Use of the analytical network process to identify and prioritize determining factors in the prices of bitumen in Iran

Uso del proceso de red analítica para identificar y priorizar
factores determinantes en los precios del
betún en Irán
Uso do processo de rede analítica para identificar e priorizar
determinantes nos preços de betume no Irã

Written by:
Mansoureh Aligholi[21]
Aida Ghahremani[22]

Abstract

Pricing is an important and largely neglected tool in industrial marketing. Research on business-to-business marketing represents the importance of pricing for firm's profitability and long term survival. However, setting a competitive price is highly demanding because of the complexity and wealth of influential factors. As with any strategic decision, pricing strategy is influenced by two types of factors, internal and external factors. Identification and relative weight of internal and external factors that influence Iran bitumen pricing strategies, is the main purpose of the paper.

Qualitative and quantitative methods used to determine internal and external factors, using ANP method to rank them. By interview with managers and questionnaire, the internal and external factors were identified and weighted by ANP method. Findings indicate that bitumen price by the most part depends on global crude oil price, supply/demand of external market, political environment such as sanction, competitive intensity, exchange rate fluctuation, vacuum bottom price (cost of production input), international experience. Environmental factors influence pricing strategies managers employ a tiny amount more than market factors. Due to environmental conditions and changes pricing strategies should be regularly adjusted.

Keywords: Price, internal factors, external factors, analytical network process.

Resumen

El precio es una herramienta importante y en gran parte descuidada en la comercialización industrial. La investigación sobre mercadeo de empresa a empresa representa la importancia de los precios para la rentabilidad de la empresa y la supervivencia a largo plazo. Sin embargo, establecer un precio competitivo es muy exigente debido a la complejidad y la riqueza de factores influyentes. Al igual que con cualquier decisión estratégica, la estrategia de precios está influenciada por dos tipos de factores, factores internos y externos. La identificación y el peso relativo de los factores internos y externos que influyen en las estrategias de fijación de precios del betún de Irán es el principal objetivo del documento. Métodos cualitativos y cuantitativos utilizados para determinar los factores internos y externos, utilizando el método ANP para clasificarlos. Mediante entrevista con los gerentes y el cuestionario, los factores internos y externos fueron identificados y ponderados por el método ANP. Los hallazgos indican que el precio del betún depende en gran medida del precio global del petróleo crudo, la oferta / demanda del mercado externo, el entorno político como la sanción, la intensidad de la competencia, la fluctuación del tipo de cambio, el precio de vacío (costo del insumo de producción) y la experiencia internacional. Los factores ambientales influyen en las estrategias de fijación de precios que los gerentes emplean una pequeña cantidad más que los factores del

[21] Department of Business Management, Central Tehran Branch, Islamic Azad University, Tehran, Iran. man.aligholi@iauctb.ac.ir
[22] Executive Master of Business Administration, Central Tehran Branch, Islamic Azad University, Tehran, Iran. ida.ghrmi@gmail.com

mercado. Debido a las condiciones ambientales y los cambios, las estrategias de precios deben ajustarse regularmente.
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Palabras claves: precio, factores internos, factores externos, proceso de red analítica.

Resumo

O preço é uma ferramenta importante e largamente negligenciada no marketing industrial. A pesquisa sobre o marketing business-to-business representa a importância do preço para a lucratividade da empresa e a sobrevivência a longo prazo. No entanto, estabelecer um preço competitivo é altamente exigente devido à complexidade e à riqueza de fatores influentes. Como em qualquer decisão estratégica, a estratégia de preços é influenciada por dois tipos de fatores, fatores internos e externos. A identificação e o peso relativo de fatores internos e externos que influenciam as estratégias de preços de betume do Irã, é o principal objetivo do documento.
Métodos qualitativos e quantitativos usados para determinar fatores internos e externos, usando o método ANP para classificá-los. Por entrevista com gerentes e questionário, os fatores internos e externos foram identificados e ponderados pelo método da ANP. Os resultados indicam que o preço do betume depende, em grande parte, do preço global do petróleo bruto, oferta / demanda do mercado externo, ambiente político como sanção, intensidade competitiva, flutuação da taxa de câmbio, preço do vácuo (custo de produção) e experiência internacional. Os fatores ambientais influenciam os gerentes de estratégias de precificação a empregar uma quantidade muito menor do que os fatores de mercado. Devido a condições ambientais e mudanças, as estratégias de preços devem ser ajustadas regularmente.

Palavras-chave: preço, fatores internos, fatores externos, processo de rede analítica.

