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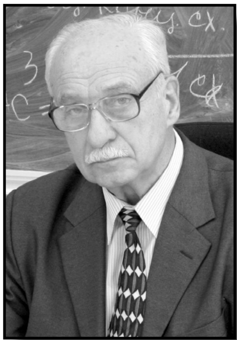
Strategic Development of Oil Shipments from Russia to Palestine



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ABSTRACT

Recent decades have seen a significant expansion of world oil trade, which contributes to development of appropriate transport infrastructure, improvement and deepening of business ties in world energy markets and acceleration of their globalization. Russia plays an increasingly important role in export of oil and oil products, thereby seriously affecting physical volumes of foreign trade operations, prices, and the level of supply and demand. At the same time, interest in Russian oil is obviously taking into account the use of the existing or planned transport infrastructure. Despite the featured significant fluctuations in prices, which are caused by various factors of economic, geopolitical, and political nature, it is obvious that the general tendencies towards increase in oil prices remain against the background of the expected increase in demand for liquid fuel. This conclusion can be made on the basis of the costs of extracting energy resources, organizing the logistics component, of growing relevant political risks, according to competitive realities. In this regard, selection of an optimal transport route is of particular importance.

The objective of the study is to test the algorithm developed by the authors for solving the multicriteria problem of choosing a rational route of fuel delivery within the framework of logistics chains from an oil refinery to a consumer. Testing is carried out at the example of development of hypothetical oil shipments from Russia to the State of Palestine. The use of the methods of economic analysis, multicriteria problem solving, expert assessments, representation of tasks in a multi-criteria setting using the developed deterministic method allows in each case to objectively find the best practical solution. The results of the analysis based on a sample of four options, have confirmed the possibility of using the proposed algorithm for solving the multicriteria problem to select the optimal route.

The developed theory allows to objectively select the best proposal among possible variants; to improve the quality of the result obtained not only by the digital values of the accepted criteria, but also by taking into account the significance of different criteria among themselves by their influence on the process under consideration; to refine the intermediate data by using linear and nonlinear interpolation; to consider possible financial, time and other risks; to pose and solve problems taking into account hypothetical ways of transporting liquid fuel and compare the results with existing schemes.

Keywords: *transportation, logistics, multimodal transportation, objective method, oil cargo delivery, track variations, rational transportation route.*

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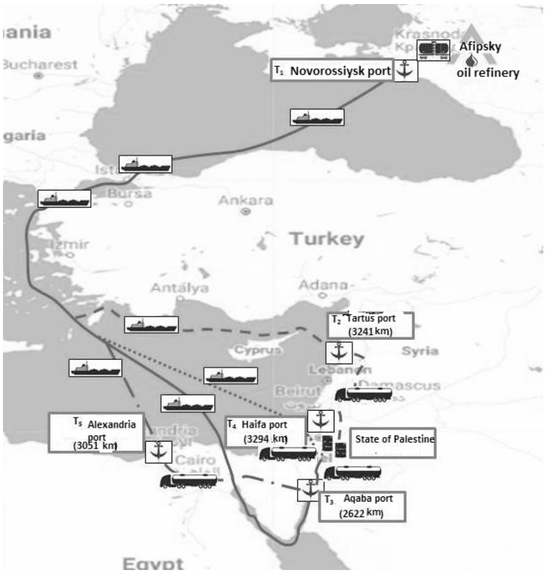

Pic. 1. Scheme of possible routes.

Background. In the process of growth in world oil trade following emergence of new suppliers and consumers, emergence of new commercial ties, the number of routes from oil refining and loading points to final consumers is expanding.

The works [1–4] on freight forwarding of oil deliveries both to export and to the domestic market, are focused on innovations in transport infrastructure, improving management, and ensuring the availability of transport services. Simultaneously with the above-mentioned works, it is worth noting works of researchers of many countries in oil segment, referring to accounting, logistics of oil routes [5–9].

As a result, objective prerequisites were met to develop a single approach to find optimal solutions in multimodal transportation not only through cost and time factors, which is very important in itself, but also taking into account other indicators, including possible risks.

In many cases, a complex supply chain using several modes of transport is required. Amidst the Middle East countries we can quote the Syrian Arab Republic and the State of Palestine as being examples of fields of multimode transportation practices.

Under these conditions, search for a reliable method for calculating the optimal route, taking into account a number of criteria, including time and cost, is of great importance.

