STUDY ON THE NECESSITY OF THE OPERATION OF SOME RURAL CAR SERVICES IN A PANDEMIC CONTEXT

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Abstract. *The paper aims to analyze using mathematical methods, a statistical model, considering as a case study an AUTO service in rural areas so that, under restrictive conditions generated by COVID-19 and compared to similar periods in previous years, it was possible to optimize the profit obtained by to the company manager. The study was conducted based on a mechanical workshop, "Vest Transcom", from which we evaluated the correlation coefficient. The mechanical workshop is located in the rural area of Caraș-Severin County. The analyzed period was one month during the pandemic, respectively May 2021. The correlation coefficient is the one that measures the degree of independence between two quantities. Some of the parts in the workshop were highlighted. Their cost and the total cost of a mechanical repair were evaluated. The authors continued the study by analyzing the dependence of labor price, this time as a function of the total price of parts (primary and secondary) it was observed that the second-degree polynomial model better approximates the phenomenon, R2 = 0.85. The mathematical function that describes the analyzed model is of several variables, so the factors generated favorable opinion for the business by the age of the car park in rural areas and the distance to large cities with CAR REPRESENTATIONS for different brands. From the statistical interpretation of the experimental data which represents a sample of the total parts contained in the "Vest Transcom" workshop, we can conclude that the ratio between the costs of parts and the repair price induced by the exchange of a certain one is the best possible because the correlation coefficient has a positive value less than 1. Given the pandemic context, the mechanical workshop "Vest Transcom" worked very well, given that the car fleet from the rural area mostly includes old cars, which always need maintenance and upkeep, even if people have travelled less, there were still many cars to be repaired, so it is very necessary to have car workshops in the rural areas.*

Keywords*: rural environment, mechanical workshop, mathematical analysis*

INTRODUCTION

The study was performed based on a mechanical workshop, "Vest Transcom", from which we evaluated the correlation coefficient. The mechanical workshop is located in the rural area of Caraș-Severin County. Some of the parts in the workshop were highlighted and their cost and the total cost of a mechanical repair were evaluated.

In a mechanical workshop, a piece of equipment is mandatory. The equipment must be of high quality so that it can respond efficiently and professionally to any technical need (PAȘTIU, 2014).

Noise must also be combated either by using rubber sheets, felt, or other sound-insulating elements as often as possible or by using headphones or other means of protection against noise (MANOLE, 2001).

As the main equipment in a mechanical workshop can be listed the following: elevators, general mechanical equipment, tools, testers, and utilities: compressed air, lubricants, extractors, service equipment-wheels, steering adjustment stands, equipment for the Periodic Technical Inspection line, tinsmithing machines and tools, painting booth and machinery for the painting workshop, equipment for cleaning and carwashing (ȘTEFĂNESCU, 1995).

Elevators can be:

of two columns - which are also: electronic and hydraulic,
of four columns, scissor or buried type.

The electronic elevators can be driven by one motor and with the transmission to the other column, by a chain or by cardan and can be driven by two motors with electromechanical or electronic synchronization.

The two-column electro-hydraulic lifts have applications for heavy payloads over four tons or in dusty locations where electromechanical variants may suffer premature wear.

The four-column lifts are mainly used for steering adjustment or heavy vehicle repairs, but there must always be a deck jack that slides on the elevator platforms. The payload for such elevators is 3.5, 4, and 5 tons. It is very important to take into account the length of the platforms which can vary between 4100 mm and 5100 mm, on the small ones there is the possibility that vans and long vans cannot be lifted. As constructive variants, the four-column elevators can be with platforms prepared for direction checks with rotating trays and relaxation trays integrated into the platforms (ELEVATOR AUTO, 2021).

Scissor lifts are elevators used mainly for interactive reception at the entrance to the service, or in spaces where a channel that cannot be dug for objective reasons would be suitable. They are usually buried, but the foundation box is only a few inches deep. The advantage is that when they are down, the surface looks excellent, being perfectly flat, but the disadvantage is that dirt accumulates in the boxes.

General mechanical equipment, tools, testers, and utilities:

In this category, we can list the following: compressed air, lubricants, and exhausters.

