CHEMICAL ENGINEERING TRANSACTIONS
VOL. 62, 2017
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet
Guest Editors: Fei Song, Haibo Wang, Fang He

ISBN 978-88-95608- 60-0; **ISSN** 2283-9216
DOI: 10.3303/CET1762238

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

Lianxia Yuan*[a], Shizhu Yang[b]

[a]Langfang Teachers University, Langfang 065000, China
[b]Shijiazhuang Institute of Railway Technology, Shijiazhuang 050000, China
y_lx20@163.com

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_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.

Please cite this article as: Lianxia Yuan, Shizhu Yang, 2017, Research on the cost management and forecast for the projects of petrochemical enterprises, Chemical Engineering Transactions, 62, 1423-1428 DOI:10.3303/CET1762238

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.

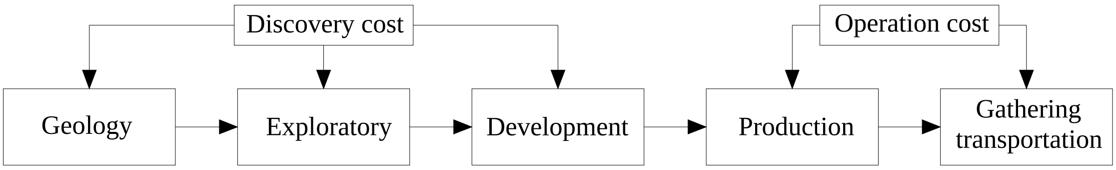

Figure 1: Oil-gas recovery enterprises industry value chain

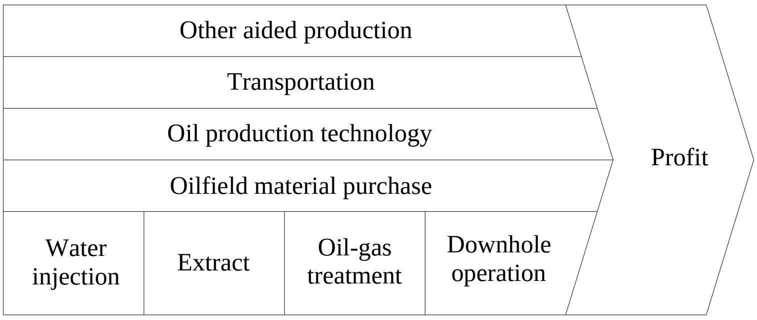

Figure 2: Internal value chain formation of petroleum enterprise

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:

$$Y = \begin{bmatrix} 0 & Y_{12} & \cdots & Y_{1n} \\ Y_{21} & 0 & \cdots & Y_{2n} \\ \cdots & \cdots & 0 & \cdots \\ Y_{n1} & Y_{n2} & \cdots & 0 \end{bmatrix} \tag{1}$$

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

$$G = \frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} y_{ij}} Y \tag{2}$$

$$Z = G^1 + G^2 + \cdots + G^n \tag{3}$$

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:

$$f_i = \sum_{j=1}^{n} b_{ij} \left(i = 1, 2, \cdots, n \right) \quad (4)$$

$$e_i = \sum_{j=1}^{n} b_{ji} \left(i = 1, 2, \cdots, n \right) \quad (5)$$

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:

$$m_i = f_i + e_i \left(i = 1, 2, \cdots, n \right) \quad (6)$$

$$u_i = f_i - e_i \left(i = 1, 2, \cdots, n \right) \quad (7)$$

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 1: Influence degree, influenced degree, centrality degree and cause degree of cost driver

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

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.

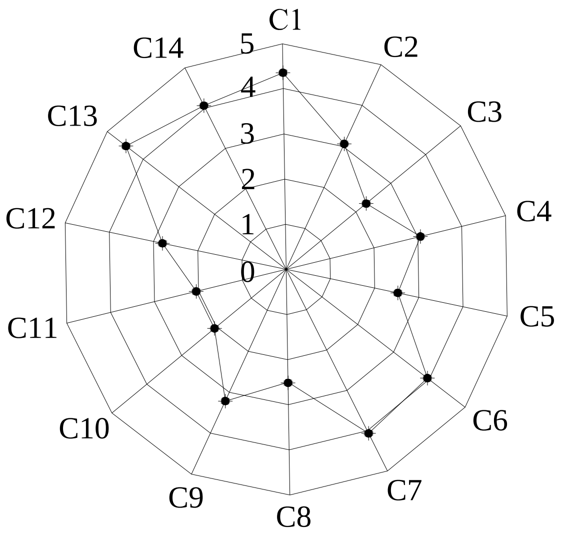

Figure 3: Cost driver centrality degree distributing graph

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.

