

THE INFLUENCE OF THE BASE PRODUCT IN THE UNIT OF PRODUCTION EFFORT METHOD: ANALYSIS AND DISCUSSION

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ABSTRACT

In this article it is analyzed and discussed if the choice of the base product of the unit of production effort (UPE) method interferes with the computed unit cost of the products. The selection of the base product is an important step in this costing method. In order to carry out this study, real data was used from a food company in the state of Santa Catarina (Brazil). The results obtained show that, irrespective of the base product chosen, there is no change in the final value allocated to each product in terms of conversion unit cost. In this way, the main contribution of the study is to prove, mathematically, the neutrality of this method in terms of the product chosen to be the base product, because it does not effectively change the value assigned each product. The results obtained can be replicated in other types of companies and industries. Additionally, we present and discuss some opportunities for future work aligned with the application and development of the proposed method.

INTRODUCTION

Some costing methods use models based on product equivalence, such as the unit of production effort method, in English (UPE), and Unidade de Esforço de Produção, in Portuguese (UEP) (Bornia, 2009; Allora and Gantzel, 1996; Afonso, Wernke and Zanin, 2018; Afonso, Zanin and Wernke, 2017), which is best known in Brazil and the Unité de Valeur Ajoutée (UVA), more widespread in France and Great Britain (Gervais and Levant, 2007). However, several authors mention that this type of method presents some inconsistencies or uncertainties, such as the need for constant updates and subjectivity in the choice of the base product (Pereira, 2015; Levant and Zimnovitch, 2013; De La Villarmois and Levant, 2011; Malaquias et al., 2007; Meyssonier, 2003). On the other hand, Wernke and Junges (2017a, 2017b) claim that the choice of the base product does not influence the value of the total unit cost of the products.

In this sense, the focus of this study is to analyze and discuss the influence of the choice of the basic product of the UPE method in the assigned unit cost of the products. A study with this focus is justified by the relevance of the this costing method, mainly in the southern region of Brazil, where the model is more widespread (Ferrari and Kings, 2016).

LITERATURE REVIEW

Both, the unit of production effort or Unidade de Esforço de Produção (UEP) method and the Unité de Valeur Ajoutée (UVA) were developed from the concept of GP unit developed in the 1940s by Frenchman Georges Perrin, who gave to the method the name of its initials (de De La Villarmois and Levant, 2011). The central idea of Georges Perrin was to allow, by means of a single unit of measure, measuring production costs and production effort in plants characterized by a high level of product diversity (Allora and Allora, 1995).

In the early 1960s, the Italian engineer Franz Allora came to Brazil and began to disclose in the country the method of Georges Perrin, which later became the UPE method. In 1978, Franz Allora created, in Blumenau (state of Santa Catarina, Brazil), a consultancy company to implement the new method of calculating costs which has been implemented, since that moment, in the industries of the region (Bornia, 2009; Allora and Gantzel, 1996). In France, the GP concept as developed by the consultancy company “Les Ingénieurs Associés”, under the direction of Jean Fiévez and Robert Zaya, and in 1977 the method was renamed to UP – Unit of Production. In 1995, the method, initially only focused on production processes was extended to the entire value chain in order to include the other business costs, when it began to be called “Unité de Valeur Ajoutée” (UVA) (De La Villarmois and Levant, 2011).

The UEP method consists in determining a common unit of measure for calculating the costs of all products manufactured by the company, simplifying the management control process and enabling the identification of costs by product. This is especially interesting for the control and computation of production

costs in industries with a large mix of products because it provides a simplification of the calculations due to the use of a single unit of measure (Bornia, 2009; Santana et al, 2017).

According to Guimarães Filho et al. (2016), Pereira (2015), Wernke (2005) and Souza and Diehl (2009), the implementation of the UEP method occurs in six phases:

- (1) Breaking down of the production process in operating stations;
- (2) Determination of the cost per hour per operating station;
- (3) Choice of the base product;
- (4) Computation of the value of the UEP/hour for each operating station;
- (5) Computation of product conversion costs in terms of UEP;
- (6) Computation of products costs and total costs of the plant considering materials costs.

Phase one aims to define the productive steps that have specific functions in the manufacturing process. Therefore, an operating station can be formed by one or more equipments (which may perform the same operation) or only by employees (manual work), who perform operations of greater or lesser duration according to the product to be manufactured. Furthermore, phase 2 is devoted to determine the cost per hour at each operating station (monthly costs are divided by the number of working hours of such period).

With regard to its theoretical foundations, Allora and Oliveira (2010) argue that the UEP method is based on three principles:

- (1) Principle of stability of operations: even though unit prices vary (manpower, energy etc.), product manufacturing efforts remain constant in time (this principle is also considered in the UVA method where is named the "principle of the relations" - Gervais and Levant, 2007).
- (2) Principle of subdivisions: the accuracy of the results depends on the level of differentiation of each new subdivision of expenses; thus, the more detailed the subdivision is, the higher the quality of the results.
- (3) Value added principle: the profit of the company comes from the effort to transform raw materials into products and therefore, the UEP prioritizes this aspect.