Introduction

Pricing is, for better or worse, the most important driver of profitability (Hinterhuber, 2016). Pricing is an important and largely neglected tool in industrial marketing—on average, a 5% price increase leads to a 22% improvement in operating profits far more than other tools of operational management (Hinterhuber, 2004). Thus, price as an adjustment parameter for profit is the easiest and fastest way to increase competitiveness (Dolgui & Proth, 2010). Pricing decisions, however, can be difficult, and often speculative, due to the uncertainties associated with today's dynamic environments (Forman & Hunt, 2005). This level of difficulty is compounded further when managers attempt to develop pricing strategies in the international arena. By attempting to operate in multiple markets, international firms are confronted with an even more complex and dynamic set of environmental contingencies, all of which serve to magnify the problem of decision uncertainty for managers (Forman & Hunt, 2005).

Obadia (2013) states that setting appropriate export prices is crucial to a company's economic performance, but it is also highly demanding because of the complexity and wealth of influential factors. Pricing strategy can be influenced by two types of factors, internal and external factors (Forman & Hunt, 2005). The inability to respond to such internal and external considerations fairly quickly may also contribute to pricing errors that affect the organization's objectives and performance adversely (Iyer et al, 2015).

Despite the fact that environmental factors impact on export price competitiveness is emphasized in many scientists works, however a comprehensive identification of the most significant determinants, evaluation of their influence that allows to increase the competitiveness of pricing, is missing (Snieskiene & Cibinskiene, 2015).

Identification of internal and external determinants that enhance price competitiveness in internal and external markets of Iran bitumen, is the main purpose of the paper.

Internal factors

According to Hollensen (2007) model, internal factors affecting international pricing can be

broken down to two sub groups, firm-level factors and product factors. firm-level factors, which include the international experience of the firm (Myers et al, 2002; Snieskiene and Cibinskiene, 2015; Forman and Hunt, 2005), cost of production inputs (Hollensen, 2007), marketing and competitive strategy and product factors which include stage in PLC (Hollensen, 2007; Myers, 2002; Snieskiene &Cibinskiene, 2015), most important product features like quality (Hollensen, 2007; Snieskiene and Cibinskiene, 2015).

External factors

According to Hollensen (2007), external factors can be broken down into two main subgroups, environmental and market factors. Environmental which include exchange rate fluctuation (Hollensen, 2007; Snieskiene & Cibinskiene, 2015; Forman & Hunt, 2005; Myers et al, 2002), tariffs and inflation rate (Myers et al, 2002; Hollensen, 2007; Snieskiene & Cibinskiene, 2015; Forman and Hunt, 2005), government regulations and intervention such as price controls, non-tariff barriers (Forman & Hunt, 2005; Myers, 2005). Market factors which include competitive intensity, competitors' prices and competitors's reaction to price changes (Hollensen, 2007; Snieskiene & Cibinskiene, 2015; Walters, 1989; Forman & Hunt, 2005; Myers et al, 2002), demand and supply (Walters, 1989; Snieskiene & Cibinskiene, 2015; Forman & Hunt, 2005).

Methodology

Data collection and analysis took place over 3-month period in 2015. Purposive sampling and semi-structured interview strategies were used, lasting between 20 to 45 min. The number of managers interviewed were 11. The interviews were conducted with bitumen experts, senior managers and managers who had influence in pricing. Most initial interviews were conducted in face to face, with follow up by telephone. Most interviews were recorded. We continued interviews until we reached a point of saturation where information began to appear frequently (Toytari et al, 2015). After qualitative content analysis, 47 internal and external variables identified. In the second stage questionnaire was prepared based on variables identified. Variables measured on a scale of 1-5 Likert-like scale. Content validity was based on the opinion of bitumen experts. To assess the reliability, Cronbach's alpha was used. After accounting for the items, this scale has a reasonably strong α coefficient of 0.95 based on responses during the data collection.

For testing the differences between variables, the Friedman test was used. The objective of this test is to determine if we may conclude from a sample of results that there is difference among treatments (Garcia et al, 2010). Null hypothesis states that there are no differences between the variables. The result of Friedman test shown in table 1:

Table 1. Friedman test result

N	11
Chi-square	158.294
Degrees of freedom (df)	46
The significance level (Asymp. Sig)	.000

The Friedman statistics was distributed according to χ_F^2 with k-1 degrees of freedom for n.

