Research on the Cost Management and Forecast for the Projects of Petrochemical Enterprises

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Aiming at the existing relevant problems in cost management for the projects of petrochemical enterprises, this paper includes a large quantity of practical data and summarizes the indicators which influence the cost of projects of petrochemical enterprises into 14 indicators including investment scale, integrated operation, key technologies of production, and environment. DEMATEL quantization algorithm is used to calculate and rank above 14 indicators. Research conclusion indicates that the ranking (from the high to the low) of importance degree of indicators which influence the cost of projects of petrochemical enterprises can be cost, investment scale, logistical support, social responsibility, key technology of production, management of production quality and so on. They are the main driving forces which influence other cost indicators. While analyzing and forecasting cost, environment, investment scale, production technology, logistical support and the social responsibility taken by enterprises shall be firstly considered. Other factors are secondary. In the latest years, petrochemical enterprises consider more cost of environment. The concentration of SO\textsubscript{2} lowers largely. It lowered for 107.2\% in 2015 comparing with that in 2006. The complex energy consumption of production value per ten thousand yuan declined for about 31.4\%.

1. Introduction

Petroleum is the important raw material for manufacturing chemical supplies, fuel of automobiles and steamships and pavement of roads. Petrochemical enterprises play important functions in the development and use of petroleum. Being different from common projects of enterprise, the projects of petrochemical enterprises have special development and cost management. Petroleum is non-renewable biochemical energy with large difficulty of exploitation, gradually small yield and low use rate. This is the common problem of global petrochemical enterprises (Afgan and Carvalho, 2008; Jefferson 2006; Markovska et al., 2009; McNair et al., 2001; Maiga 2015; Slagmulder and Cooper, 2003; Sendilvelan and Sundarraj, 2016; Ren and Zhang, 2015).

The cost management in petrochemical projects is a complex topic involving many factors. Most factors that influence cost of petrochemical projects have been confirmed. They interact and couple mutually, including depreciation of production equipment, project scale, the number of workers, key technology of production, cycle of projects and so on. In actual project cost management and forecast, corresponding evaluation indicators shall be used to confirm main factors and secondary factors (Dubois 2003; Shank and Govindarajan, 1992; Lii 2003; He 2004; Anderson 2006; Wu 2009; Anderson and Dekker, 2009; Anderson and Dekker, 2009; Stanley 2015).

Aiming at the existing relevant problems in cost management for the projects of petrochemical enterprises, this paper includes a large quantity of practical data and summarizes the indicators which influence the cost of projects of petrochemical enterprises into 14 indicators including investment scale, integrative operation, key technologies of production, and environment. DEMATEL quantization algorithm is used to calculate and rank above 14 indicators.
2. Analysis on cost management of petrochemical enterprises

The cost management of petrochemical enterprises is influenced by many factors. Most factors that influence cost of petrochemical projects have been confirmed. They interact and couple mutually, including oil exploitation, depreciation of production equipment, project scale, the number of workers, cycle of projects and so on. Figure 1 shows the relevant costs of oil exploitation; figure 2 shows the profit formation in the process of petroleum exploitation and transport.

![Diagram of Oil-gas recovery enterprises industry value chain](image1)

![Diagram of Internal value chain formation of petroleum enterprise](image2)

The factors which influence the cost of projects of petrochemical enterprises are labeled below: C1-investment scale; C2-integrative operation; C3-learning effect; C4-resource type; C5-geographical location; C6-key technology; C7-logistical support; C8-production capacity; C9-quality management; C10-workers; C11-value chain; C12-capital investment; C13-environmental cost; C14-social responsibility. C1-C7 are structural costs; C8-C12 are executive costs; C13-C14 are other cost factors.

