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A STUDY ON THE IMPACT OF AN INCREASE INCRUDE OIL PRICE AND THE US DOLLAR EXCHANGE RATE ON THE CAPABILITIES OF AN EMERGENCY MEDICAL AID CENTRE TO SERVE PATIENTS

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***Abstract**: The present researchstudies the impact of an increase in oil price and the US dollar exchange rate on the capabilities of an emergency medical aid centre to serve patients. Weighting factors have been introduced to account for the impact of both factors on the change in the price of petrol. The reduced number of calls that can be served with the current budget of the centre is calculated. Conclusions have been made.*

***Keywords:** Mathematical modelling, Emergency medical aid, Prices of raw materials.*

INTRODUCTION

The dynamic international environment and the ongoing military actions in the Middle East, where most of the world's oil is extracted, as well as changes in the US dollar (USD) exchange rate [2], lead to frequent changes in the cost of this raw material on world markets, and hence to changes in the price of petrol and diesel used as fuel for ambulances in which patient care teams of the Emergency Medical Aid Centre (EMAC) [4] travel.

Previous studies [1] indicate that transport costs of EMACs account for about 30% of the budget of such a centre.

Transport costs include two ingredients [6]:

1. **Fixed**– costs that are independent of the ambulance mileage. For convenience, when defining them they can be divided into drivers' salary costs, fixed costs for vehicles and general expenses of the Emergency Medical Aid Centre, financing of administration and medical staff, management and additional activities, as the structure of an EMAC includes the following sectors [5]:

- business and administrative;
- Regional Coordination Centre (RCC);
-emergency medical aid branches (EMAB) located on the territory of the area.

2. Variable

- part of them depend on the distance in kilometres travelled for one call (for fuel, depreciation of the transport vehicles calculated on the basis of the amortization mileage, etc.);
- costs related to the conditions under which the transportations are carried out (duration, combined technologies, etc.).

Planning the EMAC budget is essential for the good functioning of such a centre and the timely service of the patients in need (practically without waiting in the system’s queue).

Planning the number of calls to be served and the overall funding of the EMAC is based on the use of statistical data for expenditures in previous periods and forecasts for how they may change in the future.

In case of a sudden and leaping change in oil prices and an increase in the US dollar exchange rate (and hence the price of petrol), the transport service costs of a EMAC would also increase, namely the average fuel cost to serve a single call. Under the present circumstances, the EMAC management needs to have models and methodologies [7] to enable it to successfully perform its main function of providing service to patients by predicting the consequences of an increase in the above mentioned prices.

EXPOSITION

According to data published by 'Lukoil Bulgaria' company (Fig.1 and Fig.2) [3], the oil price has a direct share of about 40% in the formation of the price of petrol and diesel. Oil prices also contribute to the formation of the operating costs of petrol and diesel (including transport and distribution). With an increase in the price of oil (and that of petrol and diesel), the cost of serving one call in the EMAC changes.

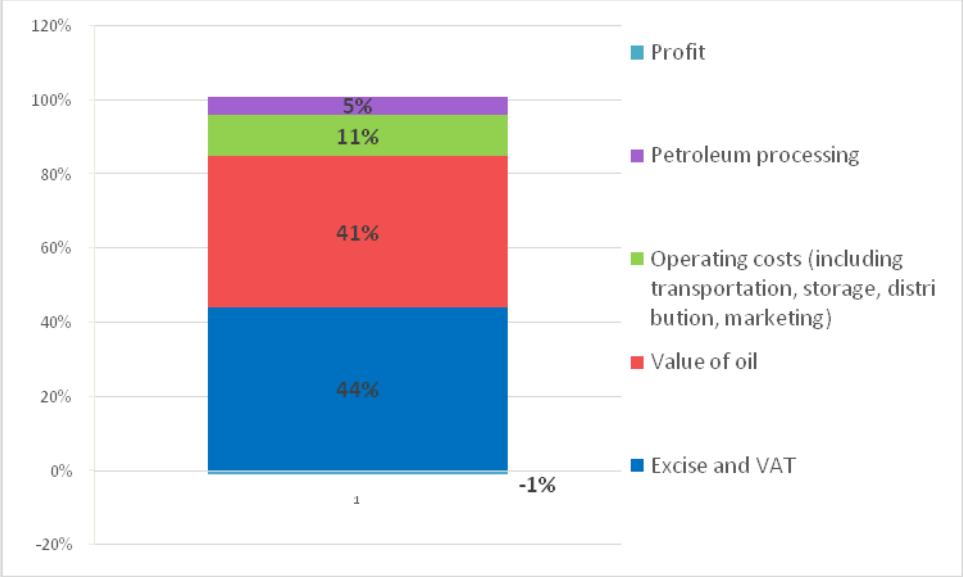

Fig.1. Structure of formation of retail price of petrol A-95 according to information provided by Lukoil Bulgaria