The UEP method allows measuring the production effort in each production step (e.g., operation, activity, process) that the product needs to be completed (Allora and Oliveira, 2010). On the other hand, like UVA (Gervais and Levant, 2007), it is also used as an effective costing system for the computation of product costs. However, the UEP method should be viewed widely as a tool to support decision-making.

In this sense, Bornia (2009), Souza and Diehl (2009), Allora and Oliveira (2010), Wernke, Junges and Claudius (2012), Wernke, Junges and Lembeck (2015) and

Wernke and Junges (2017a, 2017b) argue that, in addition to allowing the calculation of the conversion costs of the products, the UEP method can also be used to evaluate manufacturing efficiency and profitability, contribute to define the sales prices of the products, measure the production of the period, identify the production capacity, allow to compare processes, examine the need for new investments, etc.

However, there are some limitations that are assigned to the UEP method. Concerning this, Bornia (2009) reports that the UEP focuses only on the production costs of products and, therefore, structure costs may be neglected. The disregarding of these expenses can be considered a problem, since they have been increasing over the years and deserve to be analyzed in detail for their rationalization. In turn, Martins and Rocha (2010) also manifest themselves in this direction.

In addition, the accounting literature assigns several inconsistencies to these methods, for example, problems related to errors of measurement, specification and aggregation (Datar and Gupta, 1994) and underutilization of productive capacity (Kaplan and Anderson, 2004). Gervais and Levant (2007) highlight that data updates (processing times, volumes produced, etc.) when significant changes occur are essential to reduce possible errors when these costing methods are used.

However, there remain controversies regarding the subjectivity or not of the method by choice of the base product, which is addressed in the next section

Furthermore, one of the important steps in the implementation of the UEP method is the choice of the base product, which is the basis to define the standard unit of measure to be used (Bornia, 2009; Souza and Diehl, 2009; Allora and Oliveira, 1995, 2010).

For the choice of the base product, it has been recommended one that goes through many operating stations as possible, representing well all the production process (Wernke, 2005; Malaquias et al., 2007; Bornia, 2009; Souza and Diehl, 2009; Allora and Oliveira, 2010). However, because there are no criteria specifically defined for the choice of the base product, Malaquias et al. (2007) and Pereira (2015) attribute a certain level of subjectivity to this stage of implementation of the UEP method. They claim that the choice of the base product may be partially biased by the view of the consultant or manager who is implementing the method.

Also, Levant and Zimnovitch (2013), De La Villarmois and Levant (2011), Gervais (2009), Gervais and Levant (2007) and Meyssonier (2003) attribute uncertainty to the determination of the base product in the implementation of costing methods based on product equivalence.

However, Wernke and Junges (2017a, 2017b) argue that the choice of the base product does not interfere with the computation of product unit costs, even if any reason or explanation is presented to support such statement.

CASE STUDY AND RESULTS

This research was carried out in a production line of a food processing company located in the southern of Brazil. The company provided to the researchers access to the necessary cost and production information.

The data collection occurred between September to October of 2017. The information related to August was considered for the computation and analysis of the costs presented here. For data collection it was employed the technique of informal conversations with the managers of the company and with the accountant.

In order to analyse the impact or neutrality of the choice of the base product, the following steps were taken to implement the UEP method: breakdown of the production process into operating stations, computation of the cost per hour in the operating stations, estimation of production times of products in each operating station, determination of the base product and computation of the cost basis, estimation of the production potential, computation of production equivalents in UEP; computation of production in the period measured in UEP, computation of conversion costs and unit costs of of the products (Bornia, 2009; Allora and Gantzel, 1996, Allora and Allora, 1995). However, by limitation of space, only the last four steps are presented and commented here.

Computation of production equivalents in UEP

All products produced in August in the selected production line have been analysed but for the discussion on the base product only two products are presented and discussed, named here Product "P1" and Product "P2". Table 1 presents the production in UEP using P1 and P2 as the base product.

Table 1: UEP production in the two product-base options
Base Product: P1

Products	Quant.	UEP	Production
P1	20.350	1,0000000	20.350,00
P2	23.460	0,3626917	8.508,75
Other	352.563	-	185.619,96
Totals	396.373	-	214.478,70

Base Product: P2

Products	Quant.	UEP	Production
P1	20.350	2,7571629	56.108,26
P2	23.460	1,0000000	23.460,00
Other	352.563	-	511.784,45

Totals	396.373	-	591.352,72
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Total volume of UEP manufactured in the period is used in the next phase to define the monetary value of each UEP.