Exhaust gas systems

The exhausters can be: with suspended rail, with drum, buried in the floor

For exhaust systems, the number of cars that can operate simultaneously must be taken into account, as well as the number of exhaust pipes of each. There are various construction variants, fixed or mobile. Fixed variants are attached to the walls or ceiling, but there is also the option of burying in the floor.

Compressed air installations/systems

Piston air compressors, tandem air compressors, screw compressors, compressed air screwing / unscrewing gun.

Testers for car mechanics workshops

Regarding testers, it must be taken into account that a universal tester cannot do the same as an OEM (original equipment manufacturer) tester. In other words, a universal tester has a very large number of cars in the database and tries to dialogue with as many of their systems as possible (FIRU, 2021).

However, it is impossible to have a universal tester on the market able to dialogue with all cars and all their systems. Because if it existed, it would cost between 100,000 EURO and 150,000 EURO, which is the sum of prices that must be paid to have an OEM tester for each brand (PRIHOANCĂ, 2001). The differences between the universal testers available on the market are given by the quality of the information contained and not by the quantity. Namely, there may be a tester that has almost all car brands in the database, but only communicates with very few of their systems and that is less useful than another that communicates with almost all car systems in the database, even if they are fewer (BLOGDIAGNOZAPRO, 2021).

Tinsmith machines and tools:

There are a variety of tinsmith machines on the market, from the mundane tinsmith kit based on a hydraulic cylinder and a few straightening heads to sophisticated automatic pull benches. Three main groups can be identified: universal measurement systems, universal recovery benches, and caliber recovery benches. If we start in reverse order to explain the operation, we can say that the benchtops for caliber-based bodywork are the most accurate, but also the most expensive (TEODORESCU, 2004). This system was invented by Blackhawk and continued by Celette when Mr. Celette decided to resign as director of Blackhawk Europe and start his own company (STONE, 2006).

Painting booth and painting equipment:

The painting booths are differentiated by size, airflow, reputation, approvals, and constructive solution - metal base or excavated foundation. Unfortunately, many think they can produce a paint booth and many are fooled. A painting booth is a room with insulated walls, an entrance door, some light bulbs, and a hot air generator. In reality, however, the airflow, the peripheral speed of the air around the car, the economy of fuel and electricity, the time to change the filters are all important elements in evaluating a paint booth offer. A well-balanced cabin must have an efficient and constant air circuit, with a minimum of turbulence, so that the supplied flow is higher than the exhausted one. The pressure inside the cab remains positive to avoid dust particles and balanced to limit turbulence. The drying temperature must be reached in a very short time, i.e. in 3-10 minutes. The lighting angle is also important, providing almost natural light with high brightness for the best possible color matching and enlarging the surfaces of the filter elements.

Infrared lamps provide partial drying and are extremely useful in every painting workshop. For the preparation of the surfaces for painting, it is recommended to use the preparation stations in which the airflow is directed and filtered, so that the dust does not spread in the workshop and is deposited on the freshly painted machine.

The preparation zones can be separated by curtains, or just by air circulation. Generally, two cooking stations are recommended for a painting booth. The use of multi-energy and suction arms is recommended for cooking areas (CABINĂ DE VOPSIT, 2021).

Cleaning and car wash equipment:

The image of the car service is given mainly by the cleanliness of the interior and the chosen equipment (ANGHEL, 2002). It should not be neglected that in Western Europe any car that leaves service after a more expensive work of mechanics or after any work of tinsmithing is washed outside and in some cases inside. Appliances can be washed with pressurized cold water, hot water, vacuum cleaners, sweepers, and floor cleaners. There are also brush washing stations for large services (AMPLASAREA ATELIERULUI DE SERVICE AUTO, 2021).

MATERIAL AND METHODS

The analyzed period was one month during the pandemic, respectively May 2021.

For the works performed in the car service to be of good quality, it must be equipped with fixed and circulating means (TONEA,2021).

Fixed assets are those goods that participate in several production cycles and gradually transmit their value on products by way of depreciation from a technical point of view (EVA PETRESCU, 2008).

Fixed assets can be equipment and technological installations. According to the economic destination and the physical structure, it is classified in special constructions,

machines, equipment and work installations, means of transport, etc. (AMPLASAREA ATELIERULUI DE SERVICE AUTO, 2021).

