The Place and Role of Value Analysis
in the Restructuring of Production (Case Study)

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Abstract

The paper presents the results of a case study aimed at investigating the possibility of replacement of coiled tubing manufactured of X70 steel with tubing manufactured of P235GH or P265GH steel. Considering one of the base principles of Value Analysis – the principle of maximizing the relationship between use value and cost of production, the performance indicators of coiled tubing have been identified. From the comparative study of IPTF 1 and the total cost of purchasing of coiled tubing, it comes forward that American coiled tubing manufactured of X70 steel can be successfully replaced by the Romanian manufactured steel P235GH or P265GH. Comparing the ratios between IPTF 2 and the total cost of purchasing of coiled tubing, it can be concluded that for a decrease of more than 20 % of the use value of Romanian coiled tubing manufactured of P235GH or P265GH steel, they cannot be competitive with the American tubing manufactured of X70 steel.

Key words: *coiled tubing, value analysis, performance indicator, use-value, manufacturing cost, total purchasing cost*

JEL Classification: *O32, D46*

Introduction

Rapid and effective integration within the European framework requires multiple and complex restructuring, taking into consideration the nature and structure of economic agents. Without going into the details of this process, we believe that the liberalization of labour force, as well as the circulation of goods and capital, must be continued with "the integration of inputs in a common market, a more advanced stage of regional integration processes, that will lead to the relative price equalization and welfare effects that are different for different groups of interest, leading to disputes relating to their distribution"[1].

All over the world, including in Romania, coiled tubing units have many applications in drilling, operation and interventions to petroleum and gas wells[2].

Given the high production costs of coiled tubing manufactured only in the U.S.A., it was considered appropriate to replace it with lower fabrication costs of Romanian steel, with mechanical properties and chemical composition similar to the American steel.

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[1] Miron, D. *Economia Uniunii Europene,* Editura *Luceafărul*, Bucureşti 2002, pag. 98.
[2] Zisopol, D.G. *Cercetări privind construcţia tubingului flexibil utilizat în industria petrolului*, Teză de Doctorat, Universitatea Petrol – Gaze din Ploieşti, 2000.

In this context, using value analysis concept (a systemic and creative research method which, through a functional approach, aims to design and implement the studied object at minimal costs, in terms of quality to meet user needs, according to socio-economic requirements[1]), we will study the possibility of replacing coiled tubing (continuous tubular material with a length up to 11 000 m, manufactured of American steel or special alloys that give greater plasticity properties[2]), manufactured of high strength low alloy steel X70, with Romanian tubing manufactured of steel P265GH or P235GH[3].

Generalities

The subject of value analysis is an entity (product, part of a product, technology, part of a technology, an activity or sequence of activities, an investment objective) that has been assigned a function put together in a complex usable value.

Value analysis integrates in a single model the two sides – technical and economic, providing a methodology for conducting a systematic relationship functions – cost.

Regardless of the subject, the *primary objective* of the analysis is the marketing value of products and services to meet the demand of users by: the size of the use value *(Vi)* at the level of the market demand, incentive sales price, the possibility to upgrade with minimal costs, low costs of assimilation, production and sales, eliminating unnecessary costs.

Value analysis study is different from the usual research design activity and results from the application of *four key principles*[1]:

o   the principle of *functional design* - means that products or services are studied through the functions they must perform. Each function is individually designed and materialized as such and then it is assembled with other functions so that together they form a product or service that was initially considered. In value analysis, functional characteristics of the product are more important than the structural ones;
o   the principle of *double sizing* of *functions* - refers to the fact that the functions of the products will also be technically (expressed in an appropriate unit) and economically designed (expressed in cost);
o   the principle of *systemic approach to use value.* According to this principle, the subject of the method is primarily the product. Since value analysis applies only to use values that correspond to social needs, it comes natural that parts of the product cannot be a subject for this, the piece exists only as a use of the product, as a component of it;
o   the principle of *maximizing the relationship between use value and cost of production* - ensures achieving high competitiveness by establishing an optimal maximum ratio between product features and costs of their implementation.

