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 wells2.

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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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 \(V_i\) 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\(^1\):

- 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;

- 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);

- 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;

- 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\(^1\):

\[
\frac{V_i}{C_p} \rightarrow \text{max.} \quad (1)
\]

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.

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\(^3\) 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:
- increasing product performance, keeping a constant cost (see Fig. 1, a);
- reducing costs and maintaining consistent product performance (Fig. 1, b);
- increasing product performance rather than cost (Fig. 1, c);
- increasing product performance and reducing its cost (Fig. 1, d);
- reducing product performance, while significantly reducing its costs (Fig. 1, e).

Fig. 1. Ways to increase the use value.

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\(^1\):

$$C_{T,X70} = C_{TF} + (C_{ti} + C_{tx,v}) + TVA,$$  \hspace{1cm} (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\(^1\):

$$C_{T,MT} = C_{fabr} + (C_{ti} + TVA),$$  \hspace{1cm} (3)

where: $C_{fabr}$ is the cost of manufacturing the coiled tubing of P235GH or P265GH steel, to be determined using the formula\(^2\):

$$C_{fabr} = C_{u} + C_{op,s} + C_{op,con} + C_{op,v},$$  \hspace{1cm} (4)

where: $C_{u}$ is the cost of purchasing laminated pipes\(^3\);

$C_{op,s}$ – the cost of welding, calculated using the formula\(^1\):

$$C_{op,s} = C_{man} + C_{mat},$$  \hspace{1cm} (5)

where: $C_{man}$ is the cost of labor;

$C_{mat}$ – the cost of consumables, which is determined using the following formula\(^1\):

$$C_{mat} = C_{e} + C_{gi} + C_{ee},$$  \hspace{1cm} (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.

$C_{op,con}$ – the cost of non-destructive control operations of welded joints (X-ray flaw detection);

$C_{op,v}$ – 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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\(^2\) http://www.nov.com/qualitytubing.html

\(^3\) http://www.comgaz.ro
Table 1. Total cost of purchasing the coiled tubing.

<table>
<thead>
<tr>
<th>Material</th>
<th>$C_a$ (€)</th>
<th>$C_{max}$</th>
<th>$C_e$</th>
<th>$C_gi$</th>
<th>$C_{con}$</th>
<th>$C_{con,v}$</th>
<th>VAT (€)</th>
<th>$C_T$ (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P235GH</td>
<td>23 484</td>
<td>360</td>
<td>21</td>
<td>87</td>
<td>100</td>
<td>497</td>
<td>580</td>
<td>6 031</td>
</tr>
<tr>
<td>P265GH</td>
<td>26 088</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 656</td>
</tr>
<tr>
<td>X70</td>
<td>32 350</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7 764</td>
</tr>
</tbody>
</table>


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.


The use value of coiled tubing manufactured of X70 steel will be expressed through performance indicators $IPTF_1$ or $IPTF_2$. 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 operations¹ and are the following:

- $IPTF_1$ – number of defects over a length of 305 m of coiled tubing,
- $IPTF_2$ – total number of operations with coiled tubing between two successive failures.

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

<table>
<thead>
<tr>
<th>No.</th>
<th>Outer diameter, $D$</th>
<th>Part of the tubing affected by defects</th>
<th>$IPTF_1$</th>
<th>$IPTF_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>31.75</td>
<td>24</td>
<td>6.7</td>
<td>345</td>
</tr>
<tr>
<td>2</td>
<td>38.10</td>
<td>36</td>
<td>9.0</td>
<td>257</td>
</tr>
<tr>
<td>3</td>
<td>44.45</td>
<td>21</td>
<td>8.1</td>
<td>285</td>
</tr>
<tr>
<td>4</td>
<td>50.80</td>
<td>10</td>
<td>10.2</td>
<td>227</td>
</tr>
<tr>
<td>5</td>
<td>60.32</td>
<td>10</td>
<td>10.9</td>
<td>212</td>
</tr>
</tbody>
</table>

