

**PARTICULARITIES CONCERNING THE CALCULATION
AND ANALYSIS OF DEVIATIONS FROM STANDARD COSTS
WITH DIRECT MATERIALS, IN THE ROMANIAN CHARCOAL
MINING INDUSTRY**

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Abstract: During the production process one should operatively survey pre-established (standard) costs with a view of determining and analyzing deviations as costs are settled at the level of an activity considered to be normal while real activity can display deviations from this. The system of analysis and control of standard costs differs depending on the direct or indirect character of the expenditures. Nevertheless, irrespective of the character of the expenditures, the analysis and control of standard costs have as a goal the determining (calculation) of deviations, namely of the minus or plus differences between real costs and standard costs. The final objective is the finding out of the causes that have determined deviations, the adopting of corrective measures, and the determining of responsibilities. As regards raw materials and direct materials, deviations represent plus or minus differences as a result of: exceeding or disregarding specific consumptions, price changes, and the use of materials having other sizes or quality as compared with the ones envisaged by the budget, etc. (JEL: C13, D24, L23)

Key-words: standard cost, real (effective) cost, quantity deviation, price deviation, composition deviation, deviations report, deviations analysis.

Introduction

The basic function of standard costs consists in being a measuring and comparing standard of effective and standard expenditures; they consequently exert a systematic control upon such expenditures. Accordingly, the implementation of the standard cost method in industrial units implies [1]:

- The comparison of effective costs with standard costs and the measuring of the deviations as compared with standard costs;
- The analysis of the deviations from the point of view of their character, size, and causes;
- The determining of measures capable of stopping unfavorable deviations and ranging effective costs within settled standards.

Deviations represent savings or over-passing the standard costs afferent to manufactured production. They should be seen either as an expenditures increasing or as an expenditures decreasing and not as rectifications of standard costs [2].

As regards the consumption of raw materials/direct materials one should distinguish between the product whose manufacturing requires only one material

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and the more complex product that requires the combination of several raw materials/materials [3].

Standard costs deviations in case of raw materials/materials when the finite product requires a single material

The deviation between the effective consumption of material and the standard one settled according to the budget has two possible causes: a deviation of the consumed quantity of material and a deviation of the effective buying price of the material [1]. Quantity deviation emphasizes the efficiency of production and the performance of the production manager. The second deviation measures the impact of the price variations of raw materials/ materials that are imposed to the unit (in the case of the raw materials/materials that are quoted on worldwide market); it can also express the significant or the poorer performance of the supply department [3].

Let's suppose the following abbreviations:

P_s – represents the standard supplying price per unit of raw material/ material;

P_e – represents the effective supplying price per unit of raw material/ material;

c_s – represents the standard consumption of raw material/ material per product unit;

c_e – represents the effective consumption of raw material/ material per product unit;

Q – represents the quantity of manufactured products.

The global deviation (AM) from the standard costs of raw materials/ materials is calculated as follows:

$$AM = (c_e \times Q \times P_e) - (c_s \times Q \times P_s) = (Q_e \times P_e) - (Q_s \times P_s) \quad (1)$$

Where:

Q_e – represents the effective quantity of raw materials/ materials units afferent to the amount of manufactured production ($Q_e = c_e \times Q$); (2)

Q_s – represents the standard quantity of raw materials/ materials units afferent to the amount of manufactured production ($Q_s = c_s \times Q$). (3)

Global deviation should be divided into a price deviation and a quantity deviation. The method which, in most cases, determines a clear distribution of responsibilities, settles a distinction between:

- A quantity deviation, evaluated at standard price and calculated according to the following formula:

$$AC = (c_e - c_s) \times Q \times P_s = (Q_e - Q_s) \times P_s \quad (4)$$

One notices the elimination of all price effects in measuring the efficiency of the consumption of raw materials/ materials that is the responsibility of the production manager.

- A price deviation evaluated at the level of the effectively manufactured production and calculated according to the following formula:

$$AP = (P_e - P_s) \times c_e \times Q = (P_e - P_s) \times Q_e \quad (5)$$

One notices the mixed influence (price-quantity) in measuring price deviation.