Previously, the authors developed an algorithm for solving such a multicriteria problem [10–14].

In the study described in this article, the algorithm was applied in order to test it to solve the problem of practical route selection when organizing deliveries using several modes of transport and having several route options. The work is devoted to solving the multicriteria problem of choosing a rational way for a hypothetical fuel delivery within the logistic chains from Afipsky oil refinery (near the port of Novorossiysk) to the State of Palestine. When considering this itinerary of supply of oil and oil products to Palestine, there are four possible routes involving several modes of transport. It should be noted that currently the State of Palestine occupies the top places in the pricing policy in trade of energy resources, in particular gasoline, and its value exceeds the price in the Russian Federation by three times.

The following planned routes for transporting fuel from the Russian Federation to the territory of the State of Palestine are considered (Pic. 1):

1. Transportation of fuel by sea to the port of Tartus and further by road through the territory of the Syrian Arab Republic;
2. The route by sea to the port of Aqaba and further through Jordan by road;
3. Oil delivery by sea to the port of Haifa and then through Israel by road;
4. Oil delivery by sea to the port of Alexandria, then by road.

Objective. The objective of the research was to test the algorithm developed by the authors for solving the multicriteria problem of choosing a rational route of fuel delivery within the framework of logistics chains from an oil refinery to a consumer.

Methods. The authors use general scientific methods, economic analysis, multicriteria problem solving, expert assessments, representation of tasks in a multicriteria setting using the developed deterministic method.

Results.

Formulation of the problem

In the present work, according to the developed algorithm [10; 12], a solution of the multicriteria problem for determining the rational route for delivery of fuel with a mass of $M_f = 3000$ tons along one of four transport routes under consideration is presented. Pic. 1 shows a logistics range that includes the territory from Afipsky oil refinery near the port of Novorossiysk to the destination point in the State of Palestine.

Each of routes S_1, ..., S_4 (transportation options) consists of sections:

S_1 – railway, terminal T_1, sea, T_2, road;

S_2 – railway, terminal T_1, sea, T_3, road;

S_3 – railway, terminal T_1, sea, T_4, road;

S_4 – railway, terminal T_1, sea, T_5, road.

The length of track sections S_1, ..., S_4 are as follows:

S_1 – railway = 130 km, sea = 3 241 km, road = 605 km;

S_2 – railway = 130 km, sea = 2 622 km, road = 333 km;

S_3 – railway = 130 km, sea = 3 294 km, road = 147 km;

S_4 – railway = 130 km, sea = 3 051 km, road = 989 km;

The following criteria have been adopted for transportation of fuel:

k_1 – cost of fuel transportation by a specific mode of transport, rubles;

k_2 – net fuel transportation time by a specific mode of transport, hour;

k_3 – cost of transshipment of fuel in the terminals, taking into account the types of transport, rubles;

k_4 – time of transshipment of fuel between modes of transport, to the terminals and back hour;

k_5 – risk during transportation of fuel by a specific mode of transport, point;

k_6 – risk during fuel transshipment, point;

k_7 – time of stay of a ton of fuel in the terminal, days;

k_8 – cost of stay of a ton of fuel in the terminal, rubles;

k_9 – risk of fuel delivery at the agreed time, point.

The solution to the problem extends to a wide range of liquid fuels, which include crude oil, fuel oil, diesel fuel, gasoline. The cost of logistics services, depending on the type of fuel, varies between 5–10 % and is therefore almost equivalent, which makes it possible to draw a generalized conclusion on determining the effective route for transporting liquid fuel from the place of departure to the destination with respect to the entire cargo range under consideration. For a decision, averaged input data is accepted, since the applied approach in this case is aimed at effective choice of a route by a customer of cargo or forwarding companies. Rates and informational data were compiled from the commercial transport environment and may vary depending on a company's policy, foreign policy environment, economic factors, trade and economic relations with the states whose territories are included in the supply chain.

The solution of the problem

To solve the problem, the following numerical values for calculating the criteria are adopted.

Cost of transportation of 1 ton of liquid fuel (criterion k_1) per 1 km:

- along a railway: 11,3 rubles (on the territory of Russia from Afipsky oil refinery);
- along a road: for option S_1 – 56 rubles, S_2 – 42 rubles, S_3 – 76 rubles, S_4 – 49 rubles;
- by sea transport: for option S_1 – 21 rubles, S_2 – 19 rubles, S_3 – 26 rubles, S_4 – 17 rubles.