Because the p-value = .000 < 0.05, the null – hypothesis was rejected at the α = 0.05 level. We concluded that there are significant differences. With respect to the Friedman test result most important factors that managers take into account in making pricing decision recognized. Table 2 displays the summated internal and external ratings:

Table 2. Variable ratings

rank	Variables	Rating
1	Vacuum bottom price (cost of production inputs)	42.05
2	Exchange rate	40.35
3	Competitive intensity	37.65
4	Supply/demand of external market	34.3

5	Crude oil price	33.35
6	Supply terms of vacuum bottom on stock market	31.85
7	Marketing strategy	30.55
8	Bargaining power of consumers	29.6
9	Land transportation cost	29.45
10	Bitumen types and diversifications	29
11	Political environment	28.65
12	International experience	27.5

To make a pair-wise comparison and compute relative weights of factors, ANP method has been used. Analytic Network Process (ANP) method is one of the multi-criteria decision making methods for developed complex models by Saaty (1996). The ANP is a more general form of the AHP used in the multi-criteria decision analysis. The AHP structures a decision problem into a hierarchy with goals, decision criteria, and alternatives, while the ANP structures it as a network. The ANP considers the interdependence among elements not only in a hierarchy but also in different hierarchies, which appears to be closer to the reality (Zhang, 2016).

Pairwise comparison

The pairwise comparison is a process of comparing variables in pairs to judge which of

each variable has a greater amount of quantitative impact (Boateng et al., 2015). Two kinds of pair-wise comparisons are considered. The first one is related to comparisons among elements of one cluster dependent to another element and the second one corresponds to cluster comparisons of dependent clusters to one cluster (Rafiei and Rabbani, 2014). The pairwise comparisons are made depending on the 1–9 scale recommended by Saaty, where 1, 3, 5, 7 and 9 indicate equal importance, moderate importance, strong importance, very strong importance and extreme importance, respectively (Gungor et al, 2011). To aggregate judgements of different experts, geometric mean of values was applied to integrate all consistent crisp values of N evaluators.

$$a_{ij}^* = (a_{ij}^{*1} \times a_{ij}^{*2} \times ... \times a_{ij}^{*n})1/n \qquad (1)$$

a_{ij}^* is the aggregated crisp assessments of criterion i and criterion j of n experts, i, j =

1,2,…, n and n is the number of experts (Valmohammadi & Dashti, 2016).

Eliciting weights from comparison matrices

The eigenvector method is one of the popular methods used to quantify the relative dominance of the elements from pairwise comparison matrices. Saaty (1980) proposed the following

eigenvalue formulation to obtain the desired ratio-scale priority vector (or weights) w of n elements:

$$AW = \lambda_{max} W \qquad (2)$$

Where A is the positive reciprocal pairwise comparisons matrix, λ_{max} max is the maximum (or principal) eigenvalue of the matrix A. λ_{max}

max can be solved using the following expressions:

$$AW - \lambda_{max} W = 0 \qquad (3)$$

$$(A - \lambda_{max} I) W = 0 \qquad (4)$$

$$A - \lambda_{max} I = 0 \qquad (5)$$

Equation (5) would result into a polynomial of λ to the degree n and the largest root of the polynomial is the λ_{max} (Ocampo and Seva,

2016). To be sure of the validity of collected data, consistency of pair-wise comparisons obtained from expert's opinions should be computed.

Inconsistency index (I.I), is formulated as follows:

$$I.I. = \frac{(\lambda_{max} - n)}{n-1} \qquad (6)$$

Where λ_{max} the maximum eigenvalue and n is the dimension of matrix. Finally, the

$$I.R. = \frac{I.I}{IRI} \qquad (7)$$

Where RI is the mean random consistency index. If I.R < 0.1, the judgement is acceptable

Feedback and interdependence among the criteria and sub-criteria can computed from the supermatrix. If the relationship among the criteria is not interdependent, the value of the pairwise comparison would be 0. However, if an interdependent and feedback relationship exists among the criteria, the value would not be 0 anymore, and the unweighted supermatrix M would be obtained. If the matrix is not column

$$W' = \lim_{k \to \infty} w^k \qquad (8)$$

inconsistency ratio (I.R.) can be computed with the following Equation:

otherwise a new comparison should be established (Momeni, 2010).

stochastic (columns shall sum up to 1), the decision maker needs to provide the weights to make it column stochastic and obtain the weighted supermatrix W. The limited weighted supermatrix W ' can be calculated based on Eq. (8), and the accurate relative weights among the criteria can be acquired by considering the gradual convergence of the interdependent relationship (Wu et al., 2012).