Global deviation (AM) can be consequently written as follows:

$$AM = (Q_p \times P_p) - (Q_s \times P_s) = (Q_p - Q_s) \times P_s + (P_p - P_s) \times Q_p = AC + AP \quad (6)$$

As one can notice, when adding the deviation from standard consumption to the deviation determined by price differences we get the global deviation from raw materials/ materials' standard cost [1].

Deviations from standard costs in case of raw materials/ materials when the finite product requires several raw materials/ materials

In most cases, a finite product requires a combination of various raw materials/ materials in order to be manufactured. With a view of analyzing and understanding the source of the global deviations from raw materials/ materials' standard costs one should consider the following components [3]:

- A price deviation and a quantity deviation – as in the case of the product that requires a single raw material/ material;
- A composition deviation that is determined by having in view the share of each raw material/ material within the total amount of raw materials/ materials consumed in order to get the finite product.

Generally, the analysis of raw materials/ materials' standard costs of a finite product made of "n" different raw materials/ materials can be approached as follows:

$$CT_n = (Q_1 \times P_1) + (Q_2 \times P_2) + \dots + (Q_n \times P_n) \quad (7)$$

Where:

CT_n – represents the total cost of "n" materials;

Q_n – represents the consumed quantity of "i" material;

P_i – represents the supply price of "i" material;

$i = 1, n$ type of materials.

$$Q = Q_1 + Q_2 + \dots + Q_n \quad (8)$$

Where:

Q represents the total amount of the material consumed in order to get the finite product.

And:

$$Q_1 = p_1 \times Q$$

$$Q_2 = p_2 \times Q$$

$$\dots$$

order to

$$Q_n = p_n \times Q$$

$Q_i =$ the quantity of "i" material consumed

in get the finite product

Where:

$p_i =$ the share of "i" material within the total amount of material included into the finite product.

Taking into account the above abbreviations, total cost (CT) can be re-written as follows:

$$CT = (p_1 + Q \times P_1) + (p_2 \times Q \times P_2) + \dots + (p_n \times Q \times P_n) \quad (9)$$

It is known that, conventionally, the determining of a deviation is made according to the formula:

$$\text{DEVIATION} = \text{REAL (EFFECTIVE)} - \text{STANDARD (BUDGET)}$$

Consequently, the global deviation from materials' standard cost can be written as follows:

$$\begin{aligned} AG = \text{EFFECTIVE TOTAL COST}(\text{real}) - \text{STANDARD TOTAL COS} = CT_e - CT_s = \\ = [(p_{1e} \times Q_e \times P_{1e}) + (p_{2e} \times Q_e \times P_{2e}) + \dots + (p_{ne} \times Q_e \times P_{1e})] - \\ - [(p_{1s} \times Q_s \times P_{1s}) + (p_{2s} \times Q_s \times P_{2s}) + \dots + (p_{ns} \times Q_s \times P_{1s})] \end{aligned} \quad (10)$$

In order to identify the causes that have determined the total deviation from raw materials/ materials' standard costs of a finite product made of "n" raw materials/ materials, we are going to divide it into three deviations:

- An amount deviation (Q deviation);
- A price deviation (P_i deviation) ;
- A composition deviation (p_i deviation).

Quantity deviations

Quantity deviations are determined by comparing the effective total amount of raw materials/ materials consumed in order to get the manufactured production (Q_e) with the standard total amount of raw materials/ materials settled for the manufactured production (Q_s).

As in the case of the finite production that requires a single raw material/ material, the variation of the total consumed amount (Q_e - Q_s) is going to be multiplied by the standard supply price of raw materials/ materials. In such a case, when dealing with "n" raw materials/ materials, this price is determined by calculating the mean of the standard supply price of each of the "n" raw materials/ materials ponderate with the afferent share of each of them within the standard composition of the finite product [3].

The formula of determining quantity deviations (AC) is the following one:

$$AC = (Q_e - Q_s) \sum_{i=1}^n p_{is} \times P_{is} \quad (10)$$

Where:

$\sum_{i=1}^n p_{is} \times P_{is}$ represents the average standard buying price of the standard composition of the finite product.

Price deviations

Price deviations are determined by comparing the effective supply price with the standard supply price and then, by multiplying the difference that results

with the amount of the raw material consumed in order to manufacture the production afferent to the specific period.

