SEPARATION OF FIXED AND VARIABLE COSTS FROM MIXED COSTS AT A WATER AND SEWERAGE OPERATOR

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Abstract: *Knowing the costs of some activity is essential to a financial manager. Within costs it is important to group them into variable costs and fixed costs. The operation of an enterprise generates costs that with the help of the accounting records fail to group costs into the two large categories and a third category of costs arises, namely mixed costs. Mixed costs contain both fixed and variable costs and can only be separated by statistical methods. With the least-squares method, we can make this separation of mixed costs, respecting the conditions imposed by a statistical analysis. Very many use this method without analyzing the parametricity of the data, and the results obtained are of poor quality. In this article we have reviewed the literature on variable, mixed and fixed costs and the statistical model applied. In the research we applied the least-squares regression analysis to the water and sewage operator in Harghita County for the water activity for 2020 and 2019, comparing the results over the two years.*
The results were also verified with the help of the IBM SPSS analysis program. The conclusion we have reached is that the method of the least-squares is very well applicable for the separation of mixed costs if the data collected at the accounting level are parametric as happens at the regional water operator Harviz S. A., where at the accounting level fixed, mixed and variable production costs are analytically highlighted. The decisions made on the basis of these costs are relevant and enable the undertaking to make the right decisions knowing its break-even point and the fixed costs it can incur.
Decisions are also relieved by the fact that fixed costs are highlighted in the two subcategories, namely: short-term fixed costs and long-term fixed costs. As a final conclusion, the decrease in production caused by the reduction in consumption in 2020 did not substantially change the variable costs separated from the mixed costs, so the method used provides support for correct decisions.

Keywords: *variable cost, mixed cost, least-squares method*

Classification JEL: *L95, Q25, M21, M49*

1. Introduction

For Economic Modeling and planning of production budgets for the following years it is very important to group costs according to the location of costs on cost objects, direct and indirect costs, and after their behavior towards the change in production volume in fixed and variable. If the first grouping does not present a real challenge for practitioners, the situation becomes a little more complicated if we want to group costs into fixed and variable.
In everyday practice from the point of view of cost behavior towards the volume of production we will meet three categories of costs: fixed costs, variable costs and mixed costs. In the case of mixed costs, it is necessary to apply a statistical method as accurate as possible to separate mixed costs into fixed and variable costs (Briciu, 2008). Even if some publications treat mixed costs as semi-variable costs, we consider the name of mixed costs to be much more relevant.

If we add to the determinant variable and fixed costs by accounting methods, those separated by statistical methods from mixed costs, we obtain from all the production costs (direct and indirect) all the variable and fixed costs. After this separation we have the possibility to plan production budgets for the following years, respectively taking measures to optimize existing costs.
We must admit that fixed costs can still be grouped into two subcategories, namely short-term fixed costs and long-term fixed costs, a problem that can be solved by analytical accounting.
In this article we perform separation of fixed and variable costs from mixed costs at the regional water and sewerage operator in Harghita County.

2. Paper Body

Literature review

Direct expenses are those costs that can be traced on a specified cost object (Garrison et. al., 2015), (Mocanu, 2016), (Dumbravă, Pop, 2011), (Burja C., 2011). This definition of direct costs is consistent with the definitions given by researchers in the field of management accounting. The vast majority of researchers consider that it is direct expenses that relate to the production process. In the approach of the ABC cost tracking system are considered direct costs and those that are not dare production expenses can be identified on cost objects (Kaplan, Cooper, 2001).
Indirect expenses are costs that are common to several specified cost objects (Blocher et el., 2010), (Laáb, 2017), (Tabără, Briciu et al., 2011). In the case of indirect expenses, the opinions of researchers are divided, some researchers consider indirect expenses only those costs that relate to the manufacture of products, but cannot be identified on a cost object and only on a cost center (Laáb, 2017), other researchers consider that they are indirect expenses in the broader sense and include in this category also those of sales and administration (Tabără, Briciu et al., 2011), (Atkinson, Kaplan et al., 2012).
Variable costs are generated by the production process and their value is closely related to the volume of production (Chen, Koebel, 2017). These variable costs can be linear, progressive, degressive and degressive (Musinszki, 2014). Variable costs follow to some extent the change in production volume (Fülöp, 2011).
Mixed costs are specific to the production process, but in some cases, it is not possible to separate them at the accounting level into variable and fixed costs. These mixed costs comprise both variable and fixed costs (Atkinson, Kaplan et al., 2012).
Fixed costs are costs that are independent of the change in the volume of production and are "*relatively constant relative to the level of production or activity*" (Bâtcă-Dumitru, Sahlian, 2018).
To ease the day-to-day economic decisions of managers we need the separation of variable and fixed costs from mixed costs. By knowing variable costs, we can calculate intermediate results using partial cost methods and contribution method (margins) (Bâtcă-Dumitru, Sahlian, 2018).
To estimate the mixed and variable components of a mixed cost we can use the following methods (Garrison et. al., 2015): - analysis of the account, - the minimum maximum method, - the method of the least-squares.
In the case of the last two methods as the first step of the analysis it is recommended to make a scattergraph. If the resulting graph indicates a linearity between the volume of activity and the mixed cost, then we can proceed to the minimum-maximum method or the method of least-squares. Since the method of least-squares is more accurate than the minimum - maximum method researchers recommend using it (Garrison et. al., 2015). The method of least-squares has the following steps (Bâtcă-Dumitru et al., 2020):