The fundamental relationship certifying the design and replacement of a product of the kind presented is the following[1]:

$$\frac{V_i}{C_p} \rightarrow \max. \tag{1}$$

where: V_i is use value and C_p is the production cost of the product.
The use value represents all characteristics and features offered by a product to meet social needs.

[1] Ioniţă, I. *Ingineria valorii*, Editura Economică, Bucureşti, 2000.
[2] Ulmanu, V. *Material tubular petrolier*, Editura Tehnică, Bucureşti, 1992.
[3] Trifan, C.N. *Cercetări privind tehnologiile de creştere a durabilităţii tubingului flexibil*, Teză de Doctorat, Universitatea Petrol – Gaze din Ploieşti, 2012.

The value can be increased by:

o   increasing product performance, keeping a constant cost (see Fig. 1, *a*);
o   reducing costs and maintaining consistent product performance (Fig. 1, *b*);
o   increasing product performance rather than cost (Fig. 1, *c*);
o   increasing product performance and reducing its cost (Fig. 1, *d*);
o   reducing product performance, while significantly reducing its costs (Fig. 1, *e*).
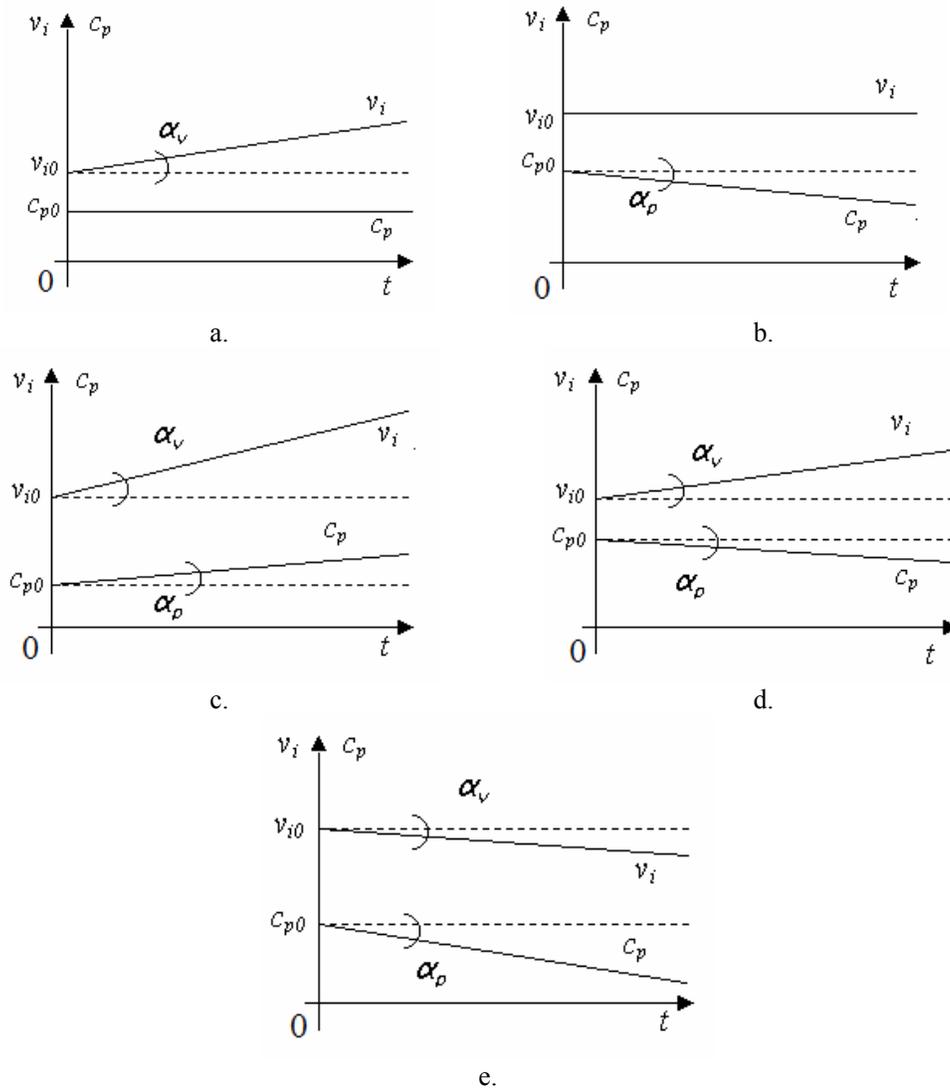
Fig. 1. Ways to increase the use value.