Circulating means are goods that are consumed during a single production cycle (raw materials, materials, energy) or in short periods (eg. spare parts, maintenance materials) and transfer their entire value to the product.

The circulating means that are part of the equipment of the car service workshop are the following: spare parts, tools, vaseline, oils.

-Consumable materials for the activities carried out in the car service: consumable materials for the painting section (primers, thinners, paints, sanding materials, putties, polishing materials) (GRIGORESCU, 2007).

-Consumables for the tinsmith section (welding materials) -materials for car maintenance and cosmetics.

The correlation coefficient is the one that measures the degree of independence between two quantities. The graph of two quantities between which there is a connection is represented in figure 1, the graph of two independent quantities is shown in figure 2, and that of two correlated quantities is in figure 3.

The correlation follows the connection between a statistical characteristic *x* considered an independent variable and *y* being the dependent variable. This connection between the two variables is called the regression function and we note it y=f(x) (ROTARIU, 2017).

It is called the normal random variable of the variable X$\binom{x_i}{p_i}$ a new random variable Y that has the values:

$$\frac{x-\bar{x}}{\sigma_x}, \text{ so Z } \binom{\frac{x_i-\bar{x}}{\sigma_x}}{p_x}$$

If we have:

$$X\binom{x_i}{p_i}, Y\binom{y_i}{q_i}; i=\overline{1,n}$$

Then the normed variables $\bar{X}$ și $\overline{Y}$ will be:

$$\bar{X}\binom{\frac{x_i-\bar{x}}{\sigma_x}}{p_x}, \overline{Y}\binom{\frac{y_i-\bar{y}}{\sigma_x}}{q_x}, i = \overline{1,n}$$

Definition: $\bar{X}$ and $\overline{Y}$ they can also be written like this:

$$\bar{X}=\frac{x-\bar{x}}{\sigma_x}, \overline{Y}=\frac{Y-\bar{y}}{\sigma_y}$$

și

$$\overline{XY}=\frac{1}{\sigma_x\sigma_y}[(X-\bar{x})(Y-\bar{y})]$$

Thus:

$$r=M(\overline{XY})=\frac{1}{\sigma_x\sigma_y}M[(X-\bar{x})(Y-\bar{y})]$$

where

$\sigma_x=\sqrt{D(X)}, \sigma_y=\sqrt{D(Y)},$ (ROTARIU, 2017)

Let X be a population to be surveyed. Selection is the formation of a sub-community in a population according to a certain criterion or with elements taken at random and results in a sample denoted X (ROTARIU, 2017)

X has the shape $X\begin{pmatrix} x_i \\ p_i \end{pmatrix}$

It is called a random selection variable, a random variable with a uniform distribution

$$X^* \begin{pmatrix} x_1 x_2 \ldots x_n \\ \frac{1}{n}\frac{1}{n}\ldots\frac{1}{n} \end{pmatrix}$$

It results from X, where:

$p_i = \frac{1}{n}$

If:

$$X^* \begin{pmatrix} x_1 \\ \frac{1}{n} \end{pmatrix},\ Y^* \begin{pmatrix} y_1 \\ \frac{1}{n} \end{pmatrix}$$

Two random selection variables coupled M($X^*\ Y^*$) = $\sum_{i=1}^{n} x_1\, y_1 p_i$

Then the correlation coefficient will be:

$r = \frac{M[(X^*-\bar{x})(Y^*-\bar{y})]}{\sigma_x \sigma_y} = \frac{\sum_{i=1}^{n}(x_1-\bar{x})(y_1-\bar{y})\frac{1}{n}}{\sqrt{\sum_{i=1}^{n}(x_1-\bar{x})^2\frac{1}{n}} * \sqrt{\sum_{i=1}^{n}(y_1-\bar{y})^2\frac{1}{n}}}$, $r = \frac{\sum_{i=1}^{n}(x_1-\bar{x})(y_1-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_1-\bar{x})^2 * \sum_{i=1}^{n}(y_1-\bar{y})^2}}$

Where $\bar{x}, \bar{y}$ have the form:

$\bar{x} = \frac{\sum_{i=1}^{n} x_1}{n}$, $\bar{y} = \frac{\sum_{i=1}^{n} y_1}{n}$ (ROTARIU, 2017)

RESULTS AND DISCUSSIONS

To study the correlation between a resultant characteristic y= $(y_1 y_2 \ldots . y_n)$ and a single factorial characteristic x_i from the crowd x = $(x_1 x_2 \ldots . x_p)$ the partial correlation coefficient was defined, which studies the correlation between y and x_i when all other features x_k, k≠i, k=1,....,p, are considered.