When compared with the previous case when the finite product requires a single raw material/ material, the interpretation is more difficult as one should notice two effects that do not compulsorily follow the same direction [3]:

- A price variation that is expressed as a difference between the supply costs noticed during the specific period and the standard supply prices afferent to each type of raw materials/ materials that have enabled the elaboration of the expenditures budget;
- A specific effect of composition that manifests through the ponder differences of the various raw materials/ materials within the finite product; consequently, it is able to change the average price of the whole amount of raw materials/ materials consumed in order to get the finite product with no change of the individual supply price of each raw material/ material. In case the raw materials/ materials consumed in order to manufacture the finite product display relatively different supply prices [7], the average price of the raw material/ material is going to change as a result of a modification of the composition of the raw materials/ materials the finite product is made of.

The formula of determining the price deviation (AP) is the following one:

$$AP = Q_s \sum_{i=1}^n p_{is} (P_{is} - P_{is}) \quad (12)$$

Composition deviations

Composition deviations occur only in case of the finite products manufactured through the consumption of "n" different raw materials/materials.

This type of deviation is encountered within those production processes where the share of different raw materials/materials in the finite product can vary. It measures the impact upon the cost of the variation of the share of each raw material/material in the finite product manufactured according to the composition standard previously settled [3].

The formula of determining composition deviation (AS) is the following one:

$$AS = \sum_{i=1}^n Q_s (p_{is} - p_{is}) P_s \quad (13)$$

Calculation, analysis, and report of the deviations from materials' standard costs in coal mining units

In order to show the manner of calculating and reporting the deviations from materials' standard costs, let's consider a coal mining unit that displays the following characteristics at the end of the N-1 financial exercise (table 1). Five

materials are employed by the production department no. 1 of the mining unit in order to extract the desired coal amount.

Out of the five materials exhibited, only three materials (metal net, T.H. profile, and explosive) are expressed according to the same measuring units (kg.); accordingly, only these materials are going to be analyzed in order to calculate both quantity deviations and composition deviations. For the other two (mine timber and primers) we are going to determine only the quantity and volume deviations.

The deviations from materials' standard costs can be calculated and reported at relatively short periods of time (e.g.: weekly).

Let's consider that during the period January 1 N – January 7 N, the amount of the coal production within the analyzed production department represents 100 tons.

In order to calculate the deviations we should first determine the value of the materials that have been consumed. To do this we should know both the consumed amounts (effective/standard) and the buying prices (effective/standard). According to the data provided by the balance sheet and to those predicted for the financial exercise N (table no.1) we are able to elaborate the report regarding the value of the materials that have been consumed (effective/standard) (table 2).

In order to calculate global deviation and the three deviations it is made of, we should identify the values of the different variables that intervene in the deviations' formulas previously defined.

- Q_e represents the total effective amount of materials consumed in order to extract the 100 tons coal production: 245 kg of M_2 ; 130 kg of M_3 ; 30 kg of M_4 ; (total: 405 kg);

- Q_s represents the total standard amount of materials settled by the budget, afferent to the 100 tons coal production: 250 kg of M_2 ; 130 kg of M_3 ; 30 kg of M_4 ; (total: 410 kg);

- p_{1e} represents the amount of $M_2/Q_e = \frac{245}{405} = 60.50\%$;
- p_{2e} represents the amount of $M_3/Q_e = \frac{130}{405} = 32.10\%$;
- p_{3e} represents the amount of $M_4/Q_s = \frac{30}{405} = 7.40\%$;
- p_{1s} represents the amount of $M_2/Q_s = \frac{250}{410} = 60.98\%$;
- p_{2s} represents the amount of $M_3/Q_s = \frac{130}{410} = 31.70\%$;

- p_{3s} represents the amount of $M_4/Q_s = \frac{30}{410} = 7.32\%$.