Source: Ioniță, I. *Ingineria valorii*, Editura Economică, București, 2000.

Data Analysis

In order to study the possibility of replacing American coiled tubing manufactured of X70 steel, with Romanian coiled tubing, manufactured of P235GH or P265GH steel, we will use the principle of maximizing the relationship between use value V_i and cost of production C_p, by reducing performance product while significantly reducing its costs (Fig. 1, *e*). For the analysis, we will consider coiled tubing manufactured in the U.S.A. and in Romania, with the outer diameter, D = 31.75 mm, wall thickness, t = 3.17 mm and length, L = 6500 m.

The total cost of purchasing coiled tubing manufactured of X70 steel (see Table 1) is given by[1]:

$$C_{T,X70} = C_{TF} + \left(C_{ti} + C_{tx,v}\right) + TVA,$$ (2)

where: C_{TF} is the cost of coiled tubing manufactured of X70 steel[2];
C_{ti} – the cost of transportation of tubing; it is considered that C_{ti} = 0;
$C_{tx,v}$ – the cost of customs duties; it is considered that $C_{tx,v}$ = 0.

For the coiled tubing manufactured of P235GH or P265GH steel, the total cost of purchasing (see Table 1) is determined by the formula[1]:

$$C_{T,MT} = C_{fabr} + \left(C_{ti}\right) + TVA,$$ (3)

where: C_{fabr} is the cost of manufacturing the coiled tubing of P235GH or P265GH steel, to be determined using the formula[2]:

$$C_{fabr} = C_a + C_{op.s} + C_{op.cnd} + C_{op.v},$$ (4)

where: C_a is the cost of purchasing laminated pipes[3];
$C_{op.s}$ – the cost of welding, calculated using the formula[1]:

$$C_{op.s} = C_{man} + C_{mat},$$ (5)

where: C_{man} is the cost of labor;
C_{mat} – the cost of consumables, which is determined using the following formula[1]:

$$C_{mat} = C_e + C_{gi} + C_{ee},$$ (6)

where: C_e is the cost of welding electrodes;
C_{gi} – the cost of inert gas;
C_{ee} – the cost of electricity consumed in welding.
$\qquad$ $C_{op.cnd}$ – the cost of non-destructive control operations of welded joints (X-ray flaw detection);
$\qquad$ $C_{op.v}$ – the cost of checking the coiled tubing through internal pressure tests. It is *considered* that C_{ti} = 0;
VAT – value added tax (24%).

The total cost of purchasing the coiled tubing analyzed is summarized in Table 1 and represented in Figure 2.

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[1] Zisopol, D.G., Zaharia, M. *Cercetări teoretico – experimentale privind comportarea tubingului flexibil la solicitări ciclice de încovoiere cu presiune interioară*, Proiect de diplomă, Universitatea Petrol – Gaze din Ploieşti, 2009.
[2] http://www.nov.com/qualitytubing.html
[3] http://www.comgaz.ro

Table 1. Total cost of purchasing the coiled tubing.

Material	C_a	C_{fabr} (€)						VAT	C_T
		$C_{op.s}$				$C_{op.cnd}$	$C_{op.v}$		
		C_{man}	C_e	C_{gi}	C_{ee}				
-	(€)	(€)						(€)	(€)
P235GH	23 484	360	21	87	100	497	580	6 031	31 160[3]
P265GH	26 088							6 656	34 389[3]
X70	32 350	-	-	-	-	-	-	7 764	40 114[2]

Source: adaptation by the author, calculations based on the data from: Zisopol, D.G., Zaharia, M. *Cercetări teoretico – experimentale privind comportarea tubingului flexibil la solicitări ciclice de încovoiere cu presiune interioară*, Proiect de diplomă, Universitatea Petrol – Gaze din Ploieşti, 2009.