When determining cost of delivering fuel by road, it was assumed that 50 tank trucks with a capacity of 30 tons of fuel each were involved in the transportation process in directions S_1–S_4. From the condition of a given mass of transportation of 3000 tons, the required number of cars is determined with one go for transportation of fuel (3000/30 = 100). Based on the result, the required number of trips for 50 cars is determined. For practical reasons, 50 trucks making each 2 round trips are considered. From the result obtained, the cost of transporting a given mass of fuel by road is determined, taking into account the empty mileage of the tank truck (Table 1).

To calculate the numerical value of the criterion k_2, speed of movement by railway is set to 60 km/h, by road – 50 km/h, by sea – 30 km/h. This takes into account the need for implementation of accepted road trips from the point of departure to the point of arrival and back. Given the speed of transport on the road (50 km/h), the necessary time is determined for transportation of the entire mass of fuel S_1 = (605 km • 3)/50 km) = 36,3 hours; S_2 = 19,98 hours; S_3 = 8,82 hours; S_4 = 59,34 hours.

It is assumed that the cost of transshipment of fuel (criterion k_3) in terminal T_1 will be 190 rubles during each process per one ton. At the same time, two processes are taking place – liquid fuel entering the terminal and oil cargo being pumped into the tanker. Similar processes occur at each terminal with a variation in modes of transport. The cost of transshipment of fuel to and from the terminals (two processes in total) is 220 rubles for the terminal T_2 per ton, for the terminal T_3–340 rubles, for the terminal T_4–420 rubles per ton, for the terminal T_5–380 rubles per ton.

Time of fuel transshipment (criterion k_4) from railway tanks to the terminal for the accepted mass of fuel M_f = 3000 tons will be 2 hours, from the terminal to the tanker – 5 hours, then:

If a destination is in Syria, transshipment from sea transport to the oil tank is 7 hours, from the oil tank to road transport it is of 5 hours.

If destination points are in Jordan, Israel, Egypt, time of transshipment from sea transport to the terminal is 3 hours, from the terminal to road transport – 3 hours. At the same time, fuel stay in the terminal T_1 – 2 days, T_2 – 4 days, T_3 – 2 days, T_4 – 3 days, T_5 – 5 days.

The numerical value of the criterion k_5 (risk during transportation) is calculated taking into account the score $k_5^{(1)}$ for a particular type of transport, fuel mass M_f (3 000 tons) and distance l of transportation:

$$D_{k5} = \frac{k_5^{(1)}}{M_f \ell}, \quad (1)$$

In accordance with the considered suggested algorithm, it is accepted that the higher is the degree of risk (ranging from 0 to 1), the lower is its digital value. The following values of $k_5^{(1)}$ are accepted:

a) sea transport $k_{5(S)}^{(1)} = 0{,}96$;

b) railway transport $k_{5(R)}^{(1)} = 0{,}9$;

c) road transport $k_{5(Ro)}^{(1)} = 0{,}8$.

The value of risk during transshipment of fuel for options S_1, ..., S_4 of fuel transportation is calculated by the expression:

$$D_{k6} = \frac{k_6^{(2)}}{M_f}, \quad (2)$$

In this case k_6 is accepted:

a) during transshipment from sea to road transport $k_{6(SRo)}^{(2)} = 0{,}9$;

b) during transshipment from railway transport to the terminal $k_{6(RT)}^{(2)} = 0{,}88$;

c) during transshipment from the terminal to sea transport $k_{6(TS)}^{(2)} = 0{,}86$;

d) during transshipment from sea transport to the terminal $k_{6(ST)}^{(2)} = 0{,}86$.

e) during transshipment from the terminal to road transport $k_{6(TRo)}^{(2)}$ = 0,89.

Time of stay of fuel in the terminal of the port of Novorossiysk T_1 (criterion k_7) is 2 days, in the terminal of the port of Tartus T_2 – 4 days, in the terminal of the port of Aqaba T_3 – 2 days, in the terminal of the port of Haifa T_4 – 3 days, in the terminal of the port of Alexandria T_5 – 5 days.