1.Calculation of the average volume of activity:

$$\bar{Q} = \frac{\sum_{t=1}^{n} Q_t}{n}$$

2. Calculation of average mixed costs:

$$\bar{C} = \frac{\sum_{t=1}^{n} C_t}{n}$$

3. Calculation of the deviation of the volume of activity from the average volume of activity:

$$X_t = Q_t - \bar{Q}$$

4. Calculation of the deviation of the costs of activity from the average costs:

$$Y = C_t - \bar{C}$$

5. Calculation of variable costs per unit of activity:

$$cv = \frac{\sum_{t=1}^{n} (XY)_t}{\sum_{t=1}^{n} X_t^2}$$

6. Calculation of total variable costs:

$$Cv_t = cv \times Q_t$$

7. Calculation of total fixed costs:

$$Cf_t = C_t - Cv_t$$

The method of research used and case study

We made a brief presentation of the specialized literature and based on the data provided by the Regional Water and sewerage operator Harviz SA we separated from the fixed and variable mixed costs for the years 2019, 2020 to compare the two values and analyze the effects of the decrease in the volume of activity on the mixed costs and the variable unit cost established using the least-squares method.
From figure no.1 there is a certain linearity of the mixed costs with monthly water production. This linearity makes it possible to apply the least-squares method for separating fixed and variable costs. It is very important to examine the data using a scattergraph, because if the data does not show certain collinearity then the results returned by the least- squares method is unusable.

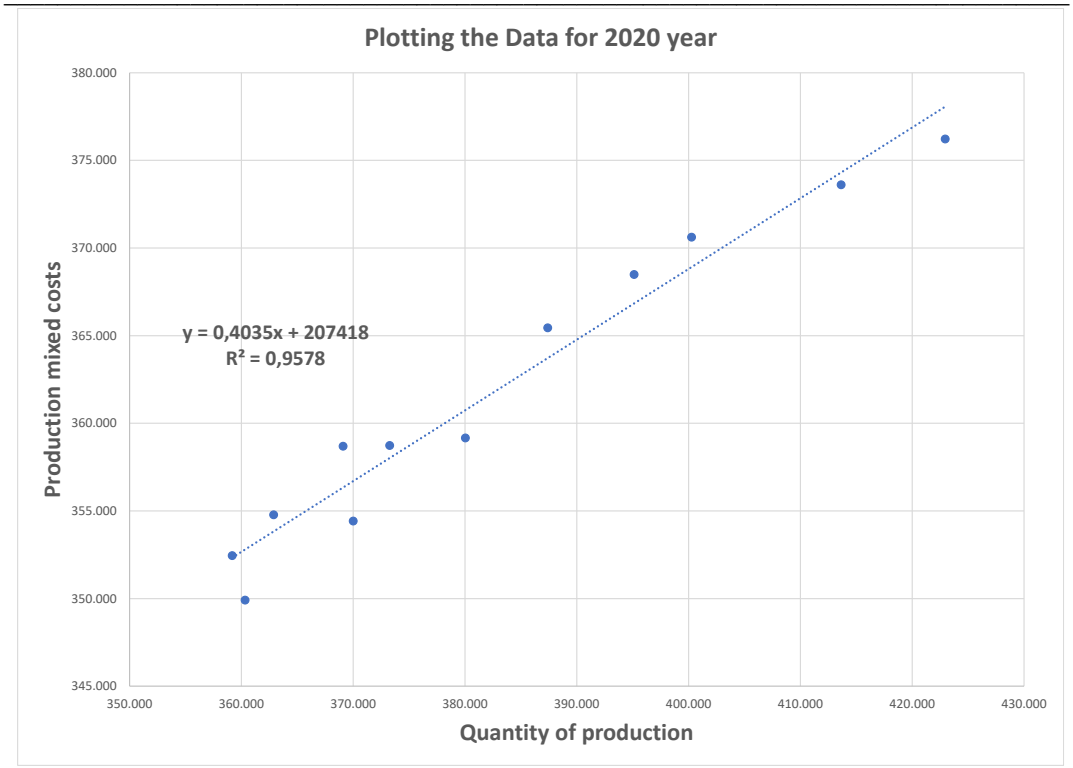

Figura nr.1 Scattergraph Method of Cost Analysis for 2020 year (source: own elaboration)