The total cost of purchasing Romanian coiled tubing is 14 ... 22 % lower than the total cost of purchasing American coiled tubing (Table 1, Figure 2).
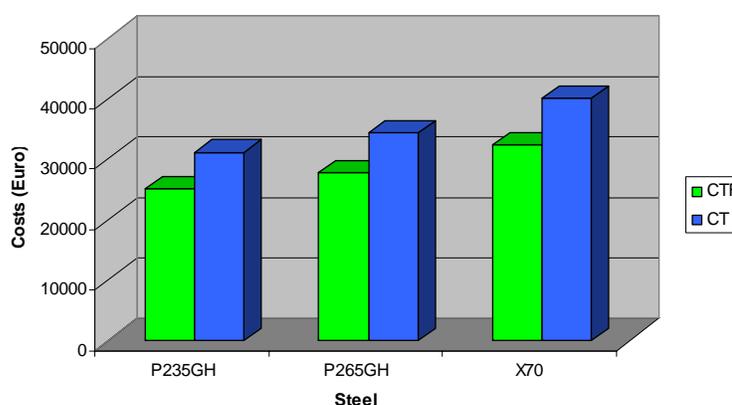
Fig. 2. Production costs of coiled tubing.

Source: Van Adrichem, Willem P. *Coiled Tubing Failure Statistics Used to Develop Tubing Performance Indicators*, Society of Petroleum Engineers, SPE paper no. 54478, Texas, 1999.

The use value of coiled tubing manufactured of X70 steel will be expressed through performance indicators *IPTF* 1 *or IPTF* 2[1]. These performance indicators are defined based on experimental data obtained by Schlumberger - Dowell (see Table 2, Fig. 3, 4), after the study of 4600 km of American coiled tubing, a total of 35 190 operations[1] and are the following:

o   *IPTF* 1 – number of defects over a length of 305 m of coiled tubing,

o   *IPTF* 2 – total number of operations with coiled tubing between two successive failures.

Table 2. Performance indicators of coiled tubing manufactured of X70 steel.

| No. | Outer diameter, D | Part of the tubing affected by defects | Performance indicators of coiled tubing | |
			IPTF 1	IPTF 2
-	mm	%	-	-
1.	31.75	24	6.7	345
2.	38.10	36	9.0	257
3.	44.45	21	8 1	285
4.	50.80	10	10.2	227
5.	60.32	10	10.9	212

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[1] Van Adrichem, Willem P. *Coiled Tubing Failure Statistics Used to Develop Tubing Performance Indicators*, Society of Petroleum Engineers, SPE paper no. 54478, Texas, 1999.

Source: Van Adrichem, Willem P. *Coiled Tubing Failure Statistics Used to Develop Tubing Performance Indicators*, Society of Petroleum Engineers, SPE paper no. 54478, Texas, 1999.

For coiled tubing manufactured of X70 steel, P235GH and P265GH steel, using formula *1,* we will express quantitatively the ratios between use value, represented by performance indicators *IPTF* 1 or *IPTF* 2, and the total cost of purchasing for each tubular material[1]:
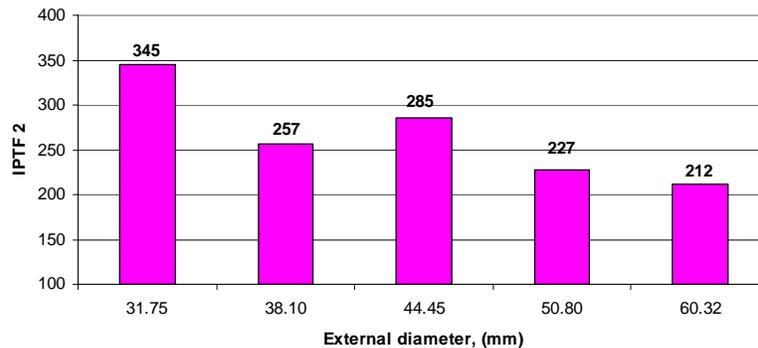
$$R_{1-X70} = \frac{IPTF1}{C_{X70}} = 16,70 \cdot 10^{-5} \text{ defects / Euro,} \tag{7}$$