The cost of maintaining fuel in the terminals: T_1 = 120 rubles per day (criterion k_8), T_2 = 87 rubles, T_3 = 110 rubles, T_4 = 150 rubles, T_5 = 130 rubles.

Risks associated with the delivery of fuel to final points are calculated by the expression:

$$D_{k9} = [\sum \ell_{1,\dots m} / k_{1,\dots m}]^{-1}, \quad (3)$$

where $l_{1,\dots,m}$ – lengths of the pathways for each considered option of fuel delivery. Here, the larger is l, the smaller is the digital value and therefore the greater is the risk.

In accordance with the algorithm of the developed method, Table 1 is constructed, where all the digital values D of the considered criteria are located for transportation options S_1, ..., S_4 of liquid fuel.

In accordance with the algorithm of the applied method the values of Table 1 are used to construct Table 2 of total values of each numerical value of the criteria for each option S_1, ..., S_4. Further, using the digital information in Table 2, the places M of each option S are determined for each criterion, those values are put in Table 3 (in square brackets). In this case, the best place is assigned to a larger number (maximum value – 4).

Due to the fact that the criteria considered above are not equivalent to each other in their significance, a coefficient of significance k_m of those criteria is introduced by the method of expert estimates (within 0–1 range). Moreover, the more

Table 1

Values of D criteria for options S_1, ..., S_4

Numerical values of criteria	Options																			
	S_1					S_2					S_3					S_4				
	rail-way	T_1	sea	T_2	road	rail-way	T_1	sea	T_3	road	rail-way	T_1	sea	T_4	road	rail-way	T_1	sea	T_5	road
D_{k1}	4407000	–	204183000	–	152460000	4407000	–	149454000	–	62937000	4407000	–	256932000	–	50274000	4407000	–	155601000	–	218074500
D_{k2}	2,2	–	108,03	–	36,3	2,2	–	87,4	–	19,98	2,2	–	109,8	–	8,82	2,2	–	101,7	–	59,34
D_{k3}	1140000			660000		1140000			1020000			1140000			1260000	1140000				1140000
D_{k4}	2 5 7 5					2 5 3 3					2 5 3 3					2 5 3 3				
D_{k5}	$2{,}3 \cdot 10^{-6}$		$9{,}87 \cdot 10^{-8}$		$4{,}41 \cdot 10^{-7}$	$2{,}3 \cdot 10^{-6}$		$1{,}22 \cdot 10^{-7}$		$8{,}01 \cdot 10^{-7}$	$2{,}3 \cdot 10^{-6}$		$9{,}7 \cdot 10^{-8}$		$1{,}8 \cdot 10^{-6}$	$2{,}3 \cdot 10^{-6}$		$1{,}05 \cdot 10^{-7}$		$2{,}7 \cdot 10^{-7}$
D_{k6}	$2{,}9 \cdot 10^{-4}$ $2{,}8 \cdot 10^{-4}$ $2{,}8 \cdot 10^{-4}$ $2{,}9 \cdot 10^{-4}$					$2{,}9 \cdot 10^{-4}$ $2{,}8 \cdot 10^{-4}$ $2{,}8 \cdot 10^{-4}$ $2{,}9 \cdot 10^{-4}$					$2{,}9 \cdot 10^{-4}$ $2{,}8 \cdot 10^{-4}$ $2{,}8 \cdot 10^{-4}$ $2{,}9 \cdot 10^{-4}$					$2{,}9 \cdot 10^{-4}$ $2{,}8 \cdot 10^{-4}$ $2{,}8 \cdot 10^{-4}$ $2{,}9 \cdot 10^{-4}$				
D_{k7}	2		4			2		2			2		3			2		5		
D_{k8}	720000		1044000			720000		660000			720000		1350000			720000		1950000		
D_{k9}	0,00023					0,00030					0,00027					0,00022				

Table 2

Total values D of criteria for options S_1, ..., S_4

Numerical designations of significance coefficients	Options			
	S_1	S_2	S_3	S_4
D_{k1}	361050000	216798000	311613000	378082500
D_{k2}	146,53	109,58	120,82	163,24
D_{k3}	1800000	2160000	2400000	2280000
D_{k4}	19	13	13	13
D_{k5}	$2{,}85 \cdot 10^{-6}$	$3{,}23 \cdot 10^{-6}$	$4{,}22 \cdot 10^{-6}$	$2{,}68 \cdot 10^{-6}$
D_{k6}	0,00116	0,000116	0,000116	0,000116
D_{k7}	6	4	5	7
D_{k8}	1764000	1380000	2070000	2670000
D_{k9}	0,00023	0,00030	0,00027	0,00022

significant is the criterion, the corresponding coefficient k_m is closer to unity. In the particular case, the values of different k_m may coincide.