As an example between the series y and x_1 when x_2 is constantly having the coefficient:

$$r_{yx_{1,x_2}} = \frac{r_{xy_1} - r_{xy_2} \cdot r_{x_1 x_2}}{\sqrt{(1-r_{yx_2}^2)(1-r_{x_1 x_2}^2)}}$$

Where: x- productivity growth rate
y- electricity consumption
z- sales volume

Table 1

Evidence of cost for a repair (RON)

No/Criteria	Auto parts	Price (RON)	Additional parts	Parts price (RON)	Labor (RON)	Total (RON)
1.	CONTACT STOP LAMP MARELLI	50	-	-	50	100
2.	CYLINDER HEAD	220	ANTIFREEZE	60	200	480

	GASKET ELWIS ROYAL					
3.	PLANETARY BELLOW METALCAUCHO	20	PLANETARY JOINT	115	80	215
4.	GLOW SPARK PLUG BERU	60	SEALING RING	20	50	130
5.	BUFFALO BULL	600	-	-	150	750
6.	RUBBER CARPET	150	TEXTILE CARPETS	75	20	
7.	TENSIONER ARM MEYLE	200	SCREW ARM OSCILANT	20	100	320
8.	UNIX EXHAUST	180	LAMBDA PROBE	340	200	720
9.	SPARK PLUGS - BOSCH	20	-	-	40	60
10.	INCANDESCENT SPARK PLUGS - BOSCH	15	-	-	40	55
11.	SPARK PLUGS	15	-	-	40	55
12.	OIL COOLING SEAL	35	-	-	50	85
13.	BRAKE SHOE FIXING SET ATE	60	BRAKE FLUID	18	50	128
14.	OIL DIPSTICK GUIDE METALCAUGHO	10	OIL DIPSTICK	20	40	70
15.	DISTRIBUTION KIT	850	WATER PUMP HOSE	28	300	1178
16.	BRAKE PAD LPR	140	BRAKE DISCS	300	150	590
17.	POWER STEERING OIL STANDARD G00200 GREEN FEBI	40	-	-	30	70
18.	CAR WING VAN WEZEL	200	MUD SHIELDS	80	100	380
19.	CYLINDER HEAD GASKET-ELRING	125	ANTIFREEZE	60	150	335
20.	INTAKE GALLERY GASKET	30	-	-	50	80
21.	AC RELAY TRUCKTEC	20	-	-	20	40
22.	DISTRIBUTION BELT TENSIONER TRUCKTEC	250	CRANKSHAFT PINION	200	150	600
23.	SEGMENTS	82	PISTON	200	200	482
24.	COGWHEEL TRUCKTEC	170	-	-	80	250
25.	BAR GRID ISAM	120	LOGO	100	80	300
26.	ȘURUB ROATĂ-SSP	5	-	-	5	10
27.	FISĂ BUJII-BOSCH	12	SPARK PLUG PIPA	15	20	47
28.	LAMPĂ POZIȚIE	60	PLUG CONNECTION	30	40	130
29.	OIL BULB EPS FACET	25	OIL BATH	120	100	245
30.	THERMOSTAT MEYLE	35	THERMOSTAT HOUSING	150	50	235
31.	WATER DISTRIBUTOR MEYLE	25	-	-	30	55

32.	PLANETARY MEYLE	250	PLANETARY AX NUT	20	150	420
33.	OIL RAVENOL	350	OIL FILTER	30	30	410
34.	ACCESSORIES BELT	150	ROLLS	200	100	450
35.	FRONT SHOCK ABSORBER	150	FLANGE	120	150	420
36.	CLUTCH CHIT	700	fly-wheel	1500	450	2650
37.	INJECTOR	2000	INJECTOR RINGS	60	500	2560
38.	GAS FILTER	30	DIESEL FILTER SEAL	5	20	55
39.	MOTOR PUMP	450	-	-	50	50
40.	FRONT ARM	200	FRONT ARM NUT	25	80	305