$$R_{2-X70} = \frac{IPTF2}{C_{X70}} = 86 \cdot 10^{-4} \text{ operations / Euro,} \tag{8}$$
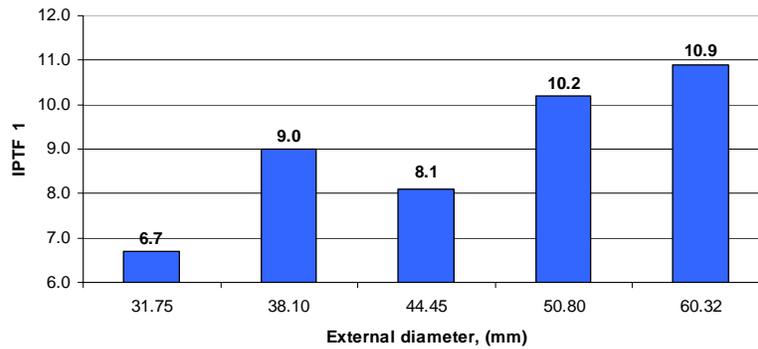
Fig. 3. Dependence between *IPTF* 1 and outer diameters of tubing.

Source: Van Adrichem, Willem P. *Coiled Tubing Failure Statistics Used to Develop Tubing Performance Indicators*, Society of Petroleum Engineers, SPE paper no. 54478, Texas, 1999.

Fig. 4. Dependence between *IPTF* 2 and outer diameters of tubing.

Source: Van Adrichem, Willem P. *Coiled Tubing Failure Statistics Used to Develop Tubing Performance Indicators*, Society of Petroleum Engineers, SPE paper no. 54478, Texas, 1999.

$$R_{1-P235GH} = \frac{IPTF1}{C_{P235GH}} \text{ defects / Euro,} \tag{9}$$

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[1] Zisopol, D.G., Zaharia, M. *Cercetări teoretico – experimentale privind comportarea tubingului flexibil la solicitări ciclice de încovoiere cu presiune interioară*, Proiect de diplomă, Universitatea Petrol – Gaze din Ploieşti, 2009.

$$R_{1-P265GH} = \frac{IPTF1}{C_{P265GH}} \text{ defects / Euro,} \tag{10}$$

$$R_{2-P235GH} = \frac{IPTF2}{C_{P235GH}} \text{ operations / Euro,} \tag{11}$$

$$R_{2-P265GH} = \frac{IPTF2}{C_{P265GH}} \text{ operations / Euro.} \tag{12}$$

Considering the hypothesis that Romanian coiled tubing has lower performance indicators in terms of value, by 10 %, 20 %, ..., 50 % of the performance indicators for American coiled tubing[1], in Table 3 we put together the results of calculations performed using formulas *9*, *10*, *11*, *12*. Percentage differences between specific ratios for coiled tubing manufactured of P235GH or P265GH steel as compared to those manufactured from X70 is determined by formula[1]:

$$\Delta R_{i-X,P} = \frac{R_{i-P} - R_{i-X}}{R_{i-X}} \cdot 100 \,(\%), \tag{13}$$

where: R_{i-P} is the ratio between use value and total cost of purchasing the tubing manufactured of P235GH or P265GH steel, R_{i-X} - the ratio between use value and total cost of purchasing of tubing manufactured of X70 steel, i = 1 or 2 (corresponding to *IPTF* 1 or *IPTF* 2).

Table 3. Ratios between use values and production costs of coiled tubing.