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$^1$:

$$R_{1\cdot X^{70}} = \frac{IPTF_1}{C_{X^{70}}} = 16.70 \cdot 10^{-5} \text{ defects / Euro},$$  \hspace{1cm} (7)

$$R_{2\cdot X^{70}} = \frac{IPTF_2}{C_{X^{70}}} = 86 \cdot 10^{-4} \text{ operations / Euro},$$  \hspace{1cm} (8)

$$R_{1\cdot P^{235GH}} = \frac{IPTF_1}{C_{P^{235GH}}} \text{ defects / Euro},$$  \hspace{1cm} (9)

Fig. 3. Dependence between $IPTF_1$ and outer diameters of tubing.


Fig. 4. Dependence between $IPTF_2$ and outer diameters of tubing.


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\[ R_{1-P265GH} = \frac{IPTF1}{C_{P265GH}} \text{ defects / Euro}, \quad (10) \]

\[ R_{2-P235GH} = \frac{IPTF2}{C_{P235GH}} \text{ operations / Euro}, \quad (11) \]

\[ R_{2-P265GH} = \frac{IPTF2}{C_{P265GH}} \text{ operations / Euro}. \quad (12) \]

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:\(^1\)

\[ \Delta R_{i-X,P} = \frac{R_{i-P} - R_{i-X}}{R_{i-X}} \cdot 100 \% \], \quad (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.

<table>
<thead>
<tr>
<th>Reduction of ( V_o ) (%)</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>( IPTF_1 )</td>
<td>7,37</td>
<td>8,04</td>
<td>8,71</td>
<td>9,38</td>
<td>10,05</td>
</tr>
<tr>
<td>( IPTF_2 )</td>
<td>310,5</td>
<td>276,0</td>
<td>241,5</td>
<td>207</td>
<td>172,5</td>
</tr>
<tr>
<td>( R_{1-P235GH} ( \times 10^{-5} ) )</td>
<td>23,65</td>
<td>25,80</td>
<td>27,95</td>
<td>30,10</td>
<td>32,25</td>
</tr>
<tr>
<td>( R_{1-P265GH} ( \times 10^{-5} ) )</td>
<td>21,43</td>
<td>23,38</td>
<td>25,33</td>
<td>27,28</td>
<td>29,22</td>
</tr>
<tr>
<td>( R_{2-P235GH} ( \times 10^{-4} ) )</td>
<td>99,65</td>
<td>88,58</td>
<td>77,50</td>
<td>66,43</td>
<td>55,36</td>
</tr>
<tr>
<td>( R_{2-P265GH} ( \times 10^{-4} ) )</td>
<td>90,29</td>
<td>80,26</td>
<td>70,23</td>
<td>60,19</td>
<td>50,16</td>
</tr>
</tbody>
</table>


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

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.

<table>
<thead>
<tr>
<th>Differences, $\Delta R$ (%)</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta R_{1,P235GH}$ against $R_{1,X70}$</td>
<td>41.62</td>
<td>54.49</td>
<td>67.37</td>
<td>80.24</td>
<td>93.11</td>
</tr>
<tr>
<td>$\Delta R_{2,P235GH}$ against $R_{2,X70}$</td>
<td>15.87</td>
<td>3.00</td>
<td>-9.88</td>
<td>-22.76</td>
<td>-35.63</td>
</tr>
<tr>
<td>$\Delta R_{1,P265GH}$ against $R_{1,X70}$</td>
<td>28.32</td>
<td>40.00</td>
<td>51.68</td>
<td>63.35</td>
<td>74.97</td>
</tr>
<tr>
<td>$\Delta R_{2,P265GH}$ against $R_{2,X70}$</td>
<td>4.99</td>
<td>-6.67</td>
<td>-18.34</td>
<td>-30.01</td>
<td>-41.67</td>
</tr>
</tbody>
</table>

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.

References


Locul și rolul analizei valorii
în restructurarea producției (studiu de caz)

Rezumat

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