Computation of the unit value of UEP

To determine the unit value of the UEP it was necessary to divide the (1) Total conversion costs of the month (in R\$) by the (2) total of UEP produced in the same period. This calculation procedure was carried out for the two alternative base products. Results are presented in Table 2.

Table 2: Computation of the unit value of UEP considering the two alternative base products

	Base Product P1	Base Product P2
1. Total conversion costs of the month (R\$)	170.809,16	170.809,16
2. Total production in UEP	214.478,70	591.352,72
3. (1/2) Unit value of UEP (R\$)	0,796392	0,288845

The results obtained show that the unit value of one UEP changes according to the base product selected (R\$ 0.796392 versus R\$ 0.288845).

Unit conversion cost of the products

The data presented in the previous two tables allow the calculation of the unit conversion cost of the products, as shown in Table 3.

Table 3: Unit conversion cost of the products considering the two alternative base products
Base Product: P1

Products	1) UEP Equivalent	2) Unit Value of UEP	3) (1x2) Unitary Product Conversion Cost (R\$)
P1	1,0000000	0,796392	0,796392172
P2	0,3626917	0,796392	0,288844805

Base Product: P2

Products	1) UEP Equivalent	2) Unit Value of UEP	3) (1x2) Unitary Product Conversion Cost (R\$)
P1	2,7571629	0,288845	0,796392172
P2	1,0000000	0,288845	0,288844805

At this point it is important to clarify that the base product converts the manufactured mix composed of different products in one abstract measure of the units produced. That is, as if all the products of a beverage factory were measured in a single unit (e.g., "litres"), even if they are manufactured in packages of 100 liters (hectolitre), 10 litres (deka), ½ litre (half litre) or 0.1 litres (10 decilitres), by example.

After this conversion, at the end of each month it would be sufficient to multiply the unit value of UEP by the quantities measured in this standardized unit to ascertain the equivalent cost of each manufactured product, irrespective of its physical characteristics.

Then, when used "P1" (Top of Table 3), it was found that the unit cost of processing this item was R \$0.796392172, while the cost of "P2" was R\$ 0.288844805. To reach these values the respective equivalents in UEP of the two products were multiplied by the unit value of UEP (R\$ 0.796392).

However, when the "P2" figured as a the base product the value of UEP in the month studied was R\$ 0.288845. With this, the equivalent in UEP became "1.0000000" for "P2" and "2.7571629" for "P1", but the unit cost of the two products remained equal to the value computed when the chosen base product was "P1".

ANALYSIS AND DISCUSSION

Once the information is collected, the operationalization and maintenance of the UEP method are relatively simple, asking mainly for the monthly updating of spreadsheets or specific software.

Nevertheless, as it was previously mentioned, one of the concerns with equivalence costing methods is the choice of the base product. In this paper, we present the results of using two different base products.

By the results shown in the preceding section (Table 3) it was found that, regardless of the base product considered, the unitary conversion cost of the products did not change: R\$ 0.796392172 for P1 and R\$ 0.288844805 for P2. Therefore, the choice of the base product does not effectively influence the cost to be allocated to the products.

That is, it has been proven mathematically that the choice of "P1" or "P2" as the base product in the UEP method does not change the the final unit cost of the products manufactured during the period. This research diverges from previous studies (Meyssonier, 2003; Malaquias et al., 2007; Pereira, 2015) that indicated that there is subjectivity in the UEP method (and probably in the others equivalence based methods) claiming that there is not a specific criterion for the definition of the basic product.

Even if this subjectivity is an inconsistency commonly attributed to this method, no publications were found that would justify, numerically, that unfavorable opinion. That is, there are mentions in the literature about this hypothetical negative aspect, but there are no published work that proves (or refutes) specifically whether the

choice of the base product would have any impact on the the product unit costs.

Therefore, in proving that the option by one product or another to act as a base product is irrelevant to the calculation of the unit cost of the products in the UEP method, it is concluded that the subjectivity indicated should be disregarded in the analysis of this costing system method.

CONCLUSIONS AND OPPORTUNITIES FOR FURTHER RESEARCH

Practitioners consider that the subjectivity regarding the choice of the base product may be qualified as a disadvantage of the UEP method or a restriction on its implementation, because managers may consider that this method would not be able to provide reliable results. In this context, this study aimed to analyze whether the choice of the base product of the UEP method would influence the computation of the conversion unit cost of the different products. The results presented in Table 3 proved that, irrespectively to the base product chosen, there is no change in the cost allocated to each product. Therefore, the main contribution of this research is to prove, mathematically, that it should be not considered as a negative aspect the absence of specific criteria to define which item should be chosen as the base product.

With regard to the limitations associated with this study, it is important to mention that some conclusions should be limited to the scope of the studied company, avoiding generalizations about it. However, on the other hand, the authors consider that the procedures reported in the previous sections allow an experiment that can be easily replicated in other manufacturing companies. Thus, other studies can be carried out in order to provide more robustness to the findings of this study.

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