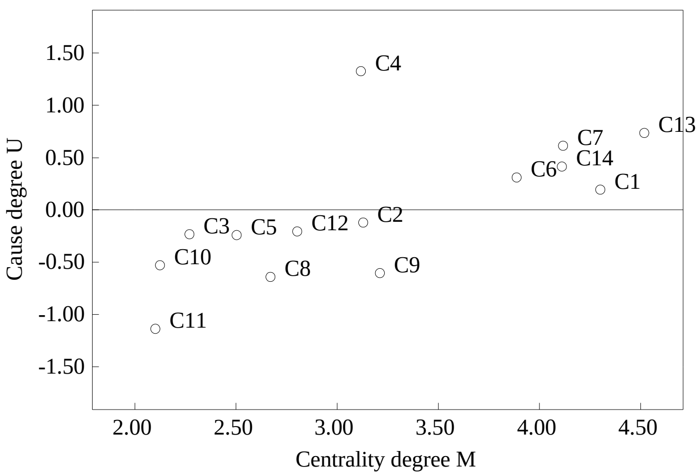

Figure 4: Relation between centrality degree and cause degree

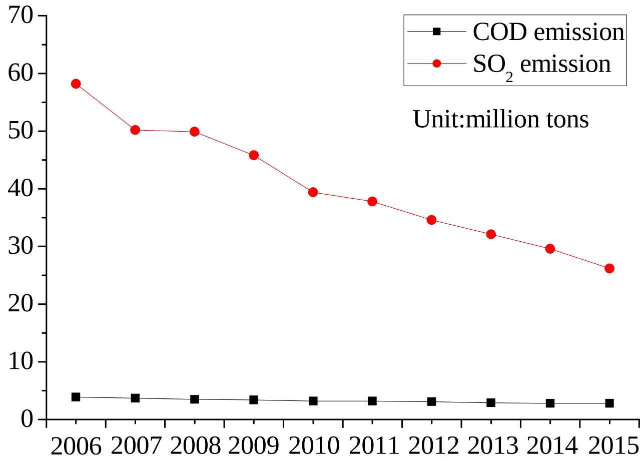

Figure 5: SO_2 and carbon emission trend of Chinese petrifaction company

At present, environmental cost and ecological balance have become the primary problems of chemical engineering projects. Decrease of chemical pollutants and CO_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_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_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.

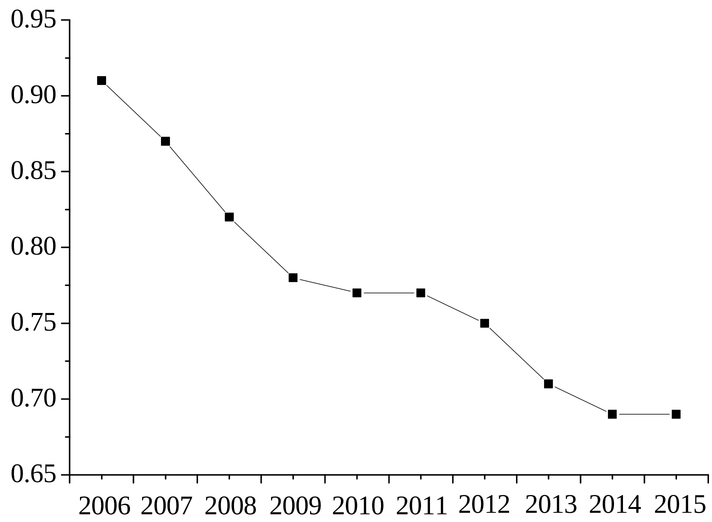

Figure 6: Complex energy consumption of production value per ten thousand yuan of Chinese petrifaction company

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 SO_2 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%.

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