Global deviation (AM) from materials' standard costs represents 1032.72 lei and is an unfavorable deviation. The three deviations previously mentioned have the following values:

- Quantity deviation (AC):

$$AC = (Q_e - Q_s) \sum_{i=1}^n P_{is} P_{is} = (405 - 410) \times [(0.6098 \times 2310) + (0.3170 \times 1265) + (0.0732 \times 4696)] = -10766951 \text{ lei}$$

- Price deviation (AP):

$$AP = Q_e \sum_{i=1}^n p_e - (P_{ie} - P_{is}) = 405 \times [0.6050(2360 - 2310) + 0.3210(1300 - 1265) + 0.0740(4560 - 4696)] = 12725.505 \text{ lei}$$

- Composition deviation (AS):

$$AS = Q_e \sum_{i=1}^n (p_{ie} - p_{is}) \cdot P_{is} = 405 \times [(0.6050 - 0.6098) \times 2310 + (0.3210 - 0.3170) \times 1265 + (0.0740 - 0.0732) \times 4696] = -919.836 \text{ lei}$$

The sum of the three deviations is the same with global deviation.

The deviation from the standard consumption of materials is a favorable deviation (- 10766.95lei) that can be mainly explained owing to a very favorable quantity deviation in case of M_2 material (metal net) that proves the efficiency of the manager whose responsibility is the consumption of materials within the above mentioned production department. Composition deviation is also favorable

(- 919.836 lei), a fact that shows that the share of M_2 material is more important within the effective production than within standard composition. This also occurs when the unitary buying price for M_2 is half of the unitary buying price for M_4 (explosive).

Price deviation is not favorable (+12725.505 lei) to such an extent that it covers the earnings provided by the efficiency of materials consumption.

In case of the other materials (M_1 and M_5) displayed by table 1 distinct calculations are to be made in order to calculate deviations as they are expressed according to different measuring units. If in case of M_5 everything is quite clear (the data exhibited by table no.1 show that there are no deviations), in case of M_1 both total deviation, quantity deviation and the deviation resulting out of price differences are calculated: AG = + 23860 lei; AC = +24240 lei; AP = -380 lei.

After being calculated, the deviations are gathered in a “REPORT regarding the deviations from the materials’ standard cost” (table no.3) that is going to be analyzed by the managers of the production department. Owing to the gathering of the reports elaborated by each production department one can get a “REPORT regarding the deviations from materials’ standard costs” at the level of the whole mining unit (table 4) [1].

It is quite important to carefully interpret the data as there are cases when quantity deviations and price deviations are totally independent. The choice of a material of higher quality implies a buying price which is higher than standard price (settled by the budget). Such a fact is going to determine a favorable quantity deviation (to the extent to which the higher quality of the material is going to determine less production rejects and failures) and a non-favorable price deviation; such deviations do not represent an improvement of the efficiency of the mining unit’s activity.

Summary

Standard costs are ante-calculated costs (pre-settled) according to rigorous scientific standards. Standard cost is both a measuring and comparing standard with effective achieved cost and an instrument of orientation and establishing the normal circumstances according to which production should take place.

The analysis of the deviations noticed between REAL (effective) and STANDARD (budget) can be done according to several levels within a mining unit. For example, the comparative analysis of the effective production cost and of the standard cost afferent to production is the responsibility of the general manager of the mining unit as he/she is the one who is responsible for the financial results obtained.

On the other hand, the data regarding the deviations at an inferior level (e.g.: deviation from the consumption of materials) is the responsibility of the managers belonging to an inferior hierarchic level (department managers). Each manager has to interpret the deviations which he/she is responsible for. No deviation should allow ambiguous interpretations. Accordingly, a methodology of selecting significant deviations is absolutely necessary [4].

The calculation, analysis, and report of the deviations from standard costs should be based upon criteria of economic efficiency as the analysis of a business is justified only in case the benefits expected from such an analysis are higher than expenditures. Out of practice managers learn that there are low deviations that are carefully examined as they can determine serious consequences upon the financial result.

At the same time, there are high deviations which, only in case they overpass a certain level, need to be analyzed as their influence upon the financial result is quite limited.