Reduction of V_i, (%)				
10	*20*	*30*	*40*	*50*
IPTF 1				
7,37	8,04	8,71	9,38	10,05
IPTF 2				
310,5	276,0	241,5	207	172,5
$R_{1\text{-}P235GH}$ (x 10^{-5})				
23,65	25,80	27,95	30,10	32,25
$R_{1\text{-}P265GH}$ (x 10^{-5})				
21,43	23,38	25,33	27,28	29,22
$R_{2\text{-}P235GH}$ (x 10^{-4})				
99,65	88,58	77,50	66,43	55,36
$R_{2\text{-}P265GH}$ (x 10^{-4})				
90,29	80,26	70,23	60,19	50,16

Source: made by author, based on the research data obtained from: Zisopol, D.G., Zaharia, M. *Cercetări teoretico – experimentale privind comportarea tubingului flexibil la solicitări ciclice de încovoiere cu presiune interioară*, Proiect de diplomă, Universitatea Petrol – Gaze din Ploieşti, 2009.

Table 4 shows the differences between ratios specific to coiled tubing manufactured of P235GH or P265GH steel compared to those manufactured of X70.
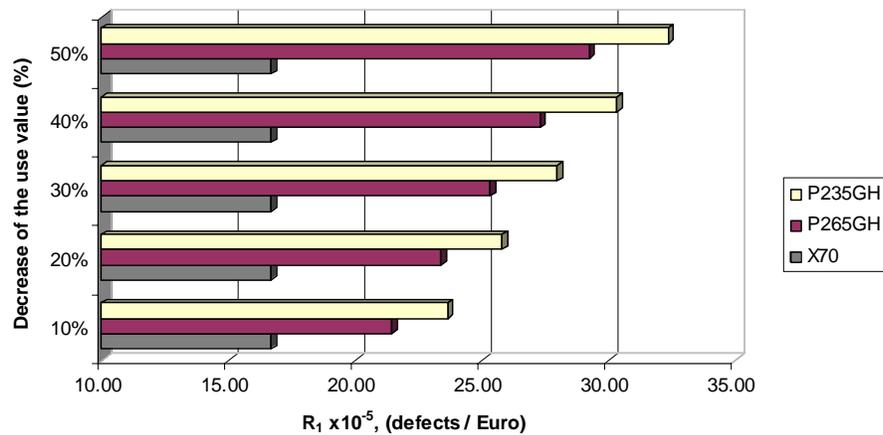
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[1] Zisopol, D.G., Zaharia, M. *Cercetări teoretico – experimentale privind comportarea tubingului flexibil la solicitări ciclice de încovoiere cu presiune interioară*, Proiect de diplomă, Universitatea Petrol – Gaze din Ploieşti, 2009.

In Figures 5 and 6 there are compared the ratios between use values *IPTF* 1 or *IPTF* 2 and the total cost of purchasing of coiled tubing manufactured of X70, P235GH and P265GH steel.

Table 4. Differences between ratios specific to coiled tubing manufactured of P235GH or P265GH steel compared to those manufactured of X70.

Reduction of V_i (%) / Differences, ΔR (%)	*10*	*20*	*30*	*40*	*50*
$\Delta R_{1\text{-P235GH}}$ against $R_{1\text{-X70}}$	41.62	54.49	67.37	80.24	93.11
$\Delta R_{2\text{-P235GH}}$ against $R_{2\text{-X70}}$	15.87	3.00	-9.88	-22.76	-35.63
$\Delta R_{1\text{-P265GH}}$ against $R_{1\text{-X70}}$	28.32	40.00	51.68	63.35	74.97
$\Delta R_{2\text{-P265GH}}$ against $R_{2\text{-X70}}$	4.99	-6.67	-18.34	-30.01	-41.67

Source: made by author, based on the research data obtained from: Zisopol, D.G., Zaharia, M. *Cercetări teoretico – experimentale privind comportarea tubingului flexibil la solicitări ciclice de încovoiere cu presiune interioară*, Proiect de diplomă, Universitatea Petrol – Gaze din Ploieşti, 2009.