ANP Application

Twelve decision variables divided into four criteria according to Hollensen (2007) international pricing model as shown in Fig. 1
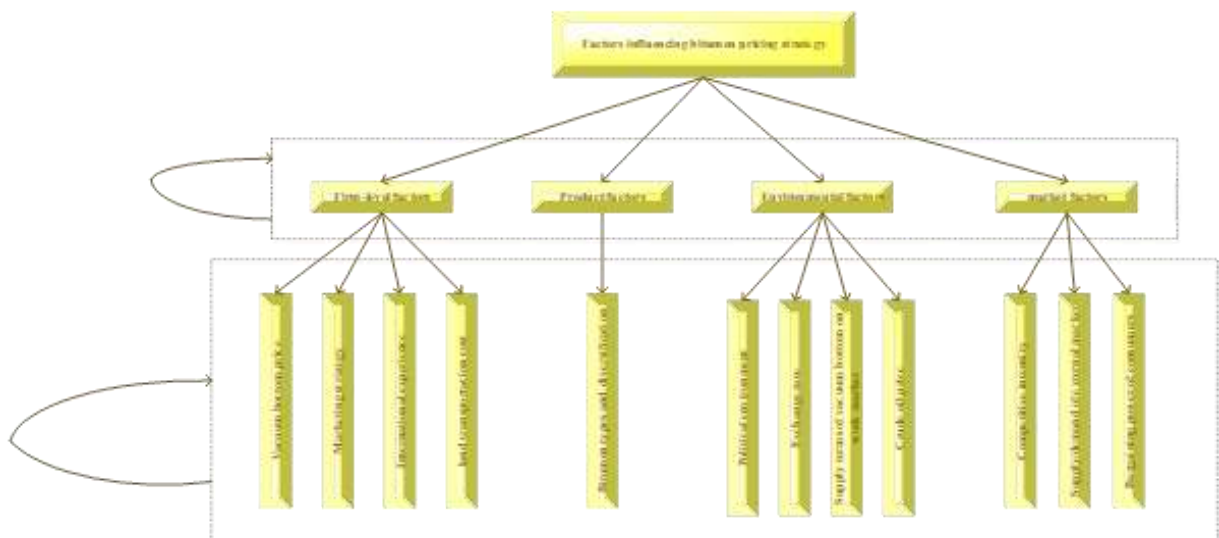
Fig.1. ANP structure of determinant factors of pricing strategy

The group was asked to elicit judgments by making pairwise comparisons of a set of elements based on relations and interrelations among elements. Table 3 shows pairwise comparison and relative importance weights of criteria with respect to the goal. The highest weight among all criteria is assigned to the market factors.

Table 3. Paire-wise comparison of criterio

	Environmental factors	Firm-level factors	Product factors	Market factors	Relative importance weights
Environmental factors	1	1	1	1/3	0.16667
Firm-level factors	1	1	1	1/3	0.16667
Product factors	1	1	1	1/3	0.16667
Market factors	3	3	3	1	0.5

Table 4, 5, 6 indicate comparison and weights of sub-criteria of market, environmental and firm-level factors. Local priority vector of each matrix is obtained and consistencies of judgment is obtained and consistencies of judgment elicitation are computed. We could not show here all pairwise comparisons matrices. The output of this step is a set of local priority vectors that will be later populated in the supermatrix.

Table 4. pair-wise comparison of sub-criteria of market factors

	Bargaining power of consumers	Competitive intensity	Supply/demand of external markets	Relative importance weights
Bargaining power of consumers	1	1	3	0.42857
Competitive intensity	3	1	3	0.42857
Supply/demand of external markets	1/3	1/3	1	0.14286

Table 5. pair-wise comparison sub-criteria of environmental factors

	Crude oil price	Exchange rate	Political environment	Supply terms of VB	Relative importance weights
Crude oil price	1	1	1	3	0.28671
Exchange rate	1	1	3	3	0.39428
Political environment	1	1/3	1	3	0.22344
Supply terms of VB	1/3	1/3	1/3	1	0.09557

Note. I.R = 0.05787 , consistent

Table 6. Pair-wise comparison sub-criteria of firm-level factors

	International experience	Land transport cost	Marketing strategy	VB price	Relative importance weights
International experience	1	7	1	5	0.44860
Land transport cost	1/7	1	1/5	1/5	0.05120
Marketing strategy	1	5	1	3	0.35537
VB price	1/5	5	1/3	1	0.14482

Note. I.R = 0.07690, consistent

The column stochastic matrix is shown in table 7. The matrix shown in table 7 is raised to large powers until it converges to a limit (Ocampo and Seva, 2016). Convergence can be observed if column values are identical as shown in table 8.