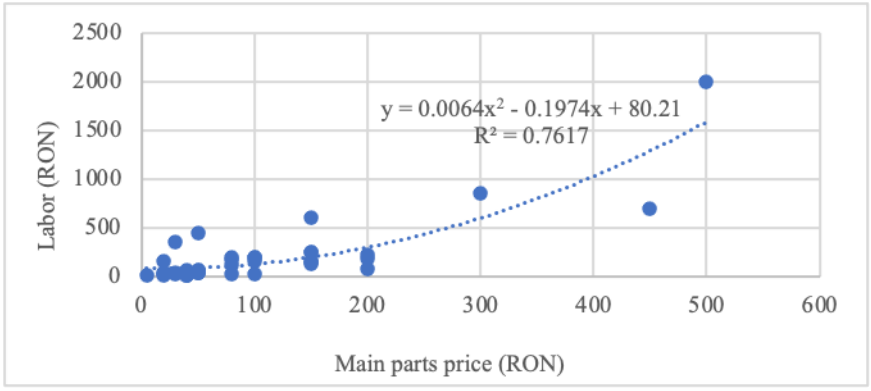

Fig. 1. The variation of labor as a function of the price of the main parts

The mathematical relationship between the price of labor (m) and the price of main parts (p) can be described using a second-degree polynomial function:
$m(p) = 0{,}0064p^2 - 0{,}1974p + 80{,}21$ with a high correlation, R^2=0,76. These details can be observed following the graph of the regression function but also the graphs of the two series made on the same system of coordinate axes.

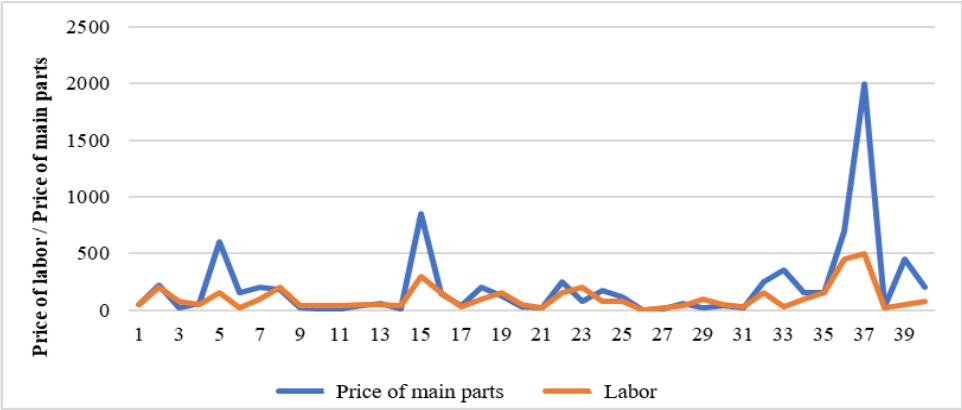

Fig. 2. Graphic representation of the price of labor and the price of the related main parts

The study is continued by analyzing the dependence of labor price, this time as a function of the total price of parts (primary and secondary) it was observed that the second-degree polynomial model approximates the phenomenon better, R^2=0,85. The graph of the regression function and the graphs indicating the respective labor price and the total price of the parts are presented next (Figure 3 and 4).

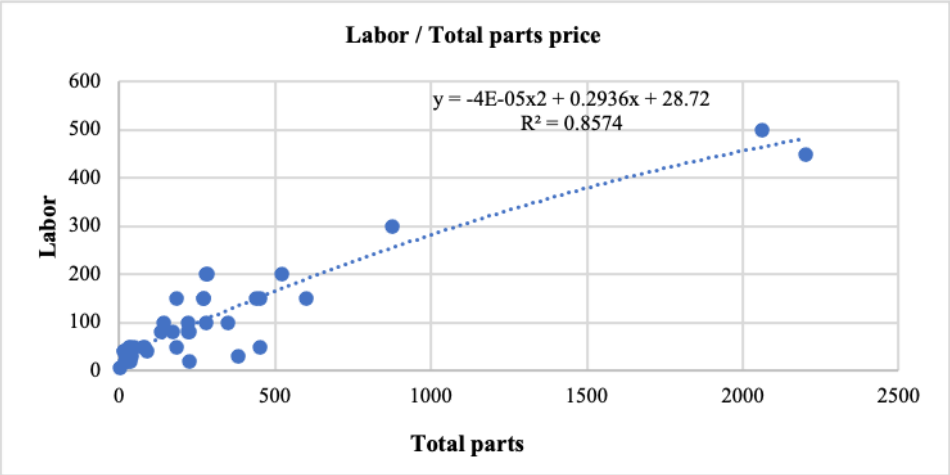

Fig. 3. Variation of labor as a function of the total price of parts (main and additional)