Fig. 5. Comparison between ratios of use values *IPTF* 1 and the total cost of purchasing of coiled tubing.

Source: made by author, based on the research data obtained from: Zisopol, D.G., Zaharia, M. *Cercetări teoretico – experimentale privind comportarea tubingului flexibil la solicitări ciclice de încovoiere cu presiune interioară*, Proiect de diplomă, Universitatea Petrol – Gaze din Ploieşti, 2009.
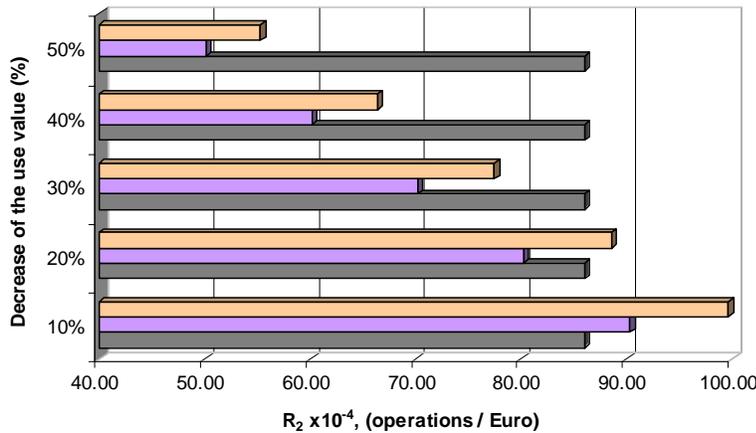
Fig. 6. Comparison between ratios of use values *IPTF* 2 and total cost of purchasing of coiled tubing.

Source: made by author, based on the research data obtained from: Zisopol, D.G., Zaharia, M. *Cercetări teoretico – experimentale privind comportarea tubingului flexibil la solicitări ciclice de încovoiere cu presiune interioară*, Proiect de diplomă, Universitatea Petrol – Gaze din Ploieşti, 2009.

Conclusions

From the comparative study of *IPTF* 1 and the total cost of purchasing of coiled tubing (see Figure 5), it comes forward that American coiled tubing manufactured of X70 steel can be successfully replaced by the Romanian manufactured steel P235GH or P265GH.

Comparing the ratios between *IPTF* 2 and the total cost of purchasing of coiled tubing (see Figure 6), it can be concluded that for a decrease of more than 20 % of the use value of Romanian coiled tubing manufactured of P235GH or P265GH steel, they cannot be competitive with the American tubing manufactured of X70 steel.

The value analysis study reveals that in both cases (*IPTF* 1 or *IPTF* 2), the best of the two Romanian variants is the one provided by the coiled tubing manufactured of P235GH steel.

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8. http://www.jeffweber.net/products/coiled-tubing/1/32.aspx
9. http://www.nov.com/qualitytubing.html
10. http://www.comgaz.ro

Locul şi rolul analizei valorii în restructurarea producţiei (studiu de caz)

Rezumat

Lucrarea prezintă rezultatele unui studiu de caz privind posibilitatea înlocuirii tubingului flexibil confecţionat din oţel X70 cu cel confecţionat din P235GH sau P265GH. Având în vedere unul din principiile de bază ale analizei valorii – principiul maximizării raportului dintre valoarea de întrebuinţare şi costul de producţie, s-au identificat indicatorii de performanţă ai tubingurilor flexibile (IPTF). Din studiul comparativ al rapoartelor IPTF 1 şi costurile totale de achiziţie a tubingurilor flexibile rezultă că tubingurile fabricate din oţel de construcţie americană (X70) pot fi înlocuite cu cele din oţel românesc (P235GH sau P265GH). Comparând rapoartele IPTF 2 şi costurile totale de achiziţie a tubingurilor flexibile, se constată că pentru o scădere cu mai mult de 20 % a valorii de întrebuinţare a tubingurilor de construcţie românească (P235GH sau P265GH), acestea nu pot fi competitive cu cele de construcţie americană (X70).