Sources: 14, 17, 21, 23

9. Risk Management in Global Transport and Logistics Networks

Questions for self-assessment:

1. What are the main risks associated with international road transport within global supply chains?
2. How do geopolitical disruptions affect international transport routes and delivery reliability?
3. What role do alternative routes and transport modes play in adapting global supply chains to disruptions?
4. How can digital platforms and real-time tracking support risk monitoring and response in international transport operations?

Recommended Sources: 6, 8, 14, 15, 16, 19, 20, 24, 25, 26, 27, 28, 29, 30

10. Features of Customs Clearance for Freight Transportation in Ukraine

Questions for self-assessment:

1. What are the main stages of customs clearance for freight transport in Ukraine?
2. What is the importance of the NCTS system for optimizing international road transport?

3. Which documents accompany cargo during customs border crossing in Ukraine?
4. How does the implementation of electronic declarations improve the speed and transparency of customs procedures?

Recommended Sources: 3, 18, 20, 28, 29, 30

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