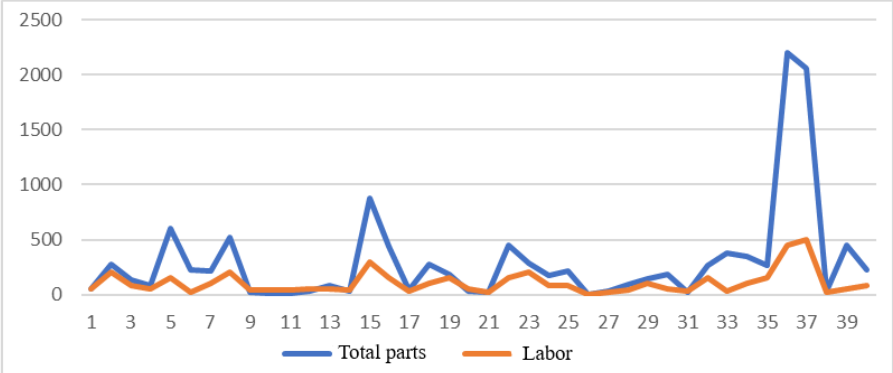

Fig. 4. Graphical representation of the labor price and the total price of the parts (main and additional)

Previous observations that indicated the existence of a mathematical link between the price of labor and the parts used were the premise for performing a multiple linear regression analysis, this time between the price of labor as a dependent variable (m) and the price of main parts (p) and those additional (s) as independent variables. The determined mathematical connection is expressed by the equation below:

The ANOVA test indicates statistically significant values (F=103,1 with p<0,01), the correlation is high and direct (R=0,92), and the values of the coefficients of the linear regression function have statistically significant values (t=5,00 with p<0,01 for the value of the

function intercept, t=11,00 with p<0,01 for the coefficient of the main parts and t=6,61 with p<0,01 for the coefficient of additional parts).

Table 2

Multiple regression analysis regarding the value of labor as a function (multifactorial) of the price of the main parts and the price of the secondary parts
a) Correlation coefficient b) ANOVA, c) Regression function coefficients

a) Correlation coefficient	
R	0.920829525
R^2	0.847927014
R^2 (adjusted)	0.839706853
Standard error	43.14813126
Number of observations	40

b) ANOVA

ANOVA	**Degrees of freedom**	**The sum of the squares**	**Average amount**	**F**	**p**
Regression	2	384089.2094	192044.6	103.1521	$7.3*10^{-16}$
Residual values	37	68885.16556	1861.761		
Total	39	452974.375			

c) Regression function coefficients

	Coefficients	**Standard error**	**t**	**p**
Intercept	40.81047862	8.15168376	5.006386	1.38E-05
Main parts price	0.223017528	0.020269274	11.00274	3.18E-13
Price of additional parts	0.193108364	0.029174407	6.619102	9.17E-08

The results of the regression analysis allowed a simulation of the labor price depending on the price of the main parts and the additional ones. In this sense, values of the main parts between 10 and 300 RON were used as inputs, respectively of the additional parts as half of the value of the main parts. The third column of the table indicates the estimated value of the labor obtained as an image of the linear regression multifactorial function determined above.