Appendix

Table 1. Report of standard expenditures for materials predicted for year “N”

Material	SPECIFIC CONSUMPTION			BUYING PRICE			STANDARD EXPENDITURES Euro	
	M.U.	Carried out N-1	According to the budget N	M.U.	Carried out N-1	According to the budget N	Carried out N-1	According to the budget N
1. Mine timber (M1)	Lm 1000m	177	177.0	Lm/cu. m	101.900	121206	17807.70	20607.40
2. Metal net (M2)	Kg 1000kg	2746	2400	Lm/kg	1923	2313	4654.04	4774
3. T.H. profile (M3)	Kg 1000kg	1387	1300	Lm/kg	1674	1285	10613.9	10447.0
4. Explosive (M4)	Kg 1000kg	395	300	Lm/kg	3913	4696	1148.99	1408.80
5. Primer (M5)	Piece 1000p	745	750	Lm/piece	1870	2203	1375.17	1652.25
TOTAL STANDARD EXPENDITURES FOR MATERIALS							10378.79	12616.85

Mining unit A, Production department no.1

Table 2. Report regarding the value of the materials consumed during the period, January 01 N – January 07 N

Material	M.U.	Consumed amounts		Buying unit price		MATERIALS' VALUE –Euro-		
		Effective	Standard	Effective	Standard	Effective cost	Standard cost	
1. Mine timber (M1)	Cu. m	177	177	121000	121206	229900	206040	
2. Metal net (M2)	Kg	2450	2500	2360	2310	578200	577500	
3. T.H. profile (M3)	Kg	1300	1300	1390	1265	149000	164450	
4. Explosive (M4)	kg	300	300	4560	4696	136800	140880	
5. Primer (M5)	piece	750	750	2203	2203	165225	165225	
TOTAL							1379125	1353930

Mining unit A, Production department no.1

Table 3. Report regarding the deviations from standard costs for materials, period January 01 N – January 07 N, production amount: 100 tons

Material	Materials' value (Euro)		DEVIATIONS (Euro)									
	Effective cost	Standard cost	Total (AG) out of which:	Of quantity (AQ)	Of price differences (AP)	Of composition (AS)						
1. Mine timber (M1)	229900	206040	-23860	-24240	-380	-						
2. Metal net (M2)	578200	577500	-	-	-	-						
3. T.H. profile (M3)	149000	164450	-103672	-10766961	-12728305	-919330						
4. Explosive (M4)	136800	140880	-	-	-	-						
5. Primer (M5)	165225	165225	0	0	0	-						
TOTAL							1379125	1353930	-25195.0	-16500.50	-9614.37	-919.37

Production department no.1

Table 4. Report regarding the deviations from standard costs for materials, period January 01 N – January 07 N, production amount: 300 tons

Production department	Materials' value (Euro)		DEVIATIONS (Euro)									
	Effective cost	Standard cost	AQ	AC	AP	AS						
1. Production department 1	1379125	1353930	-25195.0	-16500.50	-9614.37	-919.37						
2. Production department 2	1379125	1244095	-25030.0	+12690.0	-11000.0	-1340.0						
3. Production department 3	950500	950500	0	0	0	0						
TOTAL							3608750	3548525	-60225	-29190.5	-20614.37	-420.13

Mining Unit A

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**SZCZEGÓŁY DOTYCZĄCE OBLICZANIA I ANALIZOWANIA ODCHYLEŃ
OD STANDARDOWYCH KOSZTÓW MATERIAŁÓW BEZPOŚREDNICH
W PRZEMYSŁE WĘGLA DRZEWNEGO W RUMUNII**

Streszczenie: Podczas procesu produkcji należy prowadzić badania ustalonych z góry (standardów) kosztów w celu określenia i analizowania odchylenia kosztów rozliczanych na poziomie działalności, podczas gdy rzeczywiste działania mogą wykazywać od nich odstępstwa. System analiz i kontroli kosztów standardowych różni się w zależności od bezpośredniego lub pośredniego charakteru wydatków. Niemniej jednak, niezależnie od charakteru wydatków, analizy i kontrola kosztów standardowych, mają na celu określenie (obliczenie) odchylenia, czyli ujemnych lub dodatnich różnic między rzeczywistymi kosztami a kosztami standardowymi. Ostatecznym celem jest ustalenie przyczyn, które powodują odchylenia, podjęcie działań naprawczych i określenie obowiązków w tym zakresie. W odniesieniu do surowców i materiałów bezpośrednich, odchylenia stanowią dodatnie lub ujemne różnice, jako efekt: uwzględniania szczególnej konsumpcji, zmian cen oraz stosowania materiałów o innych rozmiarach i jakości w stosunku do tych przewidzianych w budżecie, itp.