Table 7. Weighted super matrix

	BTD	BP	CI	S/D	IE	LTC	MS	VBP	COP	ER	PE	ST
BTD	0	0	0.33333	0	0	0.33333	0	0	0	0	0	0
BP	0	0	0.16667	0	0	0	0.21429	0	0	0	0	0
CI	0	0.5	0	0.5	0.37500	0.33333	0.21429	0	0	0	0	0
S/D	0	0	0.16667	0	0.12500	0	0.07143	0.5	0	0	0.5	0
IE	0	0	0.33333	0	0	0	0.5	0	0	0	0	0
LTC	0	0	0	0	0	0	0	0	0	0	0	0
MS	0	0	0	0	0.5	0.33333	0	0	0	0	0	0
VBP	0	0	0	0	0	0	0	0	0.5	0	0	0.5
COP	0	0	0	0	0	0	0	0.5	0	0.5	0.5	0.5
ER	0	0.5	0	0.5	0	0	0	0	0	0	0	0
PE	0	0	0	0	0	0	0	0	0.5	0.5	0	0
ST	0	0	0	0	0	0	0	0	0	0	0	0

Table 8. Limit matrix

	BTD	BP	CI	S/D	IE	LTC	MS	VBP	COP	ER	PE	ST
BTD	0	0.0471	0.0471	0.0471	0.0471	0.0471	0.0471	0.0471	0.0471	0.0471	0.0471	0.0471
BP	0	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312
CI	0	0.1348	0.1348	0.1348	0.1348	0.13481	0.13481	0.1348	0.1348	0.1348	0.1348	0.1348
S/D	0	0.1622	0.1622	0.1622	0.1622	0.1622	0.1622	0.1622	0.1622	0.1622	0.1622	0.1622
IE	0	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650
LTC	0	0	0	0	0	0	0	0	0	0	0	0
MS	0	0.0341	0.0341	0.0341	0.0341	0.0341	0.0341	0.0341	0.0341	0.0341	0.0341	0.0341
VBP	0	0.0948	0.0948	0.0948	0.0948	0.0948	0.0948	0.0948	0.0948	0.0948	0.0948	0.0948
COP	0	0.1807	0.1807	0.1807	0.1807	0.1807	0.1807	0.1807	0.1807	0.1807	0.1807	0.1807
ER	0	0.1015	0.1015	0.1015	0.1015	0.1015	0.1015	0.1015	0.1015	0.1015	0.1015	0.1015
PE	0	0.1481	0.1481	0.1481	0.1481	0.1481	0.1481	0.1481	0.1481	0.1481	0.1481	0.1481
ST	0	0	0	0	0	0	0	0	0	0	0	0

The results is shown in Table 8, from which the ranks are extracted in Table 9. Based on the global priorities, the most important factor has been found to be the global crude oil price with the final weight of 0.18, followed by supply/demand of external market with the final weight of 0.16 and environmental factors has the highest weight among criteria, followed by market factors.

Table 9. Global priorities

Code	Factors	ANP
BTD	Bitumen types and diversifications	0.047162
S/D	Supply/Demand of external market	0.1622

CI	Competitive intensity	0.134814
BP	Bargaining power of consumers	0.031262
IE	International experience	0.065084
MS	Marketing strategy	0.034153
VBP	VB price(production cost)	0.094871
LTC	Land transportation cost	0
ST	Supply terms of VB on stock market	0
ER	Exchange rate	0.101519
COP	Crude oil price	0.180793
PE	Political environment	0.148143

Conclusion

Price setting is one of the most important methods to achieve company's goal. Having a clearer understanding of the pricing decision determinants and their implications for developing pricing strategies, assist managers in international pricing strategies. In this context, to identify determinant factors, qualitative research complemented quantitative studied. The study carried out when survival was the pricing objective of bitumen producers. Based on the study results, when taking international pricing decisions, attention must be given to a range of environmental and market factors. the results demonstrated that bitumen price competitiveness depends on global crude oil price, supply/demand of external market, political environment (sanction), competitive intensity, exchange rate fluctuation, vacuum bottom price (cost of production input), international experience, bitumen types and diversification and marketing strategy. An examination of the determinant factors suggests that organizations need to improve information gathering about competitors and environmental factors. Accurate information and anticipation of supply and demand and any of these determinants may contribute to optimal pricing. Pricing decisions in a changing environment should be frequently reviewed and adjusted.

Selection of appropriate pricing strategy how have an influence on corporate performance, is the opportunity for future research.

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