The significance coefficients k_m of all criteria are given below, they are taken into account to specify more exact values of M places of the considered options, where $M_i = M_i k_{mi}$. In the considered problem, the following k_m values are accepted for the criteria:

	Criteria								
	k_1	k_2	k_3	k_4	k_5	k_6	k_7	k_8	k_9
k_m	1	0,85	0,75	0,8	0,2	0,25	0,7	0,75	0,7

Thus, the final places *M* for each of the options S_1, ..., S_4 following each criterion are determined by multiplying the value of M by the coefficient of significance of the corresponding criterion.

The final results *m* for choosing the best option for fuel delivery according to a set of criteria are obtained by adding all *M* separately for each option *S*, i.e. $M_i = M_i(k_m)_i$, where $i_{1, ..., 9}$. A larger value of *m* corresponds to the best option for fuel delivery according to the criteria adopted in the task.

The best option for *S* transportation is option S_2, as *m* corresponding to this option has a maximum value.

Conclusion. Thus, as a result of solving the multicriteria problem, the best option for transporting liquid fuel from Afipsky oil refinery (Russia) to Palestine was determined according to accepted criteria, consisting of transporting fuel by rail to the port of Novorossiysk (for all options considered), then through two terminals by sea to the port of Aqaba (Jordan), then by road to the State

Table 3

Clarified places *M* (in square brackets) of options S_1, ..., S_4 taking into account significance coefficients «k_m» of criteria

	Options			
	S_1	S_2	S_3	S_4
M_{k1}	[2] • 1 = 2	[4] • 1 = 4	[3] • 1 = 3	[1] • 1 = 1
M_{k2}	[3] • 0,85 = 2,55	[4] • 0,85 = 3,4	[3] • 0,85 = 2,55	[1] • 0,85 = 0,85
M_{k3}	[4] • 0,75 = 3	[3] • 0,75 = 2,25	[1] • 0,75 = 0,75	[2] • 0,75 = 1,5
M_{k4}	[1] • 0,8 = 0,8	[2] • 0,8 = 1,6	[2] • 0,8 = 1,6	[2] • 0,8 = 1,6
M_{k5}	[2] • 0,2 = 0,4	[3] • 0,2 = 0,6	[4] • 0,2 = 0,8	[1] • 0,2 = 0,2
M_{k6}	[1] • 0,25 = 0,25	[1] • 0,25 = 0,25	[1] • 0,25 = 0,25	[1] • 0,25 = 0,25
M_{k7}	[2] • 0,7 = 1,4	[4] • 0,7 = 2,8	[3] • 0,7 = 2,1	[1] • 0,7 = 0,7
M_{k8}	[3] • 0,75 = 2,25	[4] • 0,75 = 3	[2] • 0,75 = 1,5	[1] • 0,75 = 0,75
M_{k9}	[2] • 0,70 = 1,4	[4] • 0,70 = 2,8	[3] • 0,70 = 2,1	[1] • 0,70 = 0,70
m	14,05	20,70	14,65	7,55

of Palestine. The calculated option maximally satisfies all the requirements (criteria).

The proposed algorithm can be used for similar tasks related to elaboration of routes of other types of deliveries and to the use of several modes of transport and choice of the optimal one based on several criteria, taking into account significance coefficients.

1. The developed theory allows to objectively increase the best option possible in multimodal transportation of liquid fuel when considering many criteria, including contradictory ones.

2. The theory makes it possible to improve the quality of the result obtained not only by the digital values of the accepted criteria, but also by taking into account the significance of different criteria among themselves by their influence on the process under consideration.

3. To improve, if necessary, the quality of the obtained calculation results, it is possible to refine the intermediate data by using linear and nonlinear interpolation.

4. The process of determining the best schemes for multimodal transportation of liquid fuel is accompanied by consideration of possible financial, temporary and other risks by taking into account the relevant criteria in the calculation.

5. The theory allows to pose and solve problems taking into account hypothetical ways of transporting liquid fuel and compare the results with existing schemes.

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