Table 3

Labor price simulation as a function of the price of the main parts and the additional ones obtained based on the regression function

No/Criteria	Main parts price (RON)	Additional parts price (RON)	Proposed labor (RON)
1.	10	5	44.01
2.	20	10	47.20
3.	30	15	50.40
4.	40	20	53.59
5.	50	25	56.79
6.	60	30	59.98
7.	70	35	63.18
8.	80	40	66.38
9.	90	45	69.57
10.	100	50	72.77
11.	110	55	75.96
12.	120	60	79.16
13.	130	65	82.35
14.	140	70	85.55

15.	150	75	88.75
16.	160	80	91.94
17.	170	85	95.14
18.	180	90	98.33
19.	190	95	101.53
20.	200	100	104.72
21.	210	105	107.92
22.	220	110	111.12
23.	230	115	114.31
24.	240	120	117.51
25.	250	125	120.70
26.	260	130	123.90
27.	270	135	127.09
28.	280	140	130.29
29.	290	145	133.49
30.	300	150	136.68

CONCLUSIONS

From the statistical interpretation of the experimental data which represents a sample of the total parts contained in the ”Vest Transcom” workshop, we can conclude that the ratio between the costs of parts and the repair price induced by the exchange of a certain one is the best possible because the correlation coefficient has a positive value less than 1.

The auxiliary parts related to the repair for the case study as well as the labor lead to an honorable and acceptable offer by the client.

The mechanical workshop from an economic point of view operates profitably taking into account the geographical positioning and the area it serves.

Being located in a rural environment from a socio-economic point of view, we find again a correlation between the not very new fleet of cars and the frequency with which they serve their maintenance.

Given the pandemic context, the mechanical workshop "Vest Transcom" worked very well, given that the car fleet from the rural area mostly includes old cars, which always need maintenance and upkeep, even if people have travelled less, there were still many cars to be repaired, so it is very necessary to have car workshops in the rural areas.

BIBLIOGRAPHY

ANGHEL,LAURENȚIU DAN, E.C., PETRESCU, 2002 - Business to business, Editura Uranus, București.

FIRU, ADRIAN CIPRIAN, ALIN ION, TAPÎRDEA, ANAMARIA IOANA, FEIER, GEORGE, DRĂGHICI - "Virtual reality in the automotive field in industry 4.0." *Materials Today: Proceedings* 45 (2021): 4177-4182.

GRIGORESCU,ADRIANA, CONSTANTIN, A. BOB, EMILIAN, M. DOBRESCU, 2007 -Marketingul afacerilor publice și private, Editura Uranus, București.

MANOLE,VICTOR, MIRELA, STOIAN, HORIA, DOROBANȚU, 2001 - Marketing, Editura Academiei de Studii Economice, București.

MICULA LIA, ROTARIU, 2017, Curs de analiză matematic aplicată, Editura Eurobit, Timișoara.

PAȘTIU,CARMEN, 2014 - Marketingul serviciilor, Alba Iulia.

PETRESCU EVA, CRISTINA, 2008 - Marketing concept de bază și aplicații, Editura Uranus, București.

PRIHOANCĂ,DIANA, HERMINA, DOROBANȚU, 2001 -Marketing, Editura Academiei de Studii Economice, București.

ȘTEFANESCU, PAUL, 1995 - Bazele marketingului, București.

STONE,MERLIN, ALISON, BOND, ELISABETH, BLAKE, 2006 - Ghidul complet al marketingului direct și interactive, Editura Bic All, București.

TEODORESCU,NICOLAE, IACOB, CĂTOIU, 2004 - Comportamentul consumatorului, Editura Uranus, Bucureşti.

TONEA, ELENA, CORINA, SIRBU, CLAUDIA, SIRBULESCU, MONICA, OCNEAN, LIA, ROTARIU, ADRIAN, FIRU, NEGOESCU, 2021 - "How was the corona pandemic perceived by the Romanian business environment?." *Agricultural Management/Lucrari Stiintifice Seria I, Management Agricol* 23, no. 2 (2021).

***AMPLASAREA ATELIERULUI DE SERVICE AUTO, https://www.scritub.com/tehnica-mecanica/auto/Amplasarea-atelierului-de-serv9413231323.php, acessed in 28.08.2021

***CABINĂ DE VOPSIT, https://www.ginamarauto.ro/cabina-de-vopsit-turisme-si-dube/, accessed in 23.08.2021

***BLOGDIAGNOZAPRO, https://www.diagnozapro.ro/blog/care-sunt-cele-mai-bune-testere-auto-ce-testere-de-diagnoza-auto-recomanda-mecanicii-auto/, acessed in 13.09.2021

***ELEVATOR AUTO, https://ro.wikipedia.org/wiki/Elevator_auto accesed in 12.09.2021