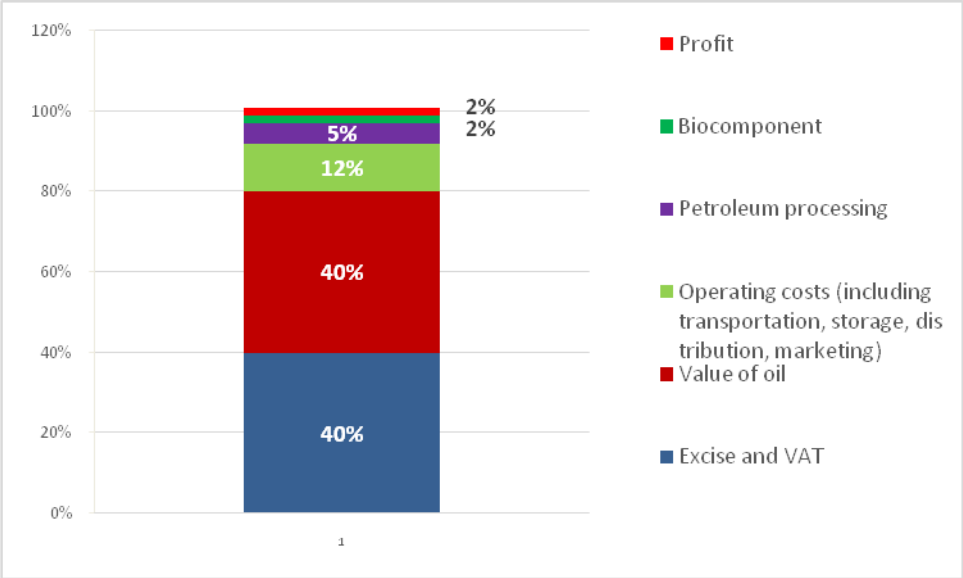

Fig. 2. Structure of formation of retail price of diesel according to information provided by Lukoil Bulgaria

We will indicate with ΔC_b the change in price per unit of measure (litre) for a given quantity of petrol. We denote the new petrol price with C_{bnew}. Then:

$$C_{bnew} = C_b + \Delta C_b, \quad (1)$$

where C_b is the price of petrol before the change in the price of oil and the exchange rate of the US dollar. The change in the price of petrol ΔC_b results in a change in the value of fixed costs Z and variable cost U of a single call.

The values of the new fixed costs Z_{new} and the new variable cost U_{new} of one call will be calculated according to formulas (2) and (3):

$$Z_{new} = Z_0 + \Delta Z(\Delta C_b), \quad (2)$$

$$U_{new} = U_0 + \Delta U(\Delta C_b), \quad (3)$$

Let us denote with S_b the EMAC budget as a permanent amount of money received from the Ministry of Health Care. With the increase in the price of oil and the dollar exchange rate (and hence the price of petrol C_b), the cost of the transport service for one call in the EMAC will increase. We will indicate with X_0 the number of served EMAC calls at a base price of petrol C_b. Then their number will be determined from the dependence:

$$X_0 = \frac{[S_b - Z_0]}{U_0}. \quad (4)$$

We will designate the new number of served calls with X_{new} after the increase in the price of oil and the US dollar. Then

$$X_{new} = \frac{[S_b - (Z_0 + \Delta Z)]}{U_0 + \Delta U}. \quad (5)$$

We introduce weighting factors K_p and K_{pr}, which take into account the impact of the change in the price of oil and the US dollar exchange rate, respectively, on the change of the fixed and the variable costs of one call in the EMAC.

From formulas (4) and (5) we get the following dependence for the change in the number of served calls:

$$\Delta \mathbf{X} = X_{new} - X_0 = \frac{[S_b - (Z_0 + \Delta Z)]}{(U_0 + \Delta U)} - \frac{[S_b - Z_0]}{(U_0)} \quad (6)$$

We substitute from (7) and (8) in formula (6) with data for one call, where

$\Delta U = q_b \Delta C_b$; $\Delta C_b = K_{pr} * \Delta C_{neft}$:

i.e. $\Delta U = q_b K_{pr} * \Delta C_{neft}$ (7)

$\Delta Z = K_p \Delta C_{neft}$ (8)

The petrol consumption (in litres) for serving one call is indicated with q_b, and the price increase per litre of oil with ΔC_{neft}.