DEMATEL quantization algorithm is used to calculate and rank above 14 cost factors. Their matrix of relation \( Y \) is:

\[
Y = \begin{bmatrix}
0 & Y_{12} & \cdots & Y_{1n} \\
Y_{21} & 0 & \cdots & Y_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
Y_{n1} & Y_{n2} & \cdots & 0
\end{bmatrix}
\]

(1)

\( Y_{ij} \) is the influence degree of cost factor \( C_i \). After normalizing \( Y \), influence matrix \( G \) and synthetic matrix \( Z \) can be:

\[
G = \frac{1}{\max_{i,j} \sum_{j} Y_{ij}} Y
\]

(2)

\[
Z = G^1 + G^2 + \cdots + G^n
\]

(3)
The degree of influence among different cost factors can be calculated according to formulas (1), (2) and (3). The centrality influence $f_i$ and cause influence $e_i$ of different cost factors can be:

$$f_i = \sum_{j=1}^{n} b_{ij} (i = 1, 2, \ldots, n)$$ (4)

$$e_i = \sum_{j=1}^{n} b_{ji} (i = 1, 2, \ldots, n)$$ (5)

$f_i$ is the synthetic influence effect of $C_i$ on other cost factors; $e_i$ is the synthetic influence effect of other cost factors on $C_i$.

The centrality degree $M$ and cause degree $U$ among different cost factors are:

$$m_i = f_i + e_i (i = 1, 2, \ldots, n)$$ (6)

$$u_i = f_i - e_i (i = 1, 2, \ldots, n)$$ (7)

$M$ is the summation of the influence of other factors on $C_i$ and the influence of $C_i$ on other factors. $U$ is the difference value between the influence of $C_i$ on other factors and the influence of other factors on $C_i$.

### 3. Calculation result and analysis

The value of $f_i$, $e_i$, $M$ and $U$ can be calculated according to formulas (4)~(7). Calculation results are shown in Table 1.

<table>
<thead>
<tr>
<th>Cost Driver</th>
<th>Influence degree $F$</th>
<th>Influenced degree $E$</th>
<th>Centrality degree $M$</th>
<th>Cause degree $U$</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>2.301</td>
<td>2.146</td>
<td>4.351</td>
<td>0.177</td>
</tr>
<tr>
<td>C2</td>
<td>1.485</td>
<td>1.637</td>
<td>3.104</td>
<td>-0.102</td>
</tr>
<tr>
<td>C3</td>
<td>1.113</td>
<td>1.308</td>
<td>2.295</td>
<td>-0.234</td>
</tr>
<tr>
<td>C4</td>
<td>2.256</td>
<td>0.912</td>
<td>3.097</td>
<td>1.358</td>
</tr>
<tr>
<td>C5</td>
<td>1.318</td>
<td>1.354</td>
<td>2.513</td>
<td>-0.237</td>
</tr>
<tr>
<td>C6</td>
<td>2.549</td>
<td>1.755</td>
<td>3.906</td>
<td>0.353</td>
</tr>
<tr>
<td>C7</td>
<td>2.667</td>
<td>1.798</td>
<td>4.118</td>
<td>0.652</td>
</tr>
<tr>
<td>C8</td>
<td>0.904</td>
<td>1.473</td>
<td>2.567</td>
<td>-0.611</td>
</tr>
<tr>
<td>C9</td>
<td>1.325</td>
<td>1.890</td>
<td>3.239</td>
<td>-0.598</td>
</tr>
<tr>
<td>C10</td>
<td>1.106</td>
<td>1.633</td>
<td>2.114</td>
<td>-0.504</td>
</tr>
<tr>
<td>C11</td>
<td>0.573</td>
<td>1.618</td>
<td>2.098</td>
<td>-1.125</td>
</tr>
<tr>
<td>C12</td>
<td>1.321</td>
<td>1.512</td>
<td>2.836</td>
<td>-0.227</td>
</tr>
<tr>
<td>C13</td>
<td>2.602</td>
<td>1.902</td>
<td>4.489</td>
<td>0.680</td>
</tr>
<tr>
<td>C14</td>
<td>2.317</td>
<td>1.883</td>
<td>4.113</td>
<td>0.445</td>
</tr>
</tbody>
</table>

Centrality degree $M$ and cause degree $U$ are the most important indicators for judging cost factors. Therefore, the radar graph of centrality degree (figure 3) and the relation between centrality degree and cause degree (figure 2) of the 14 cost factors are drawn below.
Figure 3: Cost driver centrality degree distributing graph

From Figure 3, we can know that importance degree (from the high to the low) of cost factors of the projects of petrochemical enterprises can be ranked below: C13-environmental cost > C1-investment scale > C7-logistical support > C14-social responsibility > C6-key technology > C9-quality management > C4-resource type > C2-integrative operation > C10-workers > C12-capital investment > C5-geographical location > C8-production capacity > C3-learning effect > C11-value chain. Therefore, petrochemical enterprises shall firstly consider the factors of environment, investment scale, production technology, logistical support and social responsibility while analyzing and forecasting cost.