The estimate made by the least-squares method is based on linear regression:

$$C = a + bQ$$

from which it follows:

$$b = \frac{n(\sum CQ) - (\sum C)(\sum Q)}{n(\sum Q^2) - (\sum Q)^2}$$

$$a = \frac{(\sum C) - b(\sum Q)}{n}$$

where:

Q = The level of activity
C = The total mixed cost
a = The total fixed cost
b = The variable cost per unit of activity
n = Number of observations

Linear regression for the year 2020 has the following form:

$$C = 207.418{,}57 + 0{,}403Q \ (R^2 = 0{,}958)$$

Table no.1. Application of the least-squares method for the mixed costs of water production at Harviz S. A. for the year 2020

Months	Quantity of production m³	Production mixed costs - RON -	X	Y	X * Y	X2	Variable cost - RON -	Fixed costs - RON -
January	369.997	354.420	-12.843	-7.460	95.809.500	164.946.844	149.280	205.139
February	359.163	352.449	-23.677	-9.431	223.292.293	560.615.640	144.909	207.540
March	387.394	365.450	4.553	3.570	16.257.207	20.733.057	156.299	209.151
April	362.877	354.783	-19.963	-7.097	141.672.157	398.524.297	146.408	208.375
May	360.318	349.916	-22.523	-11.963	269.446.498	507.285.229	145.375	204.542
June	380.022	359.167	-2.818	-2.713	7.645.367	7.943.848	153.325	205.842
July	395.128	368.488	12.288	6.609	81.209.094	150.991.421	159.420	209.069
August	400.263	370.624	17.423	8.745	152.361.425	303.554.889	161.491	209.133
September	422.944	376.226	40.104	14.346	575.344.000	1.608.320.924	170.642	205.584
October	413.641	373.606	30.801	11.727	361.198.782	948.685.995	166.889	206.718
November	373.250	358.729	-9.590	-3.150	30.210.731	91.975.452	150.593	208.137
December	369.087	358.695	-13.753	-3.184	43.794.707	189.151.702	148.913	209.782
	382.841	**361.880**	**0**	**0**	**1.998.241.761**	**4.952.729.300**	**1.853.543**	**2.489.011**

(Source: own elaboration based on data provided by Harviz S. A.)

1.Calculation of the average volume of activity:

$$\bar{Q} = \frac{\sum_{t=1}^{n} Q_t}{n} = \frac{4.594.087}{12} = 382.841\ m^3$$

2. Calculation of average mixed costs:

$$\bar{C} = \frac{\sum_{t=1}^{n} C_t}{n} = \frac{4.342.554}{12} = 361.880\ RON$$

3. The calculation of the deviation of the volume of activity from the average volume of activity was made for each month as follows from the column “X”

4. The calculation of the deviation of the mixed costs of activity from the average of the mixed costs was carried out for each month as shown in column “Y”.

5. Calculation of variable costs per unit of activity:

$$cv = \frac{\sum_{t=1}^{n} (XY)_t}{\sum_{t=1}^{n} X_t^2} = \frac{1.998.241.761}{4.952.729.300} = 0{,}4034\ RON/m^3$$

6. The calculation of total variable costs was made on a monthly basis as shown in the column “Variable cost”.

7. The calculation of total fixed costs was made monthly by subtracting total variable costs from mixed costs.

If we calculate at the year level the fixed unit cost from the mixed costs, it is 0.7971 RON/m^3 of water.

After performing the same calculations for 2019 at a higher total production (4,671,689 m^3 per year compared to 4,594,087 m^3 in 2020) unaffected by the pandemic, resulting a variable cost per unit of activity 0.4074 lei/mc and a fixed cost per unit of activity 0.4293 RON/m^3.

It can be seen that the change in the volume of production does not have a strong effect in establishing the variable cost per unit of activity from mixed costs.

3. Conclusions

The least squares method can be an appropriate method for separating variable and fixed costs from mixed costs. The essential condition is on the accounting side, if the collection of costs is done properly then mixed costs - such as for example maintenance and repair costs in which both components that relate to the volume of production and costs that are independent of them appear-can be separated using this method. Being a method on a statistical basis cannot be neglected the conditions imposed to achieve a linear regression, that is, the existence of a significant correlation between the dependent variable and the independent variable, respectively the data to be processed to be parametric. After proper data collection in accounting the results of the method are good.

In managerial decisions it is very important to know the level of unit variable costs and in this way the partial cost method can be applied and the break-even threshold of the enterprise can be calculated.

In times of economic recession when there is a reduction in production, without an accurate knowledge of variable costs, no relevant managerial decisions can be made.

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