The following dependence for the change of the number of served calls ΔX is obtained with an increase in the price of petrol (as a share of the cost of a single call):

$$\Delta X = -\frac{\Delta C_{neft}\{q_b K_{pr}[S_{b1} - Z_0] + K_p * U_0\}}{(U_0 + q_b K_{pr} \Delta C_{neft}) * U_0} \quad (9)$$

In formulas (6)-(9) the sign * is used for multiplication.

It is known that for the year 2017 the budget of EMAC - Ruse is S_b = BGN 3 677 949, whereas around S_{bu} = 970 978 levs (about 26.4% of the total budget) are provided for the transport service of patients' calls. The fixed costs $S_{bz} = S_b - S_{bu}$. The number of served calls in 2016 was Br = 26 614 and it can be assumed that the variable service costs per call will be calculated according to formula (10):

$$U_{01} = \frac{S_{bu}}{Br} = \frac{970\ 978}{26614} = 36.48\ levs \quad , \tag{10}$$

and the fixed costs for servicing one call –

$$Z_{01} = \frac{S_{bz}}{Br} = \frac{2706971}{26614} = 101.71\ levs. \tag{11}$$

Therefore, the total amount for servicing one call in EMAC - Ruse is

$$S_{b1} = \frac{S_b}{Br} = \frac{3677949}{26614} = 138.9\ levs. \tag{12}$$

According to data from EMAC - Ruse, emergency calls in 2016 were with an average mileage of 17.76 km, and with fuel consumption for the new ambulance of 8 litres per 100 km on average, or 0.08 l / km, the consumption for one call was 17.76 * 0.08 = 1.42 l.

As of April 19, 2017, the price of a barrel (about 159 litres) of oil is $ 52, i.e. 52/159 = 0.327 USD / l. of oil at a USD exchange rate of about 1.80 BGN / USD. Then the price per litre of oil will be calculated as 0.327 * 1.80 = 0.59 BGN / l. The price per litre of petrol on the same date is C_b = 2.04 BGN / l.

Estimates suggest [4] that at the end of 2017an oil price of about $ 65 per barrel is expected. Then the price per litre of crude oil at a projected exchange rate for the US Dollar [6] of 1.90 BGN / USD will be 65/159 * 1.90 = 0.78 levs per litre of oil. For the change in the price of oil we obtain:

$$\Delta C_{neft} = 0.78 - 0.59 = 0.19\ levs \tag{13}$$

Taking into account Figures 1 and 2 and the impact of the change in the price of oil and the exchange rate of the US dollar on the price of petrol, it can be estimated that the correction coefficients K_p and K_{pr} will take values of about 0.05 and 0.3 respectively.

By substituting the values indicated in formula (9) with the above discussed values, from equation (9) we obtain that

ΔX = -0.00247, i. eat the estimated oil prices and the US dollar exchange rate at the end of 2017, 0.247% fewer calls will be served with the available budget of the EMAC in Ruse. If the number of served calls in 2017 remains the same as in the previous year (26,614), then the centre will be able to serve about 66 fewer calls with the available budget. This will be the reduced number of served calls if oil prices and the US dollar rate remain the same throughout 2017.

Since the estimated prices are expected to be reached at the end of this year, it is likely that service provision will decrease by fewer than 33 calls.

CONCLUSION

Taking into account the decreasing number of the population in the town of Ruse, the increase in the oil price and the USD exchange rate at the end of the year will not have a significant impact on the work of the EMAC and it will be able to perform its functions providing timely service for the patients in need of emergency medical aid.

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ИЗСЛЕДВАНЕ ВЛИЯНИЕТО НА УВЕЛИЧАВАНЕТО НА ЦЕНАТА НА НЕФТА И КУРСА НА ЩАТСКИЯ ДОЛАР ВЪРХУ ВЪЗМОЖНОСТИТЕ ЗА ОБСЛУЖВАНЕ НА ПАЦИЕНТИТЕ В ЦЕНТЪР ЗА СПЕШНА МЕДИЦИНСКА ПОМОЩ

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Резюме: *В настоящата работа изследвано влиянието на увеличаването на цената на нефта и курса на щатския долар върху възможностите за обслужване на пациентите в Център за спешна медицинска помощ. Въведени са тегловни коефициенти, отчитащи влиянието на двата фактора върху изменението на цената на бензина. Пресметнат е намаленият брой заявки, които могат да бъдат обслужени с настоящия бюджет на центъра.*

Ключови думи: *Математическо моделиране, Спешна медицинска помощ, Цени на суровините.*

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