From Figure 4 which shows the relation between centrality degree and cause degree, we can see that: if certain cost factor is larger than 0, it indicates high degree of influence of the factor on other factors; if certain cost factor is smaller than 0, it indicates high degree of influence of other factors on the factor. From the figure, the value of C4-resource type, C13-environmental cost, C7-logistical support, C14-social responsibility, C6-key technology and C1-investment scale are all larger than 0. The cause degree of other factors are smaller than 0. C4, C13, C7, C14, C6 and C1 are the main drivers that influence other cost factors. In other words, above factors shall be mainly considered in the analysis and forecast on cost of chemical engineering projects. C11, C9, C8, C1, C5, C12 and C3 are secondary factors to be considered.

Figure 4: Relation between centrality degree and cause degree
Figure 5: SO\textsubscript{2} and carbon emission trend of Chinese petrifaction company

At present, environmental cost and ecological balance have become the primary problems of chemical engineering projects. Decrease of chemical pollutants and CO\textsubscript{2} emission can raise the rate of petroleum use and protect ecological environment. It is the driving factor of petrochemical enterprises for general cost control. Figure 5 shows SO\textsubscript{2} and carbon emission trend of a Chinese petrifaction company from 2006 to 2015. From the figure, we can see the large decrease of SO\textsubscript{2} emission with the performance of energy conservation and emission reduction. It declined for 107.2\% from 2006 to 2015, which indicates the raise of petroleum use rate. Figure 6 shows the complex energy consumption of production value per ten thousand yuan. The energy consumption declined for 31.4\% from 2006 to 2015.

Figure 6: Complex energy consumption of production value per ten thousand yuan of Chinese petrifaction company

4. Conclusions

Aiming at the existing relevant problems in cost management for the projects of petrochemical enterprises, this paper includes a large quantity of practical data and summarizes the indicators which influence the cost of projects of petrochemical enterprises into 14 indicators including investment scale, integrative operation, key technologies of production, and environment. DEMATEL quantization algorithm is used to calculate and rank above 14 indicators. Research conclusions are listed below:

(1) The ranking (from the high to the low) of importance degree of indicators which influence the cost of projects of petrochemical enterprises can be cost, investment scale, logistical support, social responsibility, key technologies of production, management of production quality and so on. environment, investment scale,
production technology, logistical support and social responsibility shall be firstly considered while analyzing and forecasting cost.

(2) The value of resource type, environmental cost, logistical support, social responsibility, key technology of production and investment scale are larger than 0. They are the main driving forces that influence other cost factors. In the analysis and forecast on cost of chemical engineering projects, above factors shall be mainly considered. Other factors are secondary. With petrochemical enterprises considering more about environmental cost, the emission of SO₂ decreases largely for 107.2% in 2015 comparing with that in 2006. The complex energy consumption of production value per ten thousand yuan declined for 31.4%.

Reference

Anderson S.W., 2006, Managing costs and cost structure throughout the value chain: research on strategic cost management, Handbooks of Management Accounting Research, 2(6), 481-506, DOI: 10.1016/s1751-3243(06)02001-3
Anderson S.W., Dekker H.C., 2009, Strategic cost management in supply chains, part 1: structural cost management, Social Science Electronic Publishing, 23(2), 201-220, DOI: 10.2308/accr.2009.23.2.201
He Y., 2004, Summary of the research on strategic cost management, Journal of Beijing Technology & Business University, 8(7), 64-70.
Maiga A.S., 2015, Information systems integration and firm profitability: mediating effect of cost management strategy, Advances in Management Accounting, 25, 149-179, DOI: 10.1108/s1474-787120150000025004
McNair C.J., Polutnik L., Silvi R., 2001, Cost management and value creation: the missing link, European Accounting Review, 10(1), 33-50, DOI: 10.1080/0963810020025321
Stanley C., 2015, Strategic cost management and performance, the case of environmental costs, British Accounting Review, 48(2), 269-282, DOI: 10.1080/0969160x.2017.1345812